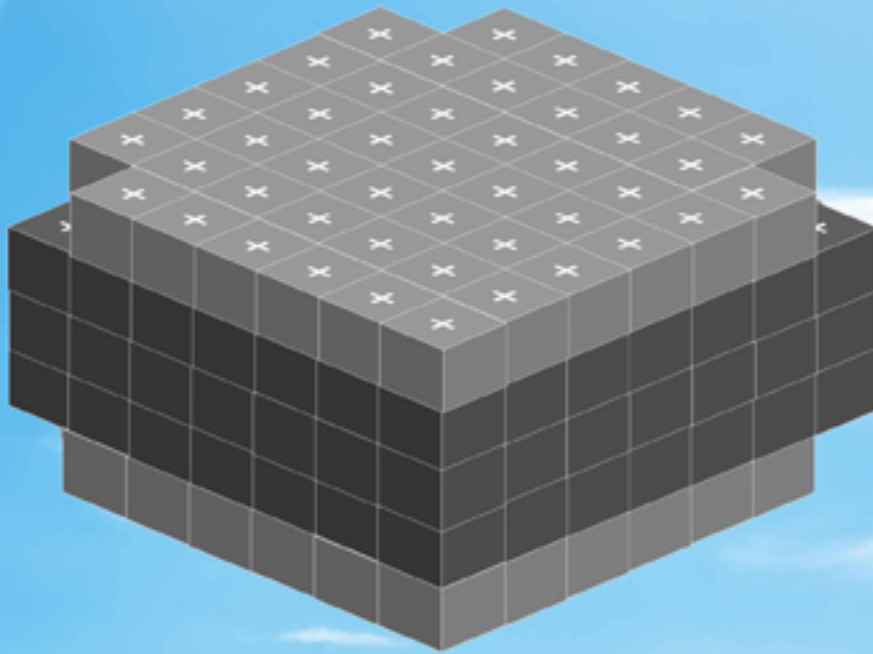


Nuclear Cubic Structure

Gengyun Li



Uranium Nucleus

U 238

Proton: 92

Neutron: 146

Spin:0

Nuclear Cubic Structure

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Period

1

2

Element Periodic Table

1

H 1/2

He 2

1 2 3 4 5 6 7 8

2

Li 3	Be 4
---------	---------

B 5	C 6	N 7	O 8	F 9	Ne 10
--------	--------	--------	--------	--------	----------

3

Na 11	Mg 12
----------	----------

Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
----------	----------	---------	---------	----------	----------

4

K 19	Ca 20
---------	----------

*

Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
----------	----------	----------	----------	----------	----------

5

Rb 37	Sr 38
----------	----------

*

In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
----------	----------	----------	----------	---------	----------

6

Cs 55	Ba 56
----------	----------

*

Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
----------	----------	----------	----------	----------	----------

7

Fr 87	Ra 88
----------	----------

*

Uut 113	Uuq 114	Uup 115	Uuh 116	Uus 117	Uuo 118
------------	------------	------------	------------	------------	------------

1 2 3 4 5 6 7 8 9 10

4*

Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30
----------	----------	---------	----------	----------	----------	----------	----------	----------	----------

5*

Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48
---------	----------	----------	----------	----------	----------	----------	----------	----------	----------

6*

#

Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------

7*

#

Lu 71	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80
----------	----------	----------	---------	----------	----------	----------	----------	----------	----------

Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102
----------	----------	----------	----------	----------	----------	----------	-----------	-----------	-----------

Lr 103	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Ds 110	Rg 111	Uub 112
-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	------------

1 2 3 4

6*

La 57	Ce 58	Pr 59	Nd 60
----------	----------	----------	----------

7*

Ac 89	Th 90	Pa 91	U 92
----------	----------	----------	---------

Nuclear Cubic Structure

All matter including solid, liquid or gas is made up of atom. The atom is one of the most fundamental building blocks of matter. An atom is the smallest unit of an element that retains the properties of that element. It is composed of protons, neutrons, and electrons. The outer part of the atom consists of a number of electrons. The nucleus is the center of the atom: it contains the nucleons, the protons and neutrons. The protons and neutrons are bound very tightly to form the nucleus. The nucleus is very tiny, only about $1/100,000^{\text{th}}$ size of atom, but it is very heavy, almost the entire mass of the atom is on the nucleus.

Proton has one unit positive electric charge

Neutrons have no electric charge.

Electron has one unit negative electric charge.

The mass of proton is about 1 atomic mass unit (amu).

The mass of neutron is slightly over 1 amu.

The mass of electron is about $1/1836^{\text{th}}$ of proton.

The atom is electrically neutral since it consists of the same number of electron and proton.


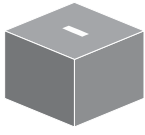


Electron, proton, neutron all have half spin $\frac{\hbar}{2}$.

Hydrogen-1 nuclide has only one proton as its nucleus.

Beside the hydrogen-1, all other nucleus must consist of both proton and neutron.

The elements differ from each other in the number of protons.

Inside the nucleus, the protons and neutrons act like a unit cube which stack together to form the nucleus: the neutron form the kernel of the nucleus whiles the proton is located on the surface of nucleus.

Spin up proton Spin +1/2	Spin down proton Spin -1/2	Spin up neutron Spin 1/2	Spin down neutron Spin -1/2
			

The nuclide is characterized by the number of proton, the number of neutron, and the nuclear spin of the nucleus.

Nuclear Isotopes are nuclides with equal proton number but different neutron numbers.

Nuclear isotones are nuclides with equal neutron number but different proton numbers.

Nuclear isomers are nuclides with equal proton number and equal neutron number, but different nuclear spin.

For example, the nucleus structure of Uranium-238 show as following:

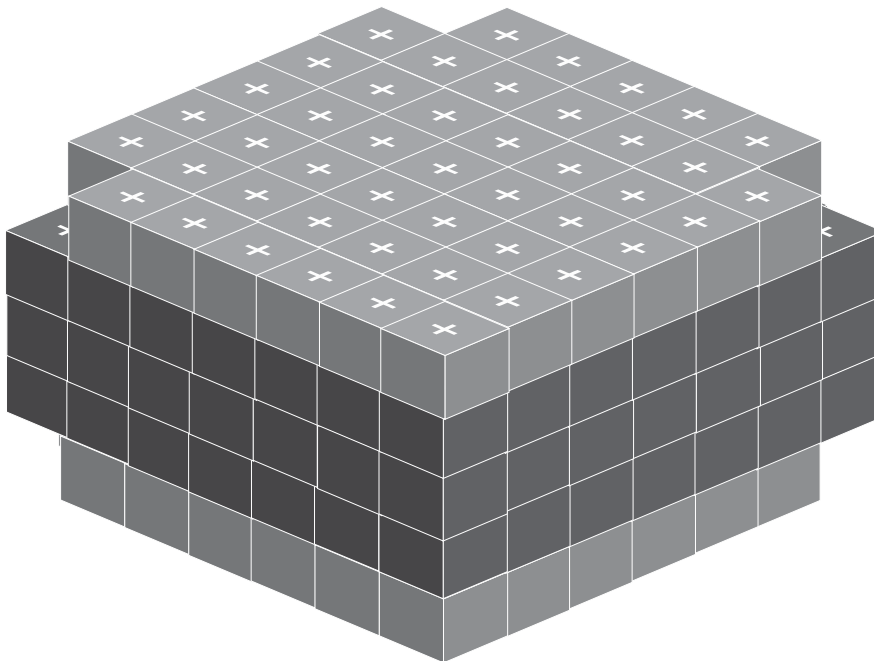
U 238

Proton: 92

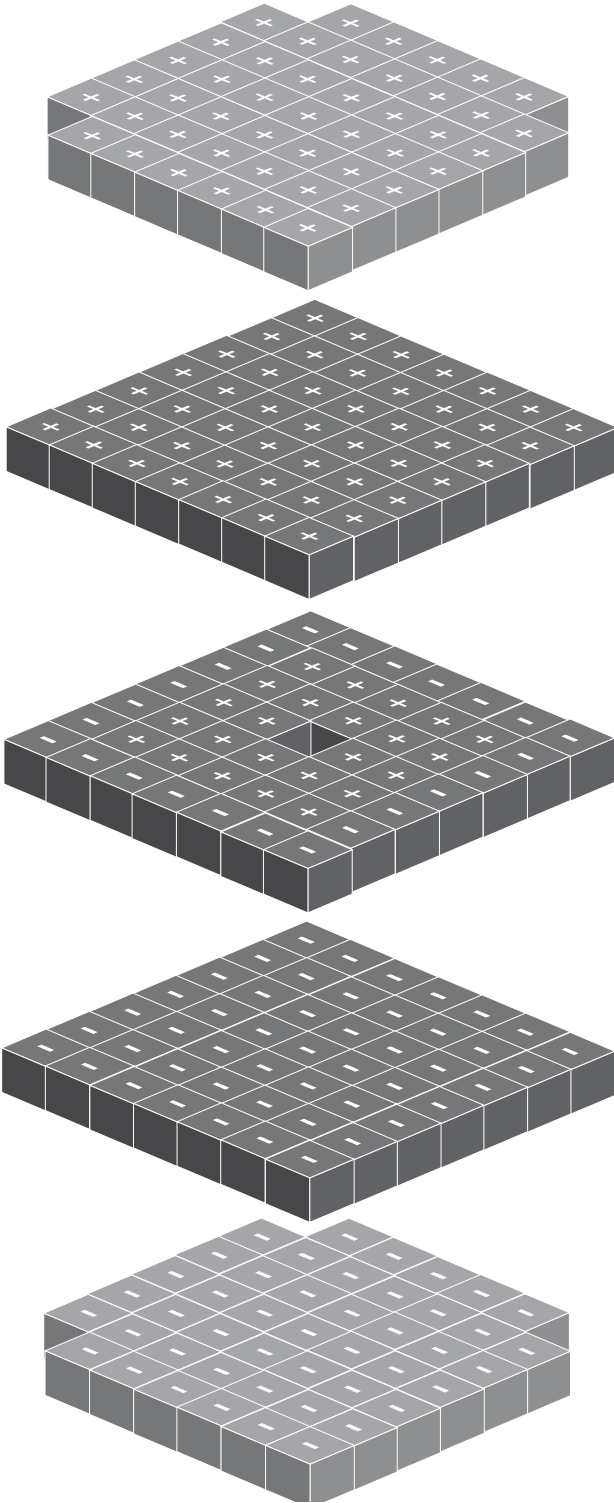
Neutron: 146

Spin: 0

Half life: 4.468×10^9 year

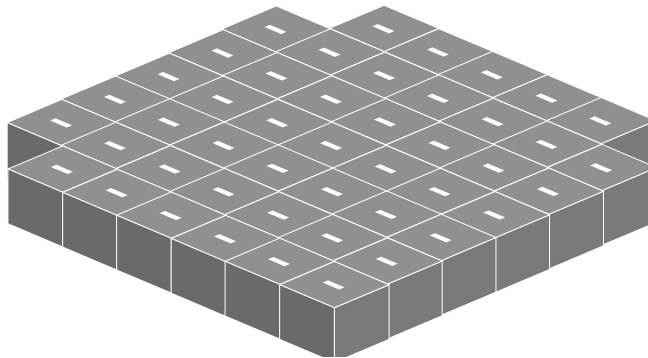
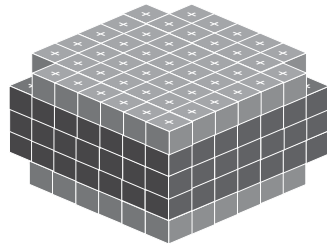
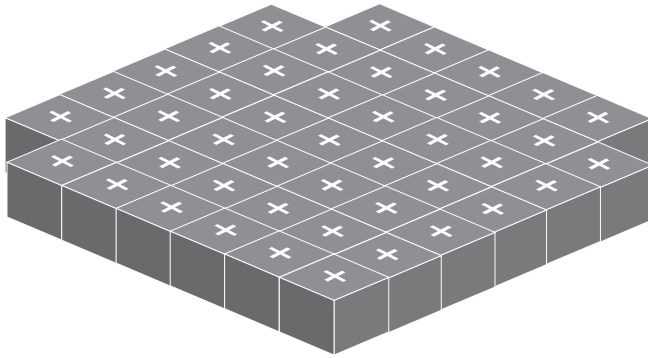


U 238



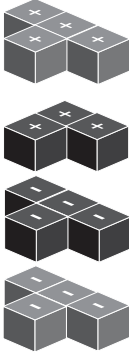









Inside the atom, the electron act like a unit cube and distribute on the surface of atom the same way as the proton distributes on the surface of nucleus, but with a much larger size. Below is the given structure.

U238 Atom Structure













The above diagram shows that the electron has the same similar distribution as proton, in fact, the nucleus should be much smaller, about $1/100,000^{\text{th}}$ of the atom.

Oxygen Nuclear Isotopes

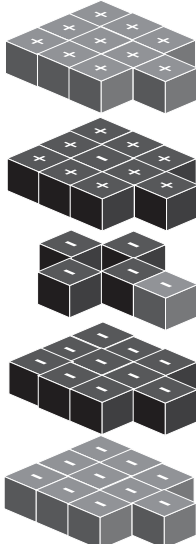
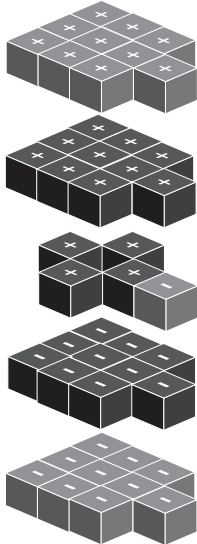
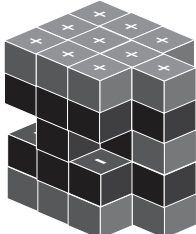
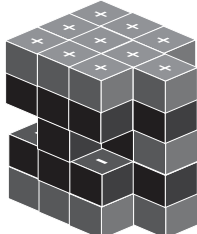
O 15 Proton: 8 Neutron: 7 Spin: -1/2 Half-life: 122.24 s	O 16 Proton: 8 Neutron: 8 Spin: 0 Stable	O 17 Proton: 8 Neutron: 9 Spin: 5/2 Stable	O 18 Proton: 8 Neutron: 10 Spin: 0 Stable	O 19 Proton: 8 Neutron: 11 Spin: 5/2 Half-life: 26.464 s
				
				

Neutron 10 nuclear isotones

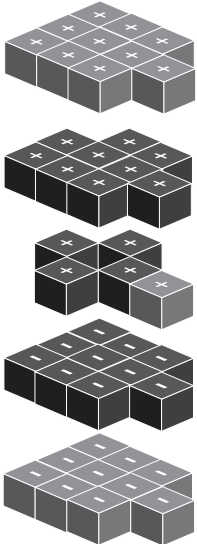
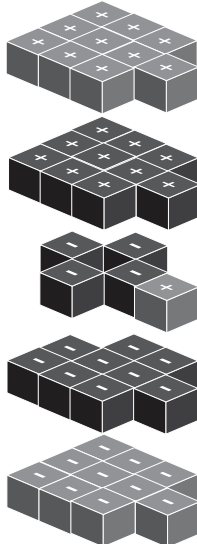
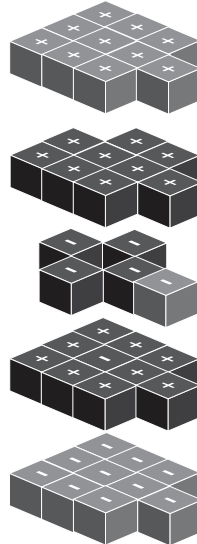
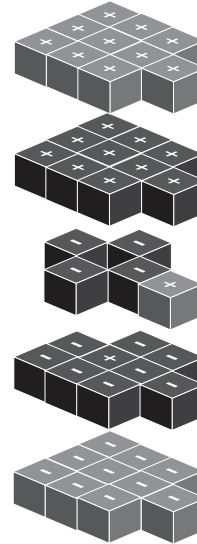
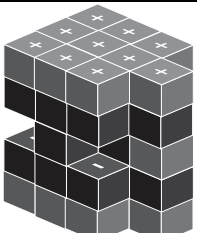
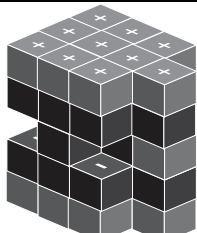
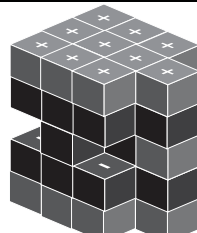
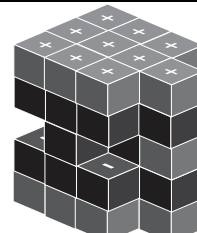
C 16 Proton: 6 Neutron: 10 Spin: 0 Half-life:0.747s	N 17 Proton: 7 Neutron: 10 Spin: -1/2 Half-life:4.173s	O 18 Proton: 8 Neutron: 10 Spin: 0 Stable	F 19 Proton: 9 Neutron: 10 Spin: 1/2 Stable	Ne 20 Proton: 10 Neutron: 10 Spin: 0 Stable
				
				

Scandium isomers

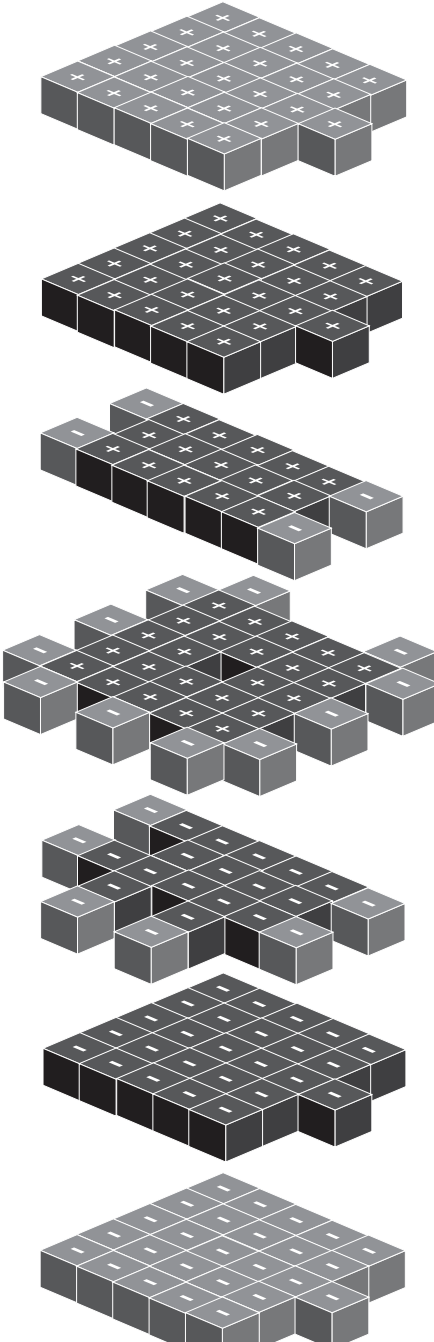
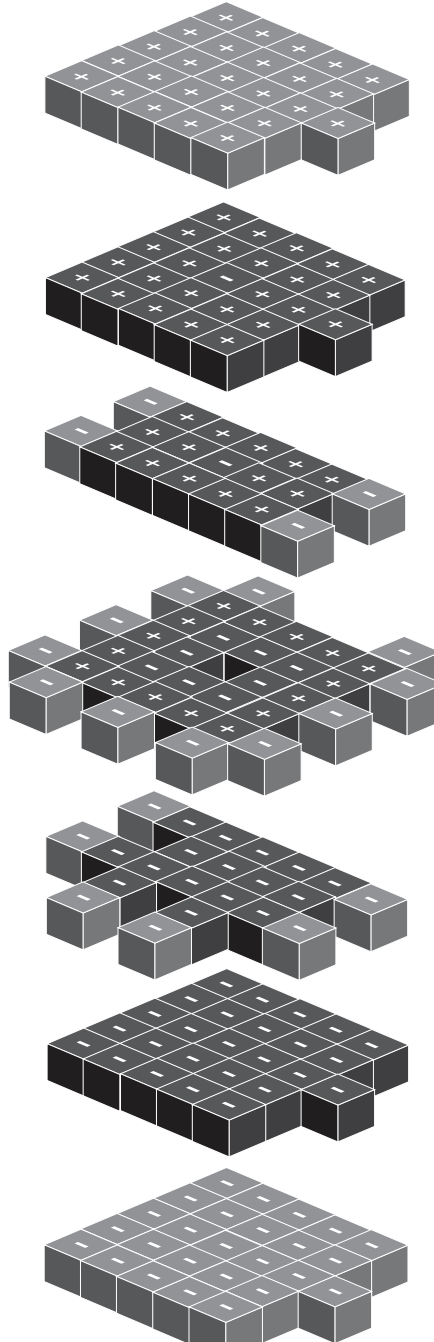
Isomers of 21 Proton and 24 neutron

<p>Sc 45 Proton: 21 Neutron: 24 Spin: $-7/2$ Stable</p>	<p>Sc 45m Proton: 21 Neutron: 24 Spin: $3/2$ Half life: 318 ms</p>
	
	

Isomers of 21 Proton and 23 neutrons

Sc 44 Proton: 21 Neutron: 23 Spin: 2 Half life 3.97 h	Sc 44m1 Proton: 21 Neutron: 23 Spin: -1 Half life: 154.2 ns	Sc 44m2 Proton: 21 Neutron: 23 Spin: 6 Half life: 58.61 h	Sc 44m3 Proton: 21 Neutron: 23 Spin: 0 Half life: 50.4 μ s
			
			

Stable Isomer Ta180m1

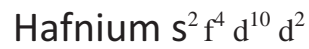
<p>Ta 180 Proton: 73 Neutron: 107 Spin:1 Half life: 8.152 h</p>	<p>Ta 180m1 Proton: 73 Neutron: 107 Spin:-9 Stable</p>
 <p>Seven 3D lattice diagrams for Ta 180. Each diagram shows a grid of cubes representing nucleons. The top two diagrams are proton-rich (mostly 'x' marks). The middle diagram is a long, thin chain. The fourth diagram is a complex, multi-layered structure. The fifth diagram is a long, thin chain with a central protrusion. The sixth diagram is a proton-rich lattice. The seventh diagram is a neutron-rich lattice (mostly '-' marks).</p>	 <p>Seven 3D lattice diagrams for Ta 180m1. Each diagram shows a grid of cubes representing nucleons. The top two diagrams are proton-rich (mostly 'x' marks). The middle diagram is a long, thin chain. The fourth diagram is a complex, multi-layered structure. The fifth diagram is a long, thin chain with a central protrusion. The sixth diagram is a proton-rich lattice. The seventh diagram is a neutron-rich lattice (mostly '-' marks).</p>

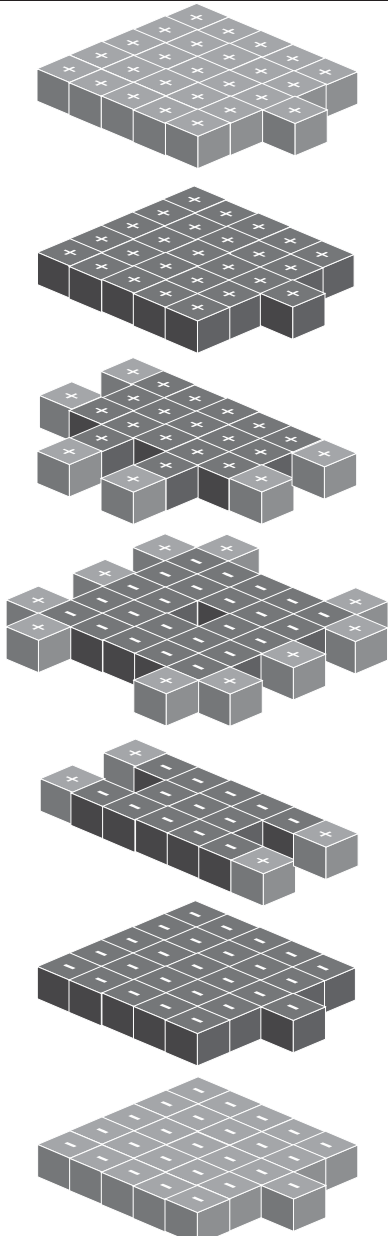
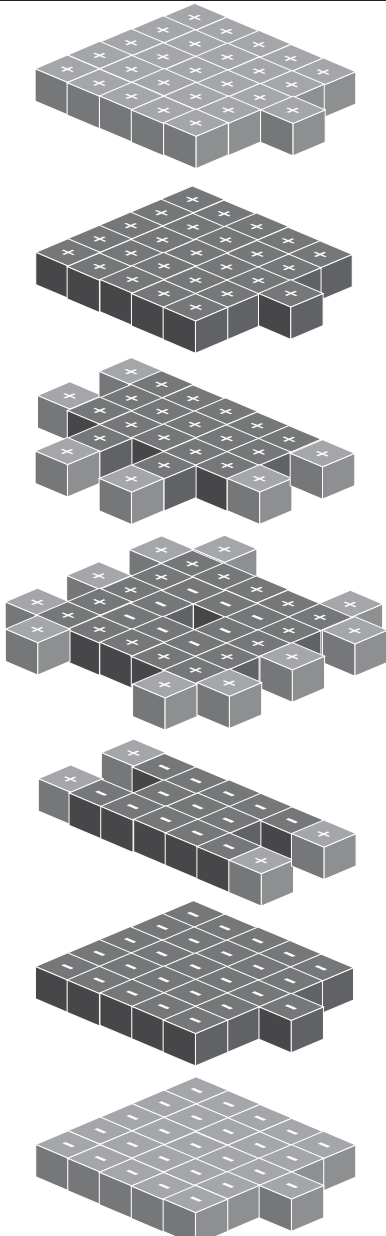
For the most nuclear Isomer, the higher energy state Isomer is not stable, but there is one exception, Ta180m1, the isomer of 73 proton, 107 neutron, and nuclear spin -9, which is in high energy state, but it is stable, never found decay.

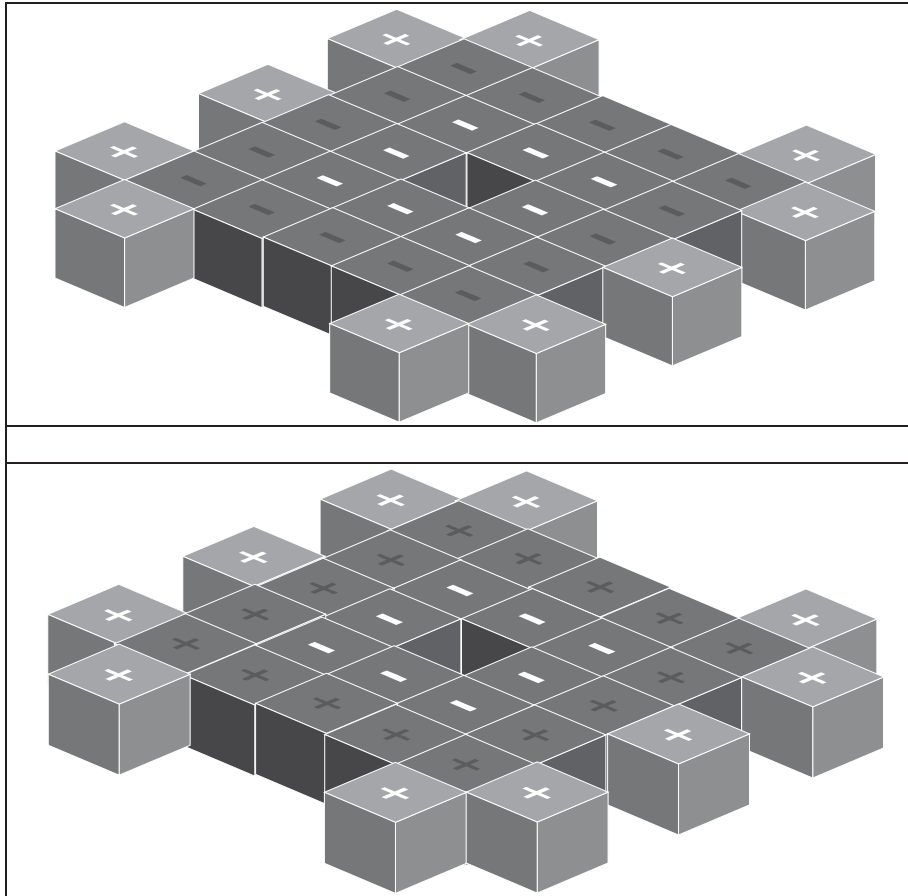
The ground state Ta180, nuclide of proton 73, neutron 107 and nuclear spin 1, it is unstable with half life about 8.152h.

Tantalum Ta180	Proton	Neutron	Spin	Half Life	Excitation energy
Ta180	73	107	1+	8.152 h	0
Ta180m1	73	107	9-	Stable	77.1 keV
Ta180m2	73	107	15-	31.2 μ s	1452.40 keV

High energy nuclear hafnium Isomer



<p>Hf 178 Proton: 72 Neutron: 106 Spin: 0 Stable</p>	<p>Hf 178m2 Proton: 72 Neutron: 106 Spin: 16 Half life: 31 year Excitation energy: 2445.69 keV</p>
	



Hf178m2, the nuclide of 72 proton, 106 neutron, and nuclear spin of 16, is very unique by the combination of high nuclear spin of 16, very long half life of 31 years, and very high excitation energy 2.445Mev.

From the nuclear structure, the only difference between Hf178 and Hf178m2 is on the hollow layer. The spin of the 16 outermost neutrons are different, for Hf178 all 16 neutrons have negative spin, for Hf178m2 all 16 neutrons have positive spin. If we can reverse the 16 neutron on the hollow layer, it will release 2.445Me energy, with the form of gamma radiation, induced gamma emission.

Because the neutron is electrically neutral, most likely there is a specific magnetic resonance frequency and under such frequency, it will trigger all the 16 neutron reversion.

One research group at the University of Texas led by Carl Collins, artificially trigger the decay of the hafnium isomer Hf178m2 by bombarding it with low energy X-rays of a dental X ray machine, caused powerful gamma ray bursts.

J. Phys. IV France 127 (2005) 163-168

The use of selected monochromatic X-rays to induce a cascade of gamma transitions from the 31-year nuclear isomer to the 4 second isomeric state of Hf-178

N.C. Zoita, F. Davanloo, C.B. Collins, J.M. Pouvesle, S. Emura, I.I. Popescu, V.I. Kirischuk, N.V. Strilchuk, T. Uruga and Y. Yoda

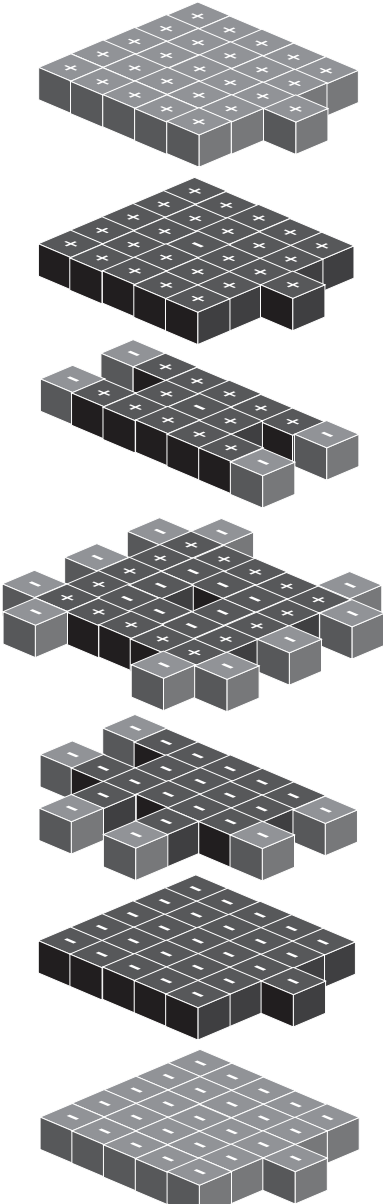
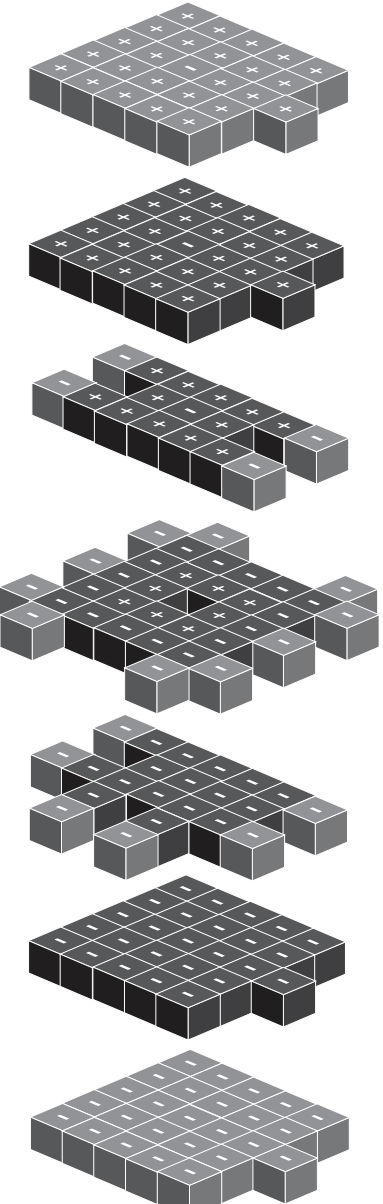
Abstract

The Hf-178m2 nuclear spin isomer stores 2.45 MeV of energy for a half life of 31 years. Unperturbed, such nuclei radiate away the stored energy through the emission of gamma photons from electromagnetic (EM) transitions occurring within the nuclei. It has been shown that the irradiation of samples containing such nuclei with pulsed X-rays can accelerate the rate of the EM transitions by relaxing the selection rules upon changes of angular momenta. Till date, most work has been done with incident X-ray energies between 9 and 10 keV, and in such cases the acceleration of the rate of gamma emission is immediate. Reported here is a channel for deexcitation excited by more energetic X-rays that result in a cascade of gamma transitions that includes a 4 second statistical time lag. This more protracted release of the energy stored in samples of the Hf-178m2 nuclear isomers encourages researchers to consider the potential of mechanical and thermal applications.



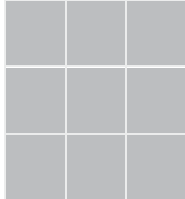
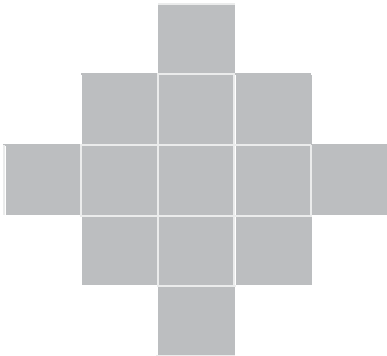
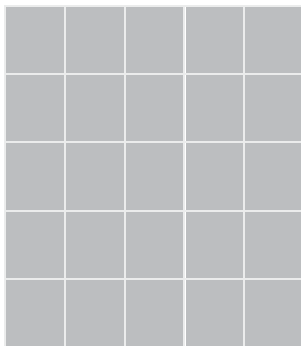
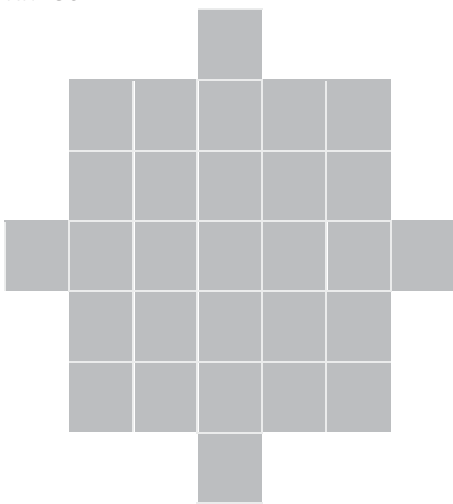
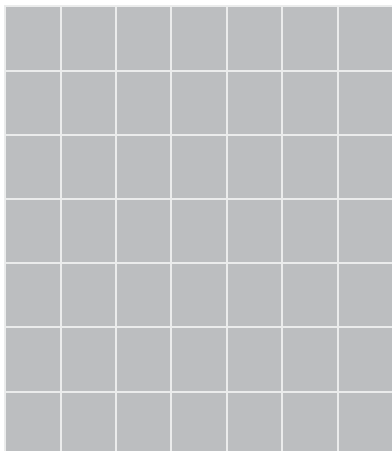
High Spin Isomers

Hafnium $s^2 f^4 d^{10} d^2$

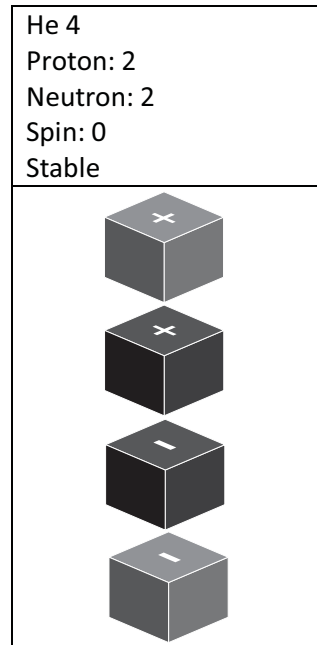
<p>Hf 177 Proton: 72 Neutron: 105 Spin:-7/2 Stable</p>	<p>Hf 177m1 Proton: 72 Neutron: 105 Spin:23/2 Half life: 1.09 sec Excitation energy:1315.45 keV</p>

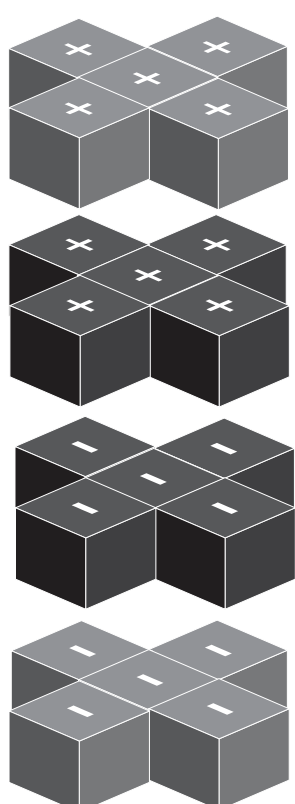
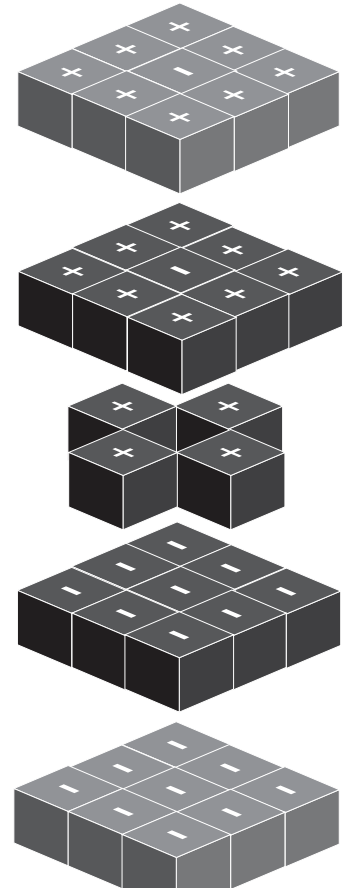
<p>Hf 177m2 Proton: 72 Neutron: 105 Spin:-19/2 Half life:55.9 μs Excitation energy:1342.38 keV</p>	<p>Hf 177m3 Proton: 72 Neutron: 105 Spin:-37/2 Half life:51.4 min Excitation energy:2740.02 keV</p>
	

Nobel Gas Nuclide Top View

	He-2 
Ne-10 	Ar-18 
Kr-36 	Xe-54 
Rn -86 	Uun-118 

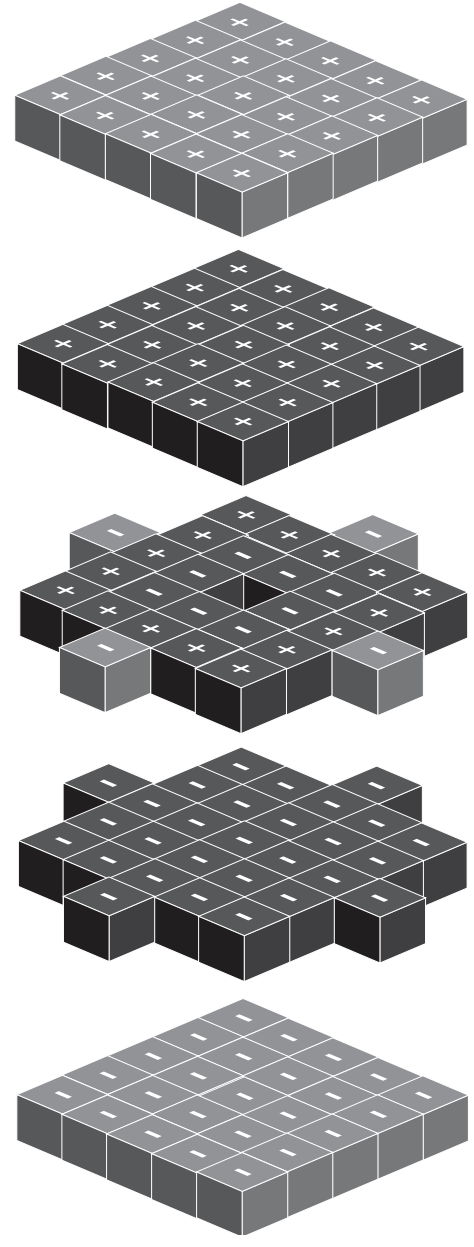
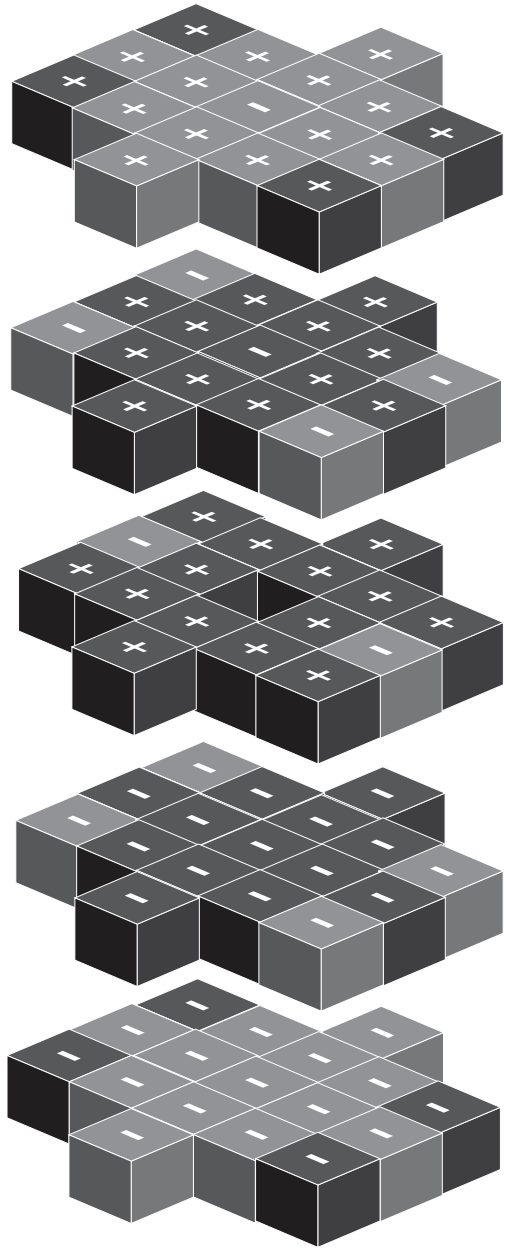
Nobel Gas Nuclei Layered Structure



<p>Ne 20 Proton: 10 Neutron: 10 Spin: 0 Stable</p>	<p>Ar 40 Proton: 18 Neutron: 22 Spin: 0 Stable</p>
 <p>The diagram shows the nucleus of Neon-20 (Ne-20) as a cluster of 20 nucleons arranged in four layers. The top two layers each contain 5 nucleons (2 protons and 3 neutrons), and the bottom two layers each contain 5 nucleons (3 protons and 2 neutrons). The nucleons are represented by cubes with 'x' marks for protons and '-' marks for neutrons.</p>	 <p>The diagram shows the nucleus of Argon-40 (Ar-40) as a cluster of 40 nucleons arranged in five layers. The top two layers each contain 9 nucleons (4 protons and 5 neutrons), the middle layer contains 6 nucleons (3 protons and 3 neutrons), and the bottom two layers each contain 10 nucleons (5 protons and 5 neutrons). The nucleons are represented by cubes with 'x' marks for protons and '-' marks for neutrons.</p>

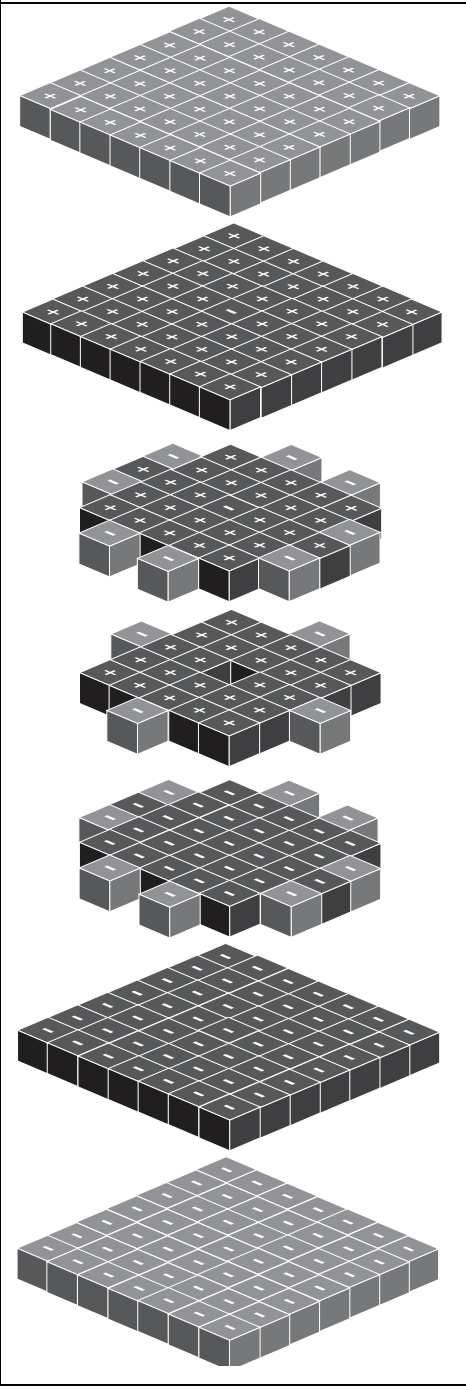
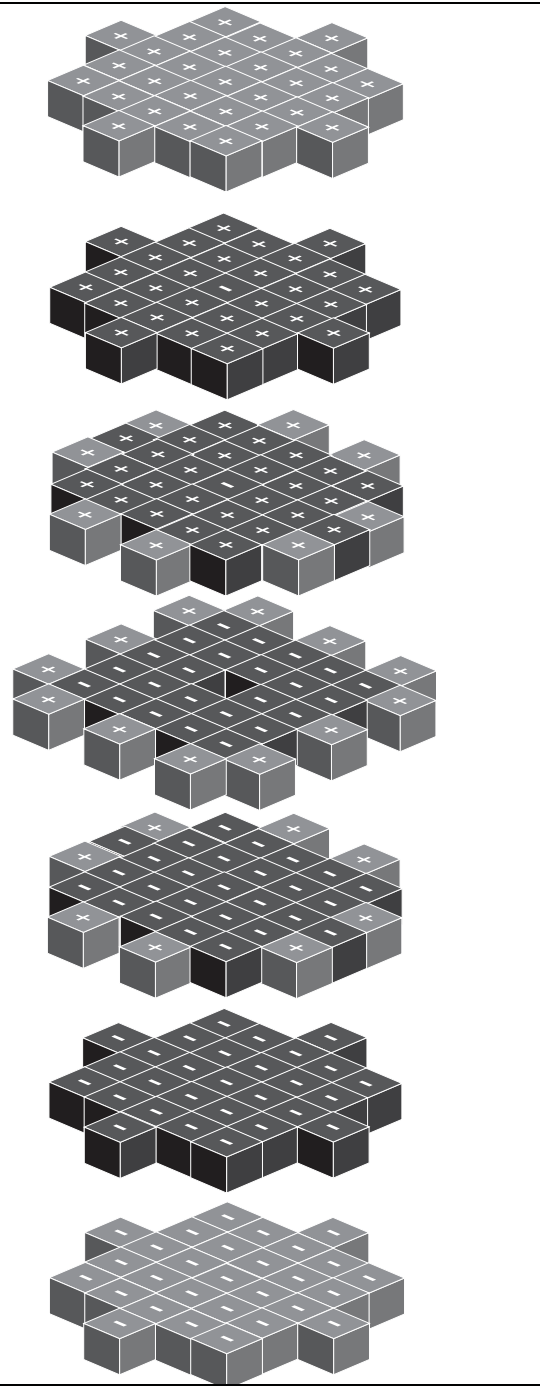
Kr 84
Proton: 36
Neutron: 48
Spin: 0
Stable

Xe132
Proton: 54
Neutron: 78
Spin: 0
Stable

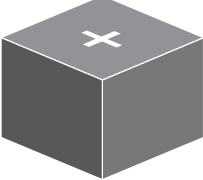



Rn 222
 Proton: 86
 Neutron: 136
 Spin:0
 Stable

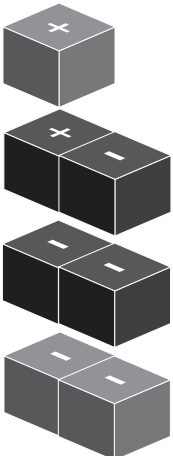
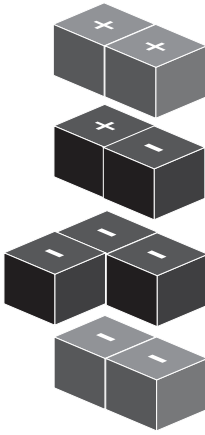
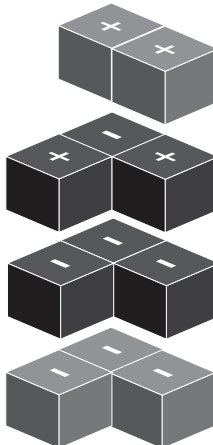
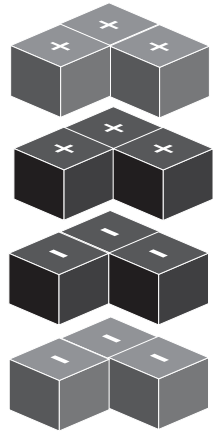
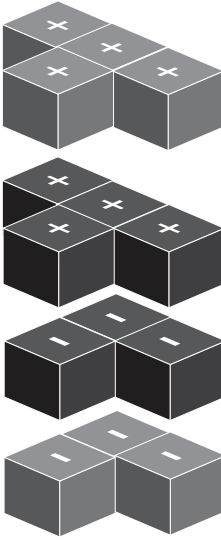
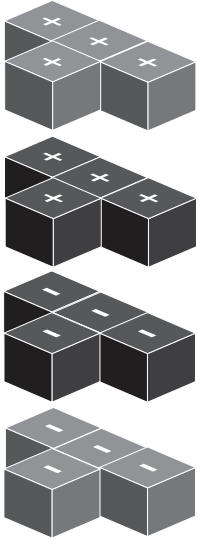
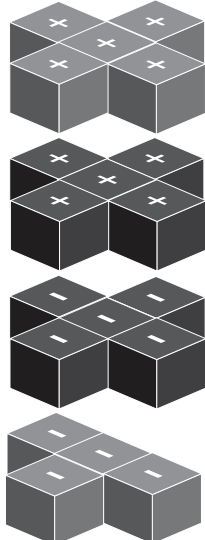
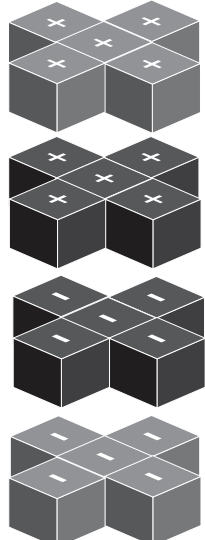
Uuo 294
 Proton:118
 Neutron:176
 Spin:0
 Stable



Period one Nuclide

<p>H1 Proton: 1 Neutron: 0 Spin: 1/2 Stable</p>	<p>He 4 Proton: 2 Neutron: 2 Spin: 0 Stable</p>
	

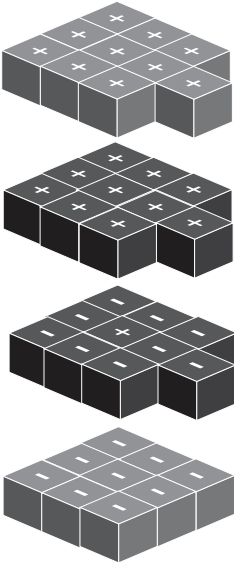
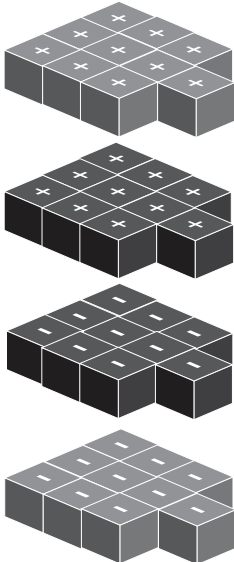
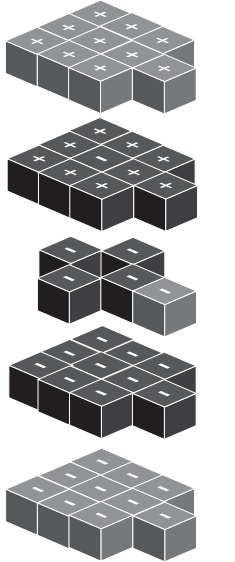
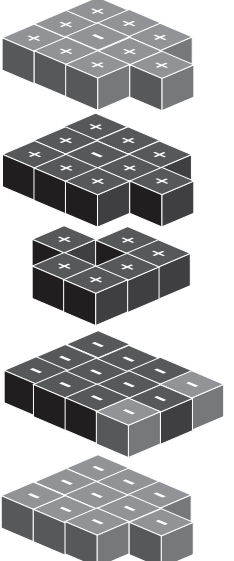
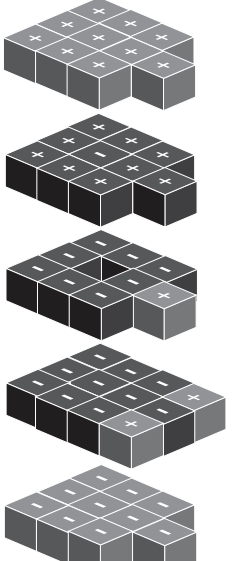
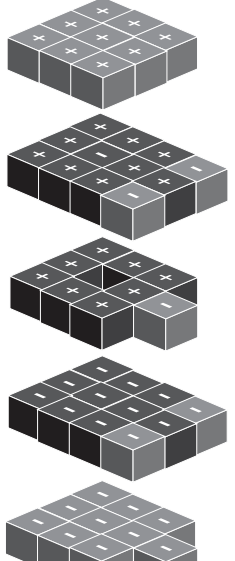
Period Two Nuclide

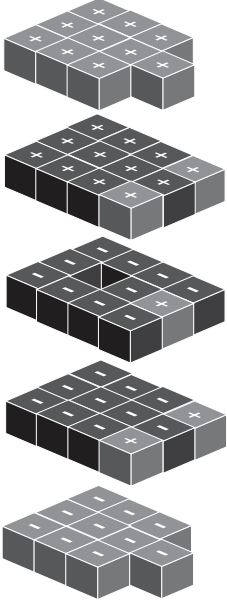
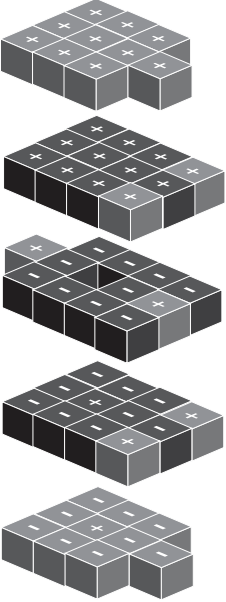
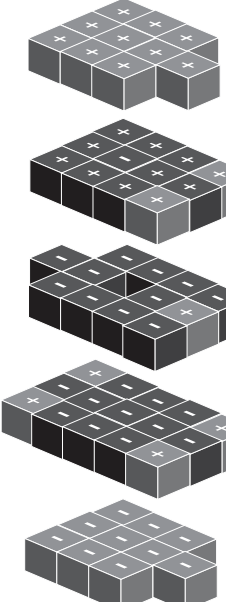
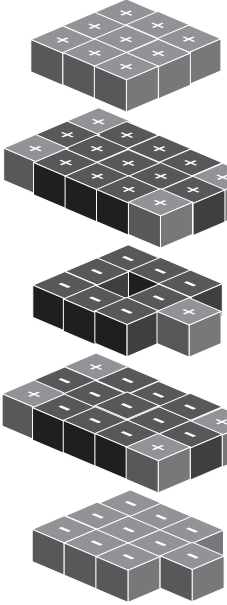
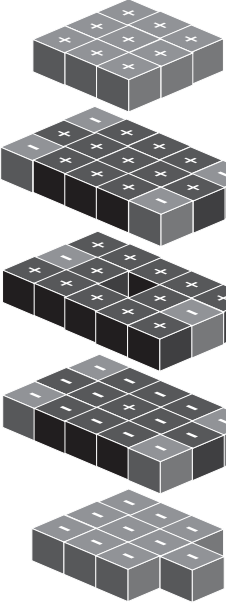
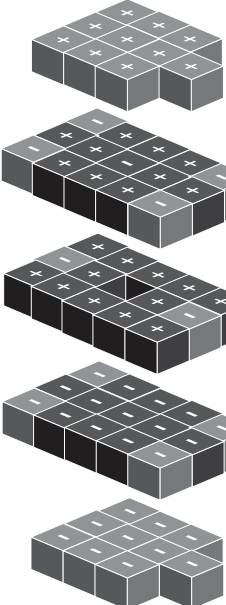
<p>Li 7 Proton: 3 Neutron: 4 Spin: -3/2 Stable</p>	<p>Be 9 Proton: 4 Neutron: 5 Spin: -3/2 Stable</p>	<p>B 11 Proton: 5 Neutron: 6 Spin: -3/2 Stable</p>	<p>C 12 Proton: 6 Neutron: 6 Spin: 0 Stable</p>
			
<p>N 14 Proton: 7 Neutron: 7 Spin: 1 Stable</p>	<p>O 16 Proton: 8 Neutron: 8 Spin: 0 Stable</p>	<p>F 19 Proton: 9 Neutron: 10 Spin: 1/2 Stable</p>	<p>Ne 20 Proton: 10 Neutron: 10 Spin: 0 Stable</p>
			

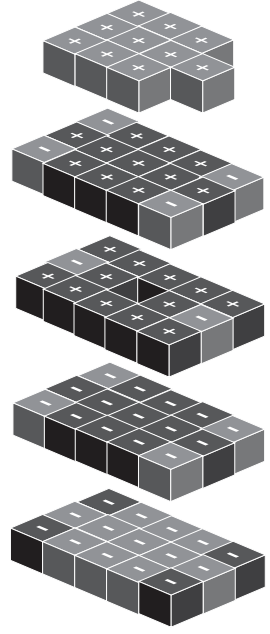
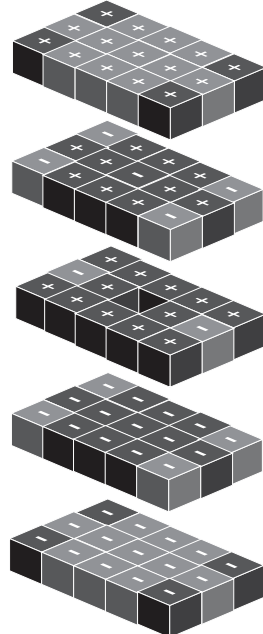
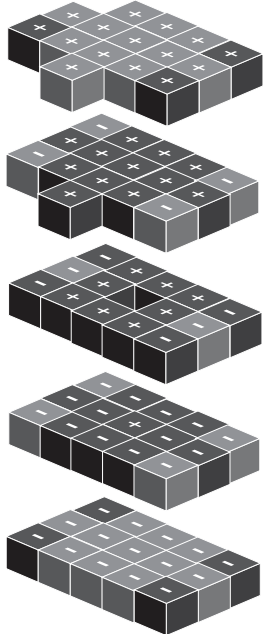
Period Three Nuclide

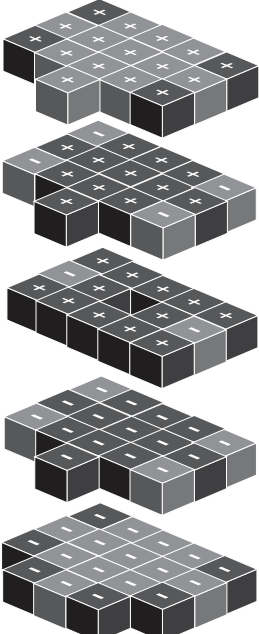
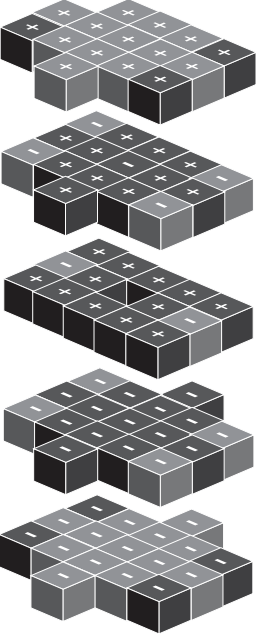
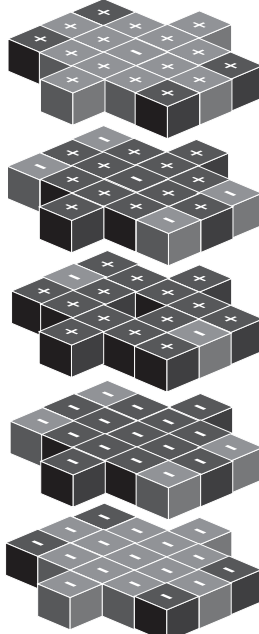
<p>Na 23 Proton: 11 Neutron: 12 Spin: 3/2 Stable</p>	<p>Mg 24 Proton: 12 Neutron: 12 Spin: 0 Stable</p>	<p>Al 27 Proton: 13 Neutron: 14 Spin: 5/2 Stable</p>	<p>Si 28 Proton: 14 Neutron: 14 Spin: 0 Stable</p>
<p>P 31 Proton: 15 Neutron: 16 Spin: 1/2 Stable</p>	<p>S 32 Proton: 16 Neutron: 16 Spin: 0 Stable</p>	<p>Cl 35 Proton: 17 Neutron: 18 Spin: 3/2 Stable</p>	<p>Ar 40 Proton: 18 Neutron: 22 Spin: 0 Stable</p>

Period Four Nuclide

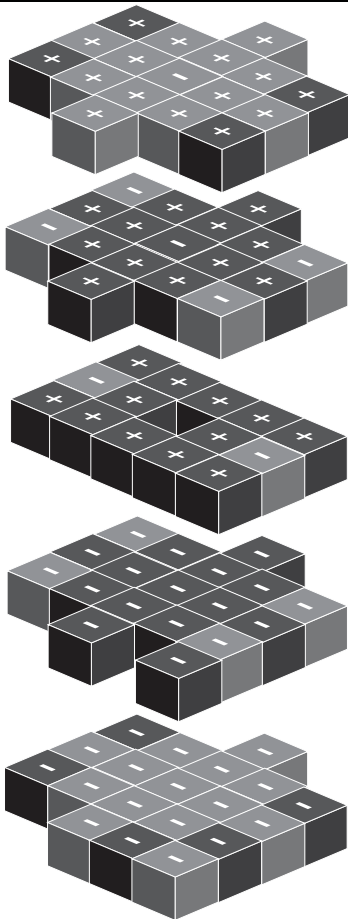
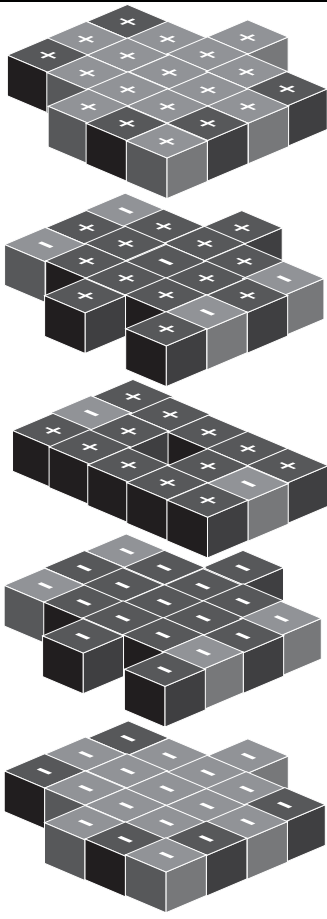
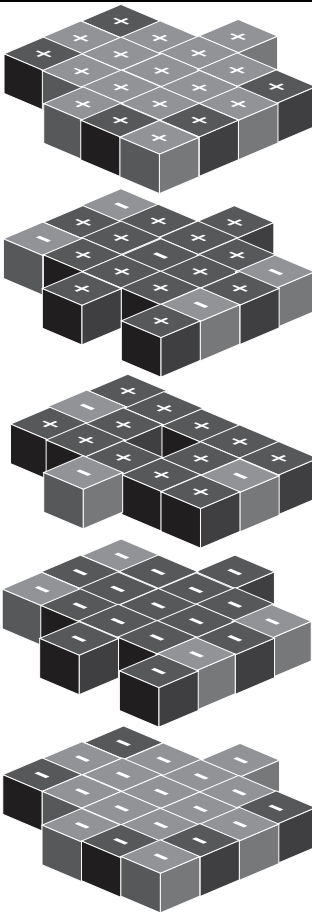
<p>K 39 Proton: 19 Neutron: 20 Spin: 3/2 Stable</p>	<p>Ca 40 Proton: 20 Neutron: 20 Spin: 0 Stable</p>	<p>Sc 45 Proton: 21 Neutron: 24 Spin: -7/2 Stable</p>
		
<p>Ti 48 Proton: 22 Neutron: 26 Spin: 0 Stable</p>	<p>V 51 Proton: 23 Neutron: 28 Spin: -7/2 Stable</p>	<p>Cr 52 Proton: 24 Neutron: 28 Spin: 0 Stable</p>
		

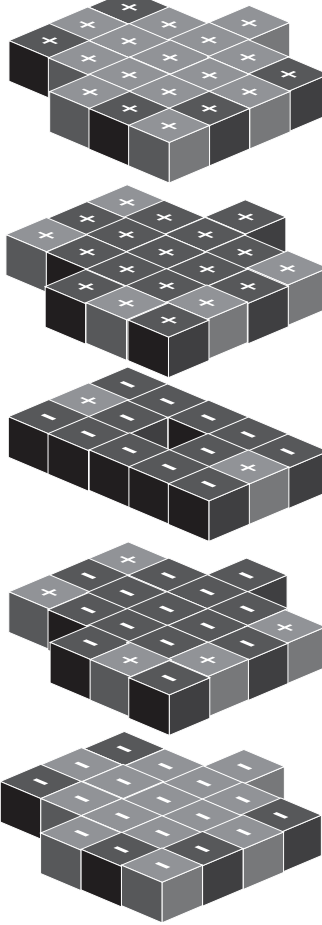
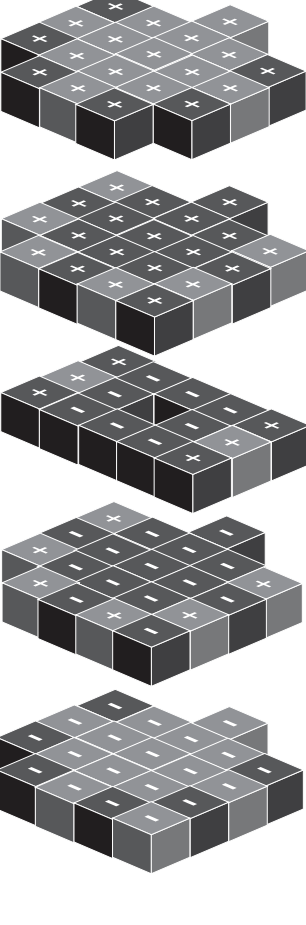
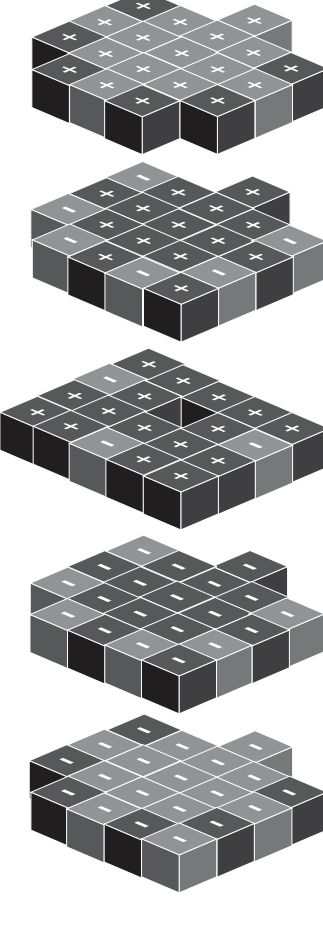
<p>Mn 55 Proton: 25 Neutron: 30 Spin: -5/2 Stable</p>	<p>Fe 56 Proton: 26 Neutron: 30 Spin: 0 Stable</p>	<p>Co 59 Proton 27 Neutron 32 Spin: -7/2 Stable</p>
		
<p>Ni 58 Proton: 28 Neutron: 30 Spin: 0 Stable</p>	<p>Cu 63 Proton 29 Neutron 34 Spin: -3/2 Stable</p>	<p>Zn 64 Proton 30 Neutron 34 Spin: 0 Stable</p>
		

<p>Ga 69 Proton 31 Neutron 38 Spin: -3/2 Stable</p>	<p>Ge 74 Proton 32 Neutron 42 Spin: 0 Stable</p>	<p>As 75 Proton: 33 Neutron: 42 Spin: -3/2 Stable</p>
		

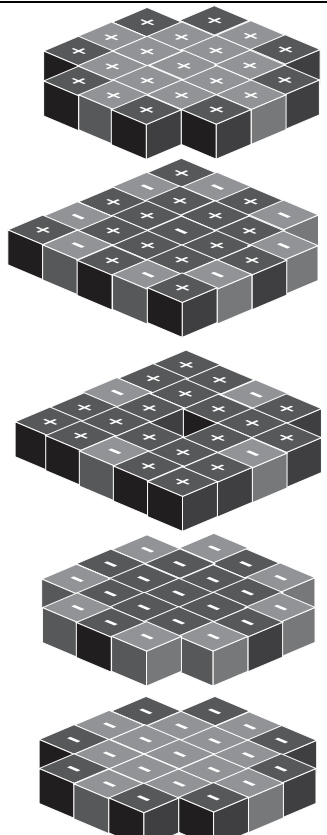
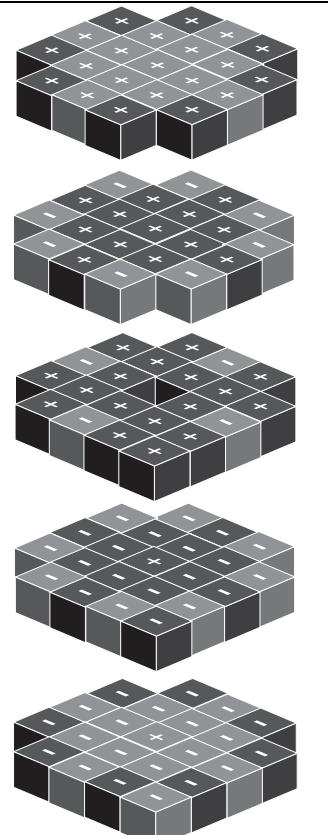
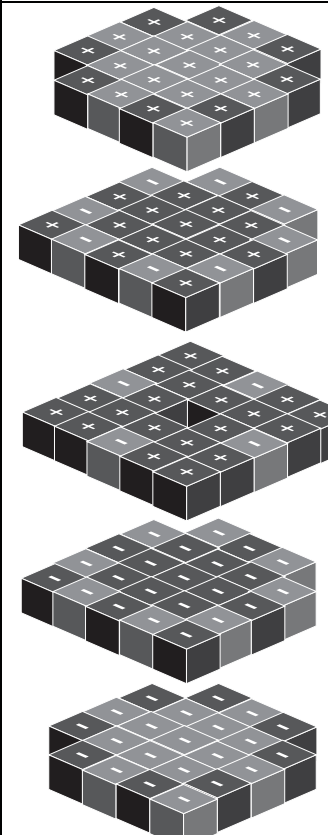
Se 80 Proton:34 Neutron:46 Spin: 0 Stable	Br 79 Proton: 35 Neutron: 44 Spin: -3/2 Stable	Kr 84 Proton: 36 Neutron: 48 Spin: 0 Stable
		

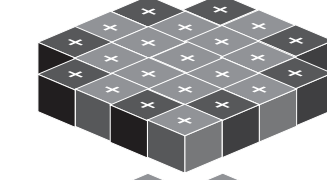
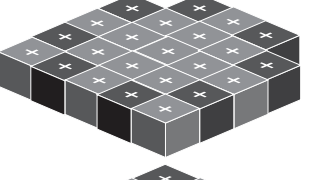
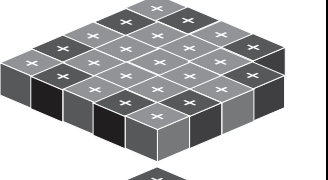
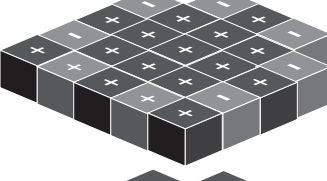
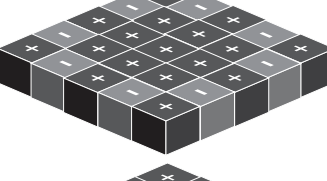
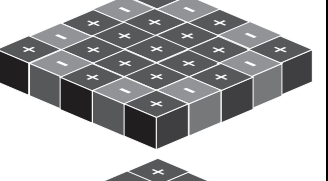
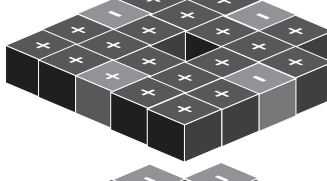
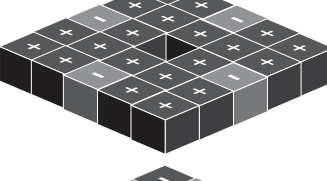
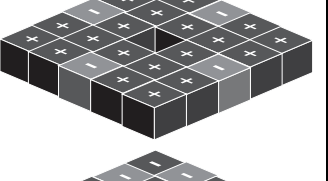
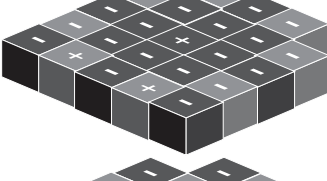
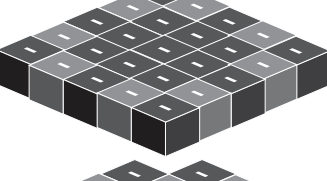
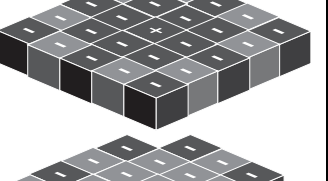
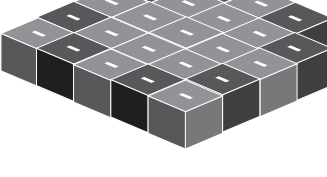
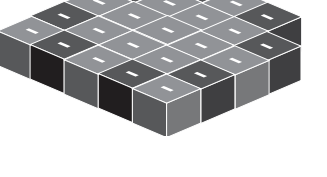
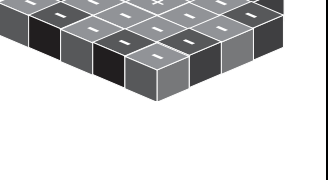
Period Five Nuclide

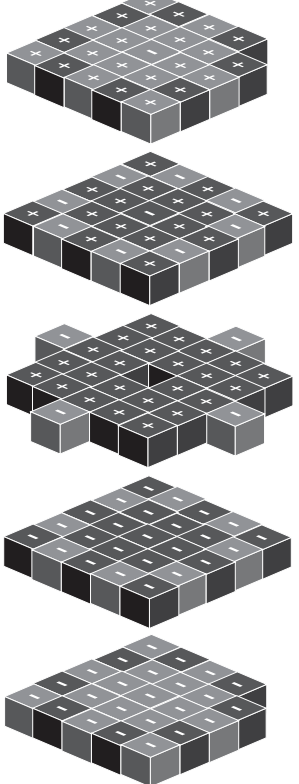
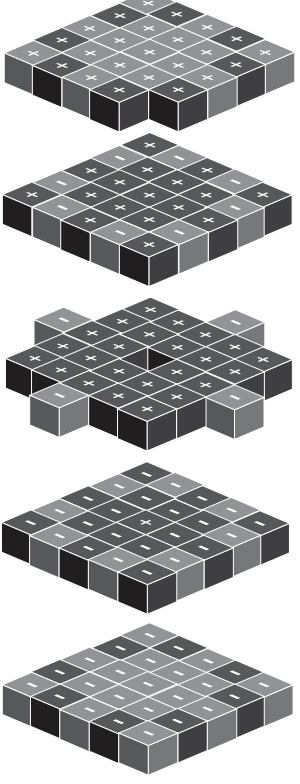
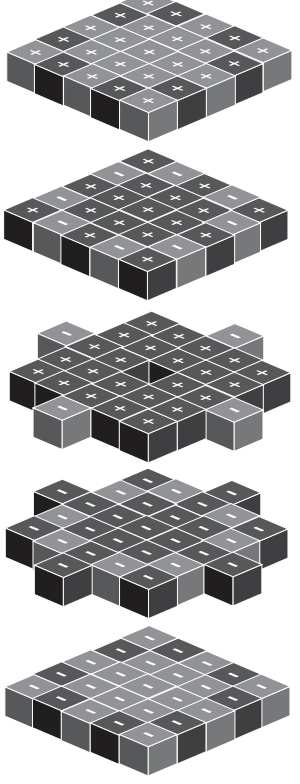
Rb 85 Proton: 37 Neutron: 48 Spin: -5/2 Stable	Sr 88 Proton: 38 Neutron: 50 Spin: 0 Stable	Y 89 Proton: 39 Neutron: 50 Spin: -1/2 Stable
		

<p>Zr 90 Proton: 40 Neutron: 50 Spin: 0 Stable</p>	<p>Nb 93 Proton: 41 Neutron: 52 Spin: 9/2 Stable</p>	<p>Mo 98 Proton: 42 Neutron: 56 Spin: 0 Stable</p>
		

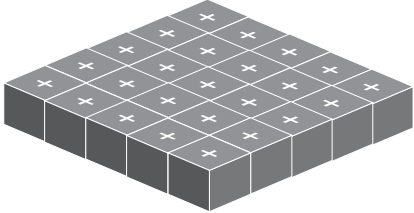
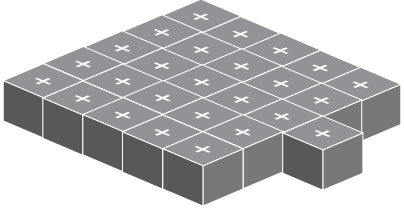
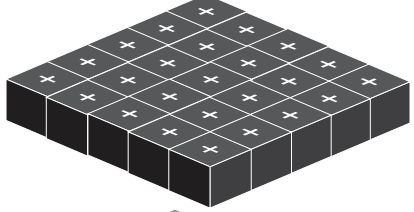
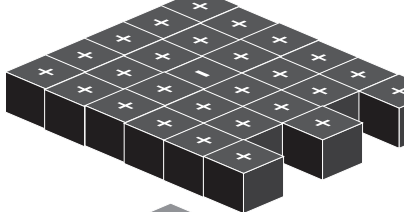
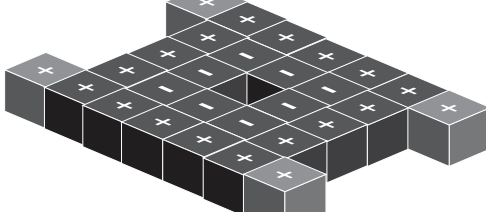
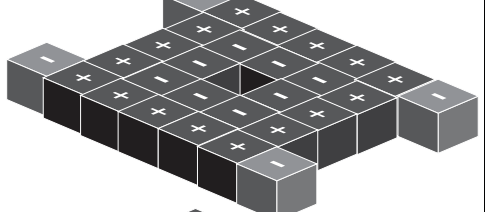
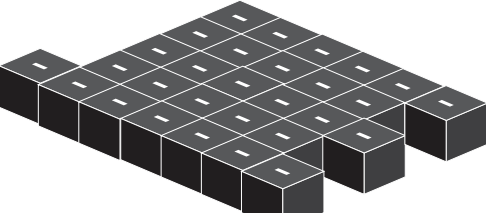
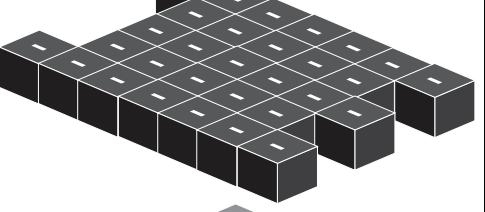
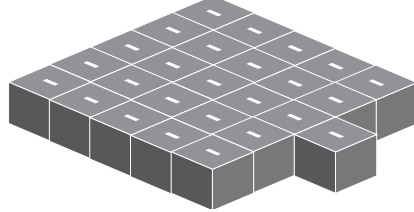
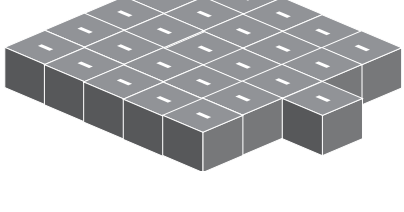
<p>Tc 99 Proton: 43 Neutron: 56 Spin: 9/2 Half-life: 2.111×10^5 year</p>	<p>Ru 102 Proton: 44 Neutron: 58 Spin: 0 Stable</p>	<p>Rh 103 Proton: 45 Neutron: 58 Spin: -1/2 Stable</p>

<p>Pd 106 Proton: 46 Neutron: 60 Spin: 0 Stable</p>	<p>Ag 107 Proton: 47 Neutron: 60 Spin: -1/2 Stable</p>	<p>Cd 114 Proton: 48 Neutron: 66 Spin: 0 Stable</p>
		

<p>In 113 Proton: 49 Neutron: 64 Spin: 9/2 Stable</p>	<p>Sn 120 Proton: 50 Neutron: 70 Spin:0 Stable</p>	<p>Sb 121 Proton: 51 Neutron: 70 Spin:5/2 Stable</p>
		
		
		
		
		

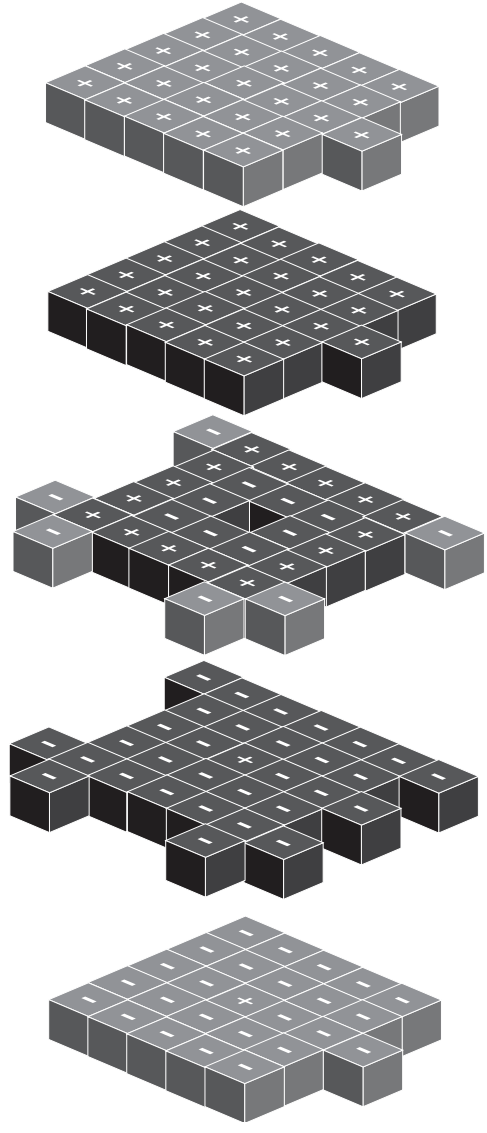
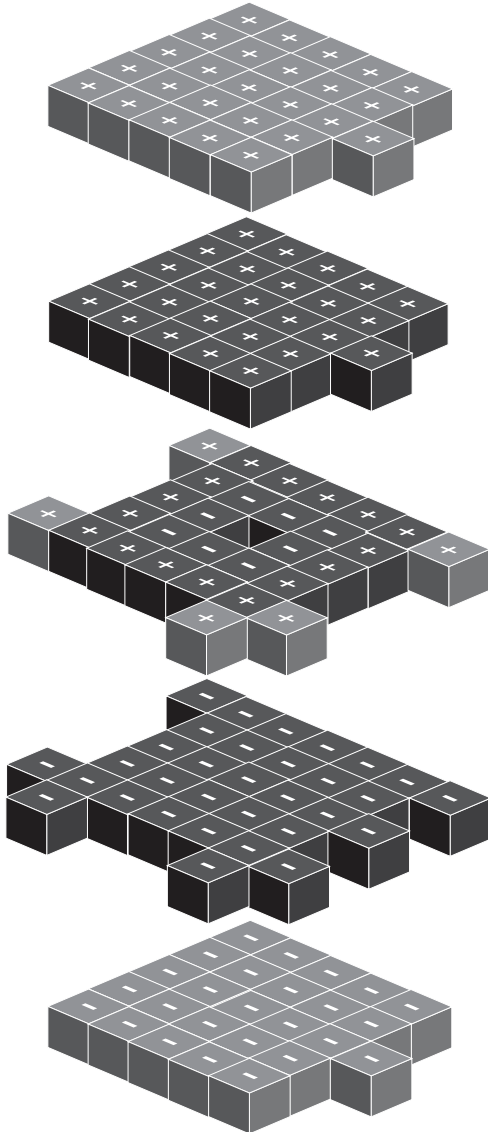
<p>Te 126 Proton: 52 Neutron: 74 Spin:0 Stable</p>	<p>I 127 Proton: 53 Neutron: 74 Spin:5/2 Stable</p>	<p>Xe132 Proton: 54 Neutron: 78 Spin:0 Stable</p>
 <p>The Te-126 models show a 2x2 grid of proton shells (marked with '+') and a 4x4 grid of neutron shells (marked with '-'). The shells are arranged in a 5x5 grid, with the top two rows representing protons and the bottom three rows representing neutrons.</p>	 <p>The I-127 models show a 2x2 grid of proton shells (marked with '+') and a 4x4 grid of neutron shells (marked with '-'). The shells are arranged in a 5x5 grid, with the top two rows representing protons and the bottom three rows representing neutrons.</p>	 <p>The Xe-132 models show a 2x2 grid of proton shells (marked with '+') and a 4x4 grid of neutron shells (marked with '-'). The shells are arranged in a 5x5 grid, with the top two rows representing protons and the bottom three rows representing neutrons.</p>

Period Six Nuclide

Cs 133 Proton: 55 Neutron: 78 Spin: 7/2 Stable	Ba138 Proton: 56 Neutron: 82 Spin: 0 Stable
	
	
	
	
	

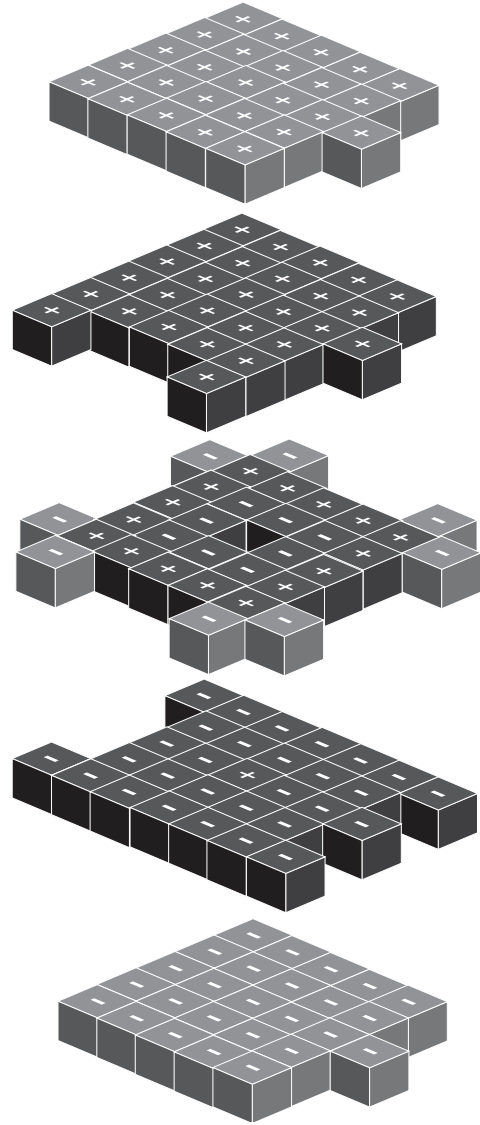
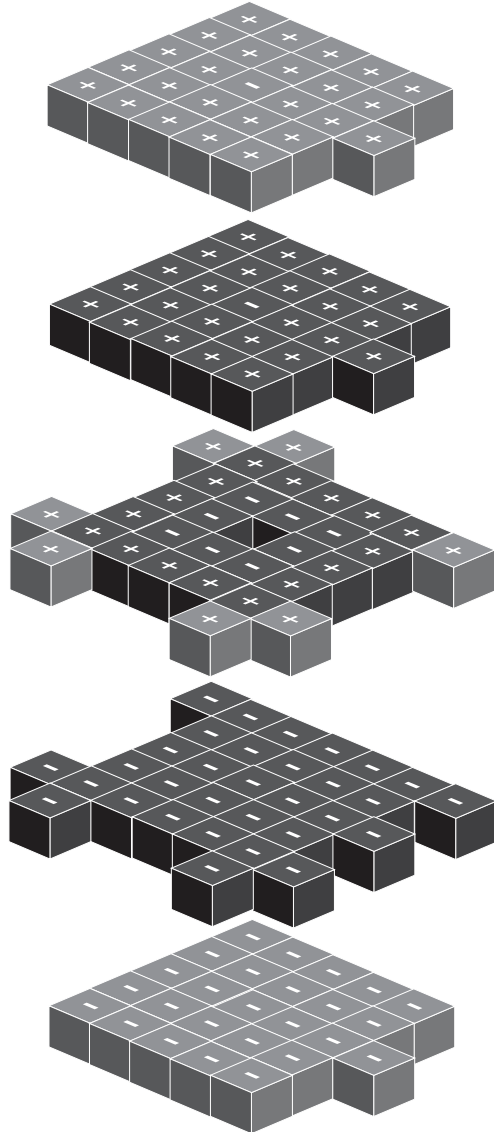
La 139
Proton: 57
Neutron: 82
Spin:7/2
Stable

Ce 140
Proton: 58
Neutron: 82
Spin:0
Stable



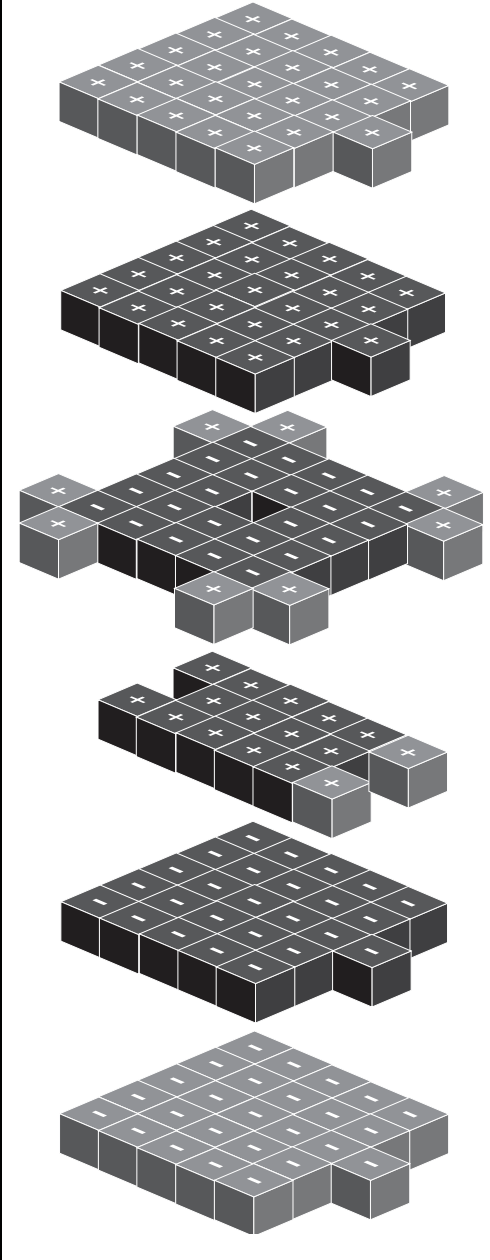
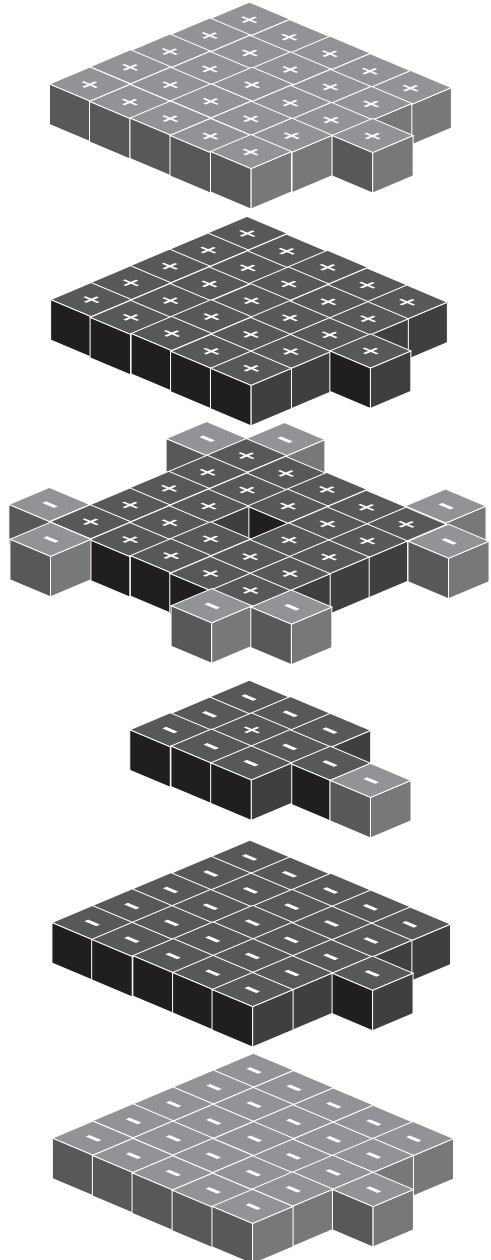
Pr 141
Proton: 59
Neutron: 82
Spin:5/2
Stable

Nd 142
Proton: 60
Neutron: 82
Spin:0
Stable



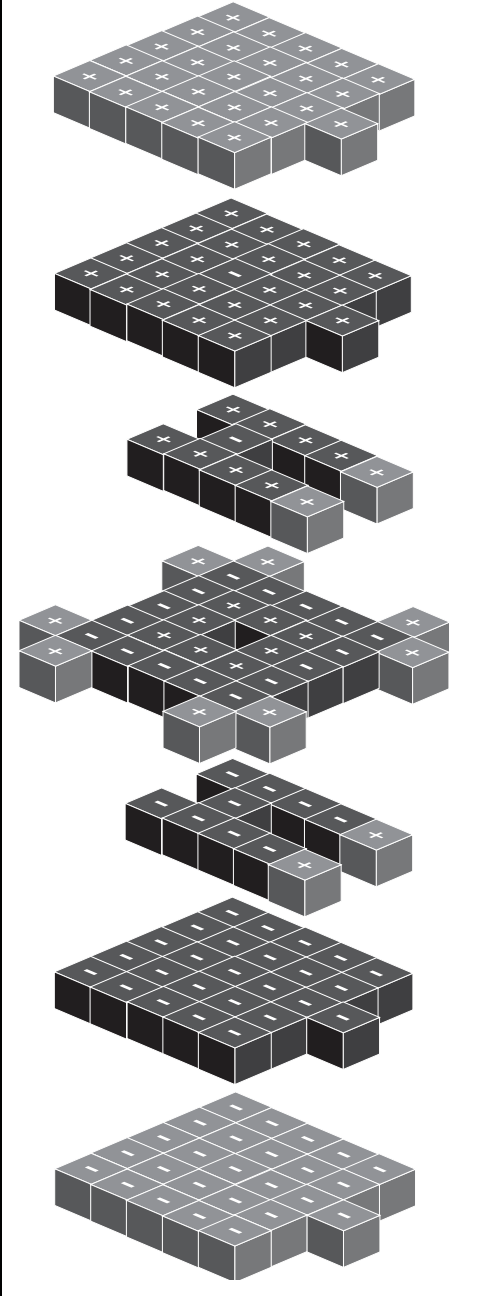
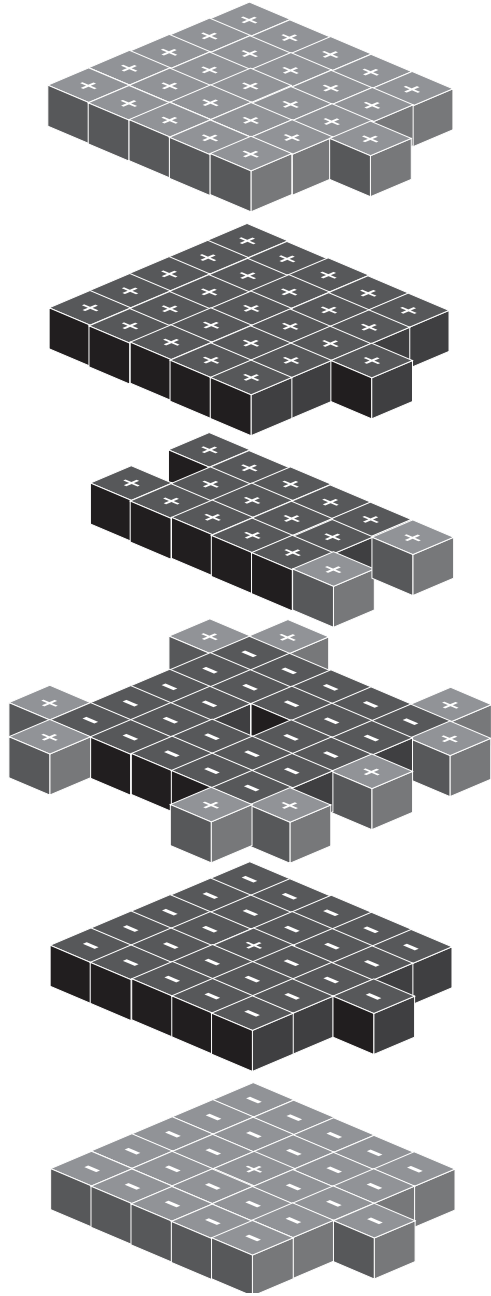
Pm 147
 Proton: 61
 Neutron: 86
 Spin: 7/2
 Half-life: 2.6234 year

Sm 152
 Proton: 62
 Neutron: 90
 Spin: 0
 Stable



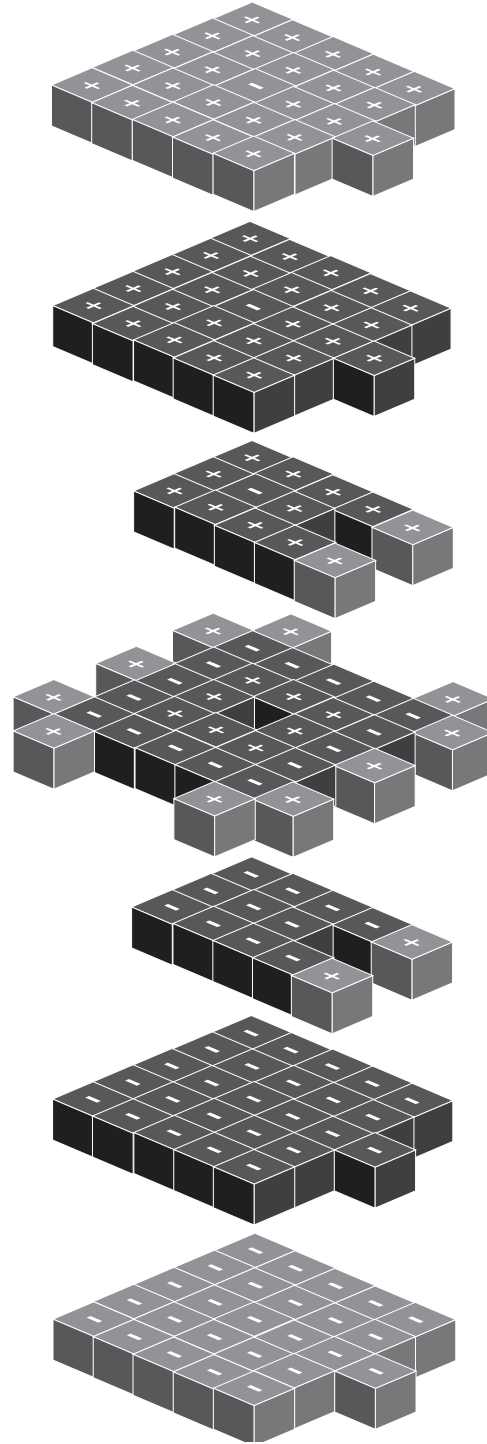
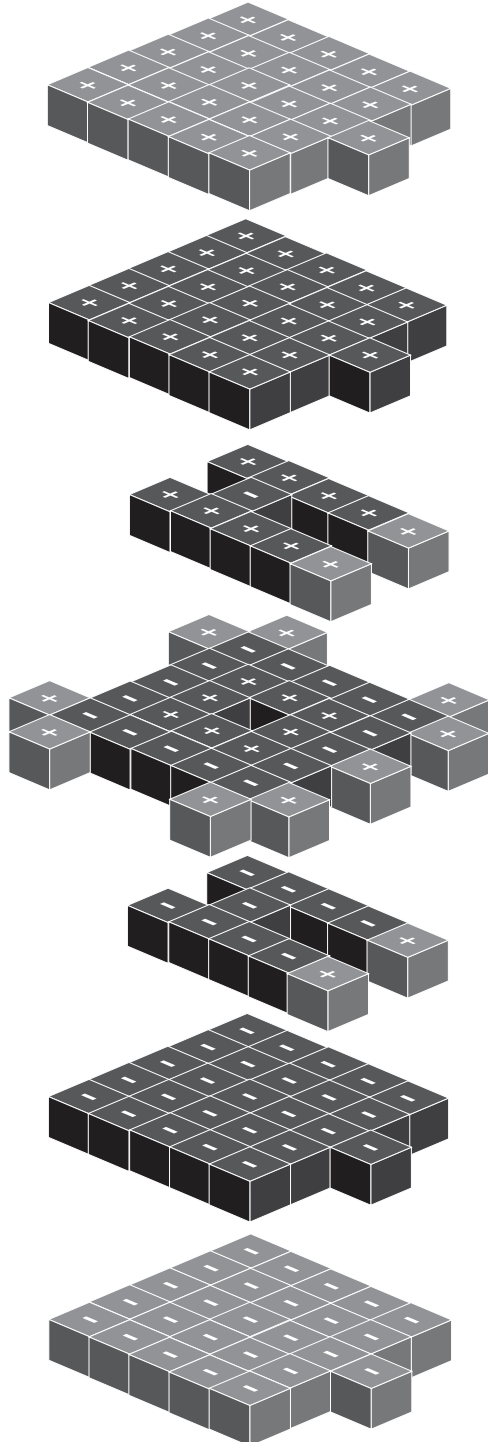
Eu 153
Proton: 63
Neutron: 90
Spin:5/2
Stable

Gd 158
Proton: 64
Neutron: 94
Spin:0
Stable



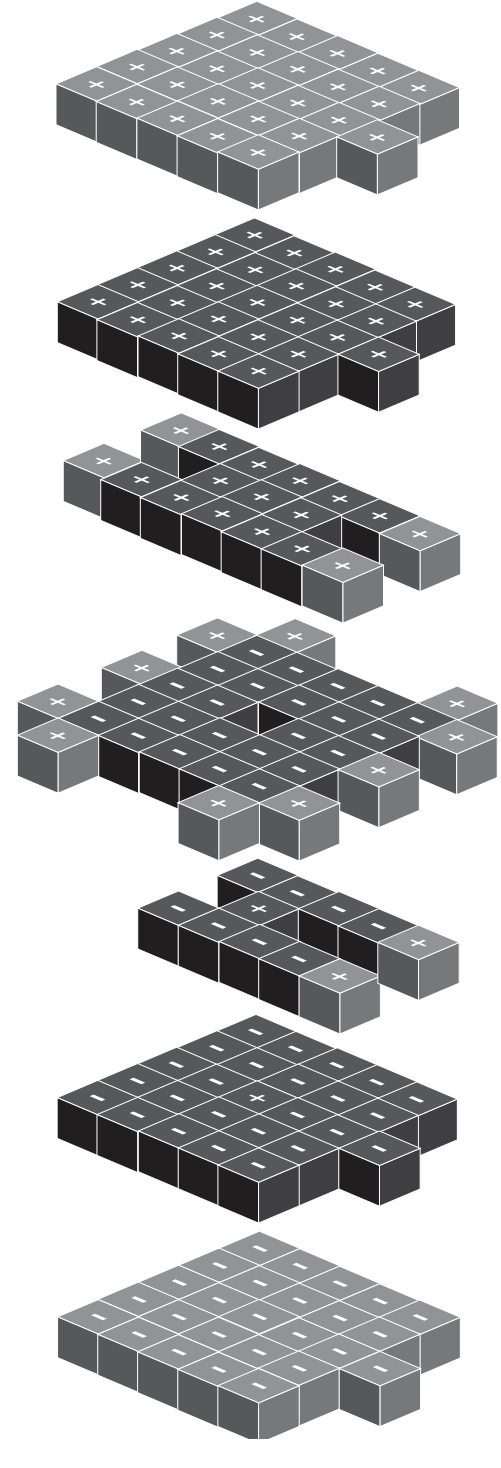
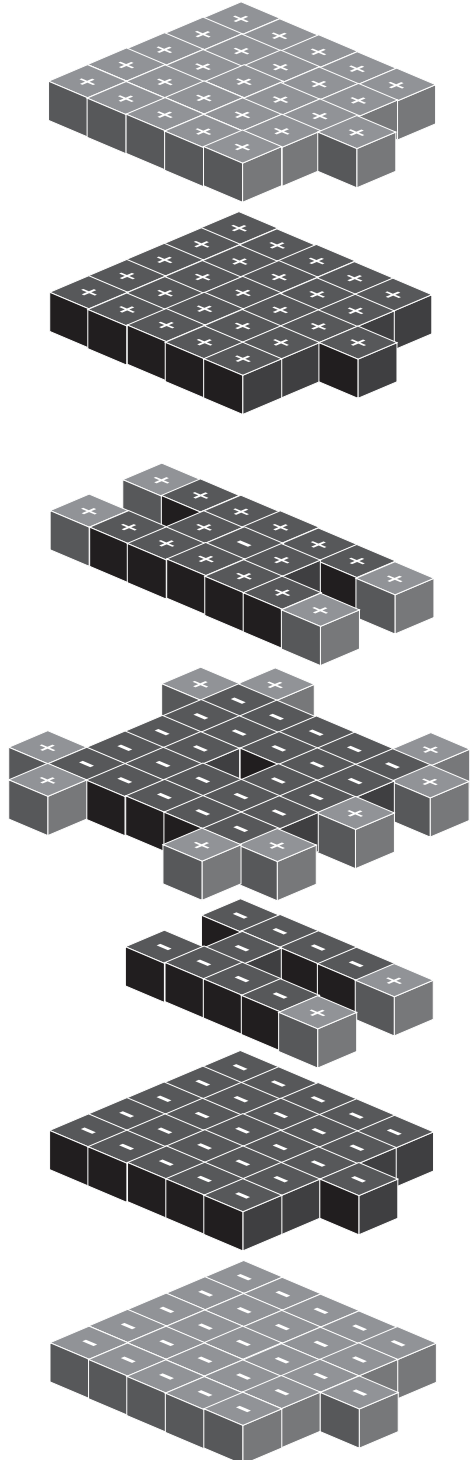
Tb 159
 Proton: 65
 Neutron: 94
 Spin:3/2
 Stable

Dy 164
 Proton: 66
 Neutron: 98
 Spin:0
 Stable



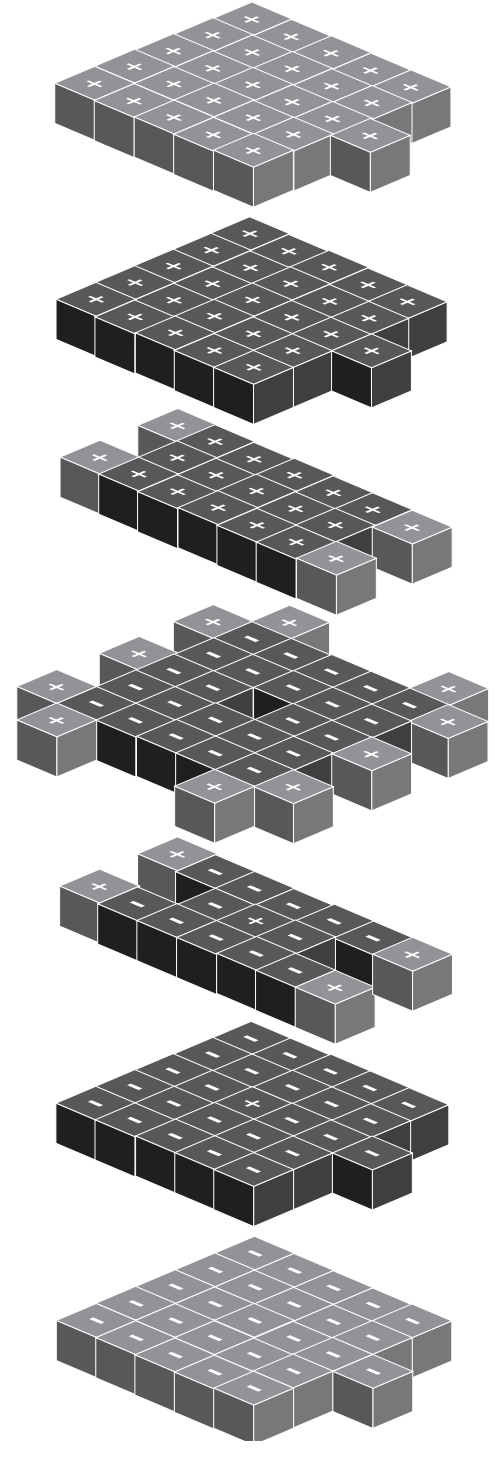
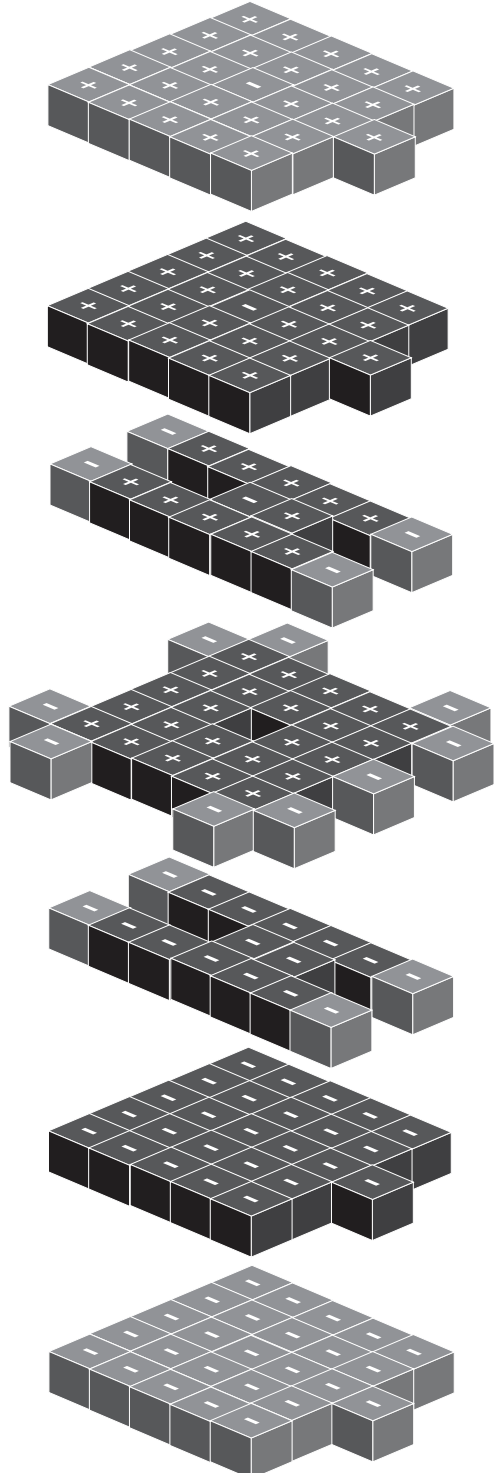
Ho 165
 Proton: 67
 Neutron: 98
 Spin:-7/2
 Stable

Er 166
 Proton: 68
 Neutron: 98
 Spin:0
 Stable



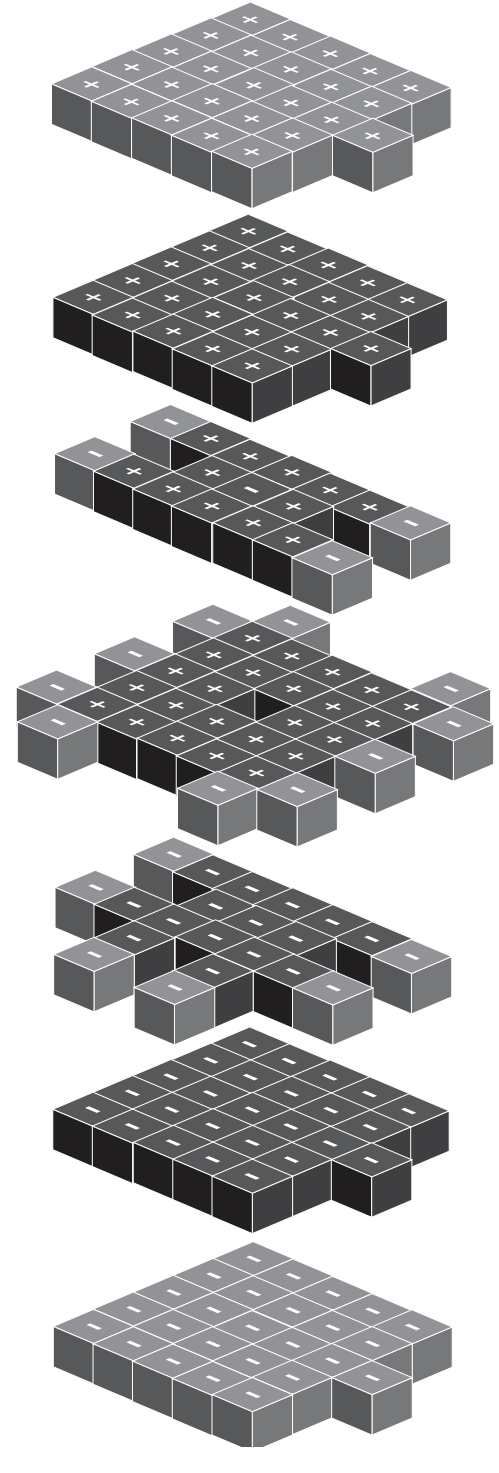
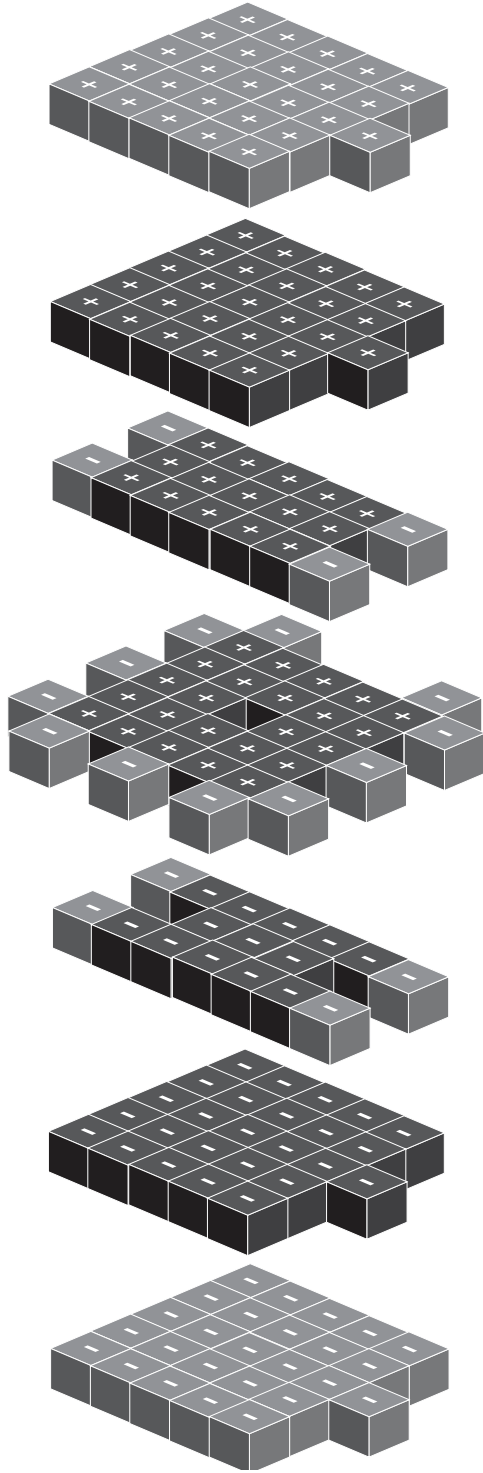
Tm 169
 Proton: 69
 Neutron: 100
 Spin:1/2
 Stable

Yb 174
 Proton: 70
 Neutron: 104
 Spin:0
 Stable



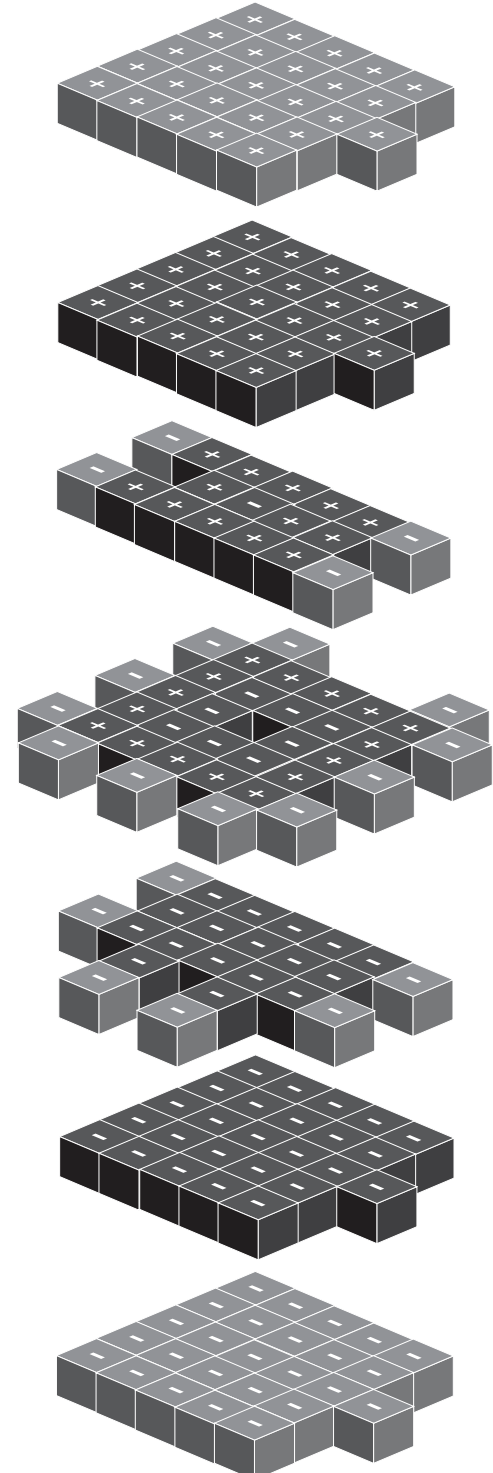
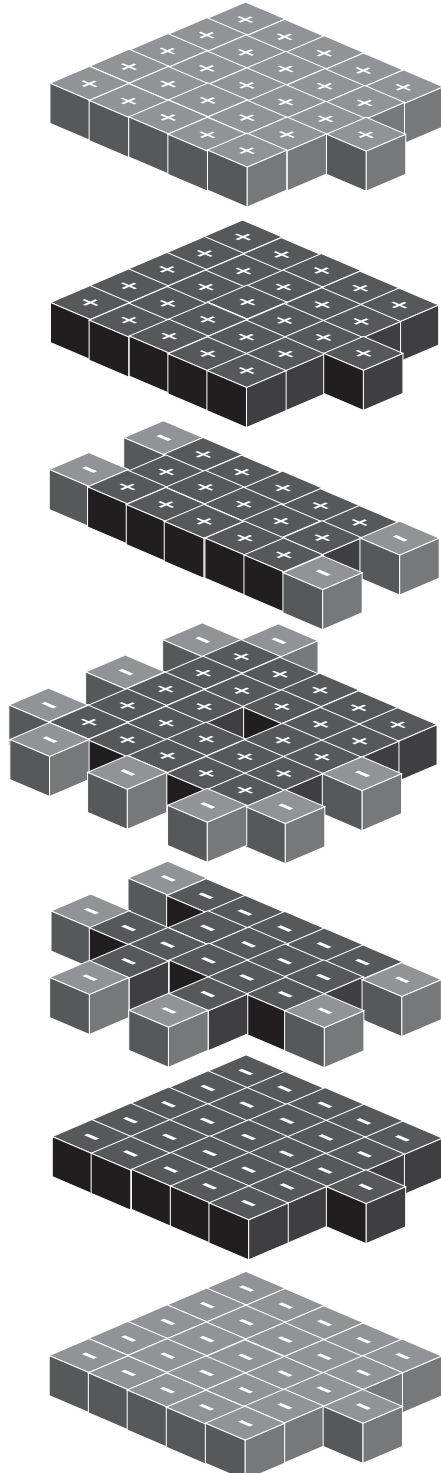
Lu 175
 Proton: 71
 Neutron: 104
 Spin: 7/2
 Stable

Hf 176
 Proton: 72
 Neutron: 104
 Spin: 0
 Stable



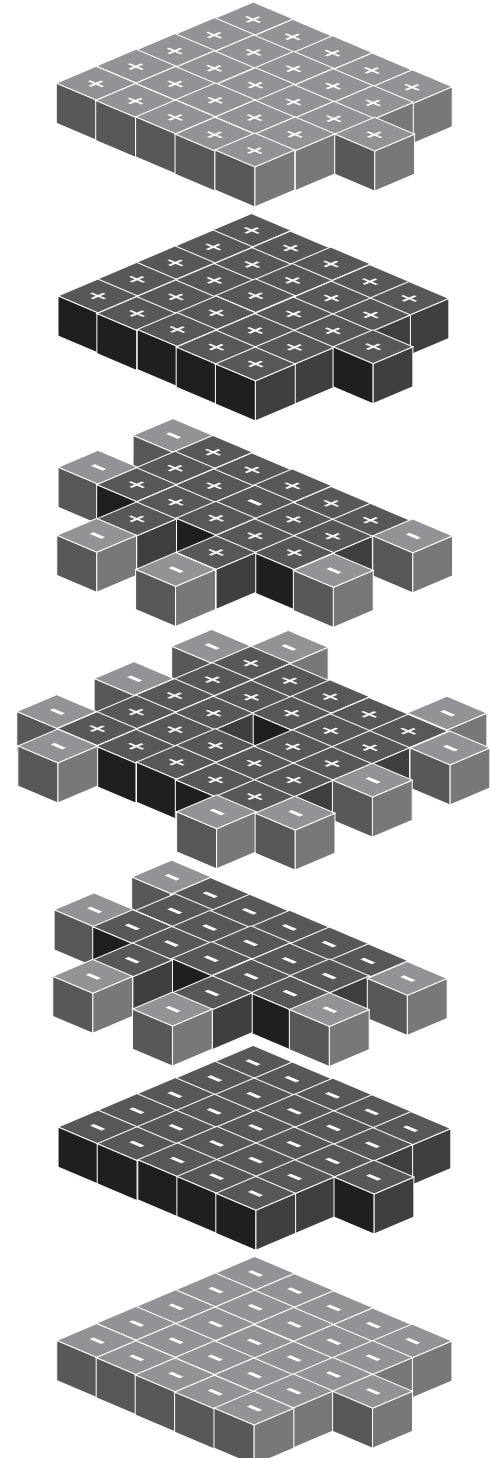
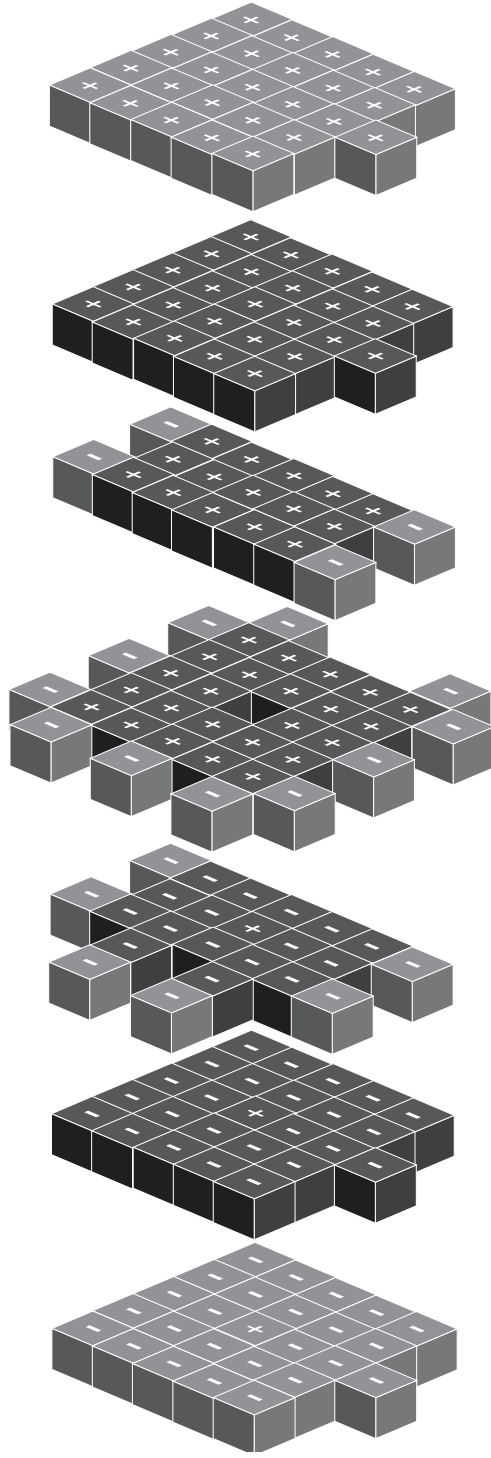
Ta 180
Proton: 73
Neutron: 107
Spin:1
Stable

Ta 180m1
Proton: 73
Neutron: 107
Spin:-9
Stable



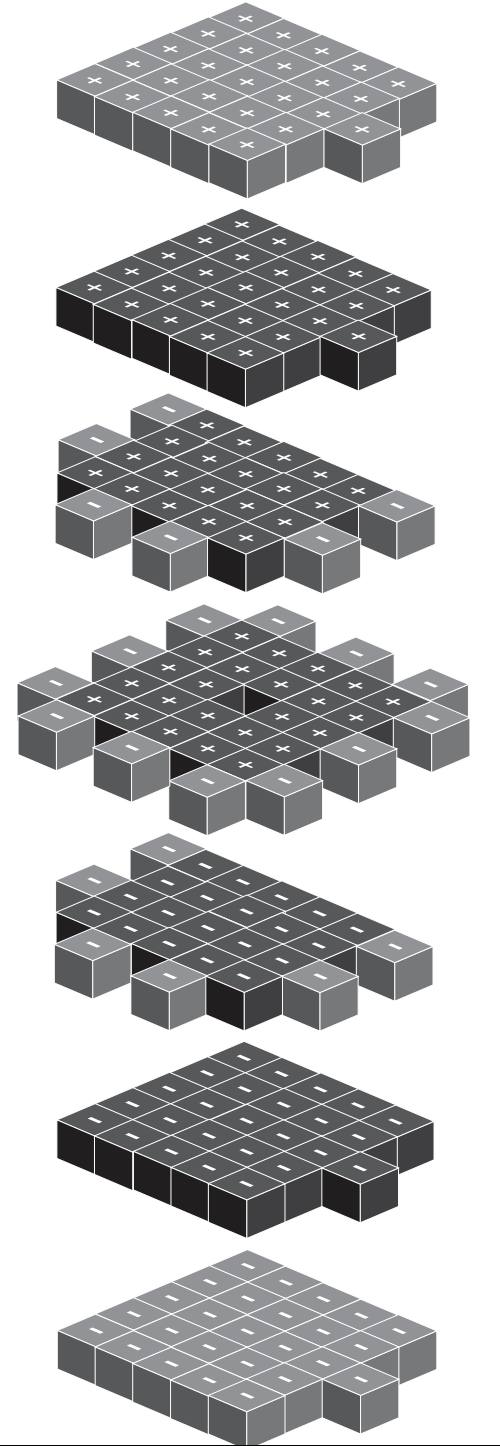
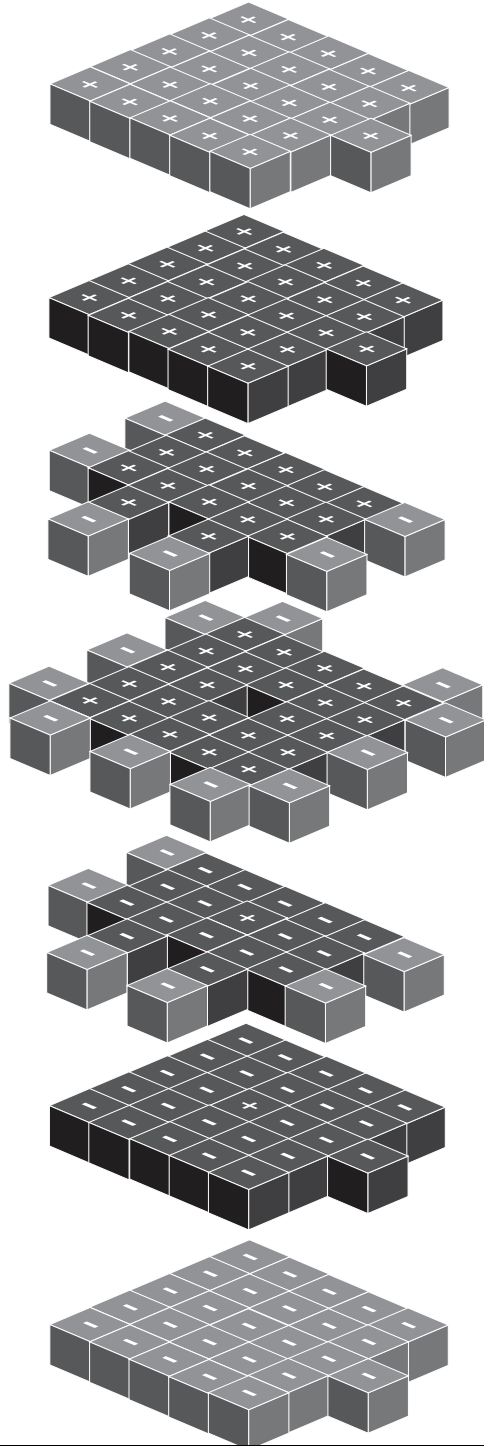
Ta 181
Proton: 73
Neutron: 108
Spin: 7/2
Stable

W 184
Proton: 74
Neutron: 110
Spin: 0
Stable



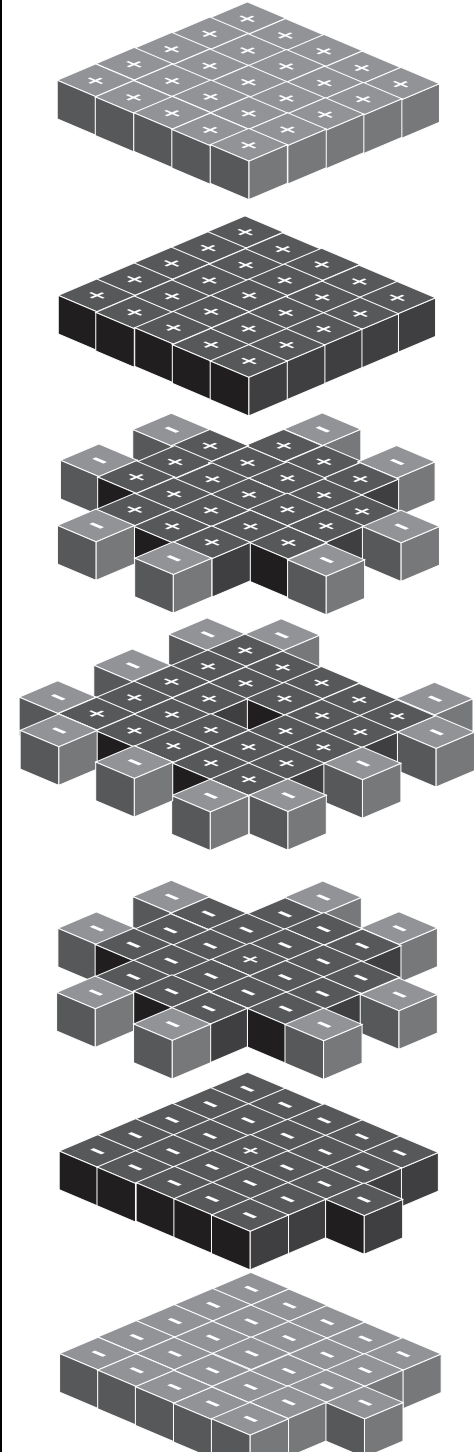
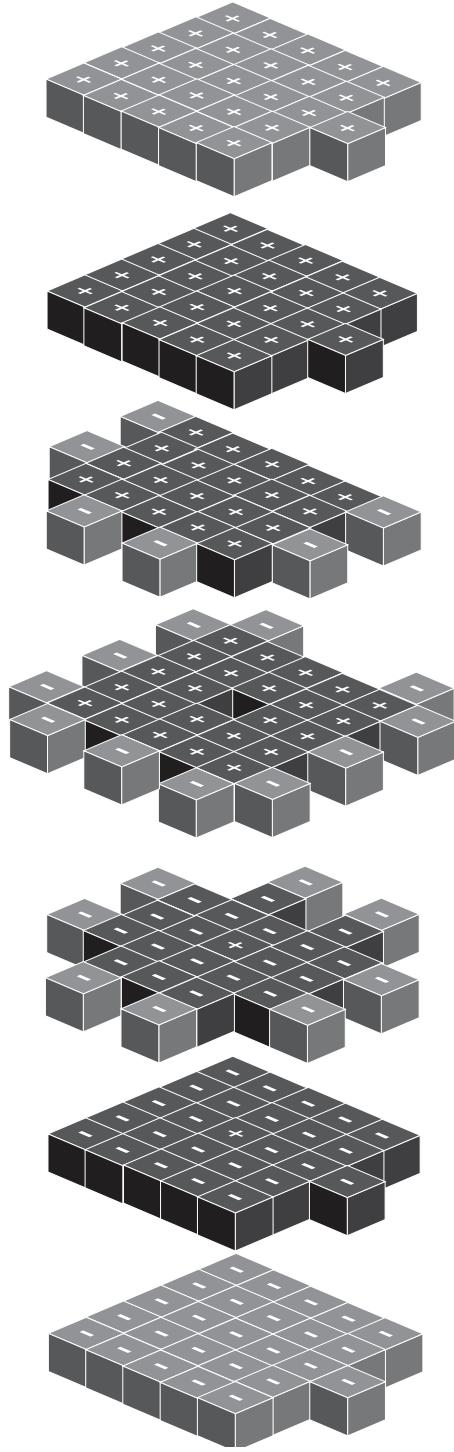
Re 185
 Proton: 75
 Neutron: 110
 Spin:5/2
 Stable

Os 192
 Proton: 76
 Neutron: 116
 Spin:0
 Stable



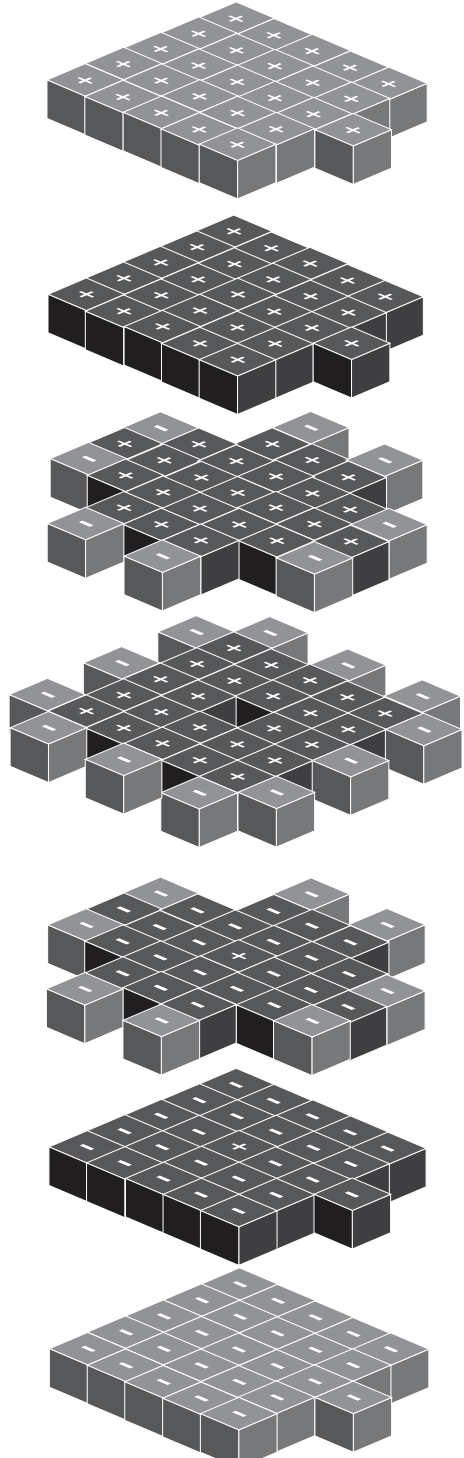
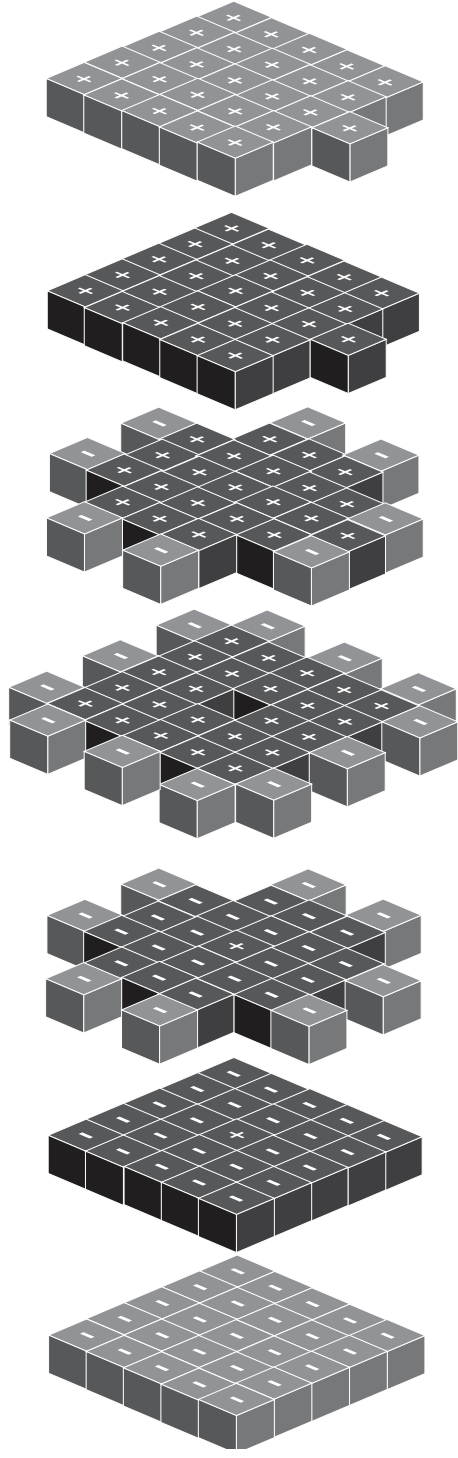
Ir 193
Proton: 77
Neutron: 116
Spin:3/2
Stable

Pt 195
Proton: 78
Neutron: 117
Spin:-1/2
Stable



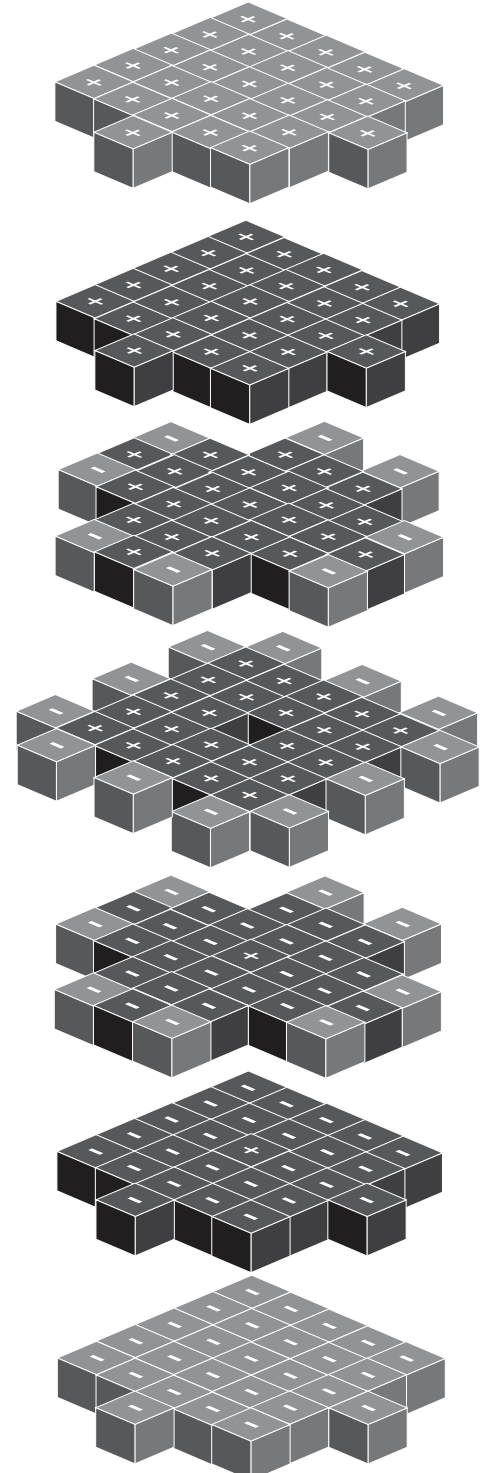
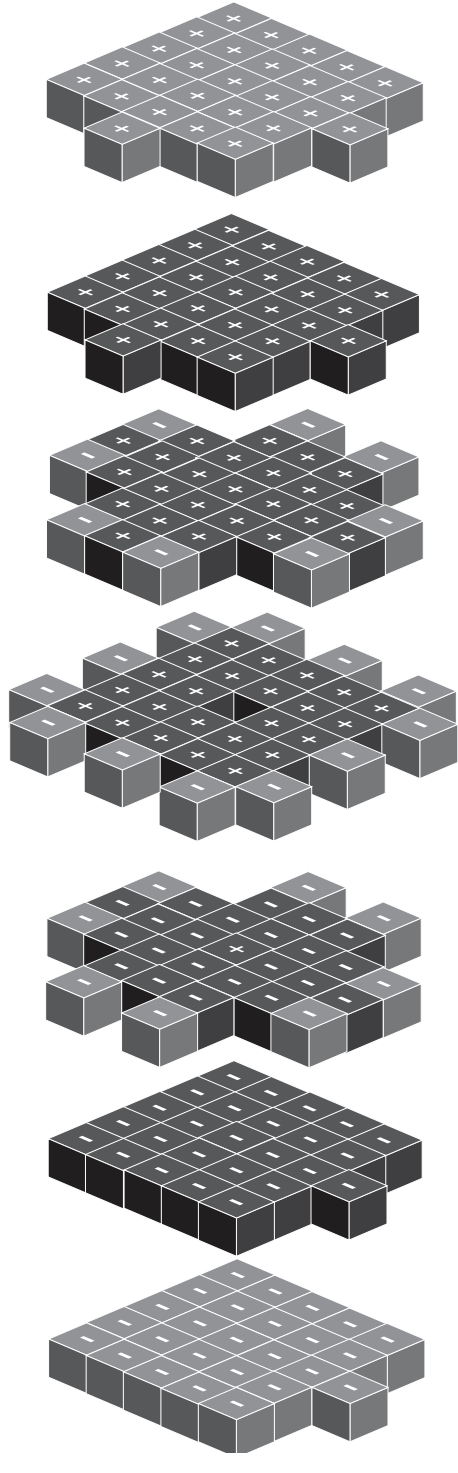
Au 197
 Proton: 79
 Neutron: 118
 Spin:3/2
 Stable

Hg 202
 Proton: 80
 Neutron: 122
 Spin:0
 Stable



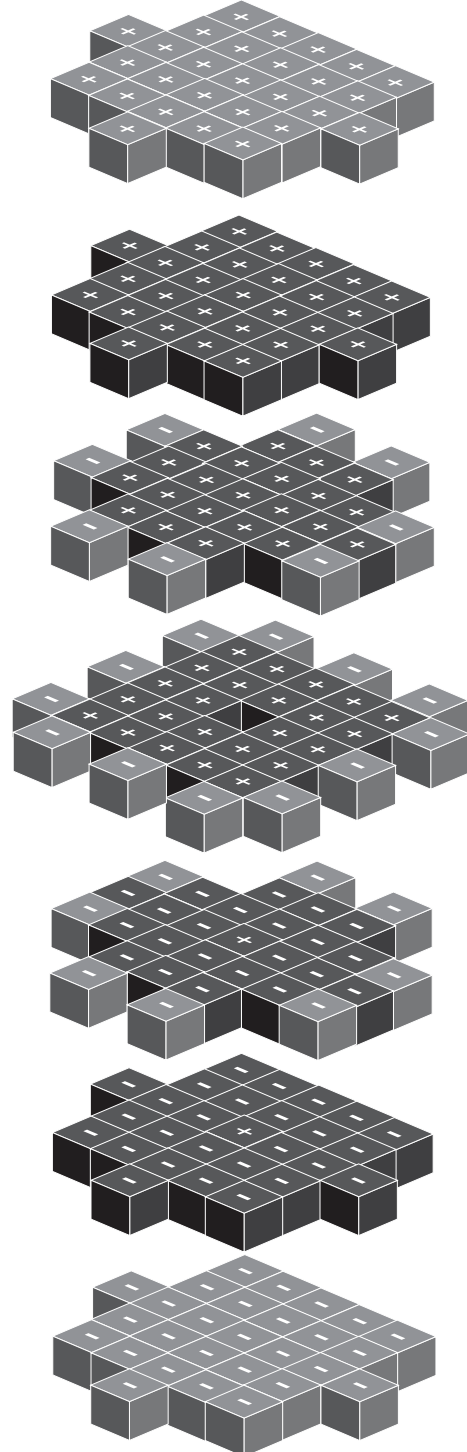
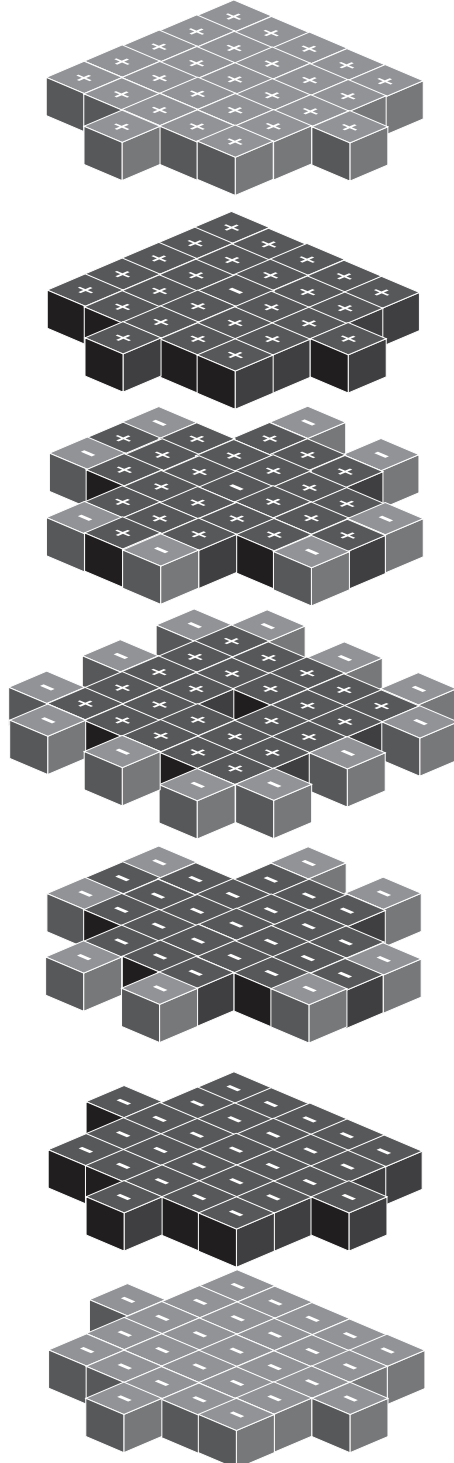
Ti 205
 Proton: 81
 Neutron: 124
 Spin:1/2
 Stable

Pb 208
 Proton: 82
 Neutron: 126
 Spin:0
 Stable



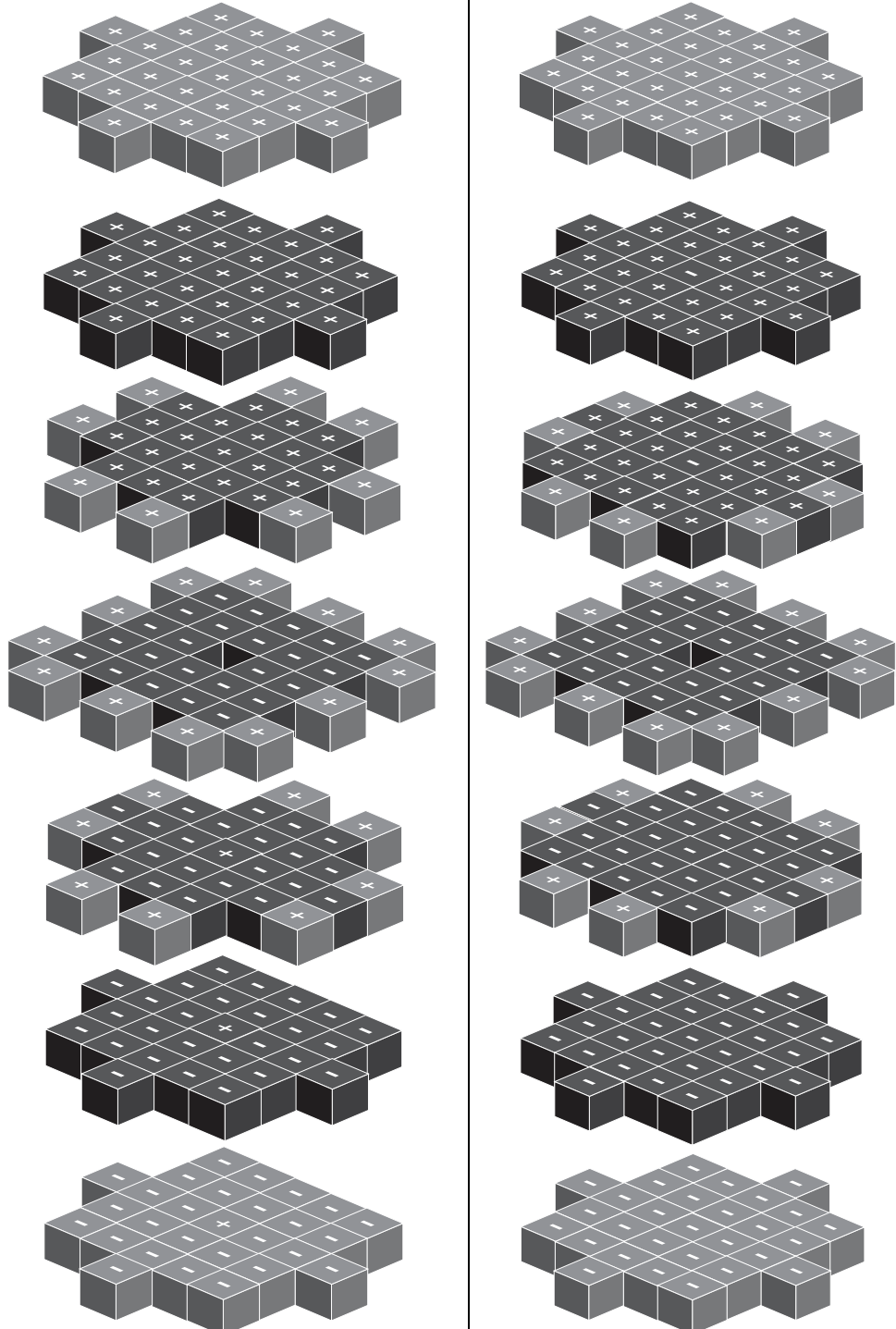
Bi 209
Proton: 83
Neutron: 126
Spin: -9/2
Half-life: 1.9×10^{19} year

Po 209
Proton: 84
Neutron: 125
Spin: -1/2
Half-life: 103 year

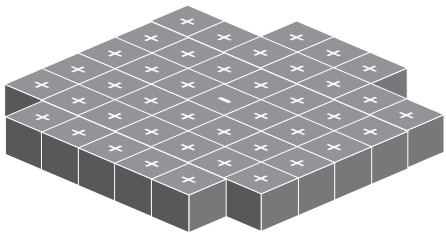
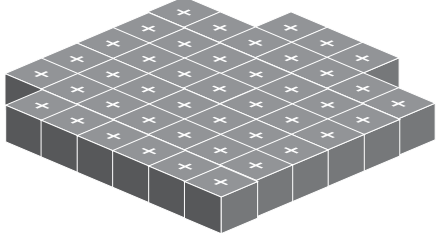
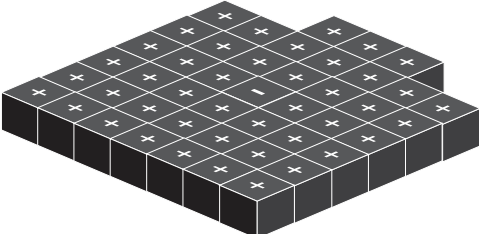
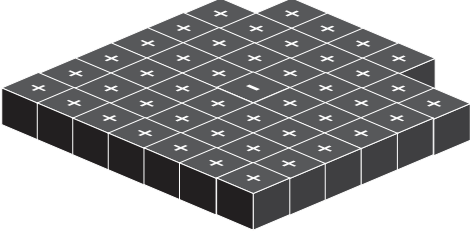
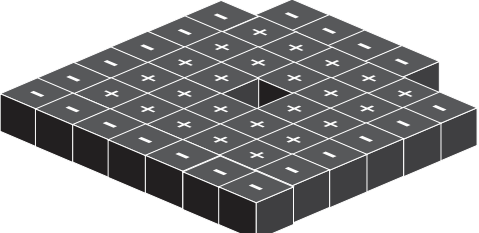
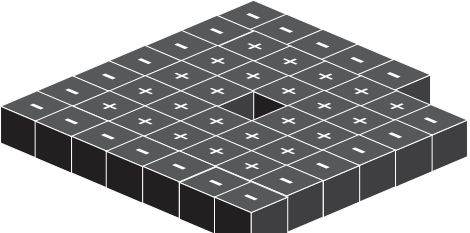
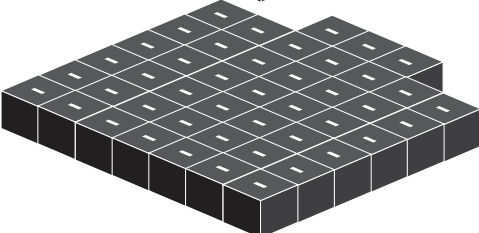
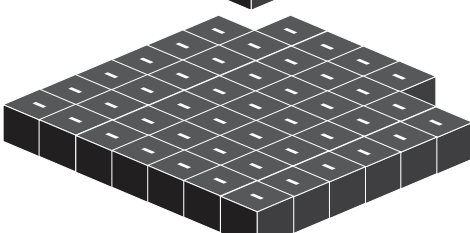
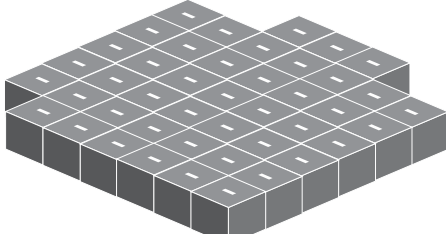
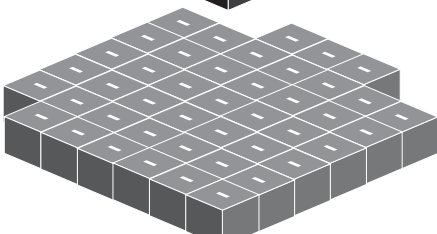


At 210
Proton: 85
Neutron: 125
Spin:5
Half-life: 8.1 h

Rn 222
Proton: 86
Neutron: 136
Spin:0
Half-life: 3.8235 d

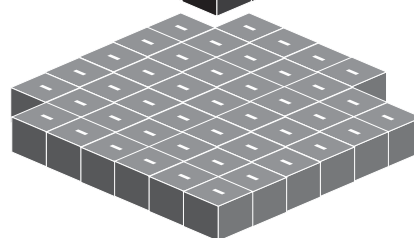
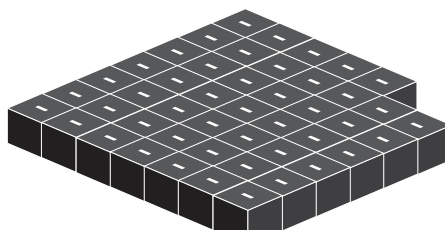
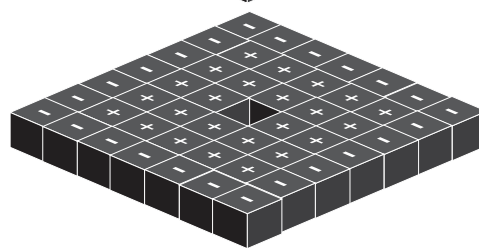
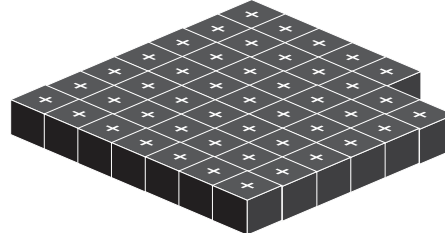
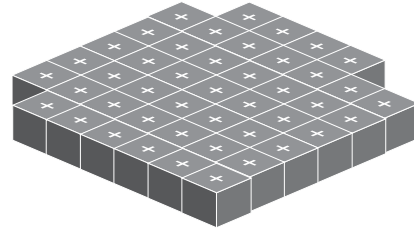
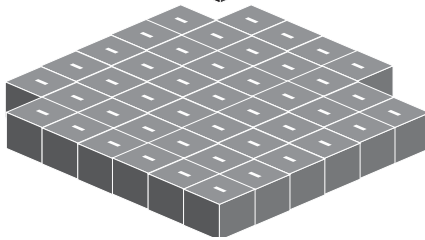
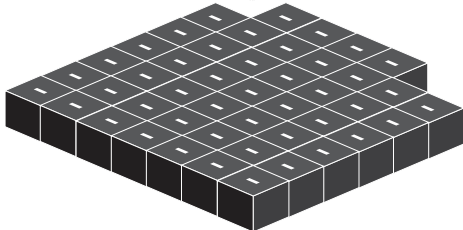
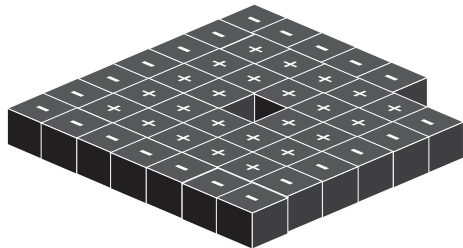
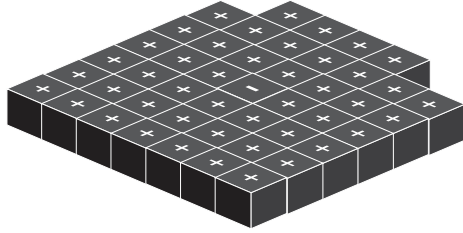
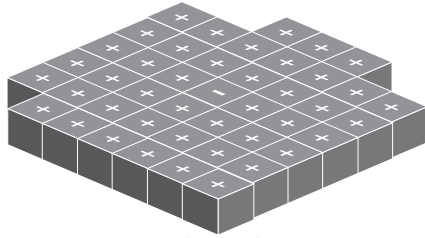


Period Seven Nuclide

Fr 223 Proton: 87 Neutron: 136 Spin: -3/2	Ra 226 Proton: 88 Neutron: 138 Spin: 0
	
	
	
	
	

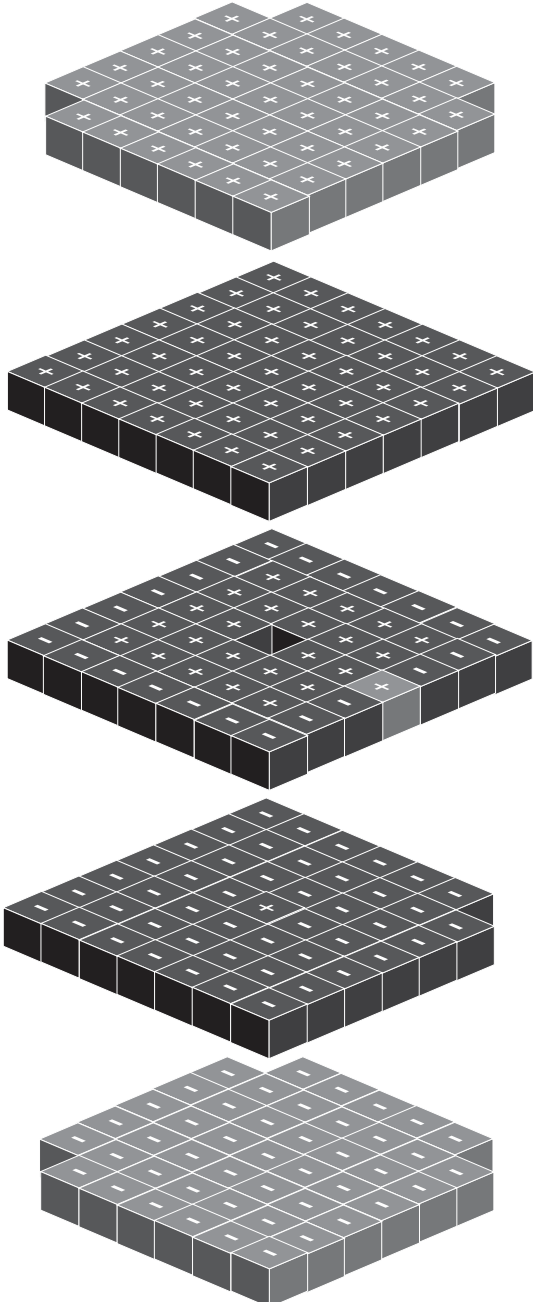
Ac 227
Proton: 89
Neutron: 138
Spin: -3/2

Th 232
Proton: 90
Neutron: 142
Spin: 0

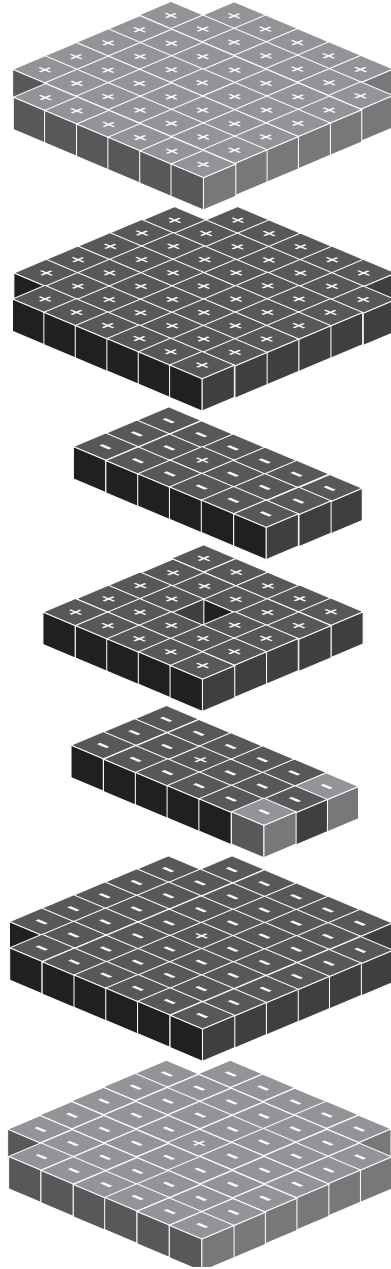


<p>Pa 231 Proton: 91 Neutron: 140 Spin: -3/2</p>	<p>U 238 Proton: 92 Neutron: 146 Spin: 0</p>

Np 237
Proton: 93
Neutron: 144
Spin:5/2

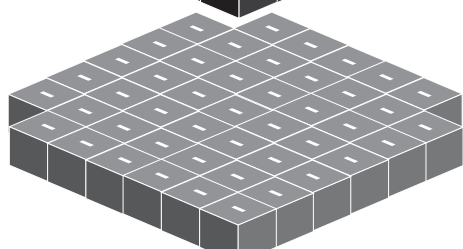
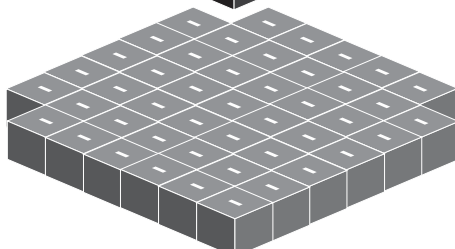
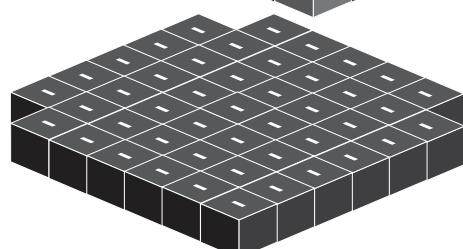
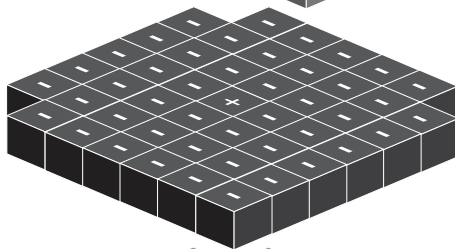
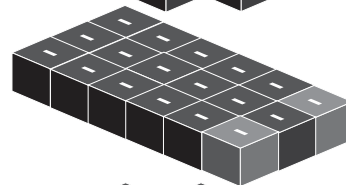
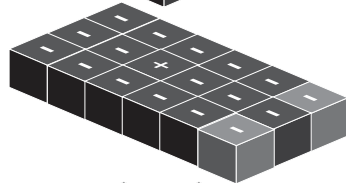
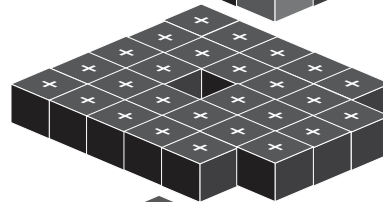
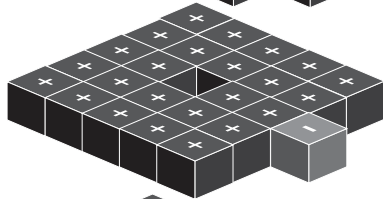
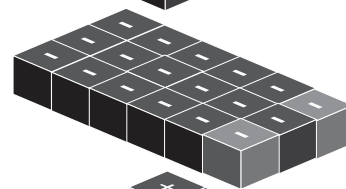
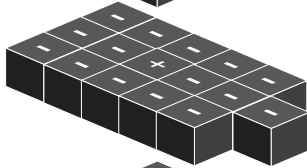
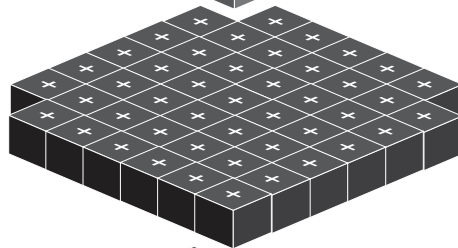
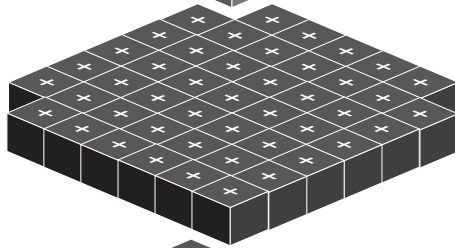
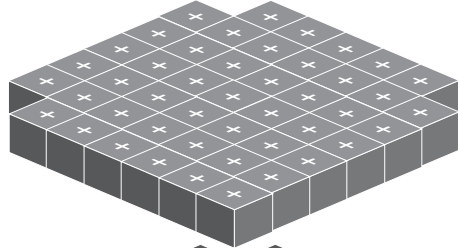
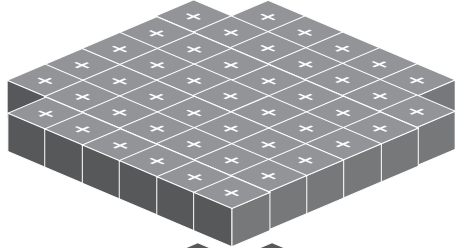


Pu 244
Proton:94
Neutron:150
Spin:0



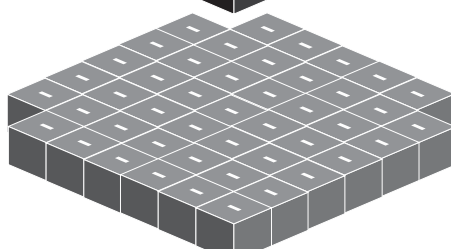
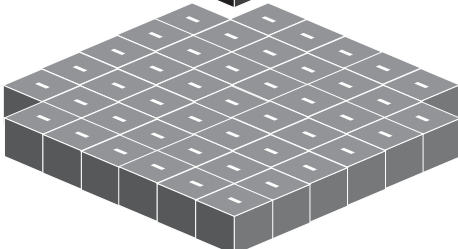
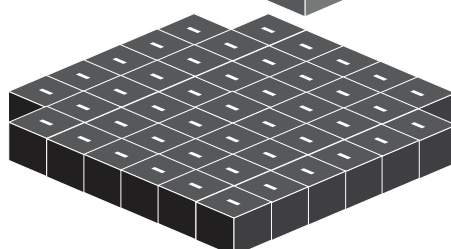
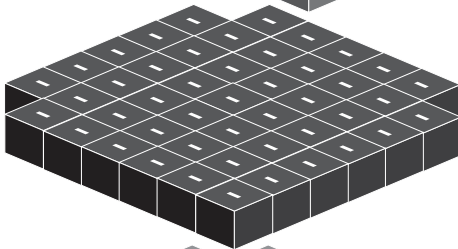
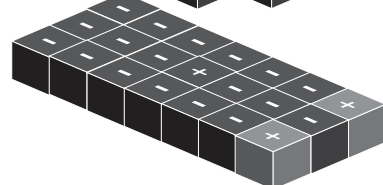
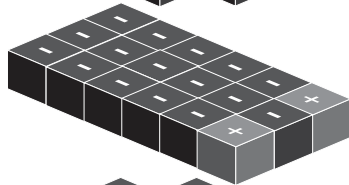
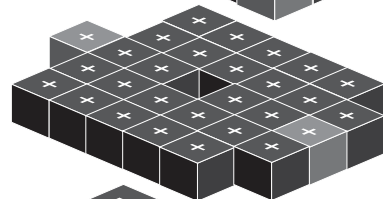
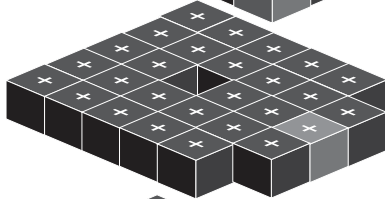
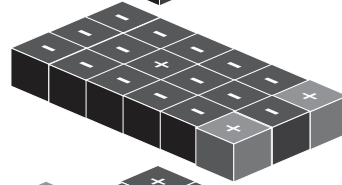
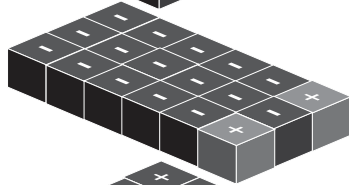
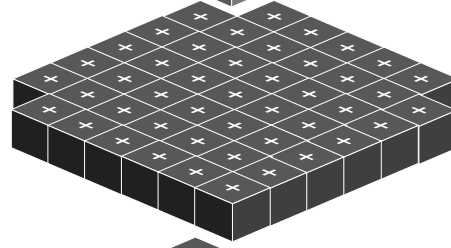
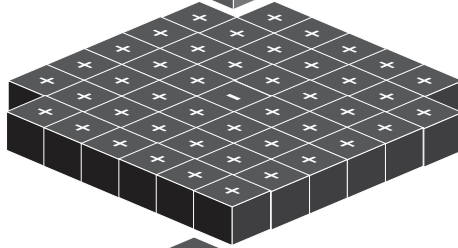
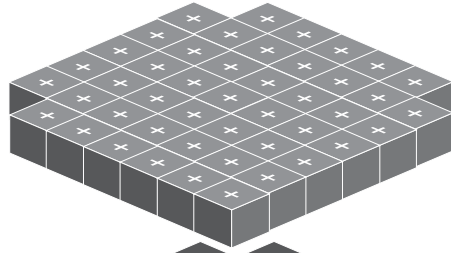
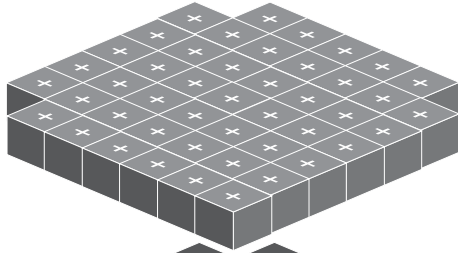
Am 243
Proton:95
Neutron:148
Spin:-5/2

Cm 247
Proton:96
Neutron:151
Spin:-9/2



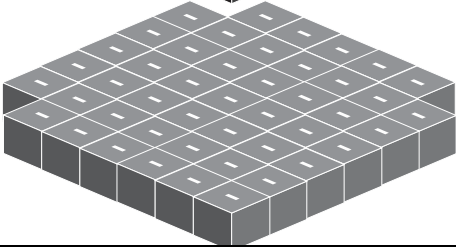
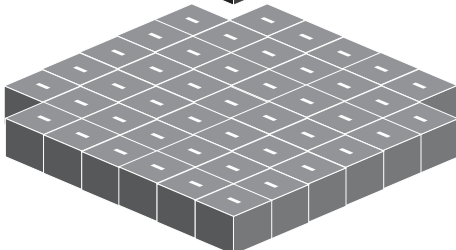
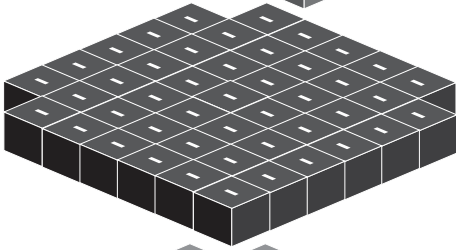
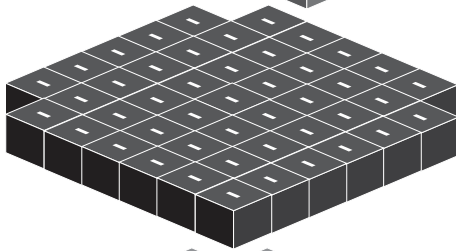
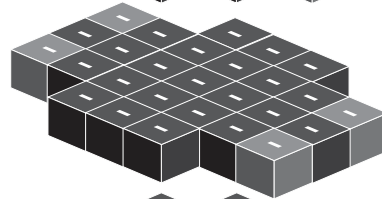
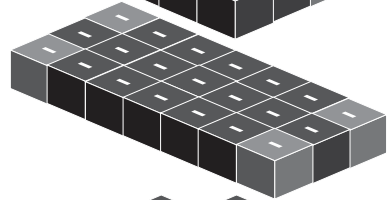
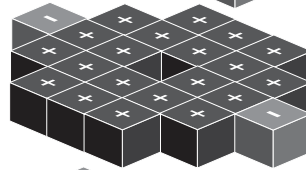
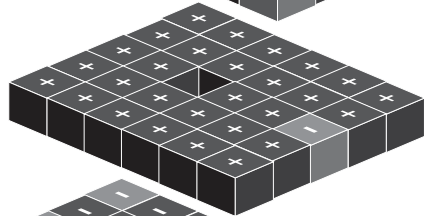
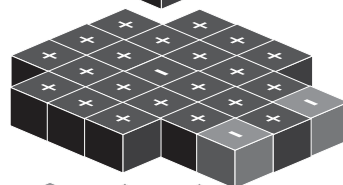
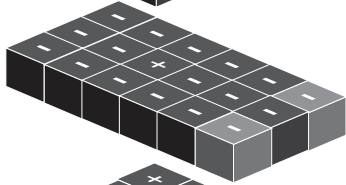
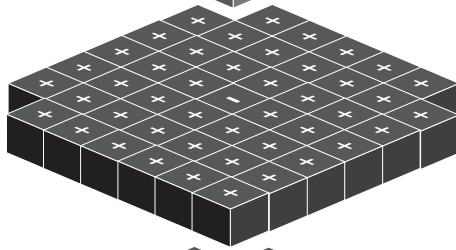
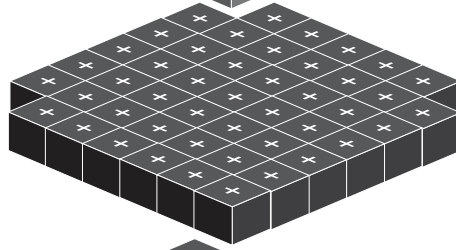
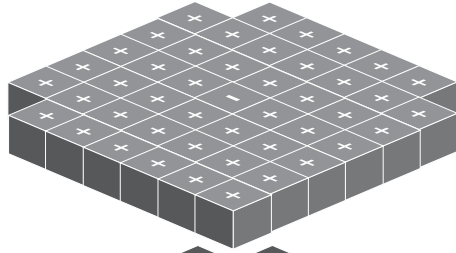
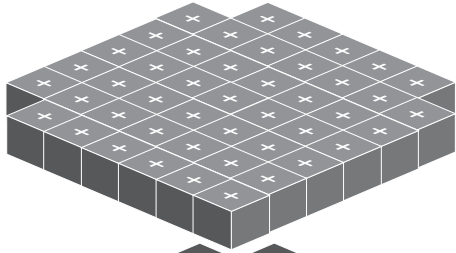
Bk 247
Proton:97
Neutron:150
Spin:-3/2

Cf 251
Proton:98
Neutron:153
Spin:1/2



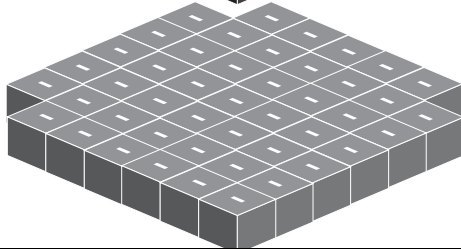
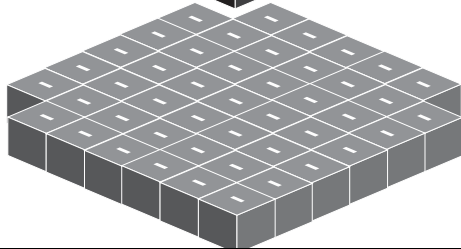
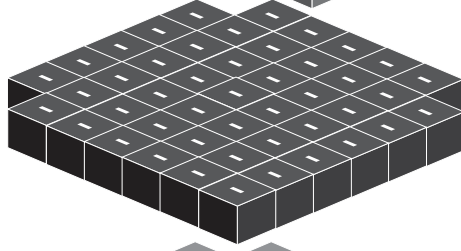
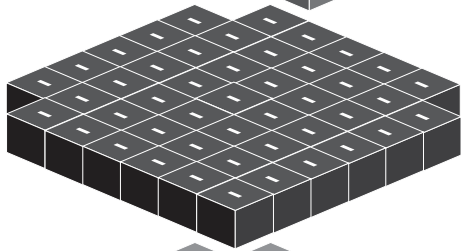
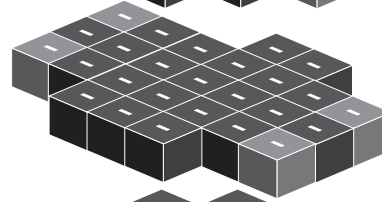
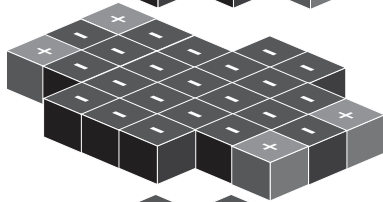
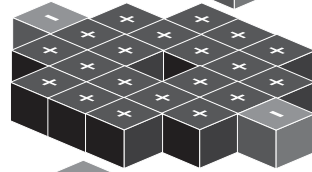
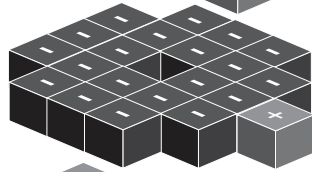
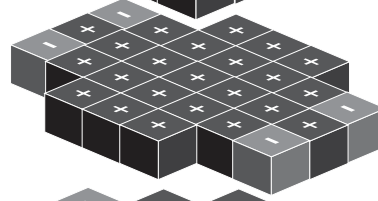
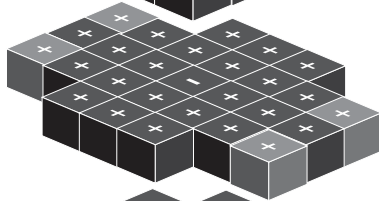
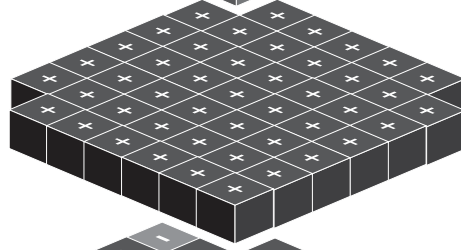
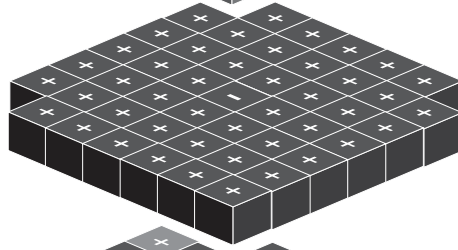
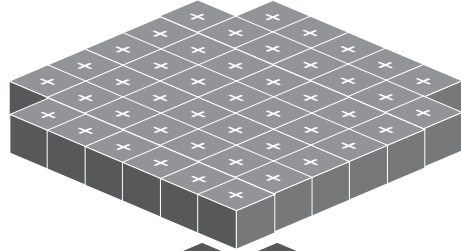
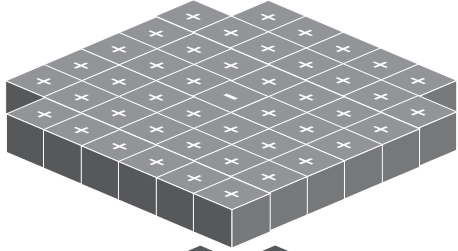
Es 252
Proton:99
Neutron:153
Spin:-5

Fm 257
Proton:100
Neutron:157
Spin:9/2



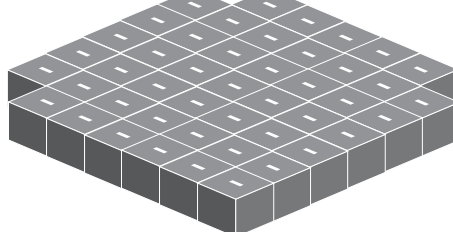
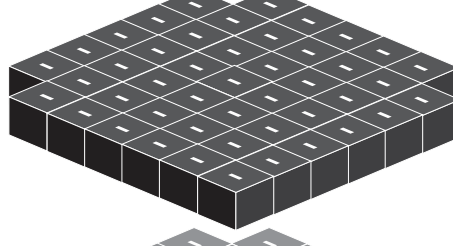
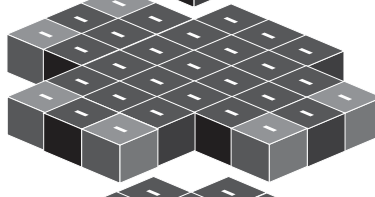
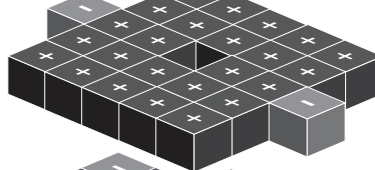
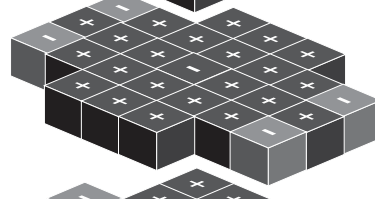
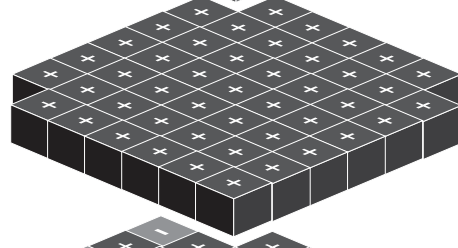
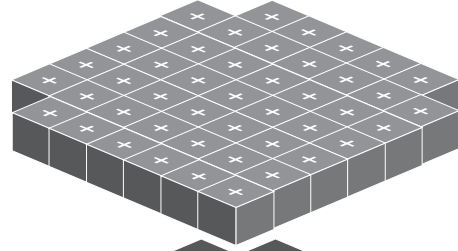
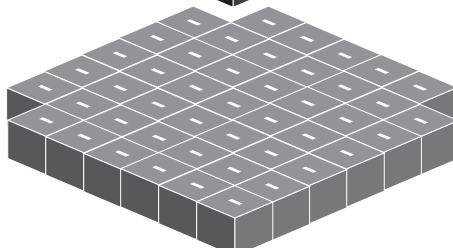
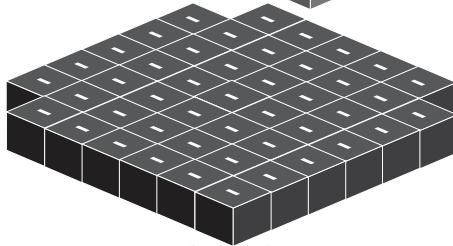
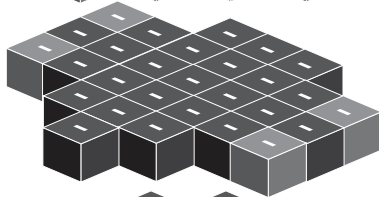
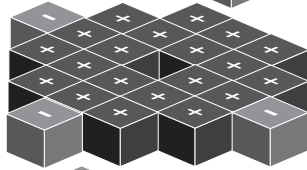
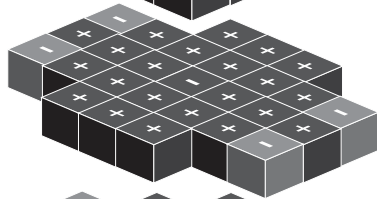
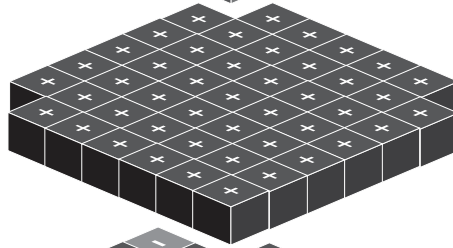
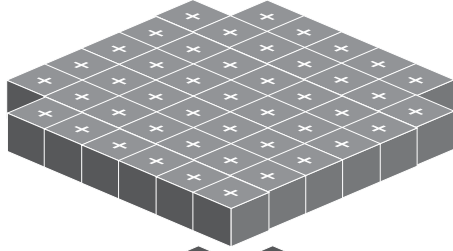
Md 258
Proton:101
Neutron:157
Spin:-8

No 259
Proton:102
Neutron:157
Spin:9/2

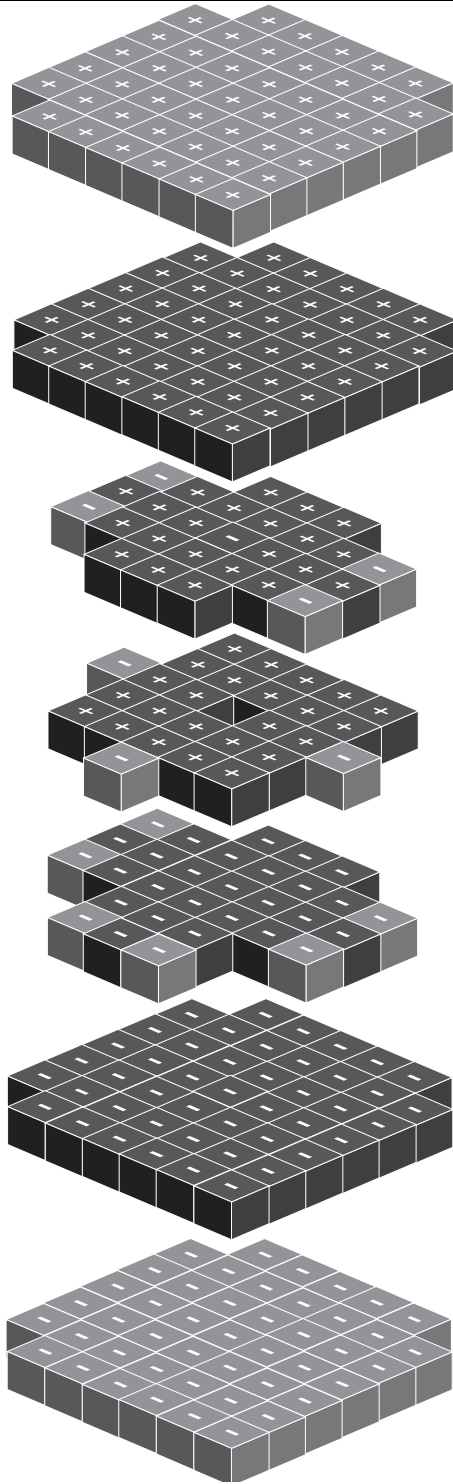


Lr 262
Proton:103
Neutron:159
Spin:2#

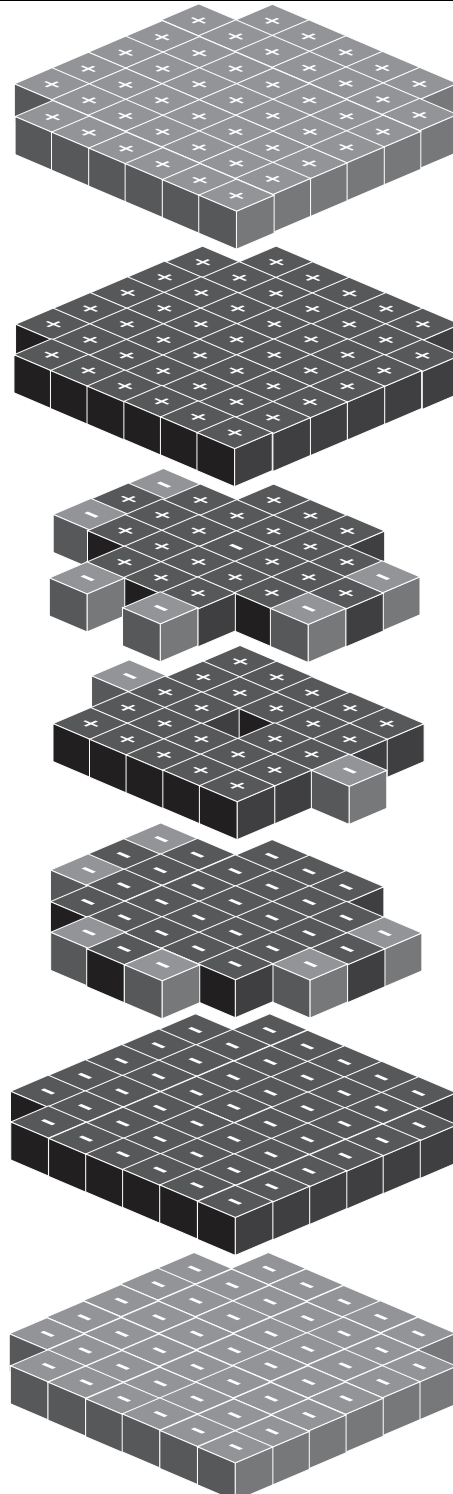
Rf 267
Proton:104
Neutron:163
Spin: 9/2#



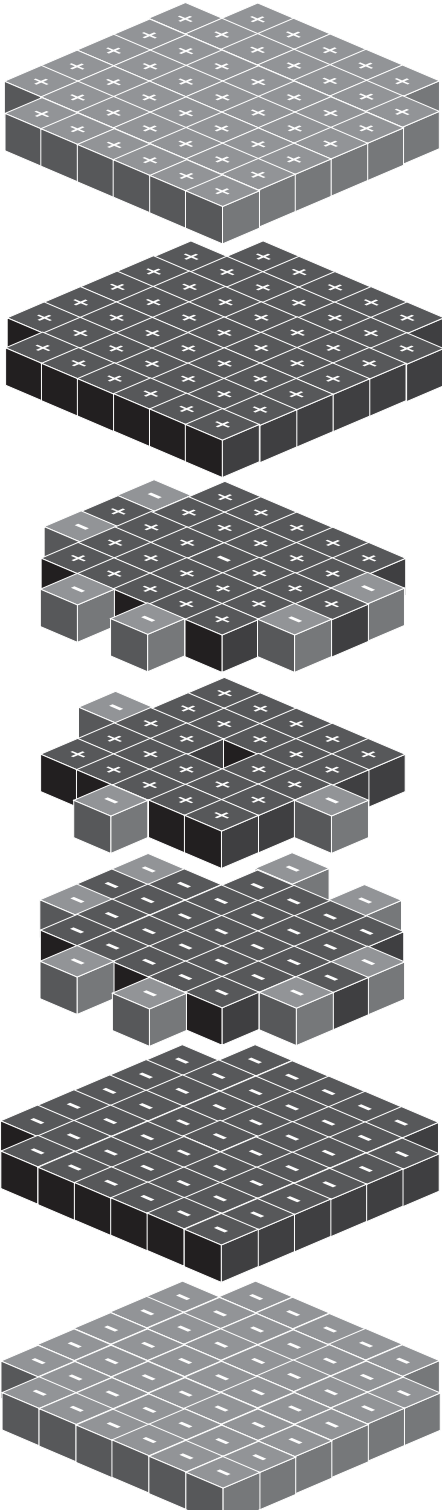
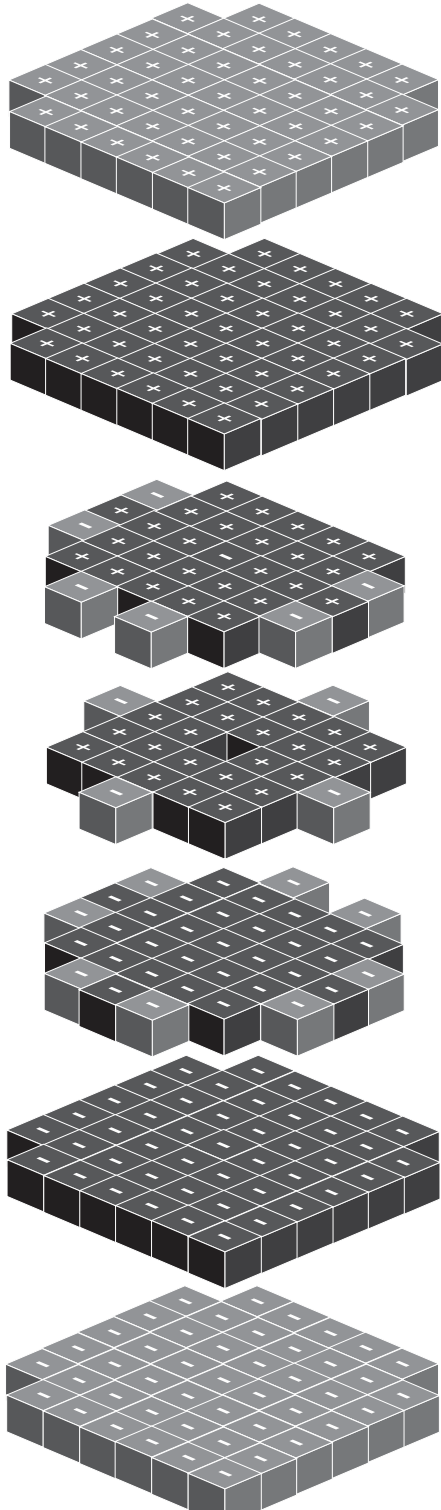
Db 268
Proton:105
Neutron:163
Spin:4#



Sg 271
Proton:106
Neutron:165
Spin:5/2#



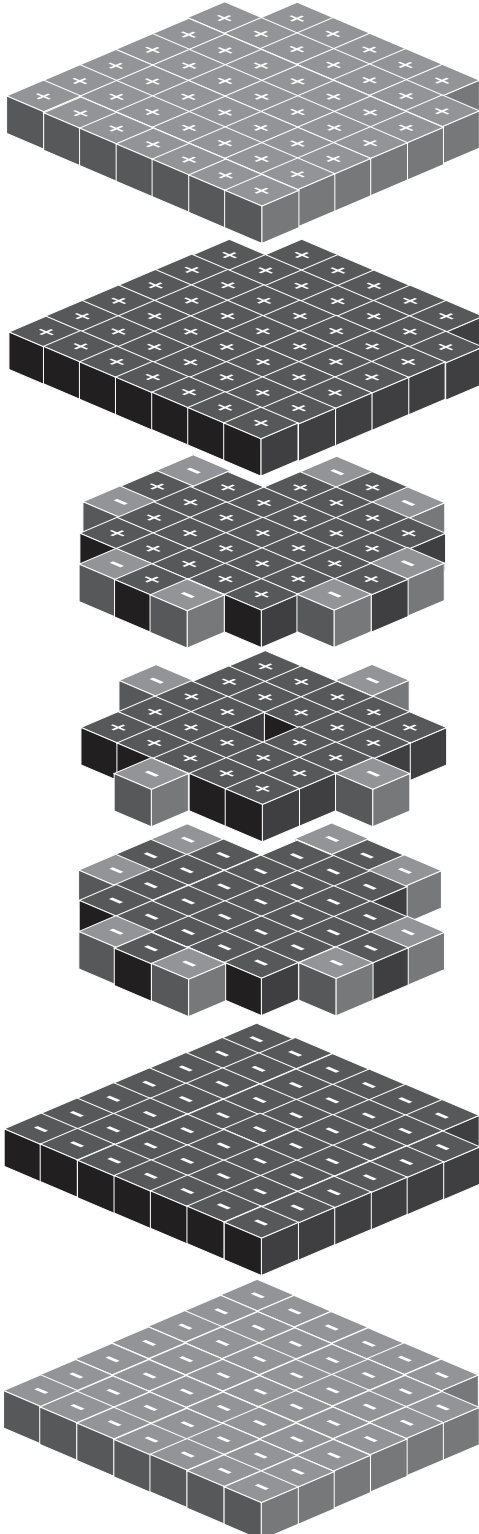
<p>Bh 274 Proton:107 Neutron:167 Spin:1</p>	<p>Hs 277 Proton:108 Neutron:169 Spin:5/2</p>

<p>Mt 278 Proton:109 Neutron:169 Spin:3</p>	<p>Ds 281 Proton:110 Neutron:171 Spin:3/2</p>
	

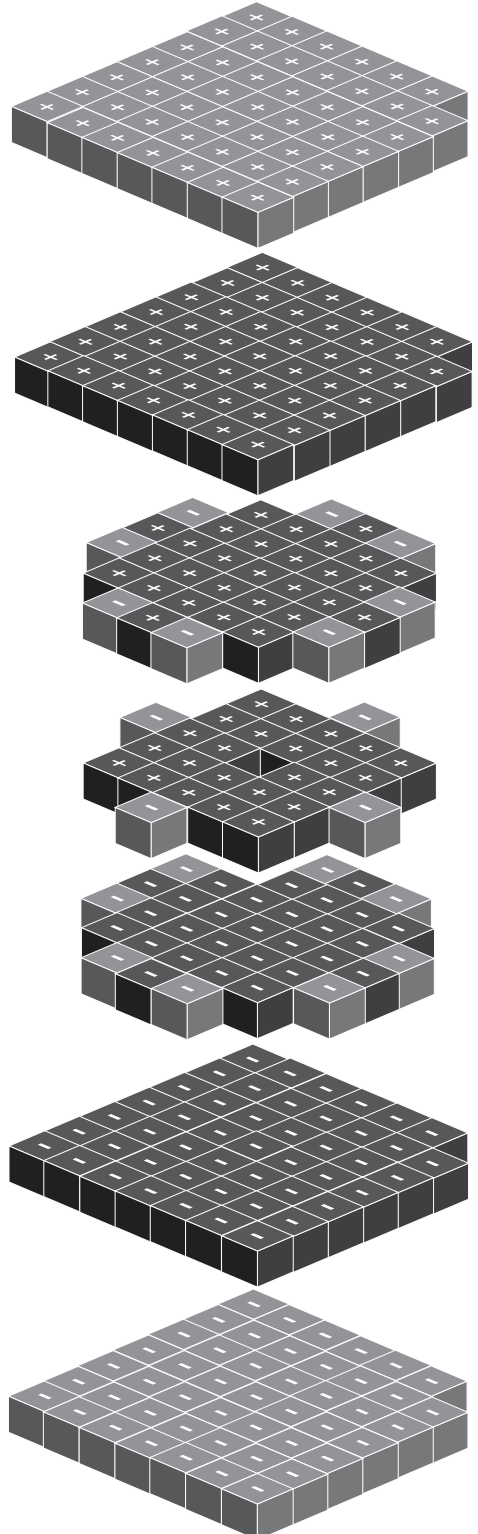
<p>Rg 281 Proton:111 Neutron:170 Spin:5/2</p>	<p>Cn 285 Proton:112 Neutron:173 Spin:5/2</p>

<p>Uut 286 Proton:113 Neutron:173 Spin:2</p>	<p>Uuq 289 Proton:114 Neutron:175 Spin:5/2</p>

Uup 289
Proton:115
Neutron:174
Spin:3/2

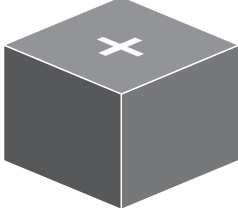
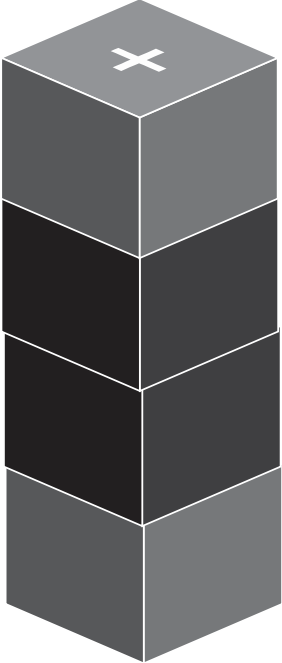


Uuh 293
Proton:116
Neutron:177
Spin:5/2

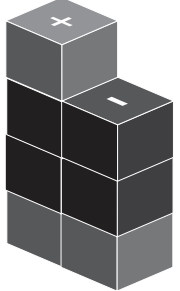

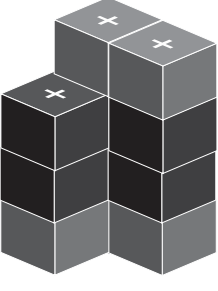
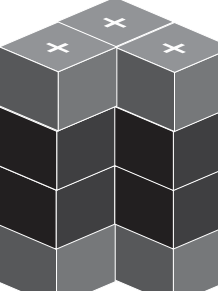
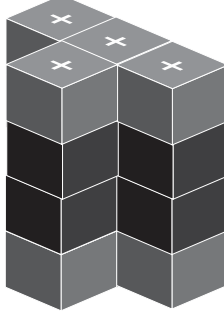
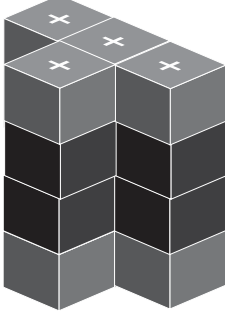
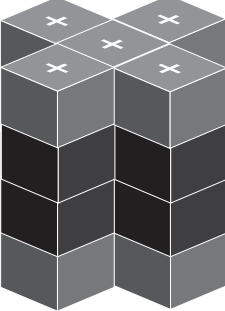
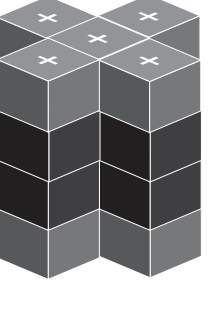


<p>Uus 294 Proton:117 Neutron:177 Spin:2</p>	<p>Uuo 294 Proton:118 Neutron:176 Spin:0</p>

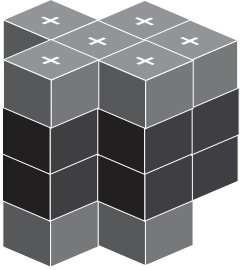
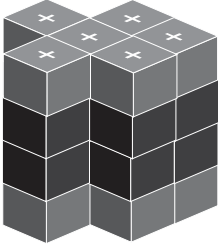
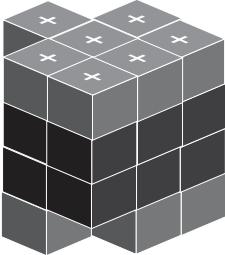
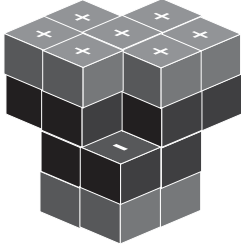
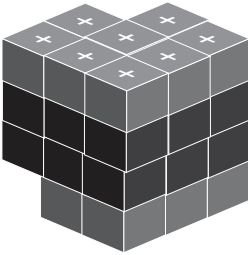
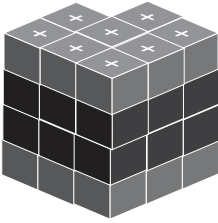
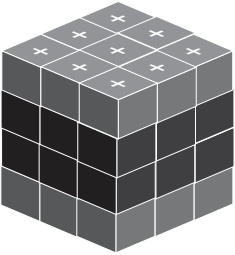
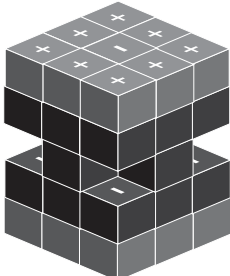
Period One Nuclide 3D Structure

<p>H1 Proton: 1 Neutron: 0 Spin: 1/2 Stable</p>	<p>He 4 Proton: 2 Neutron: 2 Spin: 0 Stable</p>
	

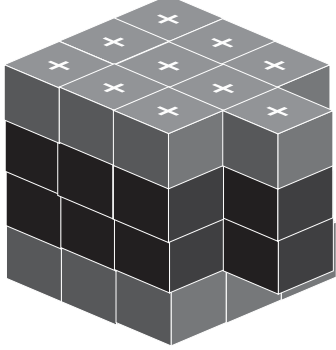
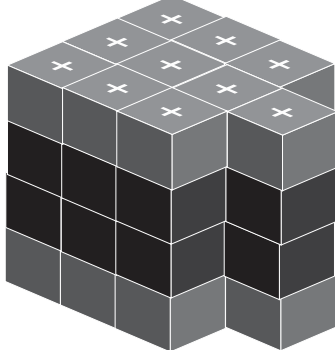
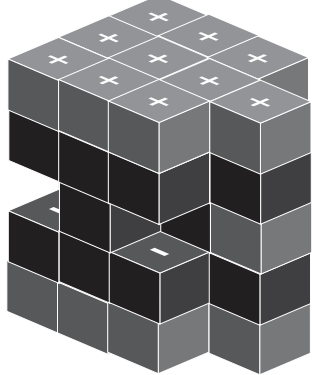
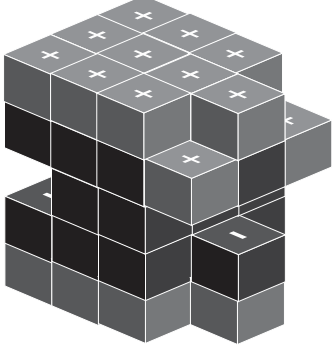
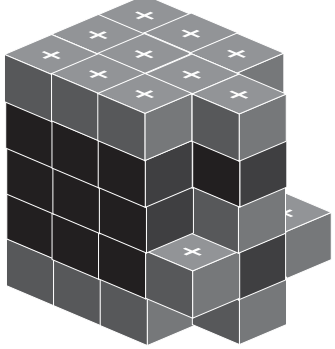
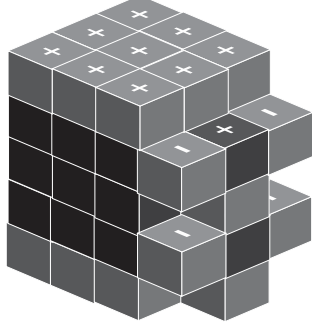
Period Two Nuclide

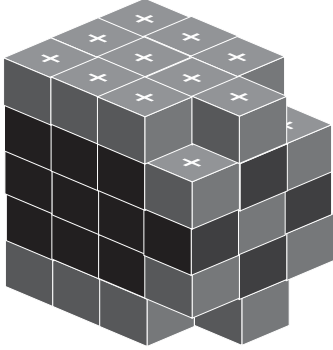
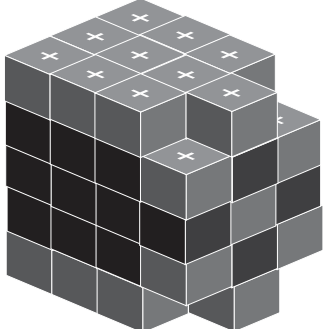
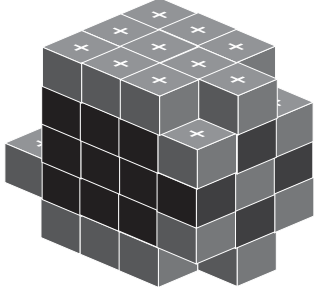
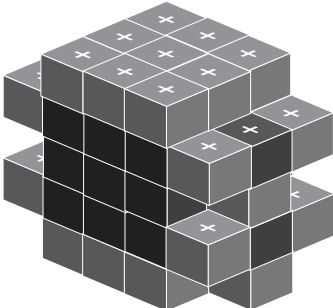
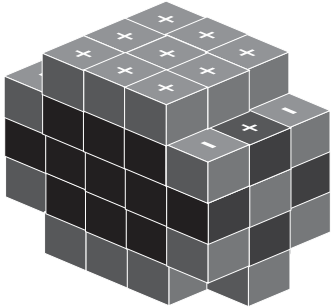
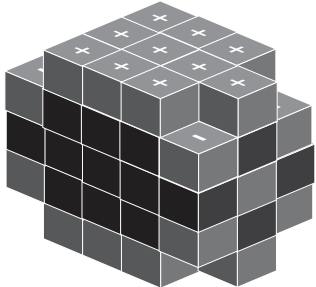
<p>Li 7 Proton: 3 Neutron: 4 Spin: $-3/2$ Stable</p>	<p>Be 9 Proton: 4 Neutron: 5 Spin: $-3/2$ Stable</p>	<p>B 11 Proton: 5 Neutron: 6 Spin: $-3/2$ Stable</p>	<p>C 12 Proton: 6 Neutron: 6 Spin: 0 Stable</p>
			
<p>N 14 Proton: 7 Neutron: 7 Spin: 1 Stable</p>	<p>O 16 Proton: 8 Neutron: 8 Spin: 0 Stable</p>	<p>F 19 Proton: 9 Neutron: 10 Spin: $1/2$ Stable</p>	<p>Ne 20 Proton: 10 Neutron: 10 Spin: 0 Stable</p>
			

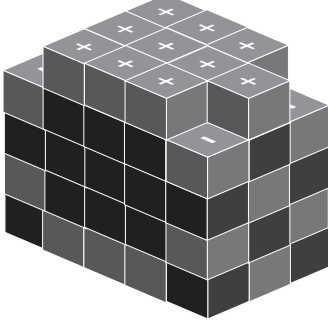
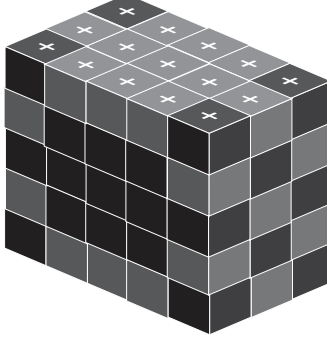
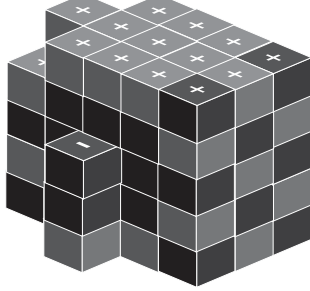
Period Three 3D Nuclide Structure

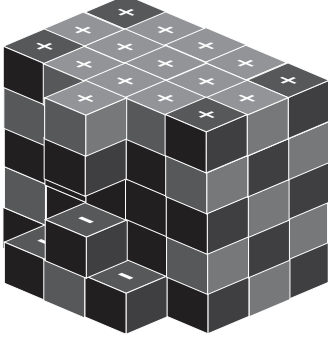
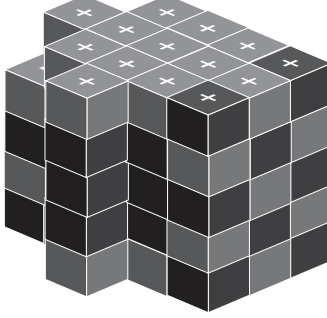
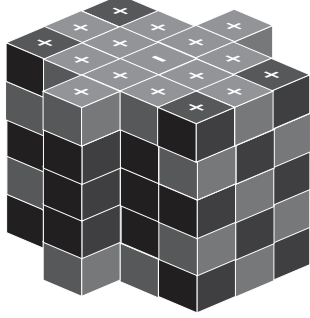
<p>Na 23 Proton: 11 Neutron: 12 Spin: 3/2 Stable</p>	<p>Mg 24 Proton: 12 Neutron: 12 Spin: 0 Stable</p>	<p>Al 27 Proton: 13 Neutron: 14 Spin: 5/2 Stable</p>	<p>Si 28 Proton: 14 Neutron: 14 Spin: 0 Stable</p>
			
<p>P 31 Proton: 15 Neutron: 16 Spin: 1/2 Stable</p>	<p>S 32 Proton: 16 Neutron: 16 Spin: 0 Stable</p>	<p>Cl 35 Proton: 17 Neutron: 18 Spin: 3/2 Stable</p>	<p>Ar 40 Proton: 18 Neutron: 22 Spin: 0 Stable</p>
			

Period Four 3D Nuclide Structure

<p>K 39 Proton: 19 Neutron: 20 Spin: 3/2 Stable</p>	<p>Ca 40 Proton: 20 Neutron: 20 Spin: 0 Stable</p>	<p>Sc 45 Proton: 21 Neutron: 24 Spin: -7/2 Stable</p>
		
<p>Ti 48 Proton: 22 Neutron: 26 Spin: 0 Stable</p>	<p>V51 Proton: 23 Neutron: 28 Spin: -7/2 Stable</p>	<p>Cr 52 Proton: 24 Neutron: 28 Spin: 0 Stable</p>
		

<p>Mn 55 Proton: 25 Neutron: 30 Spin: $-5/2$ Stable</p>	<p>Fe 56 Proton: 26 Neutron: 30 Spin: 0 Stable</p>	<p>Co 59 Proton 27 Neutron 32 Spin: $-7/2$ Stable</p>
 <p>A 3D model of the Mn-55 nucleus, showing a core of 28 nucleons (14 protons and 14 neutrons) with 27 additional neutrons arranged in a shell-like structure. The top surface is marked with 'x' symbols.</p>	 <p>A 3D model of the Fe-56 nucleus, showing a core of 28 nucleons (14 protons and 14 neutrons) with 28 additional nucleons (14 protons and 14 neutrons) arranged in a shell-like structure. The top surface is marked with 'x' symbols.</p>	 <p>A 3D model of the Co-59 nucleus, showing a core of 28 nucleons (14 protons and 14 neutrons) with 31 additional neutrons arranged in a shell-like structure. The top surface is marked with 'x' symbols.</p>
<p>Ni 58 Proton: 28 Neutron: 30 Spin: 0 Stable</p>	<p>Cu 63 Proton 29 Neutron 34 Spin: $-3/2$ Stable</p>	<p>Zn 64 Proton 30 Neutron 34 Spin: 0 Stable</p>
 <p>A 3D model of the Ni-58 nucleus, showing a core of 28 nucleons (14 protons and 14 neutrons) with 30 additional neutrons arranged in a shell-like structure. The top surface is marked with 'x' symbols.</p>	 <p>A 3D model of the Cu-63 nucleus, showing a core of 28 nucleons (14 protons and 14 neutrons) with 35 additional nucleons (15 protons and 20 neutrons) arranged in a shell-like structure. The top surface is marked with 'x' symbols.</p>	 <p>A 3D model of the Zn-64 nucleus, showing a core of 28 nucleons (14 protons and 14 neutrons) with 36 additional neutrons arranged in a shell-like structure. The top surface is marked with 'x' symbols.</p>

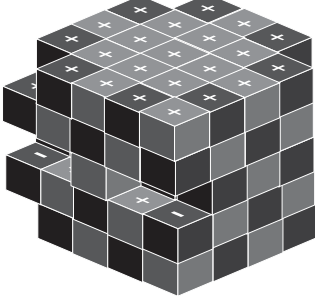
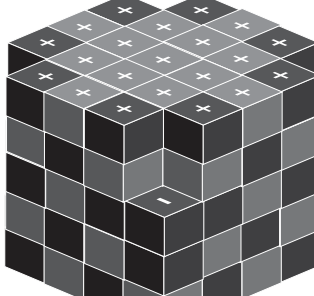
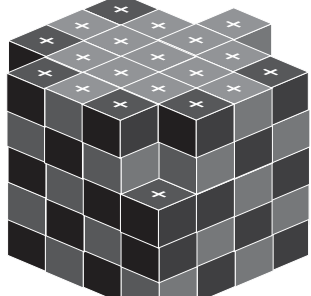
<p>Ga 69 Proton 31 Neutron 38 Spin: -3/2 Stable</p>	<p>Ge 74 Proton 32 Neutron 42 Spin: 0 Stable</p>	<p>As 75 Proton: 33 Neutron: 42 Spin: -3/2 Stable</p>
 <p>A 3D model of the Gallium-69 nucleus, showing 31 protons (represented by 'x' marks) and 38 neutrons (represented by '-' marks) arranged in a complex, roughly spherical structure.</p>	 <p>A 3D model of the Germanium-74 nucleus, showing 32 protons (represented by 'x' marks) and 42 neutrons (represented by '-' marks) arranged in a complex, roughly spherical structure.</p>	 <p>A 3D model of the Arsenic-75 nucleus, showing 33 protons (represented by 'x' marks) and 42 neutrons (represented by '-' marks) arranged in a complex, roughly spherical structure.</p>

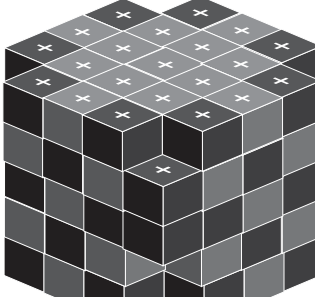
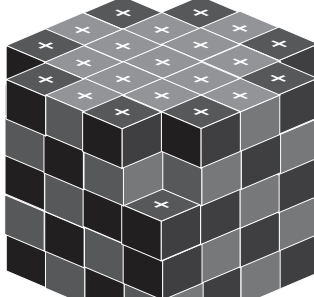
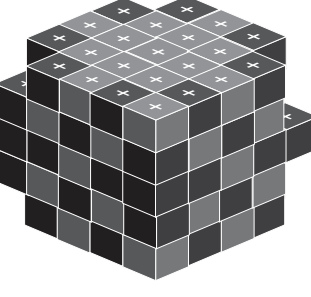
<p>Se 80 Proton:34 Neutron:46 Spin: 0 Stable</p>	<p>Br 79 Proton: 35 Neutron: 44 Spin: -3/2 Stable</p>	<p>Kr 84 Proton: 36 Neutron: 48 Spin: 0 Stable</p>
 <p>A 3D model of the Selenium-80 nucleus, showing 34 protons (represented by 'x' marks) and 46 neutrons (represented by '-' marks) arranged in a complex, roughly spherical structure.</p>	 <p>A 3D model of the Bromine-79 nucleus, showing 35 protons (represented by 'x' marks) and 44 neutrons (represented by '-' marks) arranged in a complex, roughly spherical structure.</p>	 <p>A 3D model of the Krypton-84 nucleus, showing 36 protons (represented by 'x' marks) and 48 neutrons (represented by '-' marks) arranged in a complex, roughly spherical structure.</p>

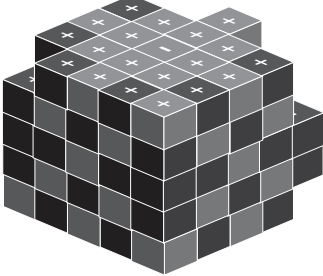
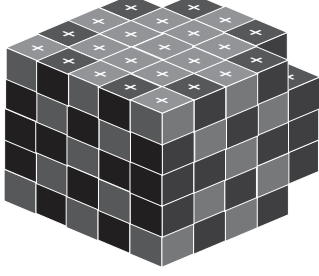
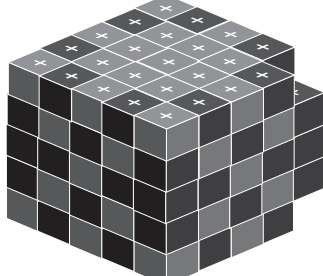
Period Five 3D Nuclide Structure

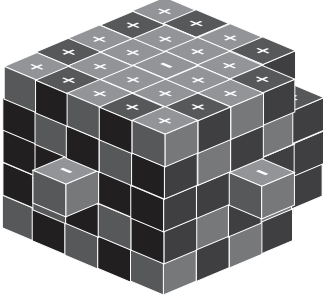
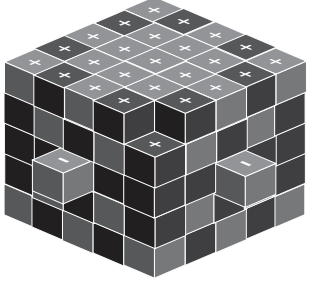
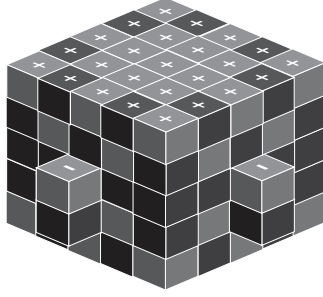
Rb 85 Proton: 37 Neutron: 48 Spin: -5/2 Stable	Sr 88 Proton: 38 Neutron: 50 Spin: 0 Stable	Y 89 Proton: 39 Neutron: 50 Spin: -1/2 Stable

Zr 90 Proton: 40 Neutron: 50 Spin: 0 Stable	Nb 93 Proton: 41 Neutron: 52 Spin: 9/2 Stable	Mo 98 Proton: 42 Neutron: 56 Spin: 0 Stable

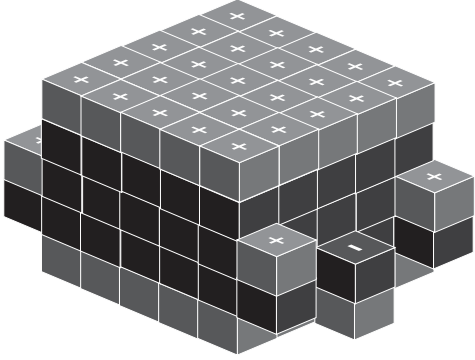
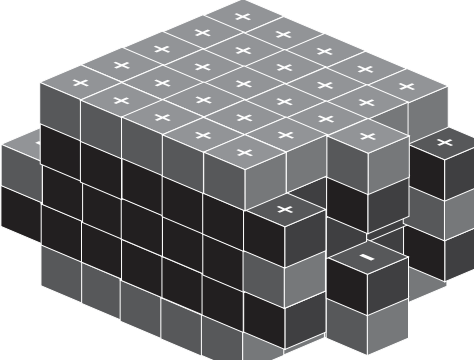
<p>Tc 99 Proton: 43 Neutron: 56 Spin: 9/2 Half-life: 2.111×10^5 year</p>	<p>Ru 102 Proton: 44 Neutron: 58 Spin: 0 Stable</p>	<p>Rh 103 Proton: 45 Neutron: 58 Spin: -1/2 Stable</p>
		

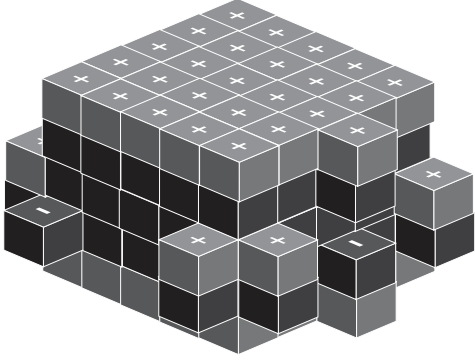
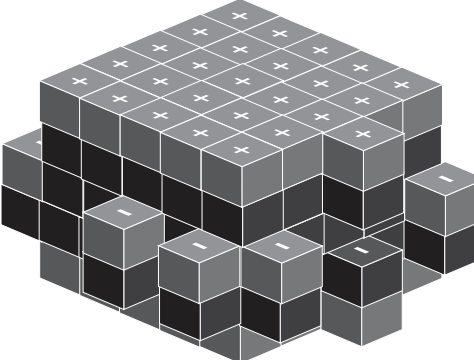
<p>Pd 106 Proton: 46 Neutron: 60 Spin: 0 Stable</p>	<p>Ag 107 Proton: 47 Neutron: 60 Spin: -1/2 Stable</p>	<p>Cd 114 Proton: 48 Neutron: 66 Spin: 0 Stable</p>
		

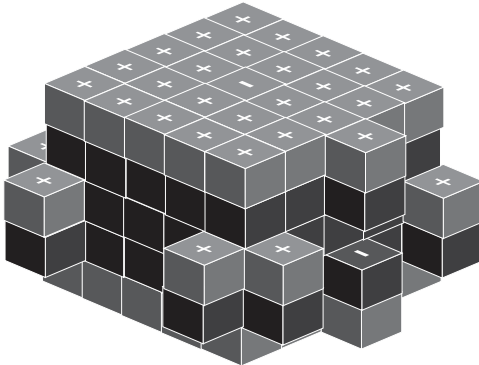
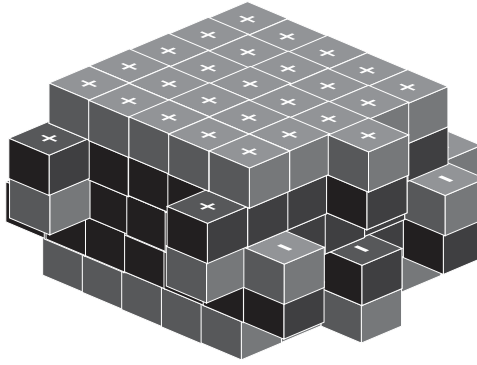
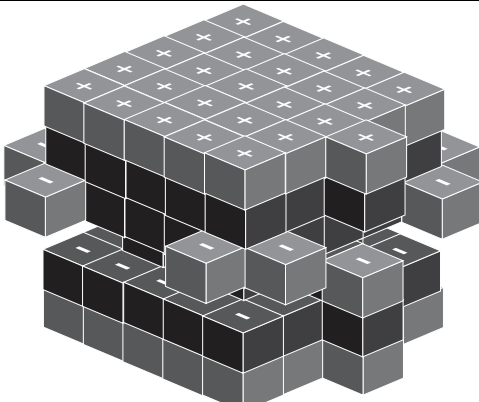
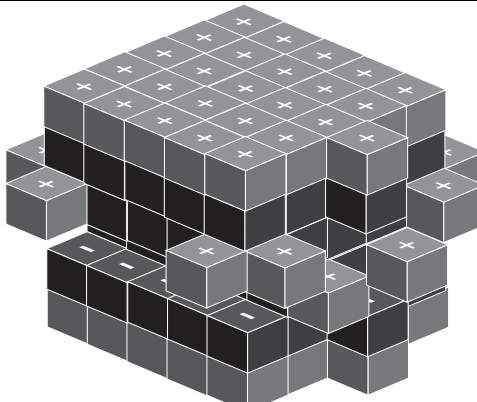
<p>In 113 Proton: 49 Neutron: 64 Spin: 9/2 Stable</p>	<p>Sn 120 Proton: 50 Neutron: 70 Spin:0 Stable</p>	<p>Sb 121 Proton: 51 Neutron: 70 Spin:5/2 Stable</p>
		

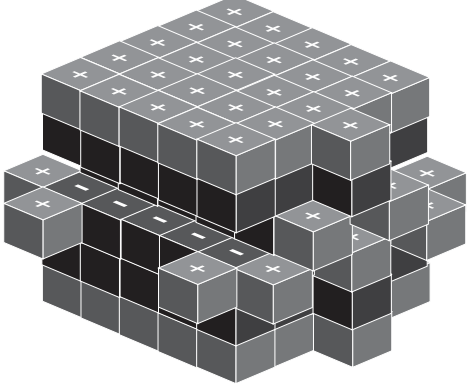
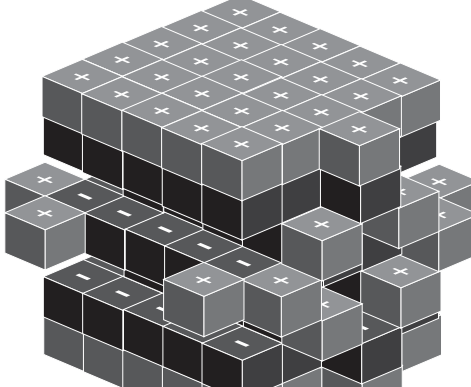
<p>Te 126 Proton: 52 Neutron: 74 Spin:0 Stable</p>	<p>I 127 Proton: 53 Neutron: 74 Spin:5/2 Stable</p>	<p>Xe132 Proton: 54 Neutron: 78 Spin:0 Stable</p>
		

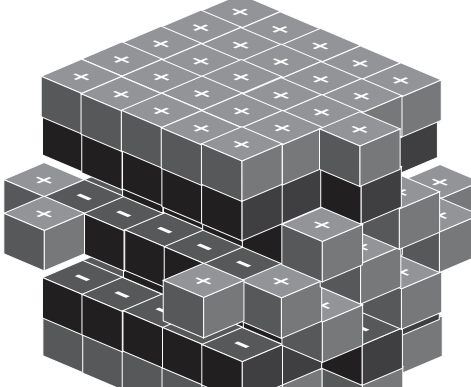
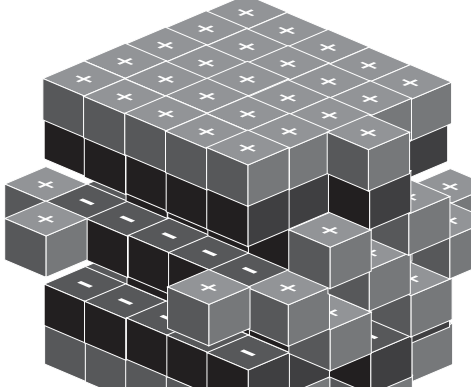
Period six 3D Nuclide Structure

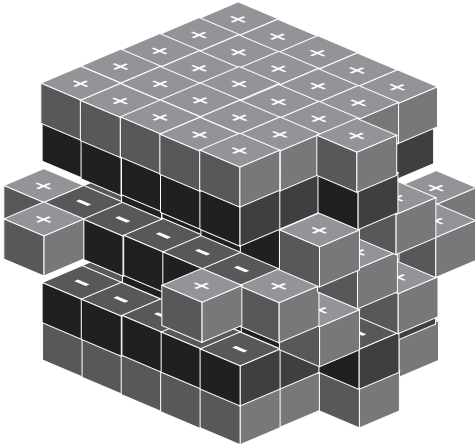
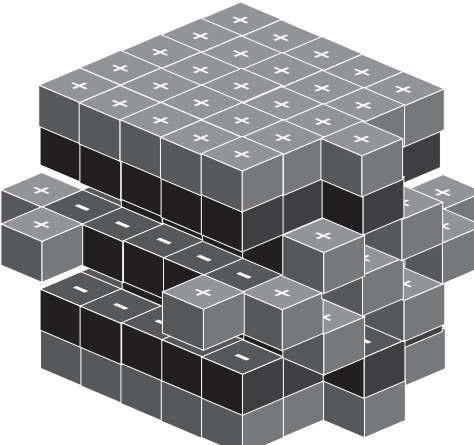
<p>Cs 133 Proton: 55 Neutron: 78 Spin: 7/2 Stable</p>	<p>Ba138 Proton: 56 Neutron: 82 Spin: 0 Stable</p>
 <p>A 3D model of the Cs-133 nuclide structure. It consists of a large central cube of 5x5x5 blocks (125 blocks) with a smaller 2x2x2 cube (8 blocks) attached to the bottom-right corner. The top surface of the 5x5x5 cube is marked with 'x' characters.</p>	 <p>A 3D model of the Ba-138 nuclide structure. It consists of a large central cube of 5x5x5 blocks (125 blocks) with a smaller 2x2x2 cube (8 blocks) attached to the bottom-right corner. The top surface of the 5x5x5 cube is marked with 'x' characters.</p>

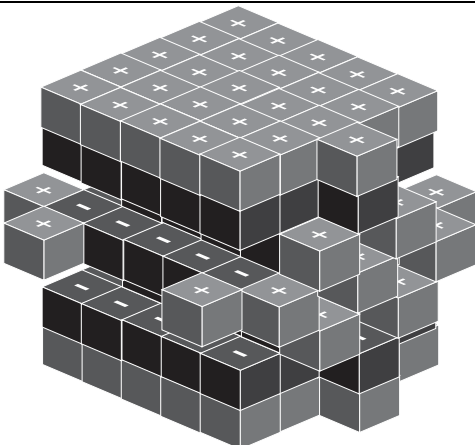
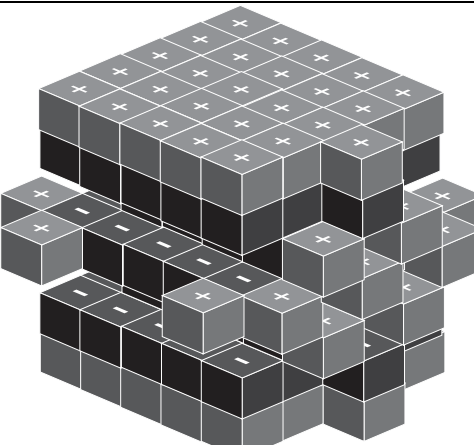
<p>La 139 Proton: 57 Neutron: 82 Spin: 7/2 Stable</p>	<p>Ce 140 Proton: 58 Neutron: 82 Spin: 0 Stable</p>
 <p>A 3D model of the La-139 nuclide structure. It consists of a large central cube of 5x5x5 blocks (125 blocks) with a smaller 2x2x2 cube (8 blocks) attached to the bottom-right corner. The top surface of the 5x5x5 cube is marked with 'x' characters.</p>	 <p>A 3D model of the Ce-140 nuclide structure. It consists of a large central cube of 5x5x5 blocks (125 blocks) with a smaller 2x2x2 cube (8 blocks) attached to the bottom-right corner. The top surface of the 5x5x5 cube is marked with 'x' characters.</p>

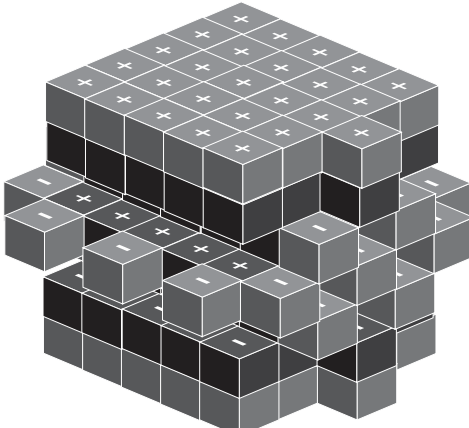
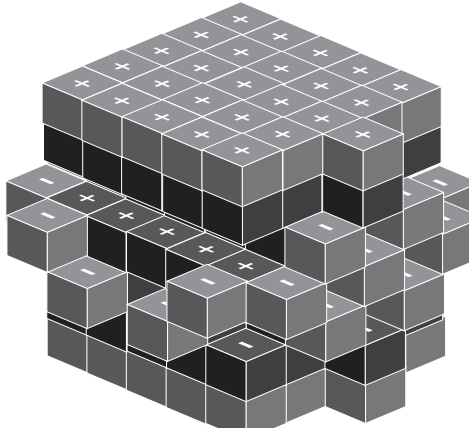
<p>Pr 141 Proton: 59 Neutron: 82 Spin:5/2 Stable</p>	<p>Nd 142 Proton: 60 Neutron: 82 Spin:0 Stable</p>
 <p>A 3D model of the Pr 141 nucleus, showing a central core of 59 protons (represented by 'x' marks) and 82 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>	 <p>A 3D model of the Nd 142 nucleus, showing a central core of 60 protons (represented by 'x' marks) and 82 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>
<p>Pm 147 Proton: 61 Neutron: 86 Spin:7/2 Half-life: 2.6234 year</p>	<p>Sm 152 Proton: 62 Neutron: 90 Spin:0 Stable</p>
 <p>A 3D model of the Pm 147 nucleus, showing a central core of 61 protons (represented by 'x' marks) and 86 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>	 <p>A 3D model of the Sm 152 nucleus, showing a central core of 62 protons (represented by 'x' marks) and 90 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>

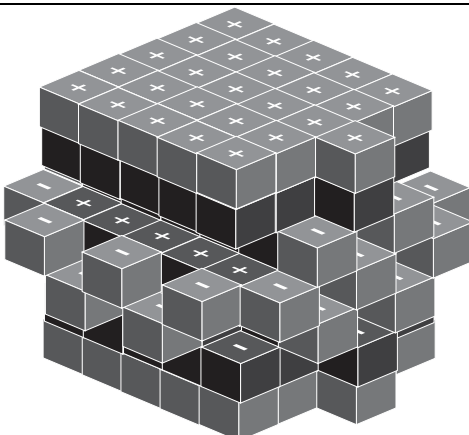
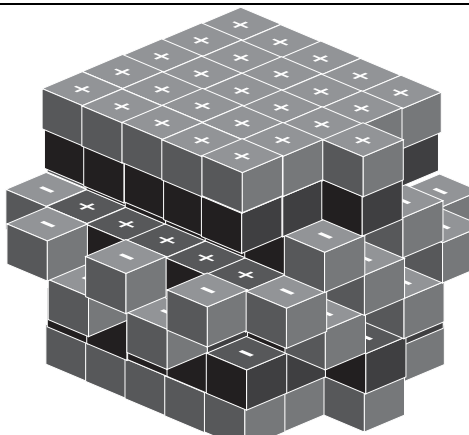
<p>Eu 153 Proton: 63 Neutron: 90 Spin:5/2 Stable</p>	<p>Gd 158 Proton: 64 Neutron: 94 Spin:0 Stable</p>
	

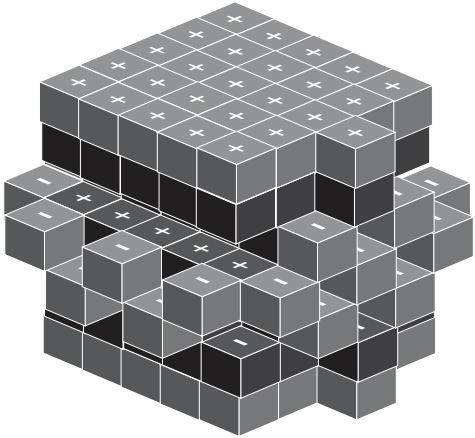
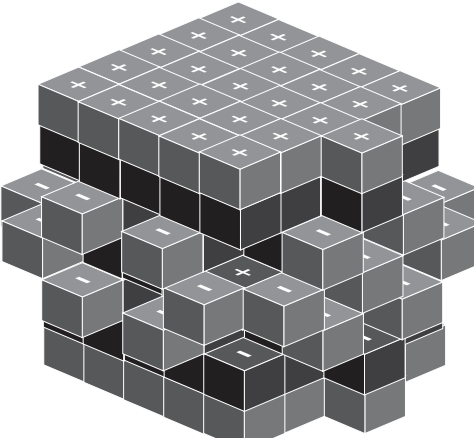
<p>Tb 159 Proton: 65 Neutron: 94 Spin:3/2 Stable</p>	<p>Dy 164 Proton: 66 Neutron: 98 Spin:0 Stable</p>
	

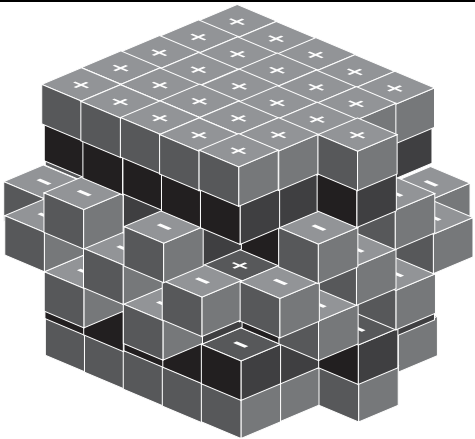
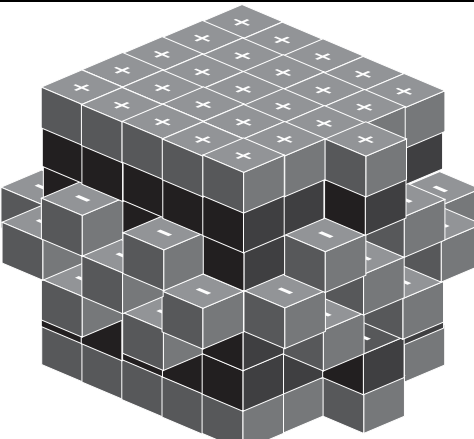
<p>Ho 165 Proton: 67 Neutron: 98 Spin:-7/2 Stable</p>	<p>Er 166 Proton: 68 Neutron: 98 Spin:0 Stable</p>
 <p>A 3D model of the Ho-165 nucleus, showing a central core of 67 protons (marked with 'x') and 98 neutrons (marked with '-' signs) arranged in a complex, roughly spherical structure.</p>	 <p>A 3D model of the Er-166 nucleus, showing a central core of 68 protons (marked with 'x') and 98 neutrons (marked with '-' signs) arranged in a complex, roughly spherical structure.</p>

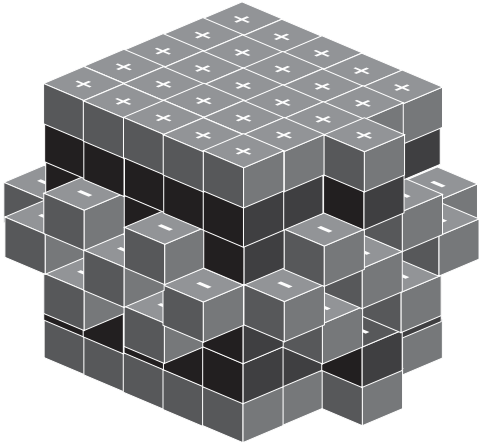
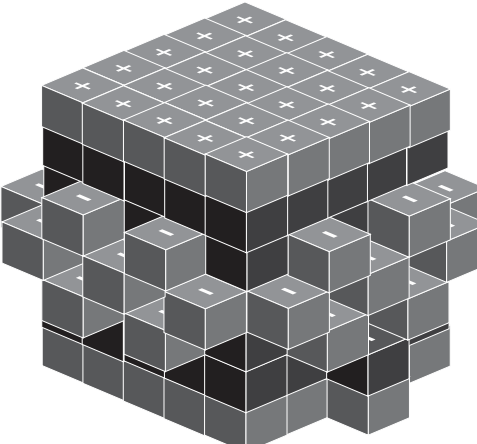
<p>Tm 169 Proton: 69 Neutron: 100 Spin:1/2 Stable</p>	<p>Yb 174 Proton: 70 Neutron: 104 Spin:0 Stable</p>
 <p>A 3D model of the Tm-169 nucleus, showing a central core of 69 protons (marked with 'x') and 100 neutrons (marked with '-' signs) arranged in a complex, roughly spherical structure.</p>	 <p>A 3D model of the Yb-174 nucleus, showing a central core of 70 protons (marked with 'x') and 104 neutrons (marked with '-' signs) arranged in a complex, roughly spherical structure.</p>

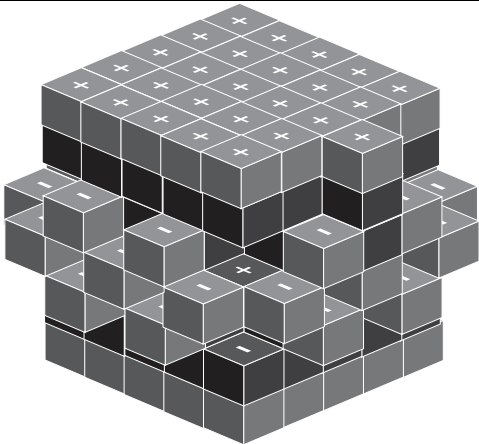
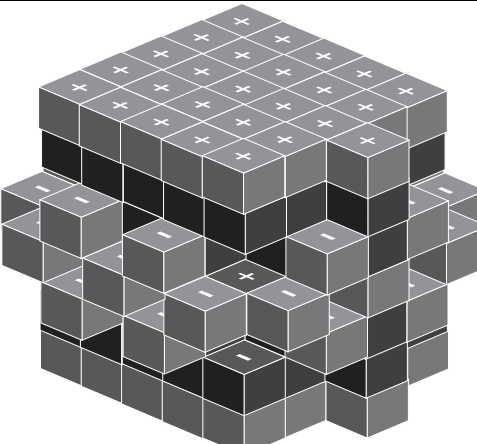
<p>Lu 175 Proton: 71 Neutron: 104 Spin: 7/2 Stable</p>	<p>Hf 176 Proton: 72 Neutron: 104 Spin: 0 Stable</p>
	

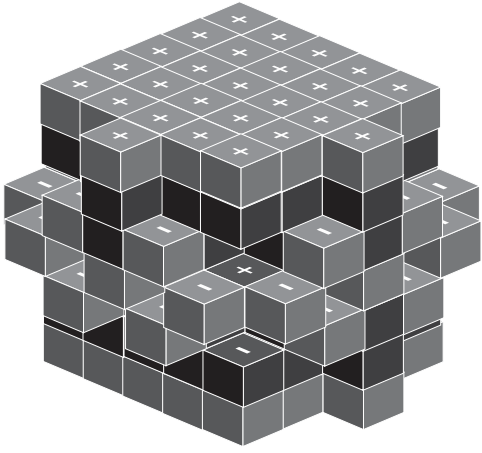
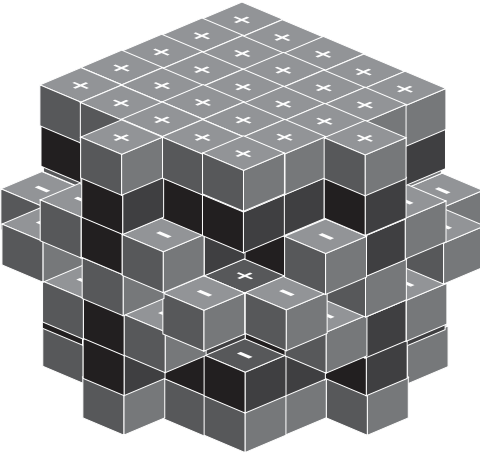
<p>Ta 180 Proton: 73 Neutron: 107 Spin: 1 Stable</p>	<p>Ta 180m1 Proton: 73 Neutron: 107 Spin: 9 Stable</p>
	

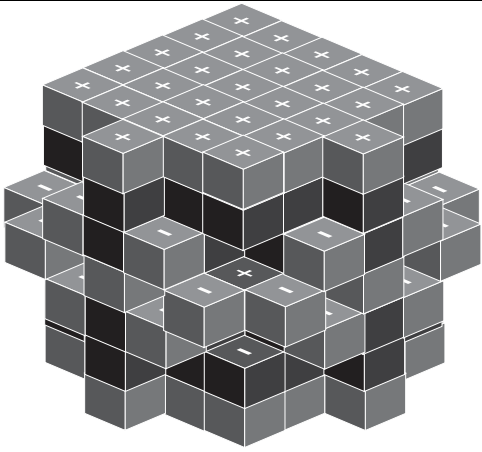
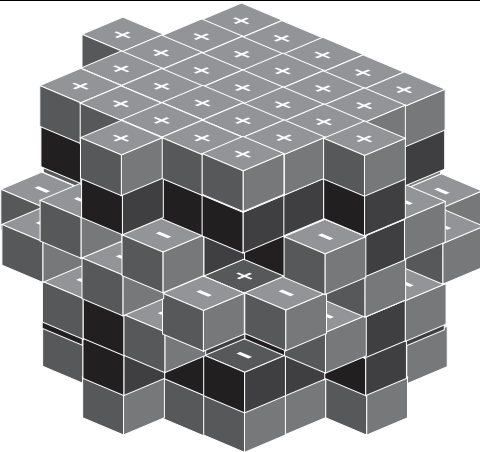
<p>Ta 181 Proton: 73 Neutron: 108 Spin:7/2 Stable</p>	<p>W 184 Proton: 74 Neutron: 110 Spin:0 Stable</p>
 <p>A 3D model of the Ta-181 nucleus, showing a central core of 73 protons (marked with 'x') and 108 neutrons (marked with '-'). The nucleus is roughly spherical with a jagged surface, characteristic of heavy nuclei.</p>	 <p>A 3D model of the W-184 nucleus, showing a central core of 74 protons (marked with 'x') and 110 neutrons (marked with '-'). The nucleus is roughly spherical with a jagged surface, characteristic of heavy nuclei.</p>

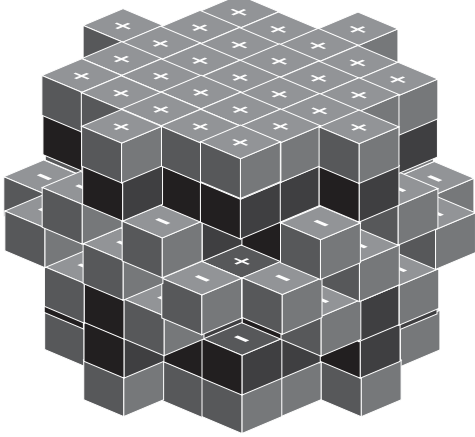
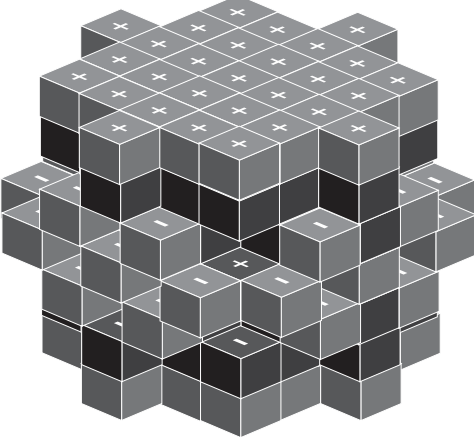
<p>Re 185 Proton: 75 Neutron: 110 Spin:5/2 Stable</p>	<p>Os 192 Proton: 76 Neutron: 116 Spin:0 Stable</p>
 <p>A 3D model of the Re-185 nucleus, showing a central core of 75 protons (marked with 'x') and 110 neutrons (marked with '-'). The nucleus is roughly spherical with a jagged surface, characteristic of heavy nuclei.</p>	 <p>A 3D model of the Os-192 nucleus, showing a central core of 76 protons (marked with 'x') and 116 neutrons (marked with '-'). The nucleus is roughly spherical with a jagged surface, characteristic of heavy nuclei.</p>

<p>Ir 193 Proton: 77 Neutron: 116 Spin:3/2 Stable</p>	<p>Pt 195 Proton: 78 Neutron: 117 Spin:-1/2 Stable</p>
 <p>A 3D model of the Ir-193 nucleus, showing a central core of 77 protons (marked with 'x') and 116 neutrons (marked with '-') arranged in a complex, roughly spherical structure.</p>	 <p>A 3D model of the Pt-195 nucleus, showing a central core of 78 protons (marked with 'x') and 117 neutrons (marked with '-') arranged in a complex, roughly spherical structure.</p>

<p>Au 197 Proton: 79 Neutron: 118 Spin:3/2 Stable</p>	<p>Hg 202 Proton: 80 Neutron: 122 Spin:0 Stable</p>
 <p>A 3D model of the Au-197 nucleus, showing a central core of 79 protons (marked with 'x') and 118 neutrons (marked with '-') arranged in a complex, roughly spherical structure.</p>	 <p>A 3D model of the Hg-202 nucleus, showing a central core of 80 protons (marked with 'x') and 122 neutrons (marked with '-') arranged in a complex, roughly spherical structure.</p>

<p>Ti 205 Proton: 81 Neutron: 124 Spin:1/2 Stable</p>	<p>Pb 208 Proton: 82 Neutron: 126 Spin:0 Stable</p>
 <p>A 3D model of a Ti-205 nucleus, showing a central core of 81 protons (marked with 'x') and 124 neutrons (marked with '-') arranged in a roughly spherical, layered structure.</p>	 <p>A 3D model of a Pb-208 nucleus, showing a central core of 82 protons (marked with 'x') and 126 neutrons (marked with '-') arranged in a roughly spherical, layered structure.</p>

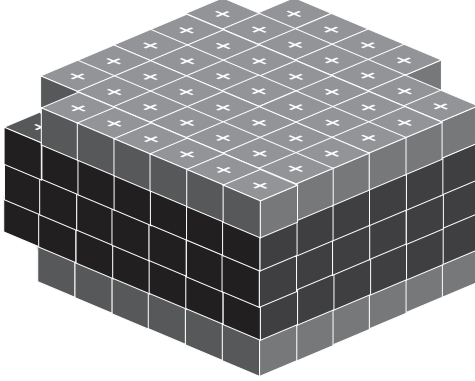
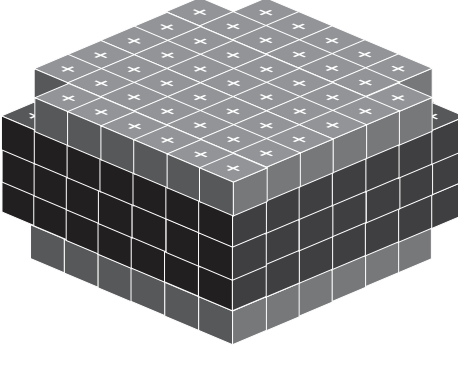
<p>Bi 209 Proton: 83 Neutron: 126 Spin:-9/2 Half-life: 1.9×10^{19} year</p>	<p>Po 209 Proton: 84 Neutron: 125 Spin:-1/2 Half-life: 103 year</p>
 <p>A 3D model of a Bi-209 nucleus, showing a central core of 83 protons (marked with 'x') and 126 neutrons (marked with '-') arranged in a roughly spherical, layered structure.</p>	 <p>A 3D model of a Po-209 nucleus, showing a central core of 84 protons (marked with 'x') and 125 neutrons (marked with '-') arranged in a roughly spherical, layered structure.</p>

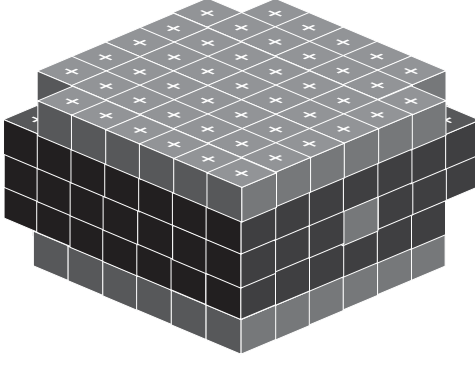
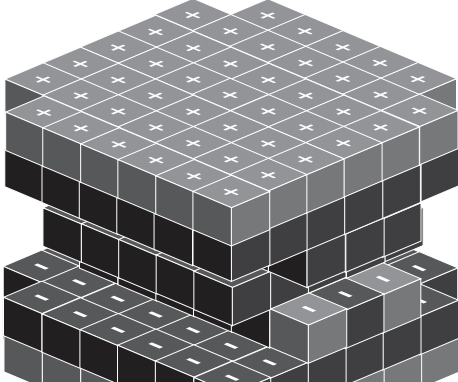
<p>At 210 Proton: 85 Neutron: 125 Spin:5 Half-life: 8.1 h</p>	<p>Rn 222 Proton: 86 Neutron: 136 Spin:0 Half-life: 3.8235 d</p>
 <p>A 3D model of an Astatine-210 nucleus, represented as a cluster of 210 nucleons. The nucleons are arranged in a roughly spherical, irregular shape. Protons are represented by grey cubes with a white 'x' on top, and neutrons are represented by black cubes with a white '-' on top. The model shows a complex arrangement of these nucleons, with some visible gaps and an overall irregular shape.</p>	 <p>A 3D model of a Radon-222 nucleus, represented as a cluster of 222 nucleons. The nucleons are arranged in a roughly spherical, irregular shape. Protons are represented by grey cubes with a white 'x' on top, and neutrons are represented by black cubes with a white '-' on top. The model shows a complex arrangement of these nucleons, with some visible gaps and an overall irregular shape.</p>

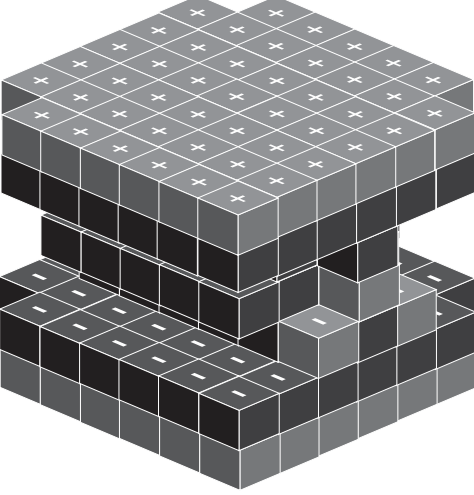
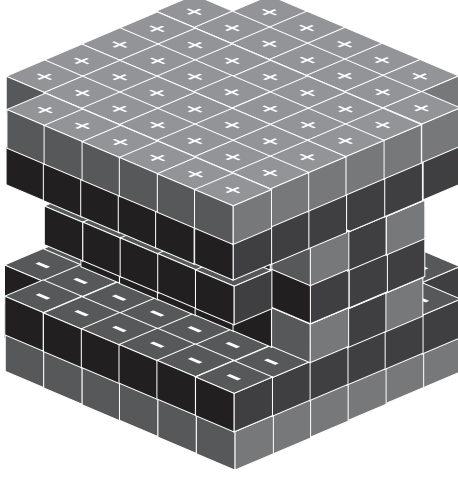
Period seven 3D Nuclide Structure

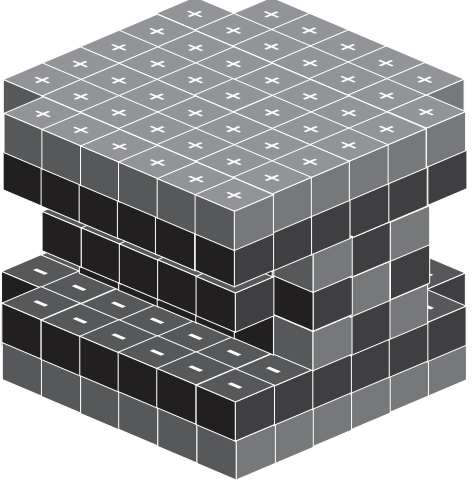
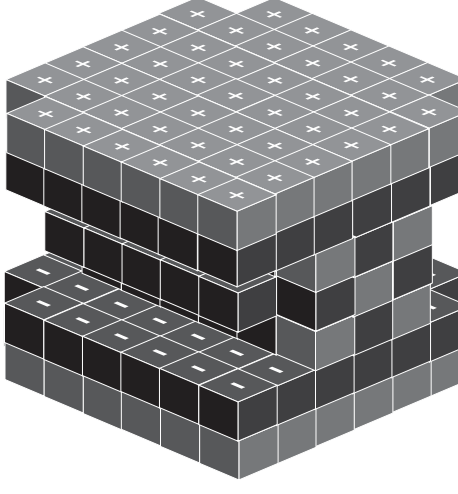
<p>Fr 223 Proton: 87 Neutron: 136 Spin:-3/2</p>	<p>Ra 226 Proton: 88 Neutron: 138 Spin:0</p>

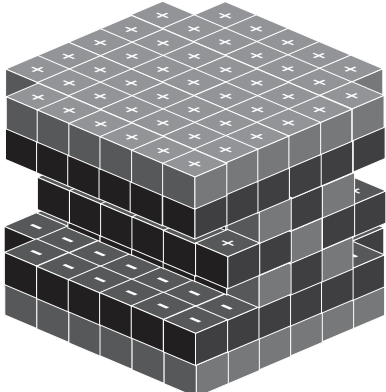
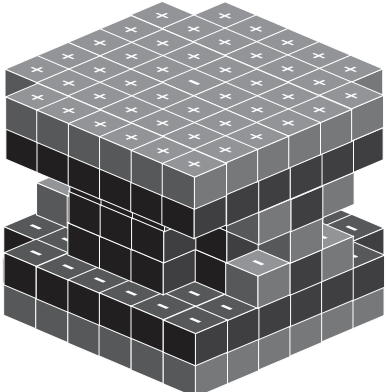
<p>Ac 227 Proton: 89 Neutron: 138 Spin:-3/2</p>	<p>Th 232 Proton: 90 Neutron: 142 Spin:0</p>

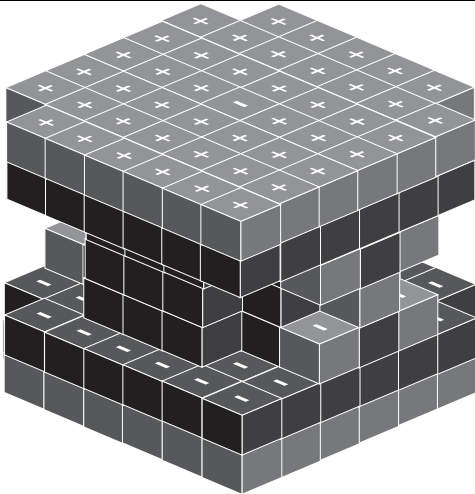
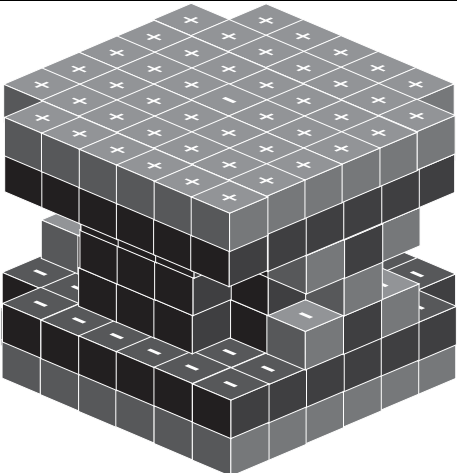
<p>Pa 231 Proton: 91 Neutron: 140 Spin:-3/2</p>	<p>U 238 Proton: 92 Neutron: 146 Spin:0</p>
 <p>A 3D model of the Pa-231 nucleus, showing a roughly spherical arrangement of nucleons. The top surface is marked with 'x' symbols, and the bottom surface with '-' symbols. The model is composed of several layers of nucleons, with a central core and an outer shell.</p>	 <p>A 3D model of the U-238 nucleus, showing a roughly spherical arrangement of nucleons. The top surface is marked with 'x' symbols, and the bottom surface with '-' symbols. The model is composed of several layers of nucleons, with a central core and an outer shell.</p>

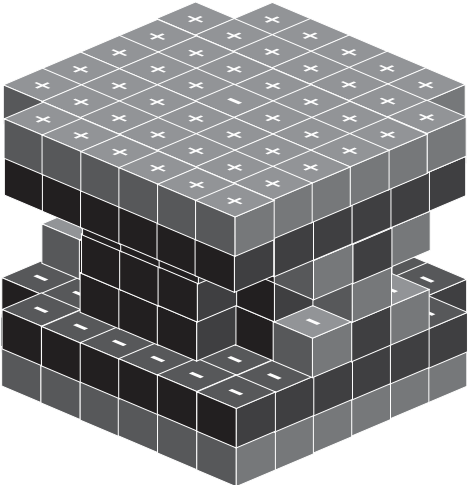
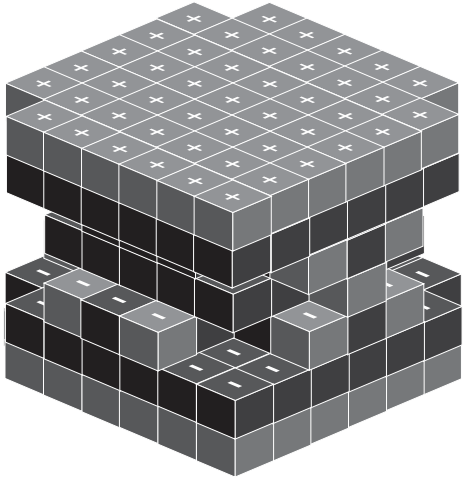
<p>Np 237 Proton: 93 Neutron: 144 Spin:5/2</p>	<p>Pu 244 Proton:94 Neutron:150 Spin:0</p>
 <p>A 3D model of the Np-237 nucleus, showing a roughly spherical arrangement of nucleons. The top surface is marked with 'x' symbols, and the bottom surface with '-' symbols. The model is composed of several layers of nucleons, with a central core and an outer shell.</p>	 <p>A 3D model of the Pu-244 nucleus, showing a roughly spherical arrangement of nucleons. The top surface is marked with 'x' symbols, and the bottom surface with '-' symbols. The model is composed of several layers of nucleons, with a central core and an outer shell.</p>

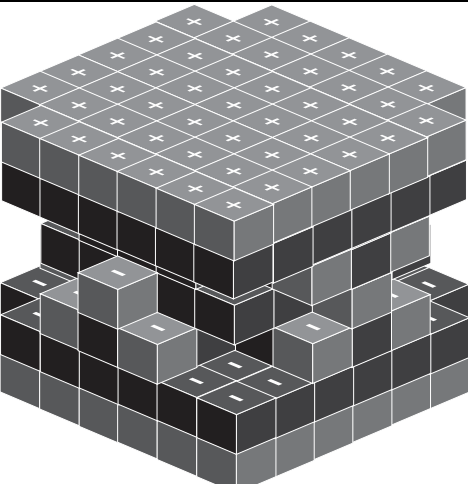
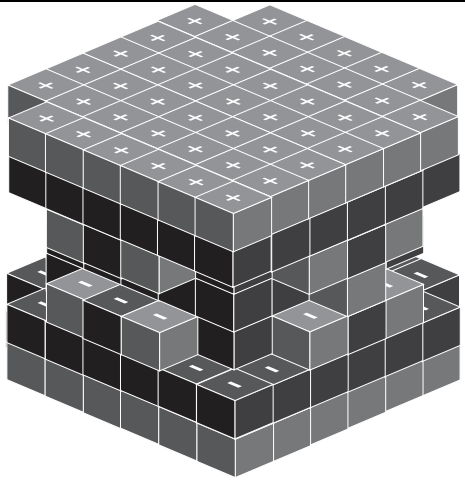
<p>Am 243 Proton:95 Neutron:148 Spin:-5/2</p>	<p>Cm 247 Proton:96 Neutron:151 Spin:-9/2</p>
 <p>A 3D model of the Americium-243 nucleus, showing a central core of 95 protons (represented by '+' signs) and 148 neutrons (represented by '-' signs). The nucleus is roughly spherical with a diameter of approximately 15 fm and a height of about 10 fm. The surface is irregular, reflecting the complex internal structure of the heavy nucleus.</p>	 <p>A 3D model of the Curium-247 nucleus, showing a central core of 96 protons (represented by '+' signs) and 151 neutrons (represented by '-' signs). The nucleus is roughly spherical with a diameter of approximately 15 fm and a height of about 10 fm. The surface is irregular, reflecting the complex internal structure of the heavy nucleus.</p>

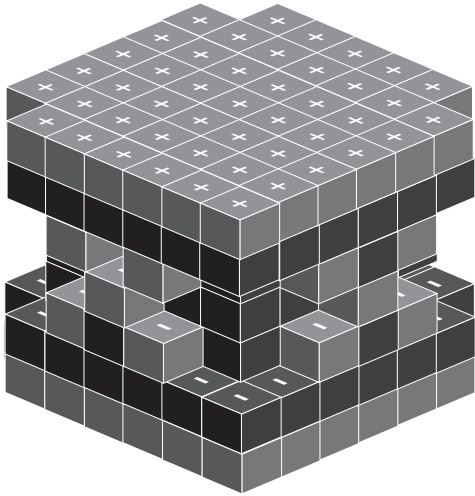
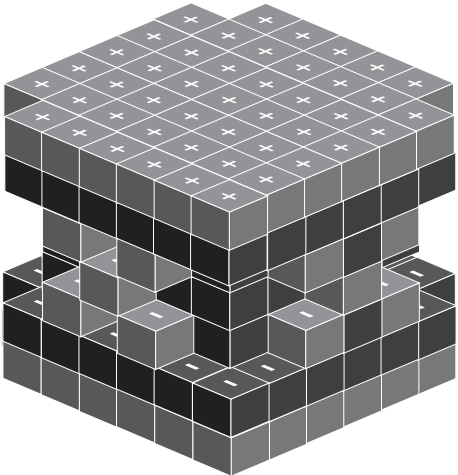
<p>Bk 247 Proton:97 Neutron:150 Spin:-3/2</p>	<p>Cf 251 Proton:98 Neutron:153 Spin:1/2</p>
 <p>A 3D model of the Berkelium-247 nucleus, showing a central core of 97 protons (represented by '+' signs) and 150 neutrons (represented by '-' signs). The nucleus is roughly spherical with a diameter of approximately 15 fm and a height of about 10 fm. The surface is irregular, reflecting the complex internal structure of the heavy nucleus.</p>	 <p>A 3D model of the Californium-251 nucleus, showing a central core of 98 protons (represented by '+' signs) and 153 neutrons (represented by '-' signs). The nucleus is roughly spherical with a diameter of approximately 15 fm and a height of about 10 fm. The surface is irregular, reflecting the complex internal structure of the heavy nucleus.</p>

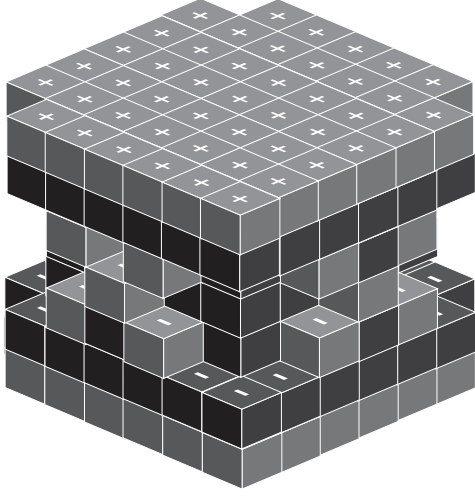
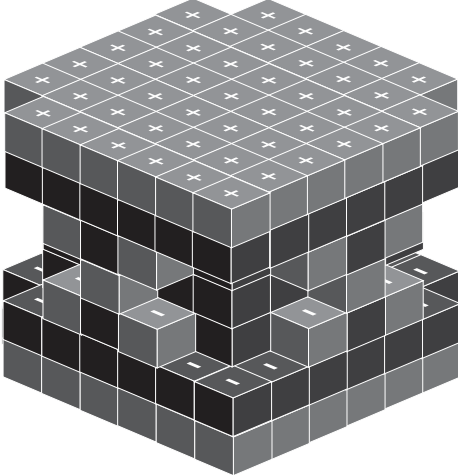
<p>Es 252 Proton:99 Neutron:153 Spin:-5</p>	<p>Fm 257 Proton:100 Neutron:157 Spin:9/2</p>
 <p>A 3D model of the Es 252 nucleus, showing a stack of 10 layers of nucleons. The top layer is a 10x10 grid of 100 protons (marked with 'x'). The bottom layer is a 10x10 grid of 100 neutrons (marked with '-'). The middle layers consist of 8 layers of 10 protons and 7 layers of 10 neutrons, totaling 153 nucleons.</p>	 <p>A 3D model of the Fm 257 nucleus, showing a stack of 10 layers of nucleons. The top layer is a 10x10 grid of 100 protons (marked with 'x'). The bottom layer is a 10x10 grid of 100 neutrons (marked with '-'). The middle layers consist of 8 layers of 10 protons and 7 layers of 10 neutrons, totaling 157 nucleons.</p>

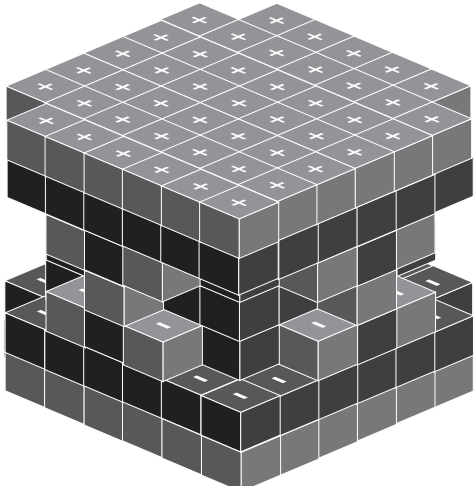
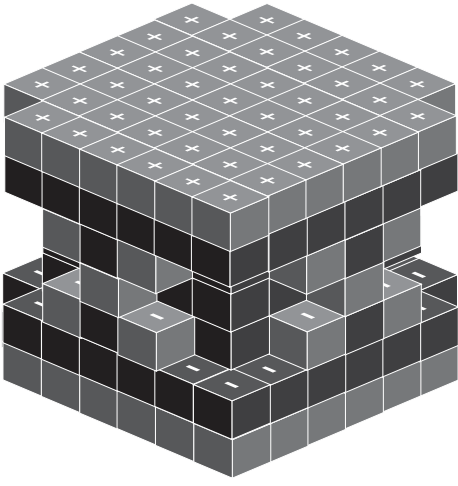
<p>Md 258 Proton:101 Neutron:157 Spin:-8</p>	<p>No 259 Proton:102 Neutron:157 Spin:9/2</p>
 <p>A 3D model of the Md 258 nucleus, showing a stack of 10 layers of nucleons. The top layer is a 10x10 grid of 100 protons (marked with 'x'). The bottom layer is a 10x10 grid of 100 neutrons (marked with '-'). The middle layers consist of 8 layers of 10 protons and 7 layers of 10 neutrons, totaling 158 nucleons.</p>	 <p>A 3D model of the No 259 nucleus, showing a stack of 10 layers of nucleons. The top layer is a 10x10 grid of 100 protons (marked with 'x'). The bottom layer is a 10x10 grid of 100 neutrons (marked with '-'). The middle layers consist of 8 layers of 10 protons and 7 layers of 10 neutrons, totaling 159 nucleons.</p>

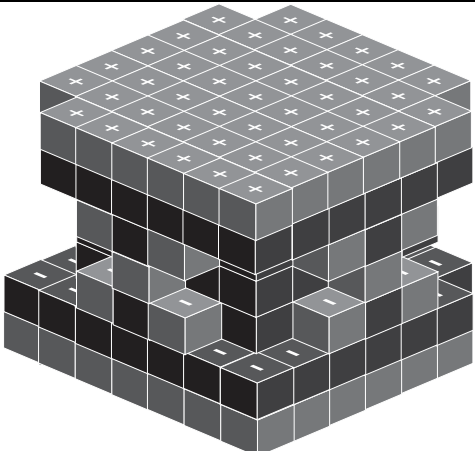
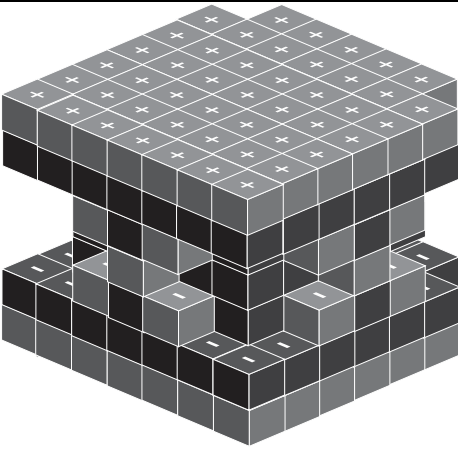
<p>Lr 262 Proton:103 Neutron:159 Spin:2#</p>	<p>Rf 267 Proton:104 Neutron:163 Spin: 9/2#</p>
 <p>A 3D model of the Lr 262 nucleus, showing a central core of 103 protons (marked with 'x') and 159 neutrons (marked with '-'). The nucleus is roughly spherical with a diameter of approximately 15 fm. The surface is irregular, with a slight indentation at the top and a protrusion at the bottom. The core is surrounded by a shell of nucleons, with the outermost layer being the most diffuse.</p>	 <p>A 3D model of the Rf 267 nucleus, showing a central core of 104 protons (marked with 'x') and 163 neutrons (marked with '-'). The nucleus is roughly spherical with a diameter of approximately 16 fm. The surface is irregular, with a slight indentation at the top and a protrusion at the bottom. The core is surrounded by a shell of nucleons, with the outermost layer being the most diffuse.</p>

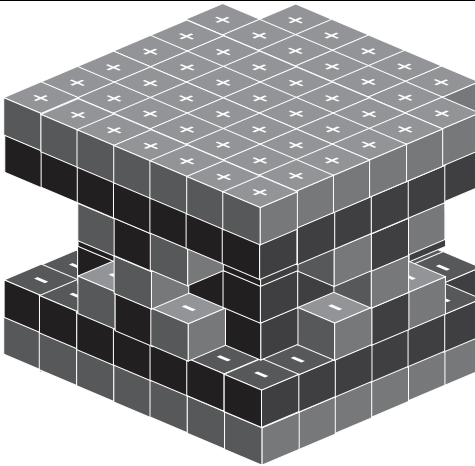
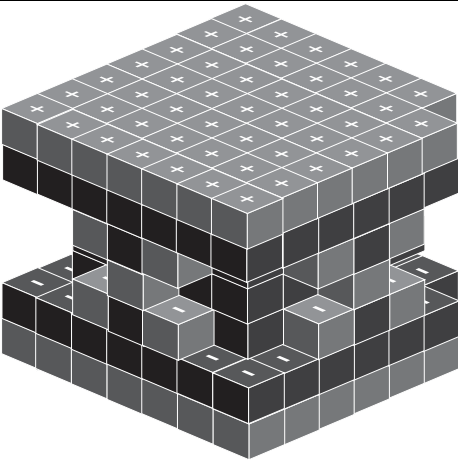
<p>Db 268 Proton:105 Neutron:163 Spin:4#</p>	<p>Sg 271 Proton:106 Neutron:165 Spin:5/2#</p>
 <p>A 3D model of the Db 268 nucleus, showing a central core of 105 protons (marked with 'x') and 163 neutrons (marked with '-'). The nucleus is roughly spherical with a diameter of approximately 16 fm. The surface is irregular, with a slight indentation at the top and a protrusion at the bottom. The core is surrounded by a shell of nucleons, with the outermost layer being the most diffuse.</p>	 <p>A 3D model of the Sg 271 nucleus, showing a central core of 106 protons (marked with 'x') and 165 neutrons (marked with '-'). The nucleus is roughly spherical with a diameter of approximately 17 fm. The surface is irregular, with a slight indentation at the top and a protrusion at the bottom. The core is surrounded by a shell of nucleons, with the outermost layer being the most diffuse.</p>

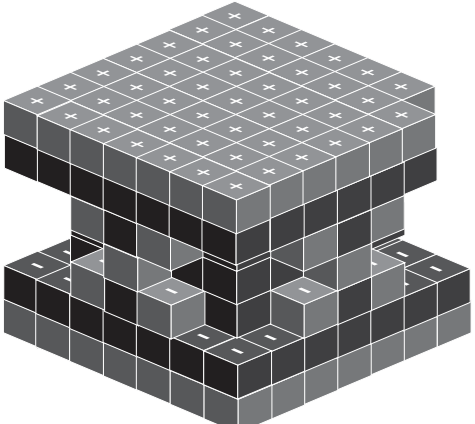
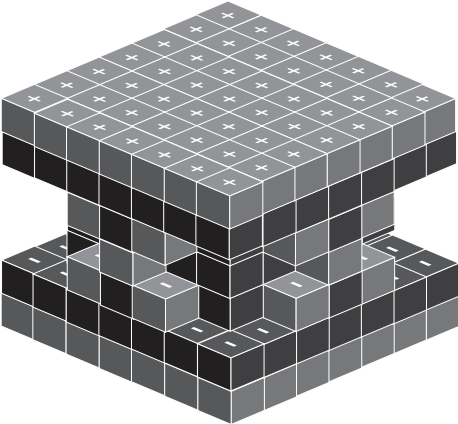
<p>Bh 274 Proton:107 Neutron:167 Spin:1</p>	<p>Hs 277 Proton:108 Neutron:169 Spin:5/2</p>
 <p>A 3D model of the Bh 274 nucleus, showing a central core of dark grey spheres and an outer shell of lighter grey spheres. The top surface is marked with 'x' symbols, representing protons.</p>	 <p>A 3D model of the Hs 277 nucleus, showing a central core of dark grey spheres and an outer shell of lighter grey spheres. The top surface is marked with 'x' symbols, representing protons.</p>

<p>Mt 278 Proton:109 Neutron:169 Spin:3</p>	<p>Ds 281 Proton:110 Neutron:171 Spin:3/2</p>
 <p>A 3D model of the Mt 278 nucleus, showing a central core of dark grey spheres and an outer shell of lighter grey spheres. The top surface is marked with 'x' symbols, representing protons.</p>	 <p>A 3D model of the Ds 281 nucleus, showing a central core of dark grey spheres and an outer shell of lighter grey spheres. The top surface is marked with 'x' symbols, representing protons.</p>

<p>Rg 281 Proton:111 Neutron:170 Spin:5/2</p>	<p>Cn 285 Proton:112 Neutron:173 Spin:5/2</p>
 <p>A 3D model of the Rg 281 nucleus, showing a central core of 111 protons (represented by 'x' marks) and 170 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>	 <p>A 3D model of the Cn 285 nucleus, showing a central core of 112 protons (represented by 'x' marks) and 173 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>

<p>Uut 286 Proton:113 Neutron:173 Spin:2</p>	<p>Uuq 289 Proton:114 Neutron:175 Spin:5/2</p>
 <p>A 3D model of the Uut 286 nucleus, showing a central core of 113 protons (represented by 'x' marks) and 173 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>	 <p>A 3D model of the Uuq 289 nucleus, showing a central core of 114 protons (represented by 'x' marks) and 175 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>

<p>Uup 289 Proton:115 Neutron:174 Spin:3/2</p>	<p>Uuh 293 Proton:116 Neutron:177 Spin:5/2</p>
 <p>A 3D model of the Uup 289 nucleus, showing a central core of 115 protons (represented by 'x' marks) and 174 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>	 <p>A 3D model of the Uuh 293 nucleus, showing a central core of 116 protons (represented by 'x' marks) and 177 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>

<p>Uus 294 Proton:117 Neutron:177 Spin:2</p>	<p>Uuo 294 Proton:118 Neutron:176 Spin:0</p>
 <p>A 3D model of the Uus 294 nucleus, showing a central core of 117 protons (represented by 'x' marks) and 177 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>	 <p>A 3D model of the Uuo 294 nucleus, showing a central core of 118 protons (represented by 'x' marks) and 176 neutrons (represented by '-' marks) arranged in a roughly spherical, layered structure.</p>

Proton Configuration

Inside the atomic nucleus, the neutron forms the kernel of nuclide. The protons located on the surface of cubic nuclide include six side, top and bottom, front and back, left and right.

On the surface of nuclide, the proton has four kind distribution number patterns as 2, 8, 10, 4.

Pattern 2 distribution (2 proton rule)

Pattern 2 proton, are the top proton and bottom proton.

Pattern 2 distribution is for the period 1 only, the first element hydrogen, has only one proton. The hydrogen nuclide proton configuration is shown as



Helium nuclide, has only two proton, one on the top, and on the bottom, inside the helium nuclide, the proton configuration is shown as



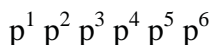
Pattern 8 distribution (8 proton rule)

Pattern 8 proton, is the 8 cubic vertex proton, are the unit cubes located at the vertices of the cubic nuclide.

The nuclide has cubic structure, the pattern 8 proton were positioned at the eight corners of a cube. Within the pattern 8 proton, the first two proton's configuration is given as



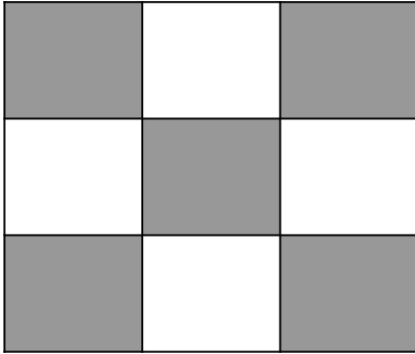
The remaining six proton's configuration is as follows



The pattern 8 protons are on the top and bottom of the cubic nuclide: top 4 corners proton, and bottom 4 corner proton, total has 8 vertex proton.

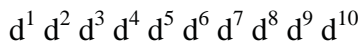
Pattern 10 distribution (10 proton rule)

Beside the top and bottom, the cubic nuclide has 4 side face, front and back, left and right. Each side face has full 5 proton distribution as shown in the diagram below



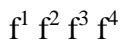
Front and back 2 side can have a total of 10 proton, left and right two side total can have 10 proton, pattern 10 proton is two side proton, each side has 5 protons.

Pattern 10 proton distributions is



Pattern 4 distribution (4 proton rule)

4 proton distributions is



First period

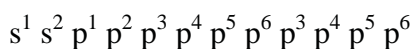


The first period, has only two proton, s^1 and s^2 . To fill the first period element, first the proton s^1 , becomes hydrogen, the second s^2 then forms the helium nuclide.

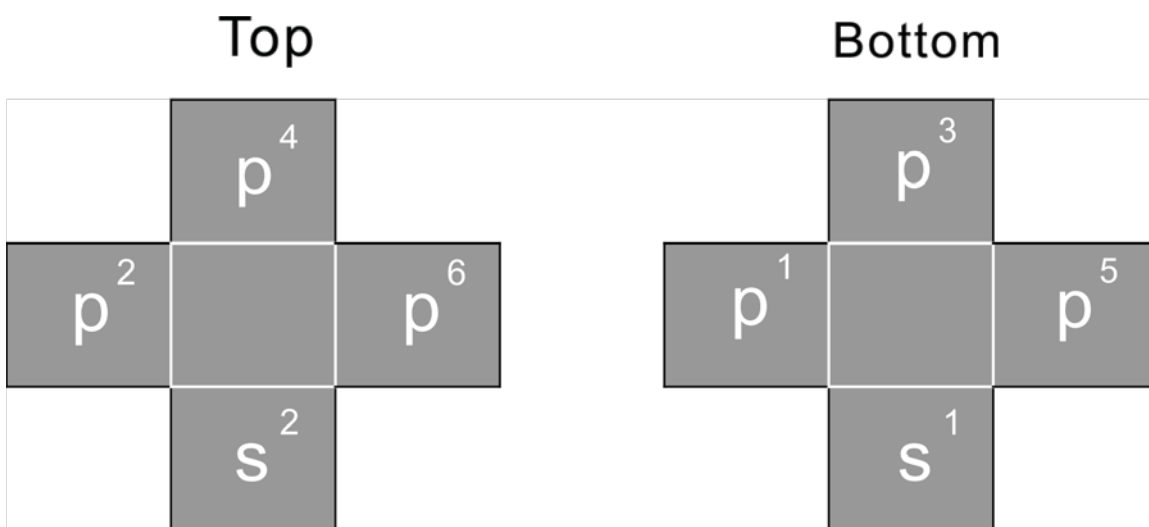
-s2 as following



Second period

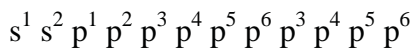


For the 2nd period, start to fill the 2 S proton, s^2 as of Be-2, then start to fill all 6 P proton, $s^2 p^6$, as of Ne-10



These 8 proton constitute the cube's 8 corner position

Third period



For the 3rd period, start to fill 2 S proton, s^2 as of Mg-12, then start to fill all 6 P proton, $s^2 p^6$ as of Ar-18

These 8 proton constitute the nuclide 8 corner unit

Top

p^4		p^6
p^2		s^2

Bottom

p^3		p^5
p^1		s^1

Fourth period

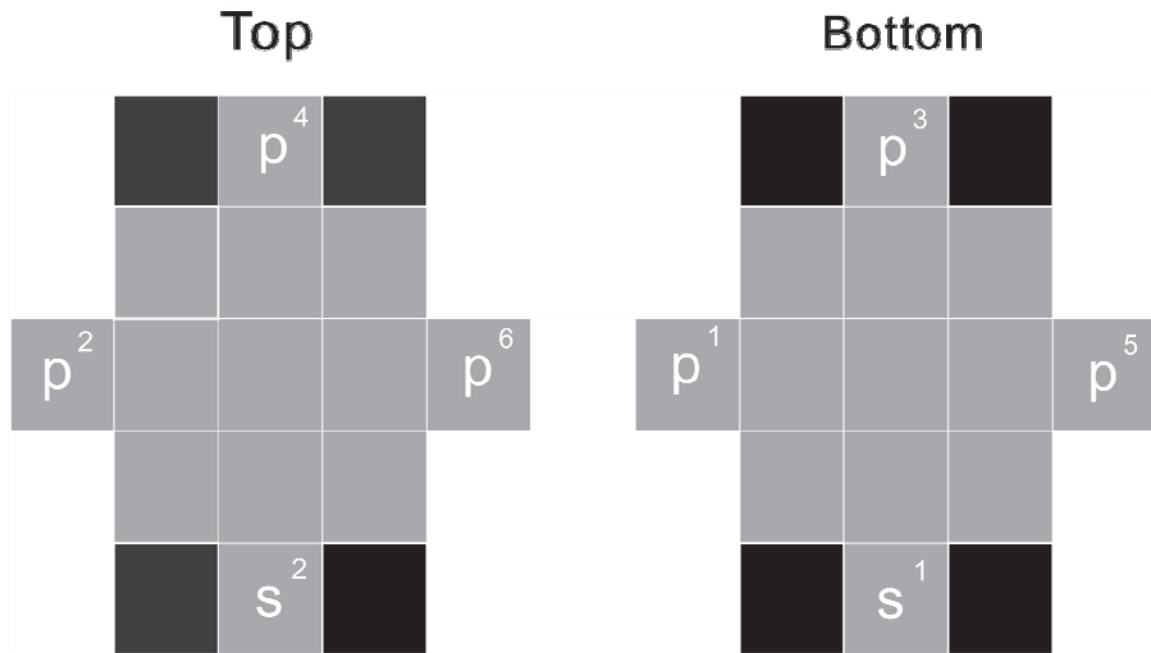
$s^1 s^2$

$d^1 d^2 d^3 d^4 d^5 d^6 d^7 d^8 d^9 d^{10}$

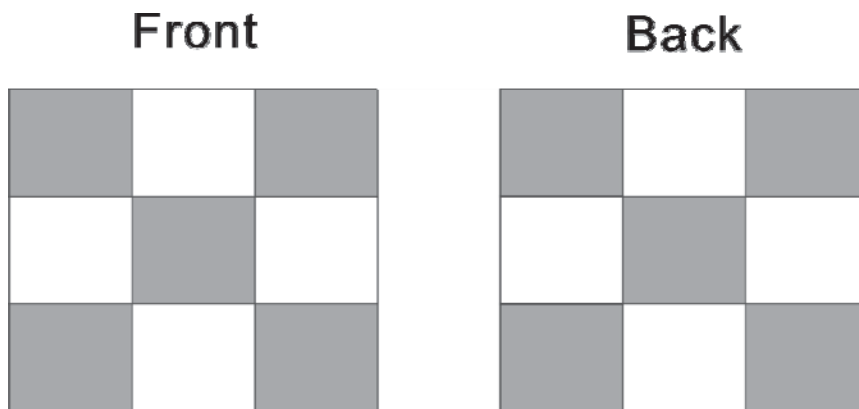
$p^1 p^2 p^3 p^4 p^5 p^6 p^3 p^4 p^5 p^6$

Starting from the fourth period, the proton begins to fill the nuclide 4 side D position.

For the fourth period, first fill the S2 protons, s^2 , as of Ca-20, and then fill the front side 5 D position, - $s^2 d^5$ as of Mn-25, then fill the back side 5 position, $s^2 d^{10}$, as of Zn-30, then start filling the 6 P proton, $s^2 d^{10} p^6$, as of Kr-36.



Pattern 10 Proton distribution



Due to S proton start to fill the D position. There are 3 exceptions

Cr-24 -- $s^1 d^5$;

Ni-28 -- $s^1 d^9$;

Cu-29 -- $s^1 d^{10}$;

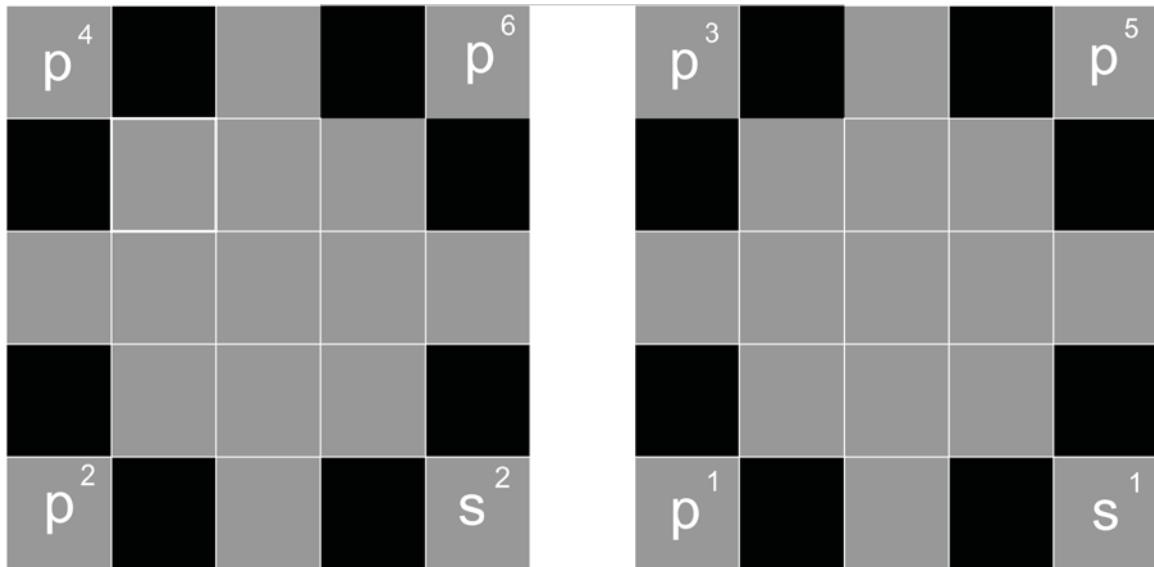
Fifth Period

$s^1 s^2$

$d^1 d^2 d^3 d^4 d^5 d^6 d^7 d^8 d^9 d^{10}$

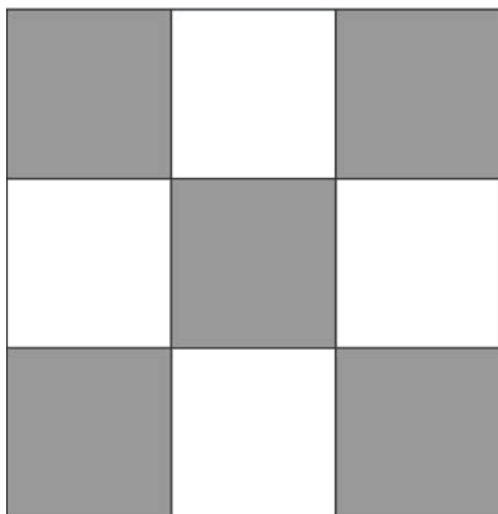
$p^1 p^2 p^3 p^4 p^5 p^6 p^3 p^4 p^5 p^6$

Very similar to the fourth period, start with the fifth period, first fill the two S protons, s^2 as of Sr-38, then fill the left side 5 D position, $s^2 d^5$, as of Tc-43, then fill the right side 5 position, $s^2 d^{10}$ as of Cd-48, then fill the 6 P position, - $s^2 d^{10} p^6$ as of Xe-54

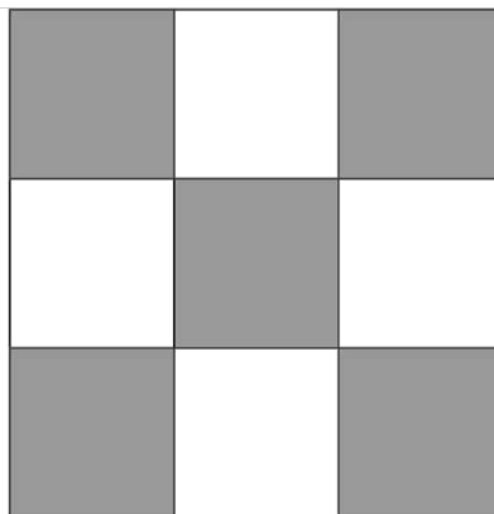


Pattern D10 distribution

Left



Right



Due to S proton start to fill the D position. There are 5 exceptions

Nb-41 -- $s^1 d^4$;

Mo-42-- $s^1 d^5$;

Ru-44 -- $s^1 d^7$;

Pd-46-- d^{10} ;

Ag-47-- $s^1 d^{10}$;

Six period

$s^1 s^2$

$f^1 f^2 f^3 f^4$

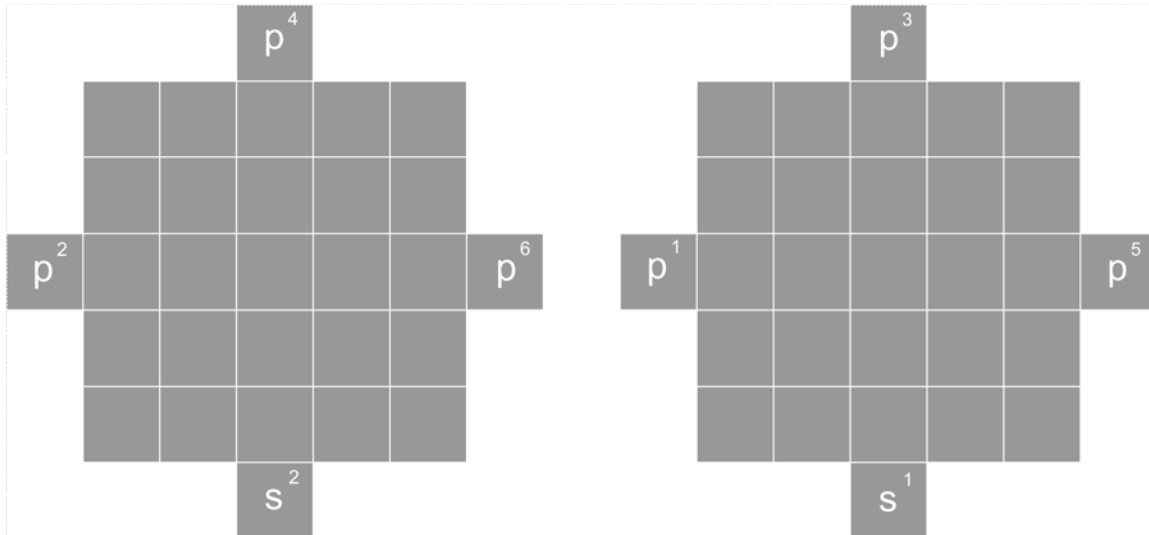
$d^1 d^2 d^3 d^4 d^5 d^6 d^7 d^8 d^9 d^{10}$

$d^1 d^2 d^3 d^4 d^5 d^6 d^7 d^8 d^9 d^{10}$

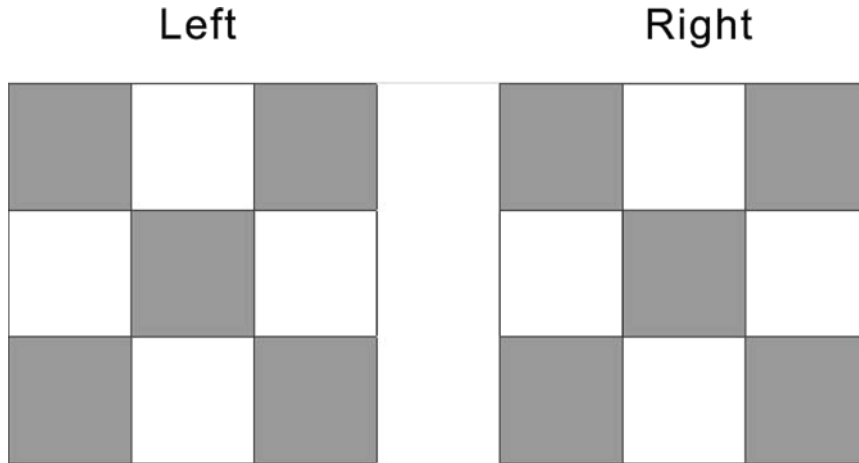
$$p^1 p^2 p^3 p^4 p^5 p^6 p^3 p^4 p^5 p^6$$

From the sixth period, it starts to fill the 4f protons.

At the beginning of the six period, first fill the two S protons, the s^2 as of Ba-56; and then fill all the four F protons, $s^2 f^4$ as of Nd-60; and then fill the front side 5 D proton $s^2 f^4 d^5$, as of Tb-65; and then fill the back side 5 D proton, both front and back side total 10 protons, $s^2 f^4 d^{10}$, as of the element Yb-70; and then to fill left side 5 D proton, left and right total has 10 D proton, $s^2 f^4 d^{10} d^5$ as of Re-75; and then to fill right side 5 D proton, left and right total has 10 D proton, $s^2 f^4 d^{10} d^{10}$, as of Hg-80; and to fill all 6 P proton, $s^2 f^4 d^{10} d^{10} p^6$ as of element Rn-86.



Pattern 10 distribution



There are two D10 distributions, one is for the cube's front and back side, a total of 10 protons; another D10 is for Cube's the left side and right side, total D10 proton.

Seventh Period

$s^1 s^2$

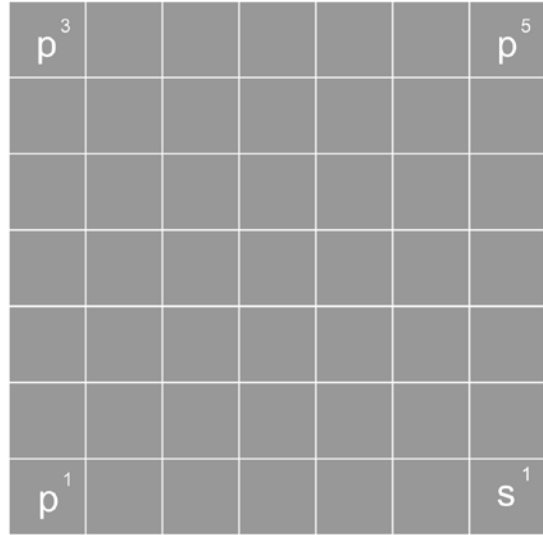
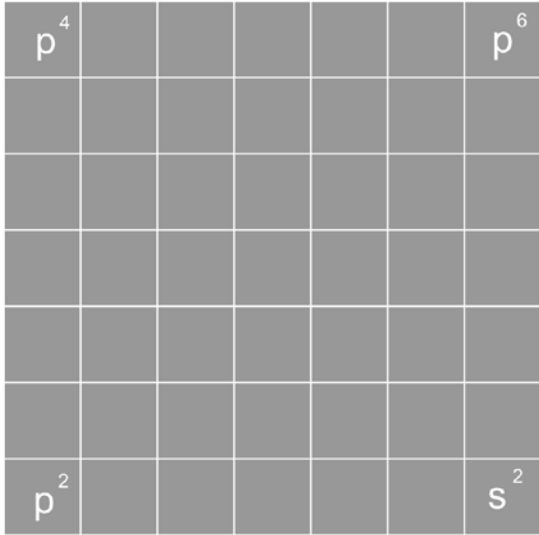
$f^1 f^2 f^3 f^4$

$d^1 d^2 d^3 d^4 d^5 d^6 d^7 d^8 d^9 d^{10}$

$d^1 d^2 d^3 d^4 d^5 d^6 d^7 d^8 d^9 d^{10}$

$p^1 p^2 p^3 p^4 p^5 p^6 p^3 p^4 p^5 p^6$

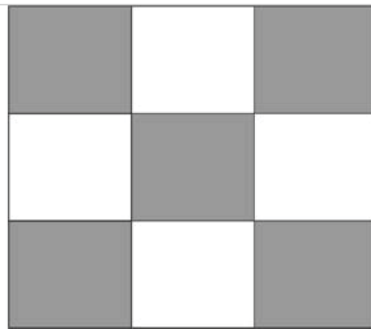
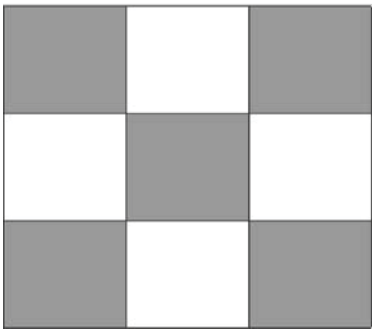
Very similar to the six period, for the seventh period, first fill the two S protons, s^2 of Ra-88; and then fill all the four F protons, $s^2 f^4$ as of U-92; and then fill the front side 5 D proton – $s^2 d^5$ as of Bk-97; and then fill the back side 5 D proton, both front side and back side, a total of 10 protons, $s^2 f^4 d^{10}$ as of element No-102; and then fill left side 5 D proton, $s^2 f^4 d^{10} d^5$ as of Bh-107; and then fill right side 5 D proton, a total of 10 D proton, $s^2 f^4 d^{10} d^{10}$ as of Uub-112, and then to fill all 6 P proton, $s^2 f^4 d^{10} d^{10} p^6$ as of the element Uuo-118.



Pattern 10 D distribution

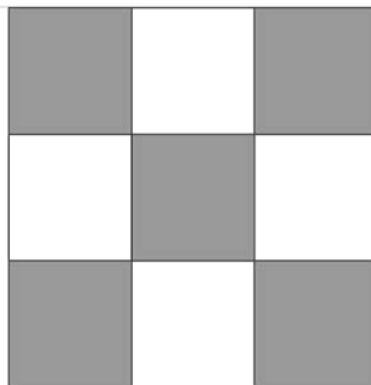
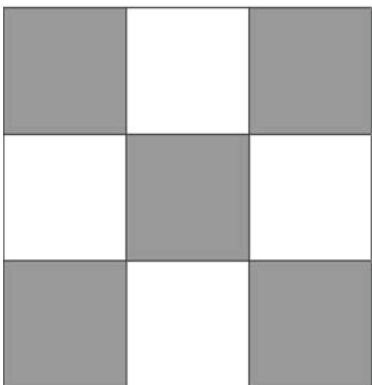
Front

Back



Left

Right



Pattern 2 proton configuration (2 proton rule)

Helium nuclide, one top proton and one bottom proton on the nucleus, fully fill the first period, to form the Helium nuclide. On the periodic table of elements, which is corresponding to the pattern 2 block.

1	2
H 1	He 2

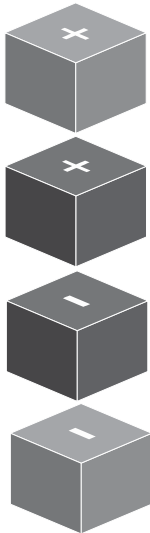
He 4

Proton: 2

Neutron: 2

Spin: 0

Stable



Pattern 8 proton configuration (8 proton rule)

The pattern 8 proton is positioned at the eight corners of a cubic nuclide, on the periodic table of element, which corresponds to the pattern 8 block.

Period	1	2		3	4	5	6	7	8
2	Li 3	Be 4		B 5	C 6	N 7	O 8	F 9	Ne 10
3	Na 11	Mg 12		Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
4	K 19	Ca 20	*	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
5	Rb 37	Sr 38	*	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
6	Cs 55	Ba 56	*	Ti 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
7	Fr 87	Ra 88	*	Uut 113	Uuq 114	Uup 115	Uuh 116	Uus 117	Uuo 118

For pattern 8 block, from period 2 to period 7, each period has 8 elements and a total of 48 elements.

Column 1 and 2, corresponding to the s^1 and s^2 proton, form the S block

From column 2 to column 8, corresponding to the $p^1 p^2 p^3 p^4 p^5 p^6$, form the P block

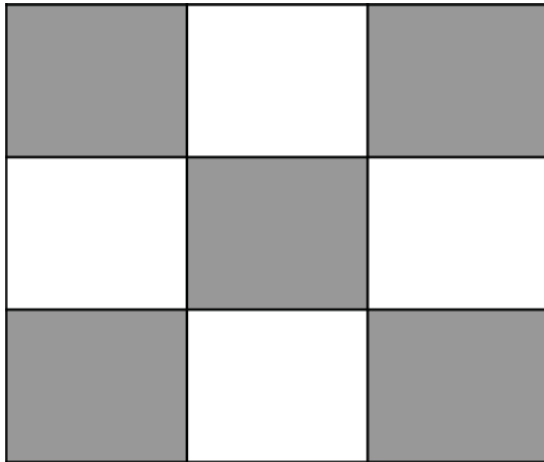
Column 8 elements, being full with all Pattern 8 protons respectively form the noble gas element nuclide.

Pattern 10 proton configuration (10 proton rule)

The cubic nuclide has six face, one top face and one bottom face, and four side face.

The pattern 10 proton, is only located on four side face.

Each side can fully fill 5 protons as shown below:



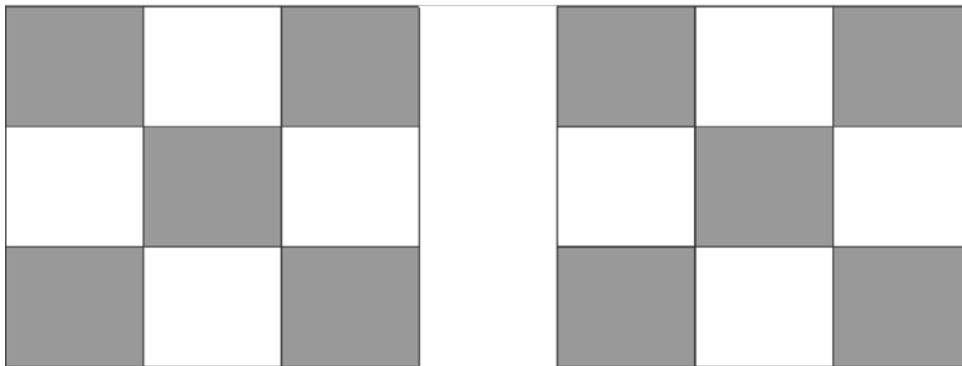
Front the side and back side, in total can fill 10 protons.

The left and right side in total can fill another 10 proton.

Pattern 10 proton distribution

Front

Back



On the periodic table of elements, Pattern 10 proton form the D block as shown below

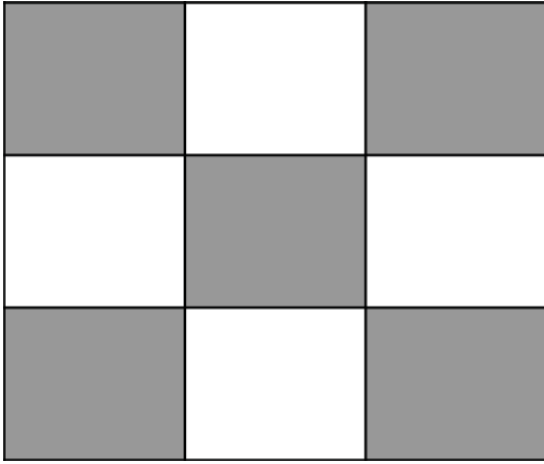
Period	1	2	3	4	5	6	7	8	9	10
4*	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30
5*	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48
6* #	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70
	Lu 71	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80
7* &	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102
	Lr 103	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Ds 110	Rg 111	Uub 112

From period 4 to period 7, there are a total of 60 pattern 10 protons within D block.

Pattern 10 D protons are located on the four side face of the nuclide (excluding the top and bottom face).

At the beginning of the period 4, the protons begin to fill the D proton, a total of four sides, front and back sides, right and left sides.

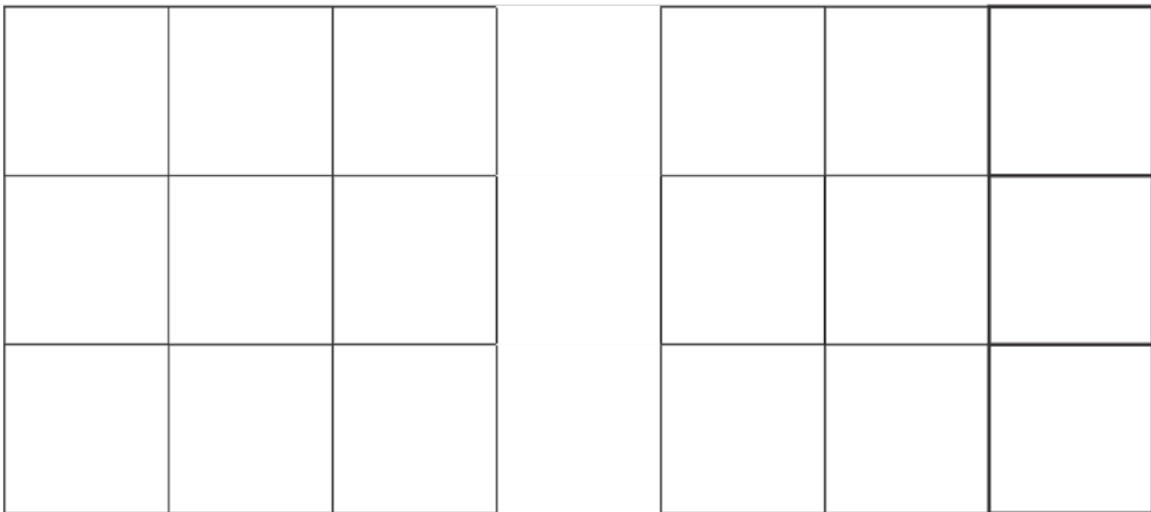
Each side can fill five protons, with a face centered proton structure as shown below:



For the pattern 10 proton, first fills the five protons of the front side, and then fills five D proton on the back side. The pattern 10 D protons distribution is shown below:

$d^1 d^2 d^3 d^4 d^5 d^6 d^7 d^8 d^9 d^{10}$

d0



d^1

d^2

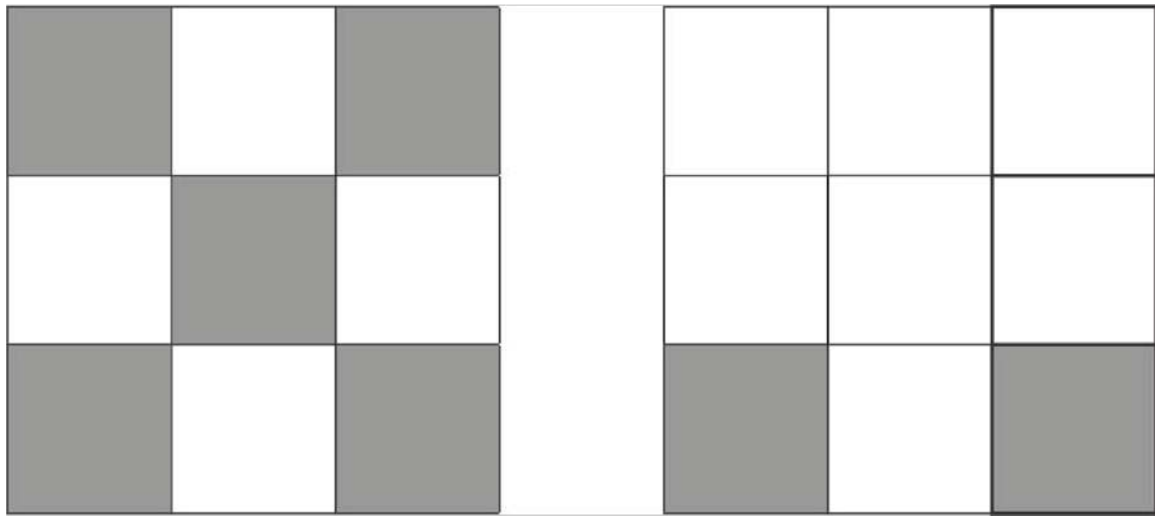
d^5

■	□	■	□	□	□	□
□	■	□	□	□	□	□
■	□	■	□	□	□	□

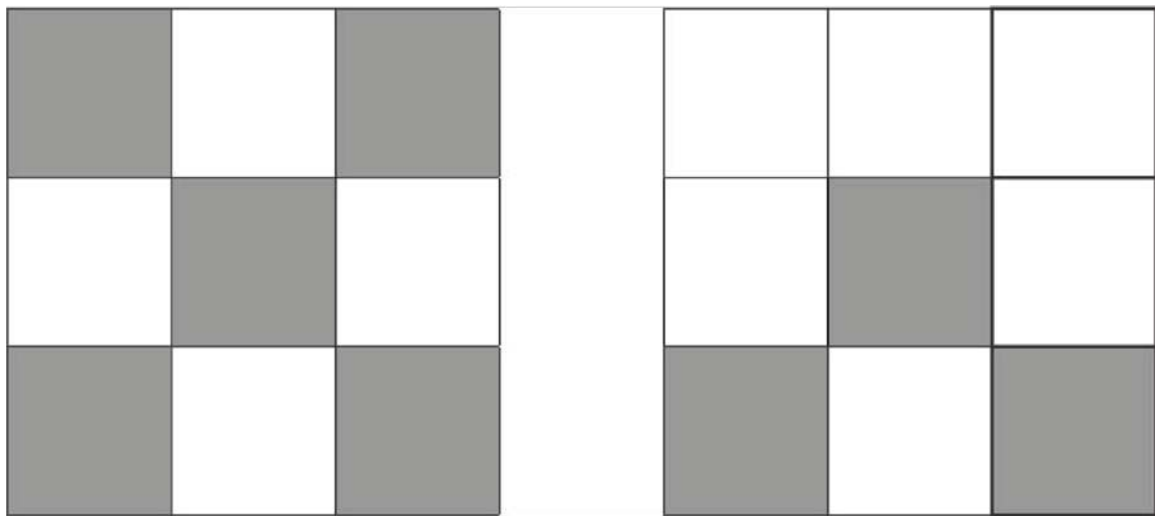
d^6

■	□	■	□	□	□	□
□	■	□	□	□	■	□
■	□	■	□	□	□	□

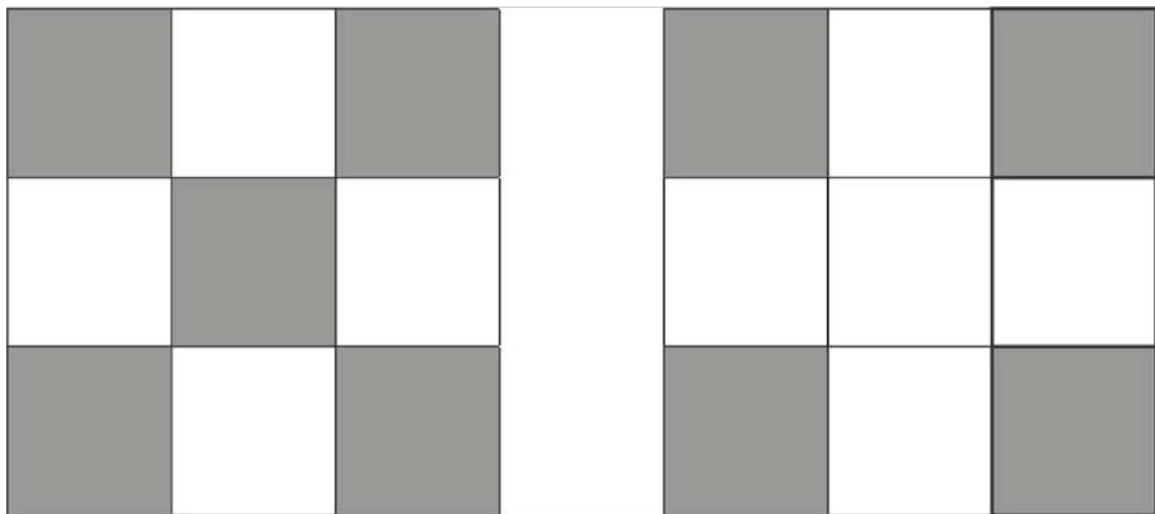
d^7



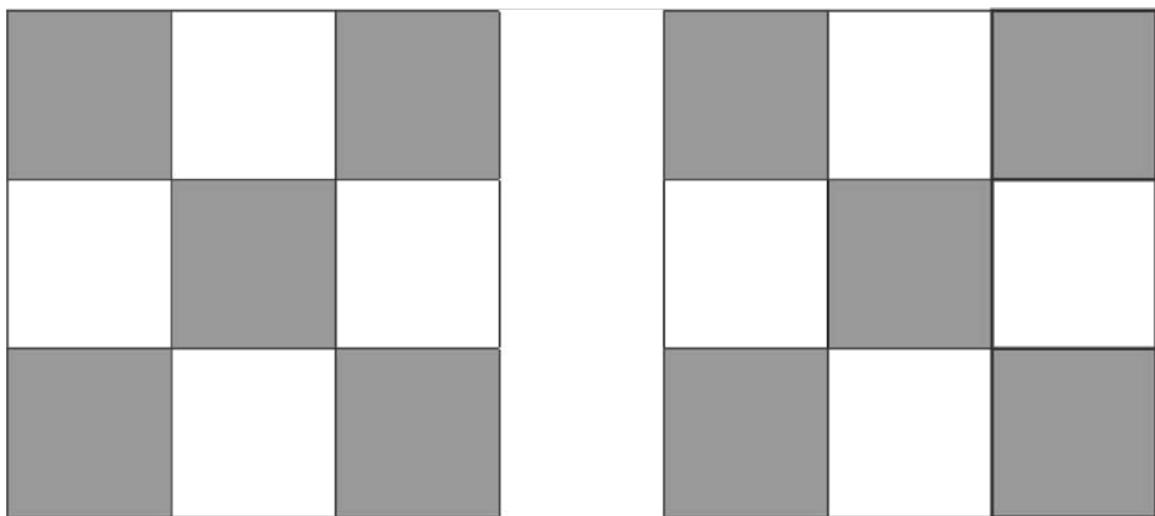
d^8



d^9



d^{10}



On the column 8, the last column on the D block, all fully fill the pattern 10 proton d^{10}

For the pattern 10 D proton, due to the 2 S proton start to fill the D proton. There are exceptions for the D proton which do not exactly follow the sequence of d^1 to d^{10} .

The column 9 element Cu-29, Ag-47 and Au-79, should have the s^2d^9 configuration, but due to one S proton which left their S position to start to fill the D proton, their proton configuration become s^1d^{10} .

The column 8 element, Ni-28 and Pt-78, should have the s^2d^8 configuration, but due to one S proton which left their S position to start to fill D position, their proton configuration become s^1d^9 .

The column 8 element Pd-46, should have the s^2d^8 configuration, but due to 2 S proton which left their S position to start to fill the D position, their proton configuration become d^{10}

The columns 5 elements, all fully fill the one side D 5 proton and they have the s^2d^5 configuration.

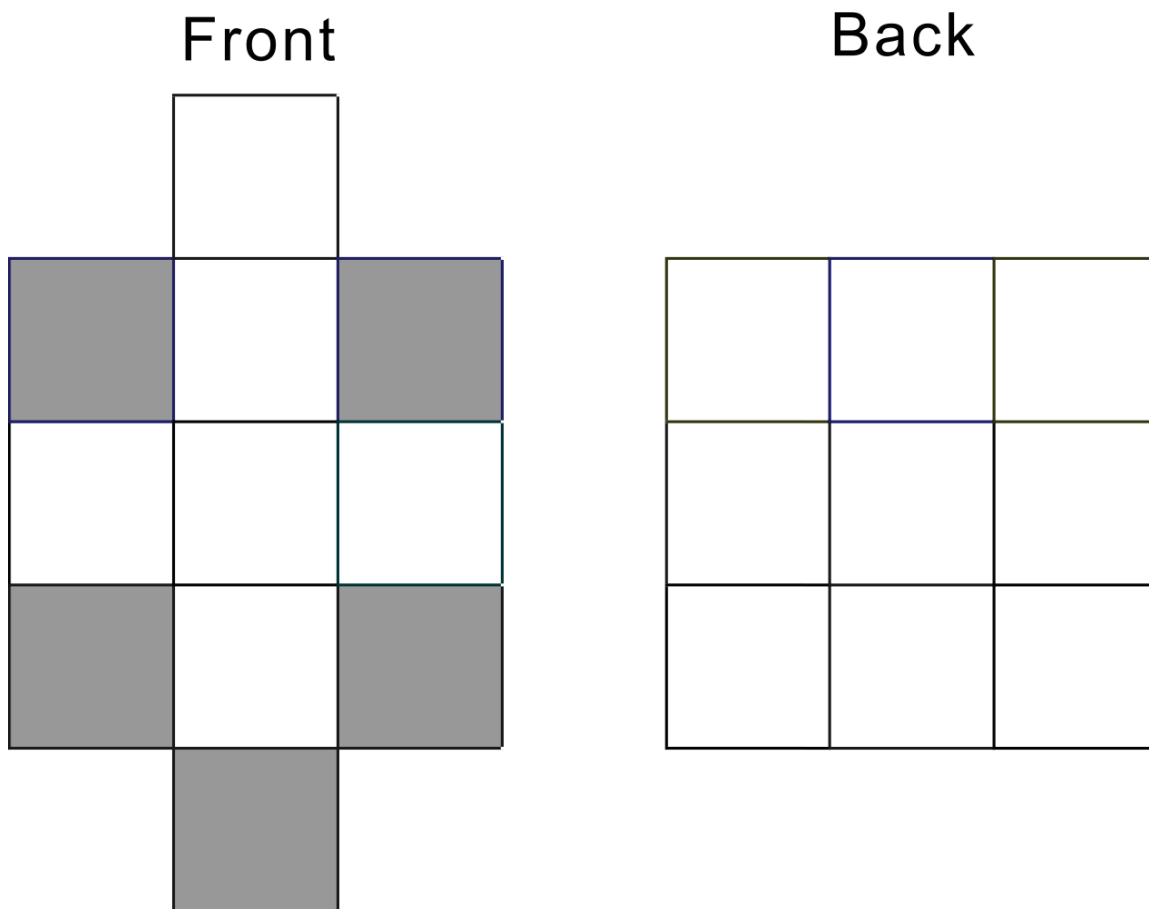
The column 4 element Cr-24, Mo-42, should have the s^2d^4 configuration but due to one S proton which starts to fill the D block, their configuration become s^1d^5

The column 3 element Nb-41, should have the s^2d^3 configuration, due to one S proton which starts to fill D position, their configuration become s^1d^4

Here is the list of exception for the D block proton

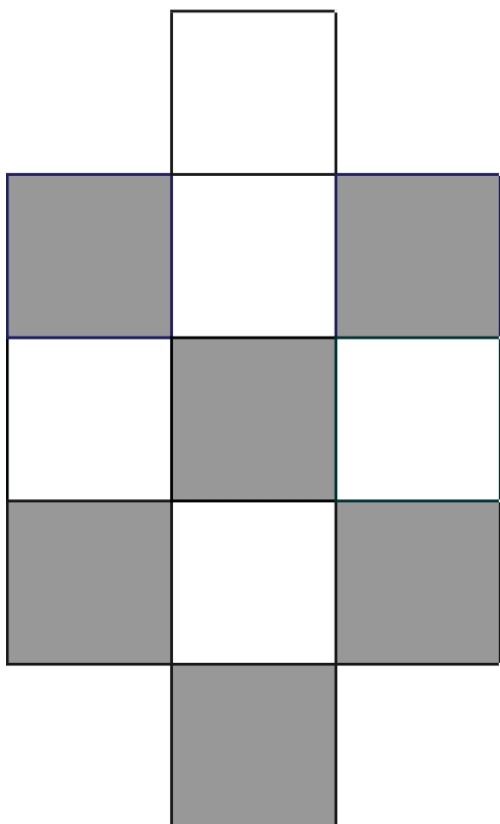
Element	Column	Configuration
Nb-41	D3	s^1d^4
Cr-24, Mo 42	D4	s^1d^5
Ru-44	D6	s^1d^7
Ni-28, Pt-78	D8	s^1d^9
Pd-46	D8	d^{10}
Cu-29, Ag-47, Au-79	D9	s^1d^{10}

Nb-41 S and D proton configuration s^1d^4 has the following pattern :

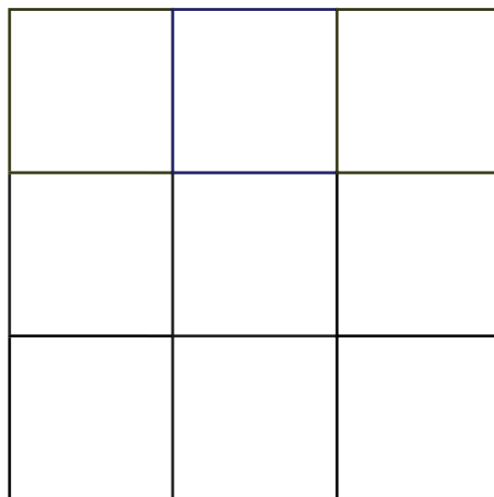


Cr 24, Mo 42 configuration $s^1 d^5$, has the following pattern:

Front

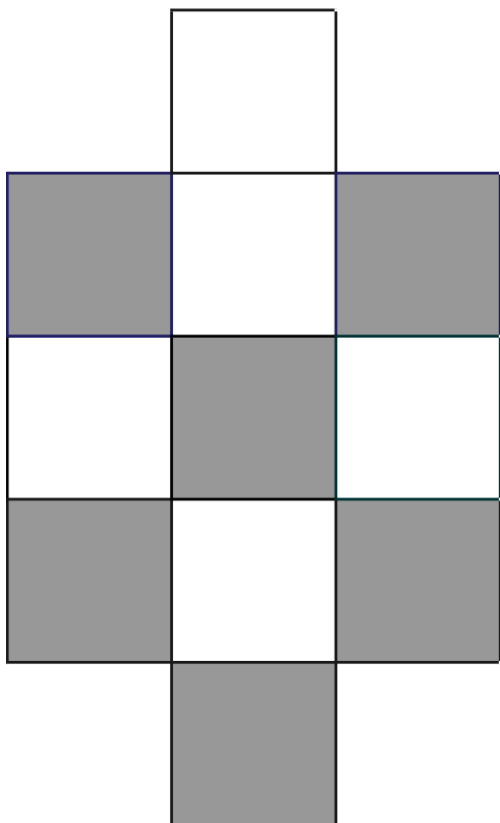


Back

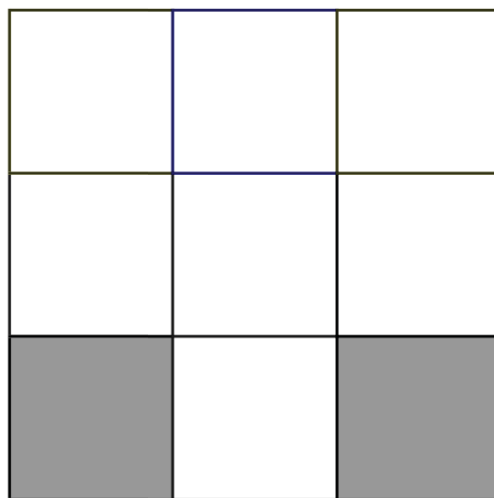


Ru-44 configuration $s^1 d^7$ has the following pattern:

Front

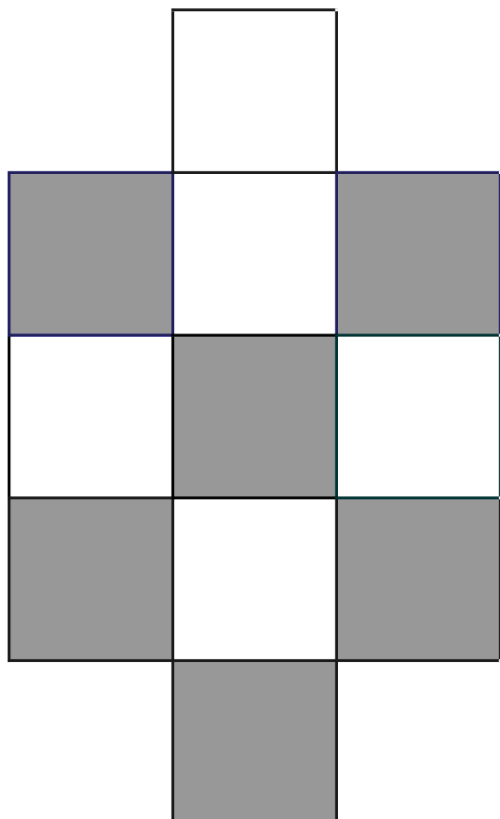


Back

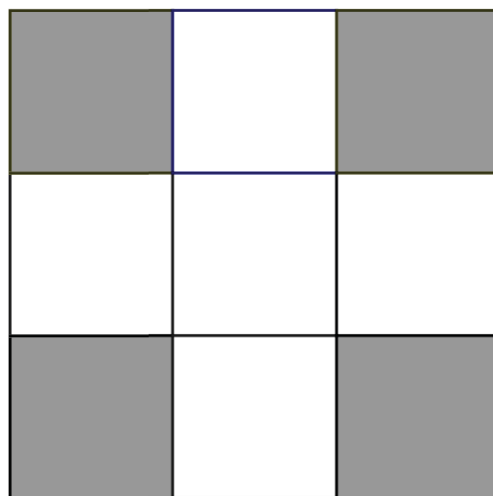


Ni-28, Pt-78 configuration $s^1 d^9$ has the following pattern:

Front

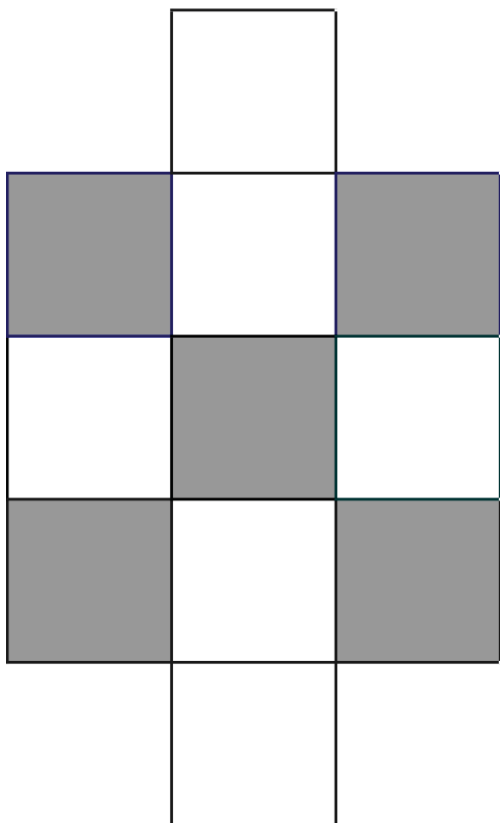


Back

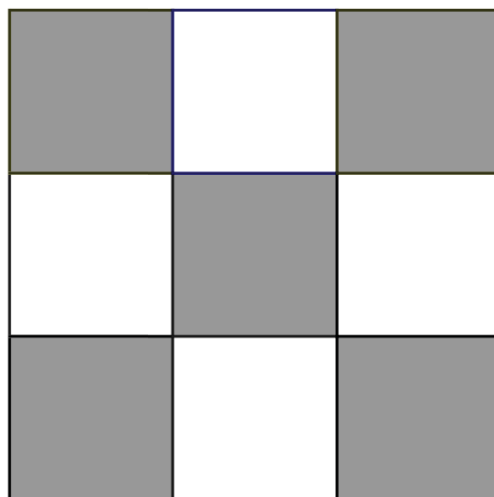


Pd-46 proton configuration d^{10} has the following pattern:

Front

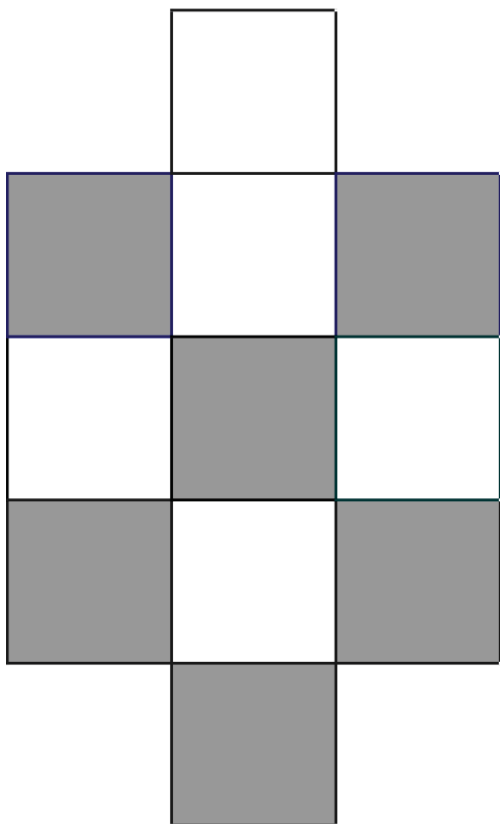


Back

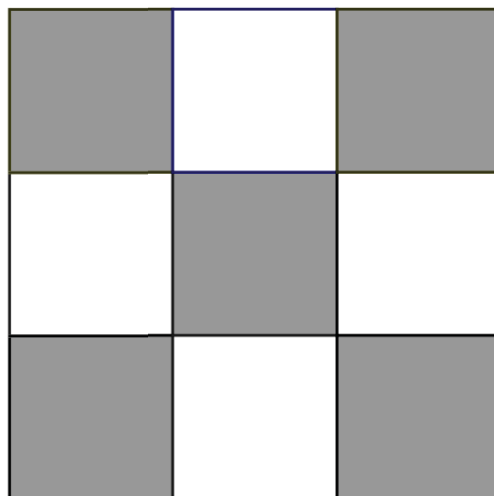


Cu-29, Ag-47, Au-79 proton configuration $s^1 d^{10}$ has the following pattern:

Front



Back

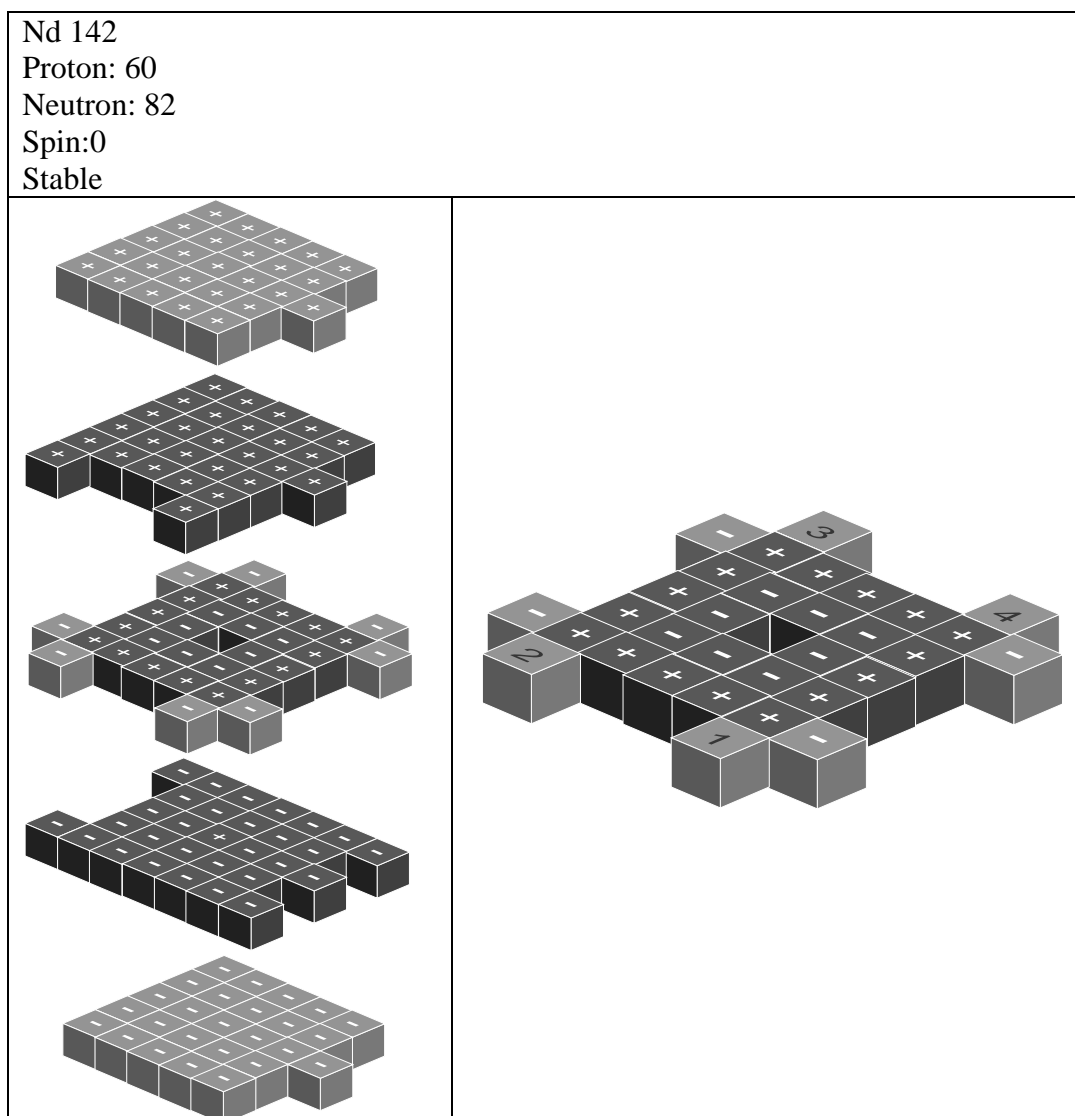


Pattern 4 proton configuration (4 proton rule)

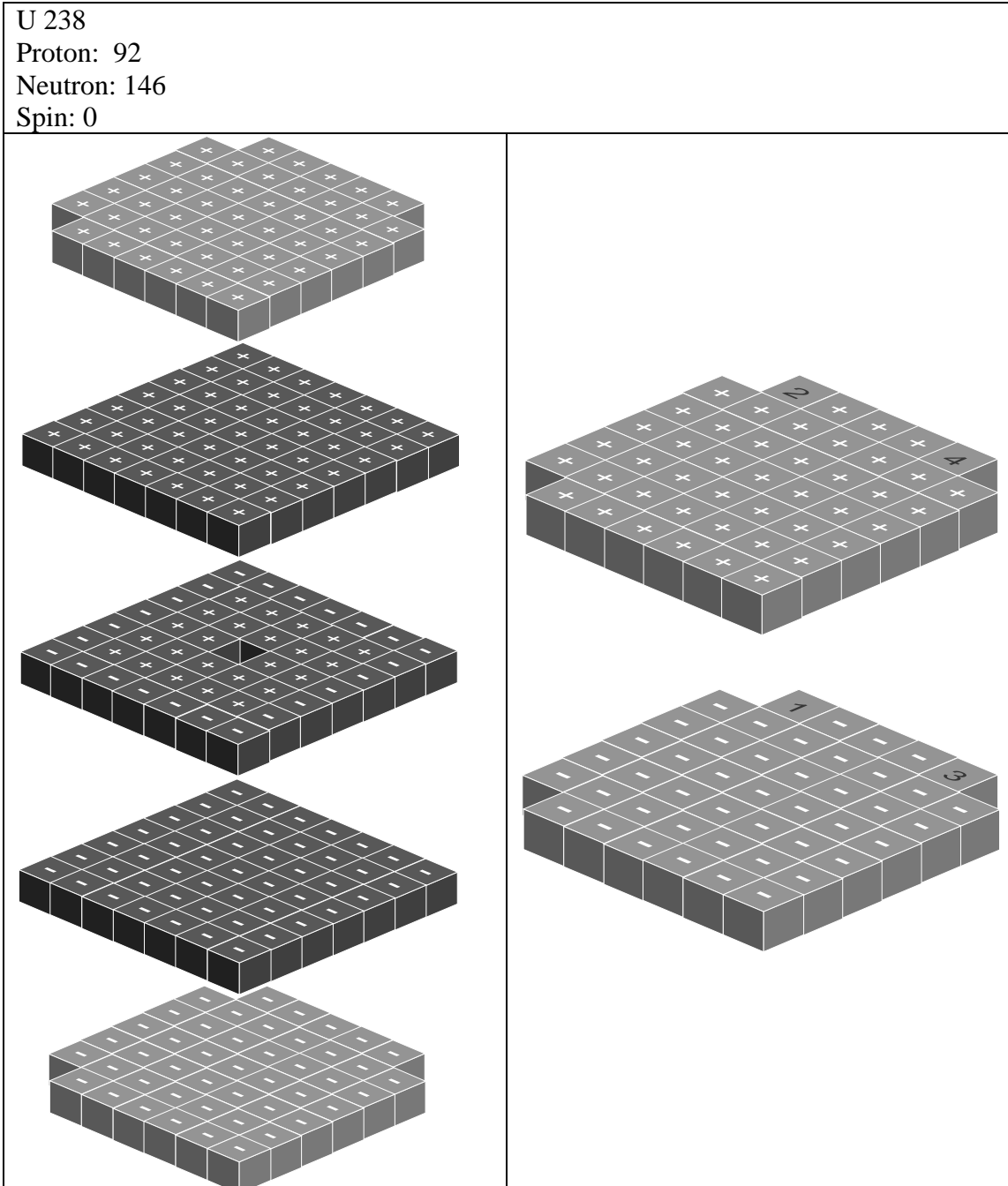
Pattern 4 proton distributions; only belong to period six and period seven. A total of eight elements, for the sixth period, to fill the full four F protons as of the elements Nd 60; for the seventh period, to fill the full four F protons as of the elements U92.

1	2	3	4
La 57	Ce 58	Pr 59	Nd 60
Ac 89	Th 90	Pa 91	U 92

For the Nd 142 nuclide, the four F proton located on the hollow layer, is shown below:



For the U238 nuclide, the four F proton located on both top layer and bottom layer, is shown below:



Hydrogen Nucleus

s^1

H1
Proton: 1
Neutron: 0
Spin: 1/2
Stable



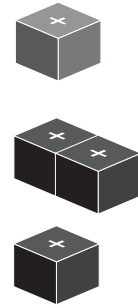
H2
Proton: 1
Neutron: 1
Spin: 1
Stable



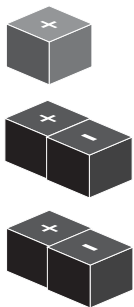
H3
Proton: 1
Neutron: 2
Spin: 1/2



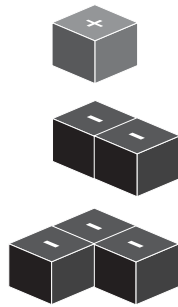
H4
Proton: 1
Neutron: 3
Spin: 2



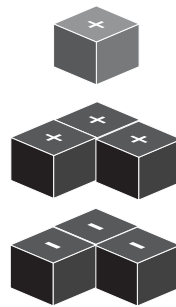
H5
Proton: 1
Neutron: 4
Spin: 1/2



H6
Proton: 1
Neutron: 5
Spin: -2



H7
Proton: 1
Neutron: 6
Spin: 1/2



Helium Nucleus

$$s^2$$

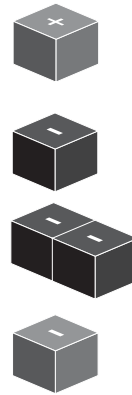
He 3
Proton: 2
Neutron: 1
Spin: $\frac{1}{2}$
Stable



He 4
Proton: 2
Neutron: 2
Spin: 0
Stable



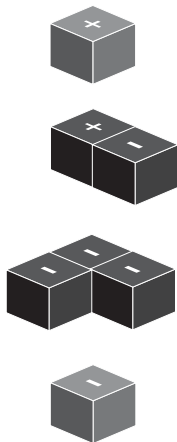
He 5
Proton: 2
Neutron: 3
Spin: $-\frac{3}{2}$



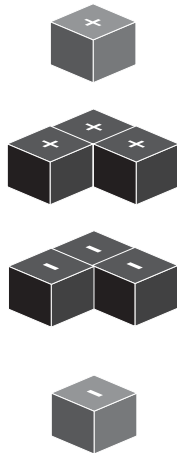
He 6
Proton: 2
Neutron: 4
Spin: 0



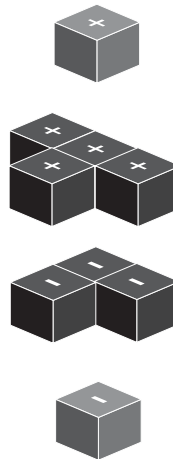
He 7
Proton: 2
Neutron: 5
Spin: $-\frac{3}{2}$



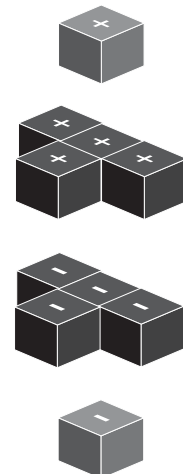
He 8
Proton: 2
Neutron: 6
Spin: 0



He 9
Proton: 2
Neutron: 7
Spin: $\frac{1}{2}$



He 10
Proton: 2
Neutron: 8
Spin: 0



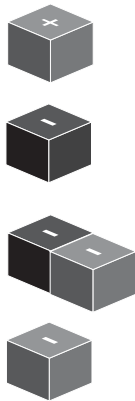
Lithium Nucleus

s^1

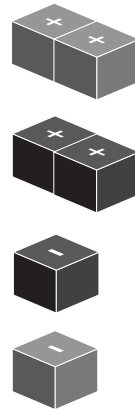
Li 4
Proton: 3
Neutron: 1
Spin: -2



Li 5
Proton: 3
Neutron: 2
Spin: $-3/2$



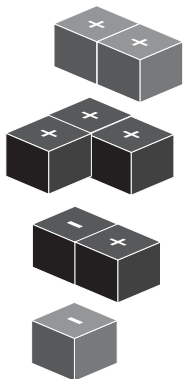
Li 6
Proton: 3
Neutron: 3
Spin: 1
Stable



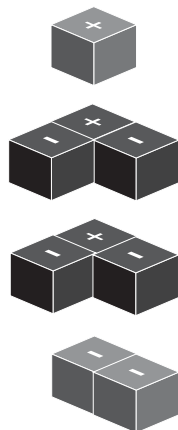
Li 7
Proton: 3
Neutron: 4
Spin: $-3/2$
Stable



Li 8
Proton: 3
Neutron: 5
Spin: 2



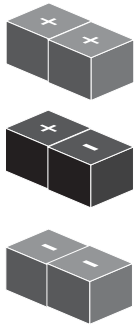
Li 9
Proton: 3
Neutron: 6
Spin: $-3/2$



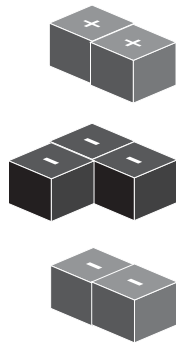
Beryllium Nucleus

s^2

Be 8
Proton: 4
Neutron: 2
Spin: 0



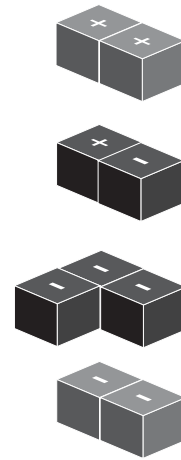
Be 7
Proton: 4
Neutron: 3
Spin: -3/2



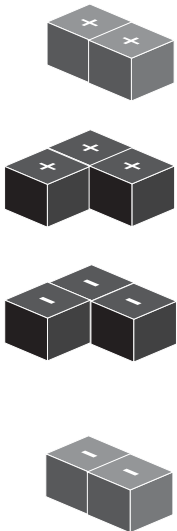
Be 8
Proton: 4
Neutron: 4
Spin: 0



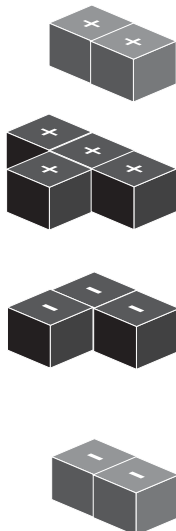
Be 9
Proton: 4
Neutron: 5
Spin: -3/2
Stable



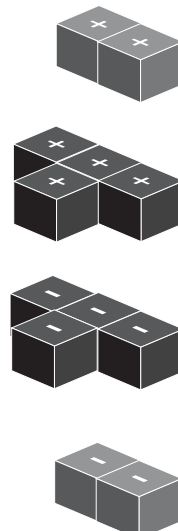
Be 10
Proton: 4
Neutron: 6
Spin: 0



Be 11
Proton: 4
Neutron: 7
Spin: 1/2



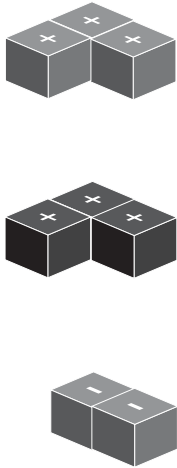
Be 12
Proton: 4
Neutron: 8
Spin: 0



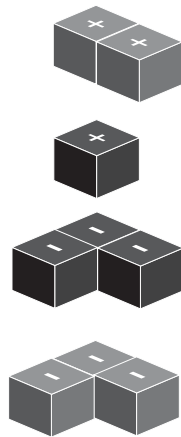
Boron Nucleus

$s^2 p^1$

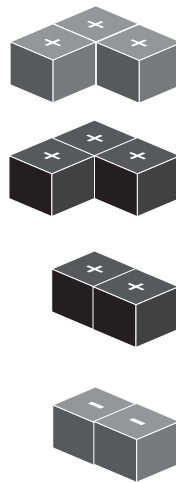
B 8
Proton: 5
Neutron: 3
Spin: 2



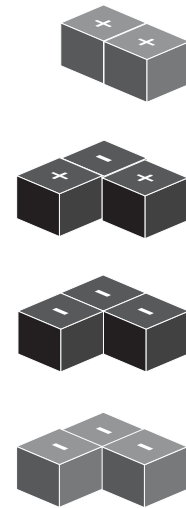
B 9
Proton: 5
Neutron: 4
Spin: -3/2



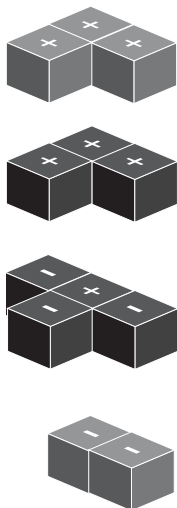
B 10
Proton: 5
Neutron: 5
Spin: 3
Stable



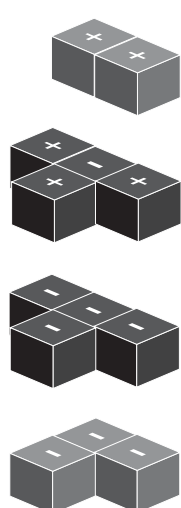
B 11
Proton: 5
Neutron: 6
Spin: -3/2
Stable



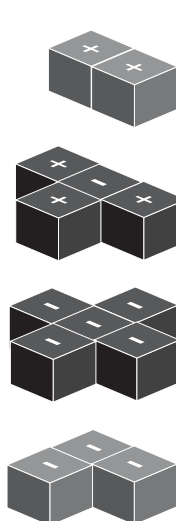
B 12
Proton: 5
Neutron: 7
Spin: 1



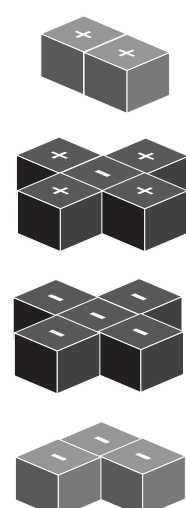
B 13
Proton: 5
Neutron: 8
Spin: -3/2



B 14
Proton: 5
Neutron: 9
Spin: -2



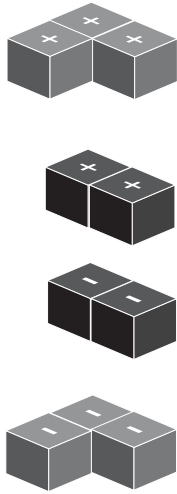
B 15
Proton: 5
Neutron: 10
Spin: -3/2



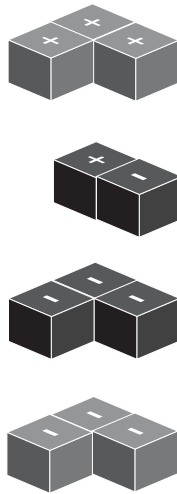
Carbon Nucleus

$$s^2 p^2$$

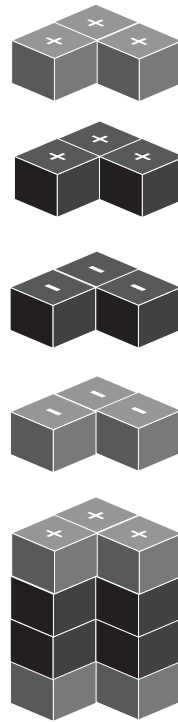
C 10
Proton: 6
Neutron: 4
Spin: 0



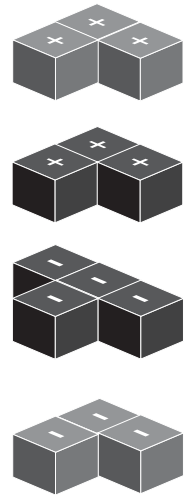
C 11
Proton: 6
Neutron: 5
Spin: -3/2



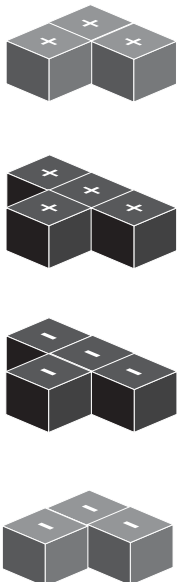
C 12
Proton: 6
Neutron: 6
Spin: 0
Stable



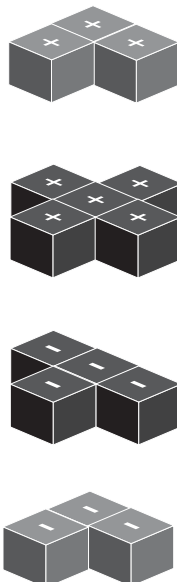
C 13
Proton: 6
Neutron: 7
Spin: -1/2
Stable



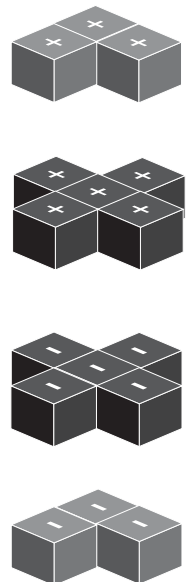
C 14
Proton: 6
Neutron: 8
Spin: 0



C 15
Proton: 6
Neutron: 9
Spin: 1/2



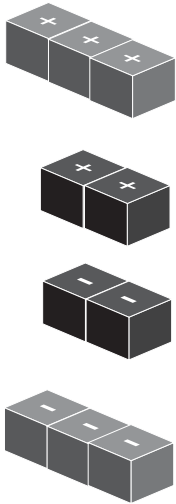
C 16
Proton: 6
Neutron: 10
Spin: 0



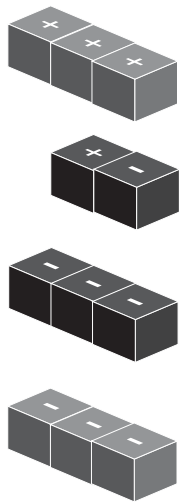
Carbon Nucleus

$s^2 p^2$

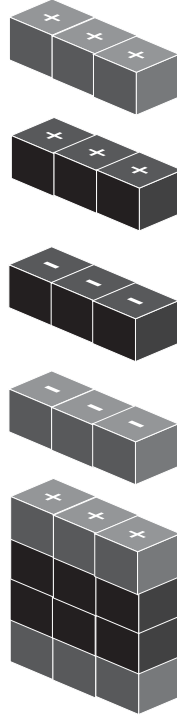
C 10
Proton: 6
Neutron: 4
Spin: 0



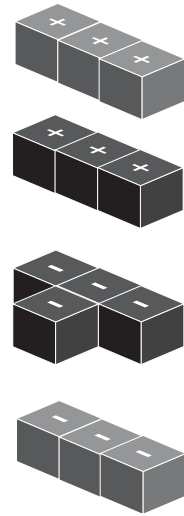
C 11
Proton: 6
Neutron: 5
Spin: -3/2



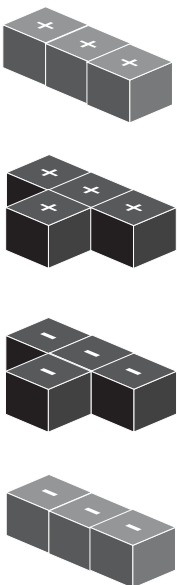
C 12
Proton: 6
Neutron: 6
Spin: 0
Stable



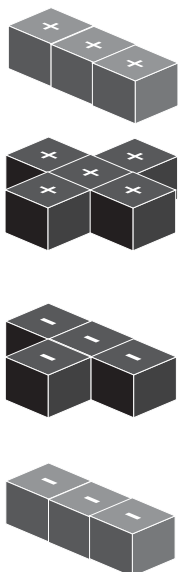
C 13
Proton: 6
Neutron: 7
Spin: -1/2
Stable



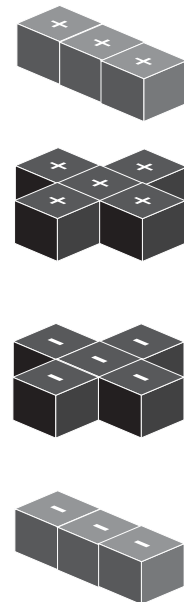
C 14
Proton: 6
Neutron: 8
Spin: 0



C 15
Proton: 6
Neutron: 9
Spin: 1/2



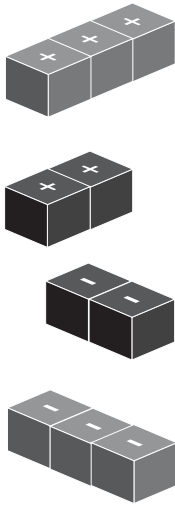
C 16
Proton: 6
Neutron: 10
Spin: 0



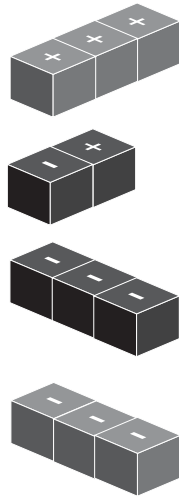
Carbon Nucleus

$$s^2 p^2$$

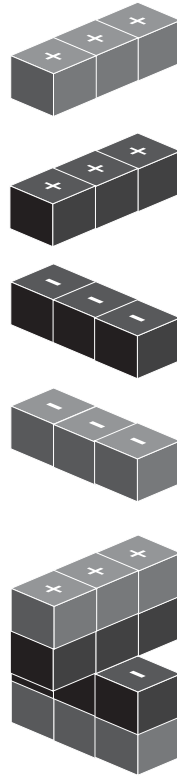
C 10
Proton: 6
Neutron: 4
Spin: 0



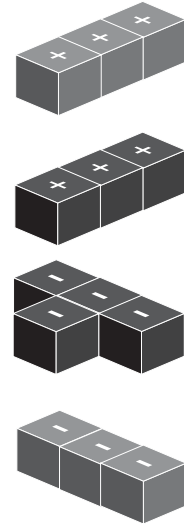
C 11
Proton: 6
Neutron: 5
Spin: -3/2



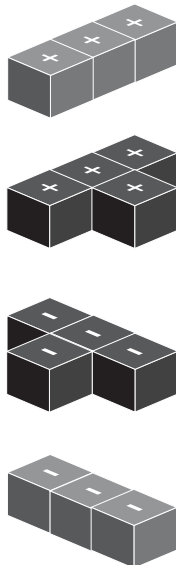
C 12
Proton: 6
Neutron: 6
Spin: 0
Stable



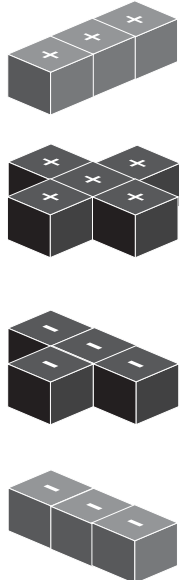
C 13
Proton: 6
Neutron: 7
Spin: -1/2
Stable



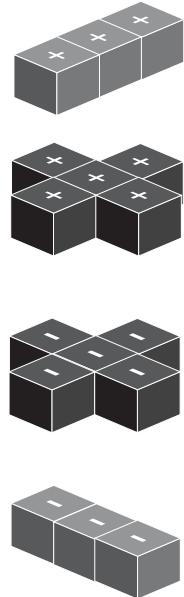
C 14
Proton: 6
Neutron: 8
Spin: 0



C 15
Proton: 6
Neutron: 9
Spin: 1/2



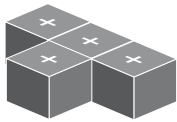
C 16
Proton: 6
Neutron: 10
Spin: 0



Nitrogen Nucleus

$$s^2 p^3$$

N 12
Proton: 7
Neutron: 5
Spin: 1



N 13
Proton: 7
Neutron: 6
Spin: -1/2



N 14
Proton: 7
Neutron: 7
Spin: 1
Stable



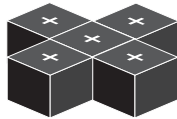
N 15
Proton: 7
Neutron: 8
Spin: -1/2
Stable



N 16
Proton: 7
Neutron: 9
Spin: -2



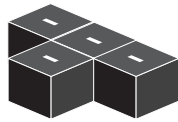
N 17
Proton: 7
Neutron: 10
Spin: -1/2



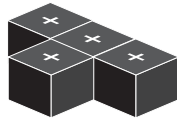
Oxygen Nucleus

$s^2 p^4$

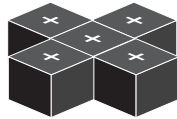
O 15
Proton: 8
Neutron: 7
Spin: $-1/2$



O 16
Proton: 8
Neutron: 8
Spin: 0
Stable



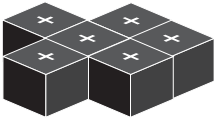
O 17
Proton: 8
Neutron: 9
Spin: $5/2$
Stable



O 18
Proton: 8
Neutron: 10
Spin: 0
Stable



O 19
Proton: 8
Neutron: 11
Spin: $5/2$



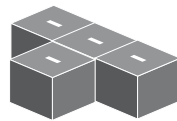
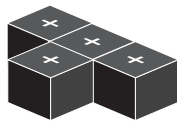
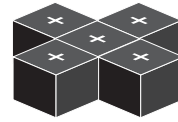
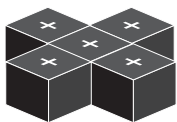
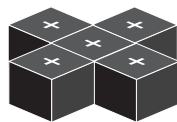
Fluorine Nucleus

$$s^2 p^5$$

F 18
Proton: 9
Neutron: 9
Spin: 1

F 18m
Proton: 9
Neutron: 9
Spin: 5

F 19
Proton: 9
Neutron: 10
Spin: 1/2
Stable



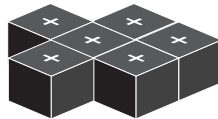
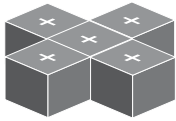
Neon Nucleus

$$s^2 p^6$$

Ne 20
Proton: 10
Neutron: 10
Spin: 0
Stable

Ne 21
Proton: 10
Neutron: 11
Spin: 3/2
Stable

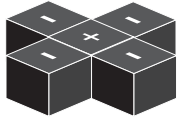
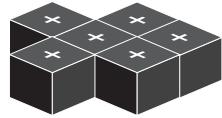
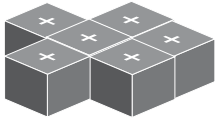
Ne 22
Proton: 10
Neutron: 12
Spin: 0
Stable



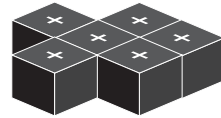
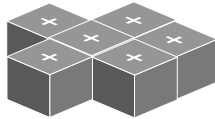
Sodium Nucleus

s^1

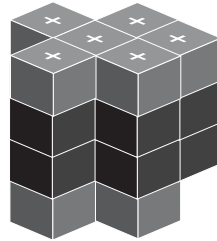
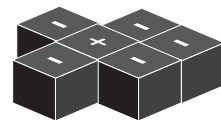
Na 22
Proton: 11
Neutron: 11
Spin: 3



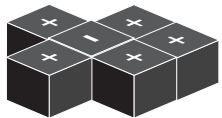
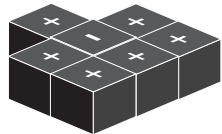
Na 22m
Proton: 11
Neutron: 11
Spin: 1



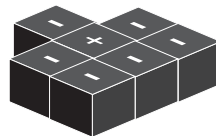
Na 23
Proton: 11
Neutron: 12
Spin: 3/2
Stable



Na 24
Proton: 11
Neutron: 13
Spin: 4



Na 24m
Proton: 11
Neutron: 13
Spin: 1



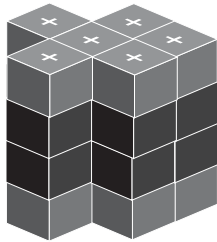
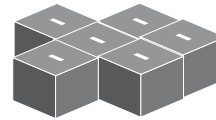
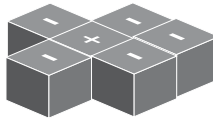
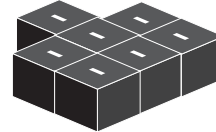
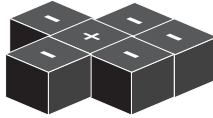
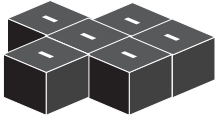
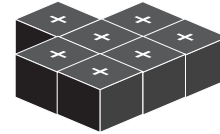
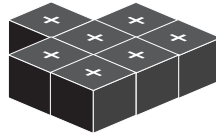
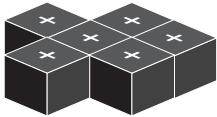
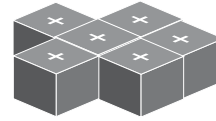
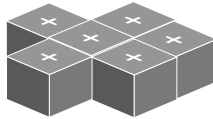
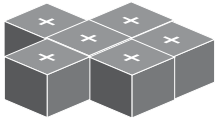
Magnesium Nucleus

s^2

Mg 24
Proton: 12
Neutron: 12
Spin: 0
Stable

Mg 25
Proton: 12
Neutron: 13
Spin: 5/2
Stable

Mg 26
Proton: 12
Neutron: 14
Spin: 0
Stable



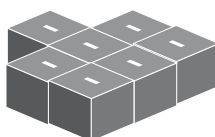
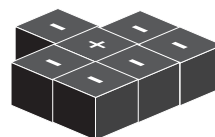
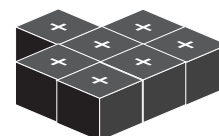
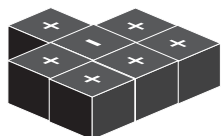
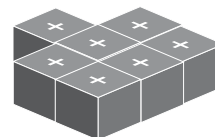
Aluminium Nucleus

$s^2 p^1$

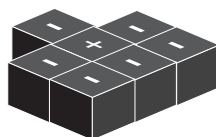
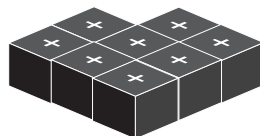
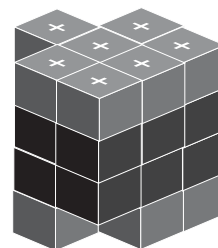
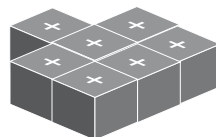
Al 26
Proton: 13
Neutron: 13
Spin: 5

Al 26m
Proton: 13
Neutron: 13
Spin: 0

Al 27
Proton: 13
Neutron: 14
Spin: 5/2
Stable



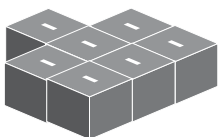
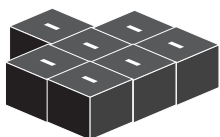
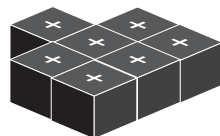
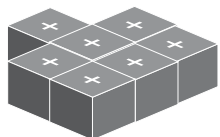
Al 28
Proton: 13
Neutron: 15
Spin: 3



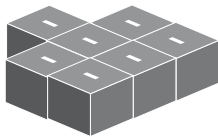
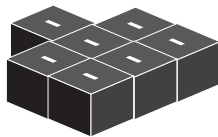
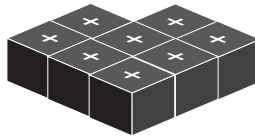
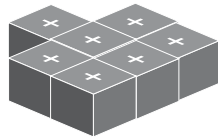
Silicon Nucleus

$s^2 p^2$

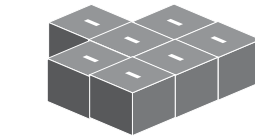
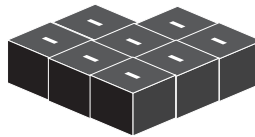
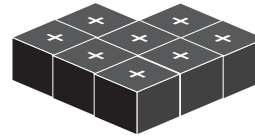
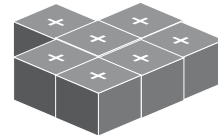
Si 28
Proton: 14
Neutron: 14
Spin: 0
Stable



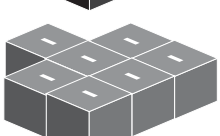
Si 29
Proton: 14
Neutron: 15
Spin: 1/2
Stable



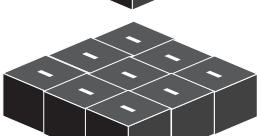
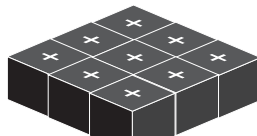
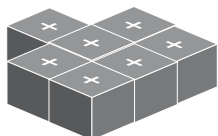
Si 30
Proton: 14
Neutron: 16
Spin: 0
Stable



Si 31
Proton: 14
Neutron: 17
Spin: 3/2



Si 32
Proton: 14
Neutron: 18
Spin: 0



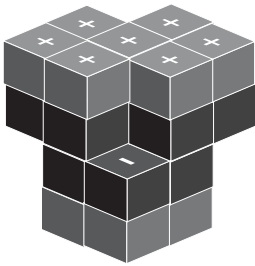
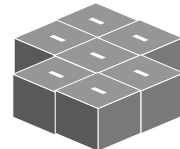
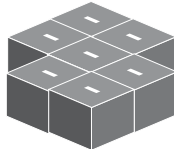
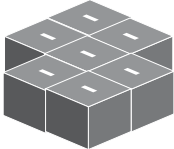
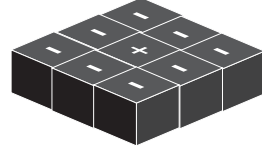
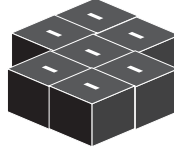
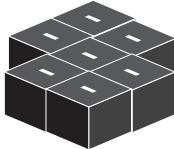
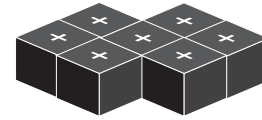
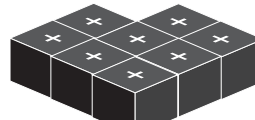
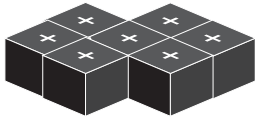
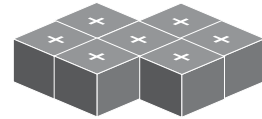
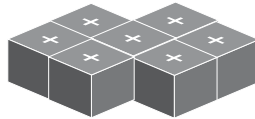
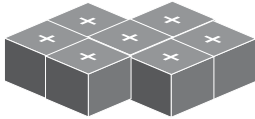
Silicon Nucleus

$s^2 p^2$

Si 28
Proton: 14
Neutron: 14
Spin: 0
Stable

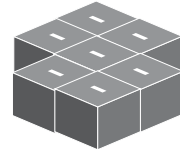
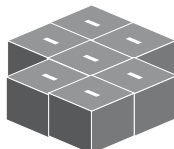
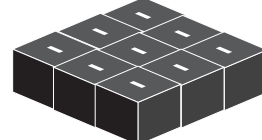
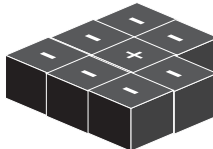
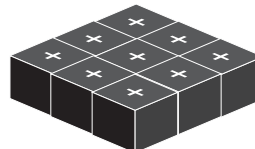
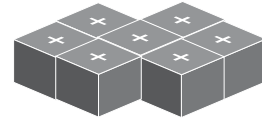
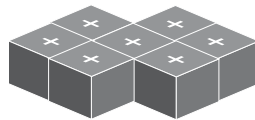
Si 29
Proton: 14
Neutron: 15
Spin: 1/2
Stable

Si 30
Proton: 14
Neutron: 16
Spin: 0
Stable



Si 31
Proton: 14
Neutron: 17
Spin: 3/2

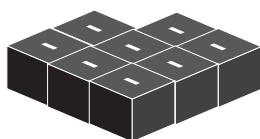
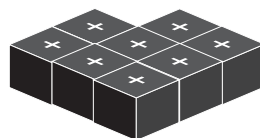
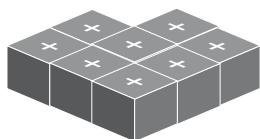
Si 32
Proton: 14
Neutron: 18
Spin: 0



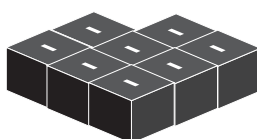
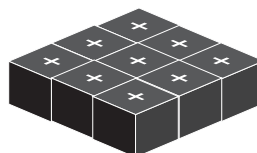
Phosphorus Nucleus

$s^2 p^3$

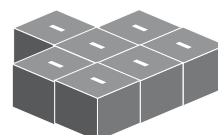
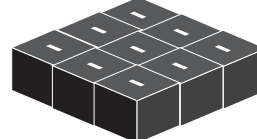
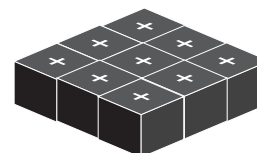
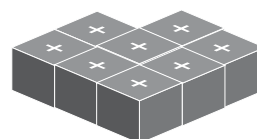
P 31
Proton: 15
Neutron: 16
Spin: 1/2
Stable



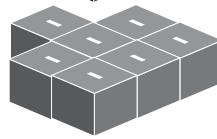
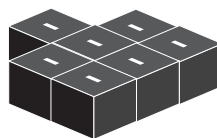
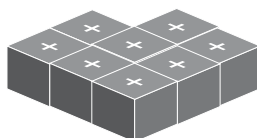
P 32
Proton: 15
Neutron: 17
Spin: 1



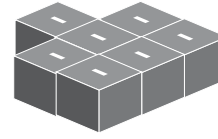
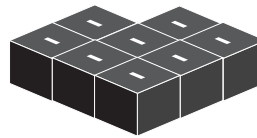
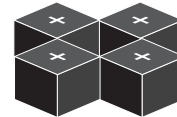
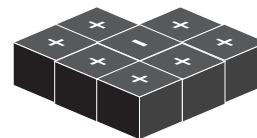
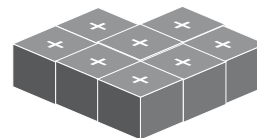
P 33
Proton: 15
Neutron: 18
Spin: 1/2



P 34
Proton: 15
Neutron: 19
Spin: 1



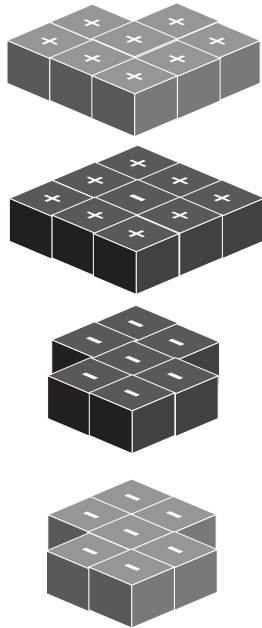
P 35
Proton: 15
Neutron: 20
Spin: 1/2



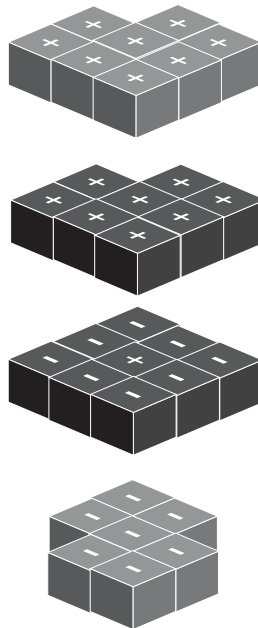
Phosphorus Nucleus

$s^2 p^3$

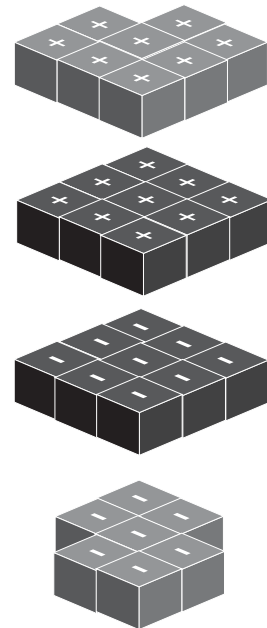
P 31
Proton: 15
Neutron: 16
Spin: 1/2
Stable



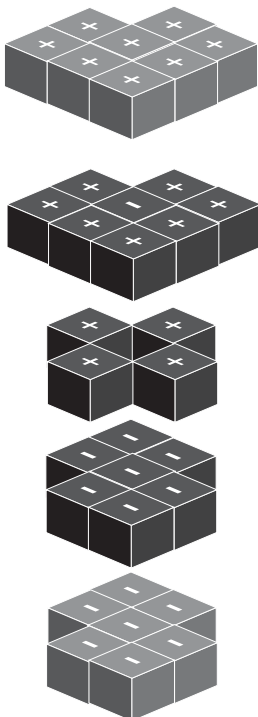
P 32
Proton: 15
Neutron: 17
Spin: 1



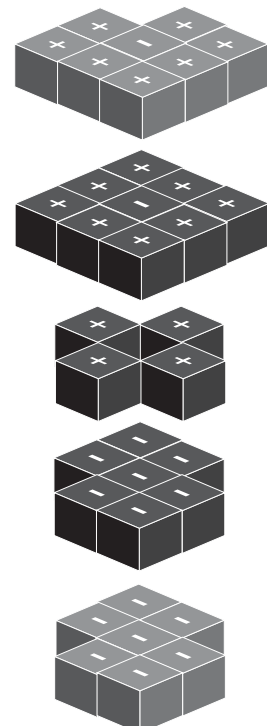
P 33
Proton: 15
Neutron: 18
Spin: 1/2



P 34
Proton: 15
Neutron: 19
Spin: 1



P 35
Proton: 15
Neutron: 20
Spin: 1/2



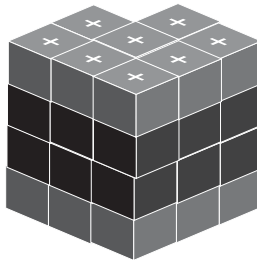
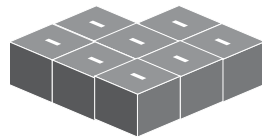
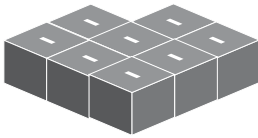
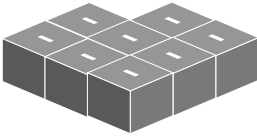
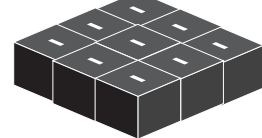
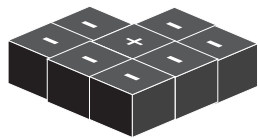
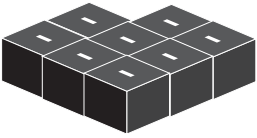
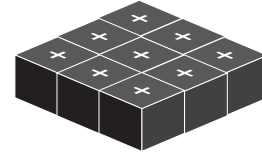
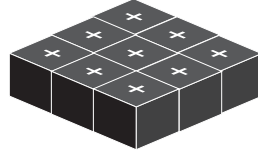
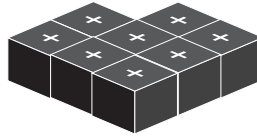
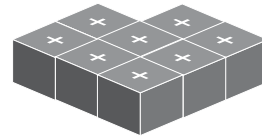
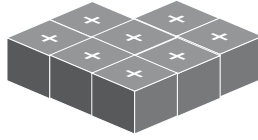
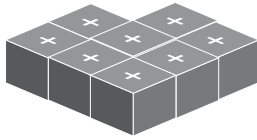
Sulfur Nucleus

$s^2 p^4$

S 32
Proton: 16
Neutron: 16
Spin: 0
Stable

S 33
Proton: 16
Neutron: 17
Spin: 3/2
Stable

S 34
Proton: 16
Neutron: 18
Spin: 0
Stable

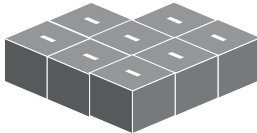
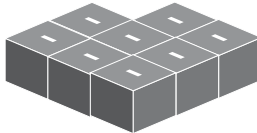
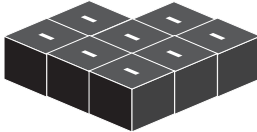
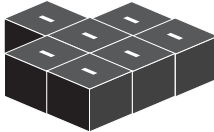
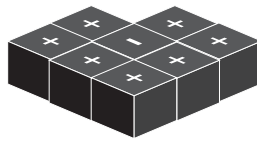
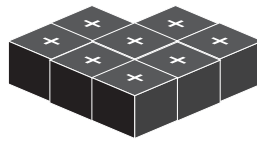
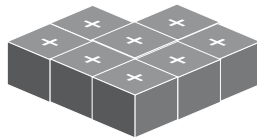
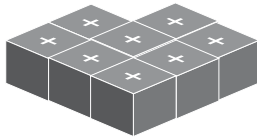


Sulfur Nucleus

$s^2 p^4$

S 35
Proton: 16
Neutron: 19
Spin: 3/2

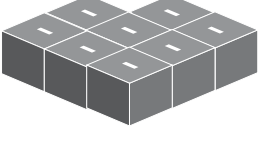
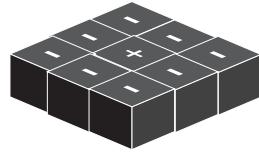
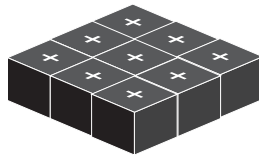
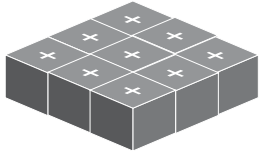
S 36
Proton: 16
Neutron: 20
Spin: 0
Stable



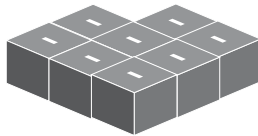
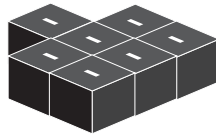
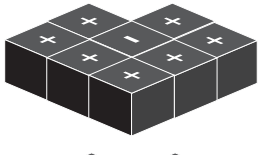
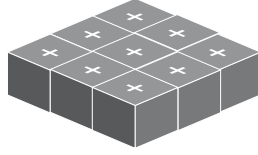
Chlorine Nucleus

$s^2 p^5$

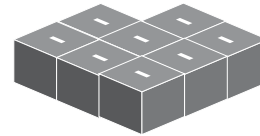
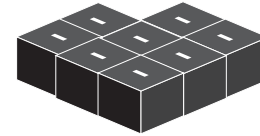
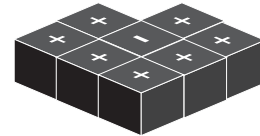
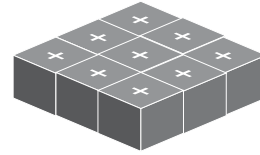
Cl 35
Proton: 17
Neutron: 18
Spin: 3/2
Stable



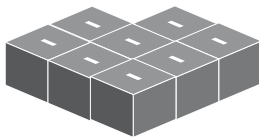
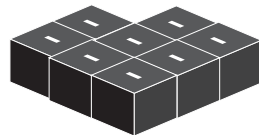
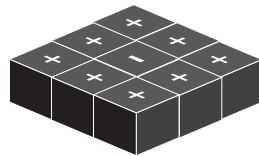
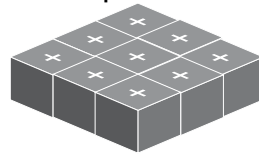
Cl 36
Proton: 17
Neutron: 19
Spin: 2



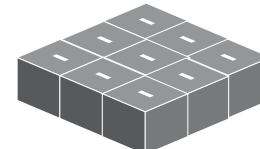
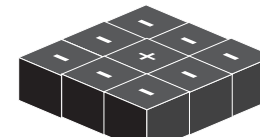
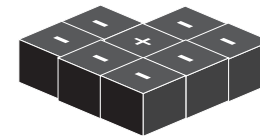
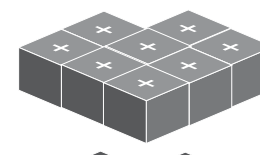
Cl 37
Proton: 17
Neutron: 20
Spin: 3/2
Stable



Cl 38
Proton: 17
Neutron: 21
Spin: -2



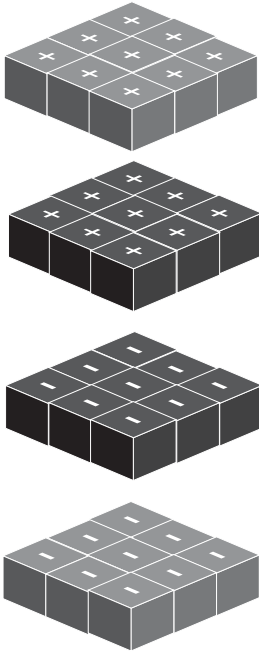
Cl 38m
Proton: 17
Neutron: 21
Spin: -5



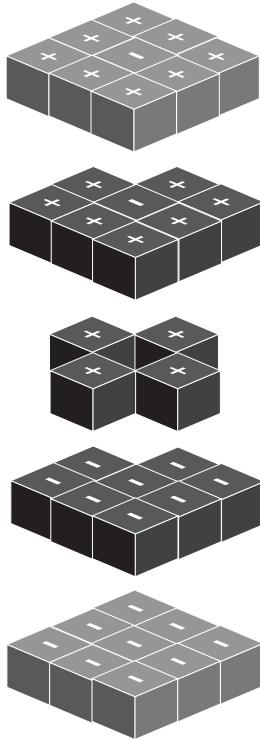
Argon Nucleus

$s^2 p^6$

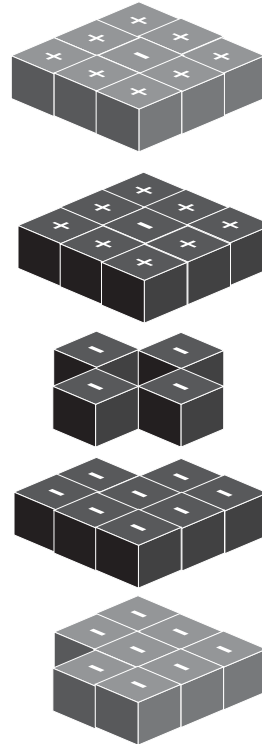
Ar 36
Proton: 18
Neutron: 18
Spin: 0
Stable



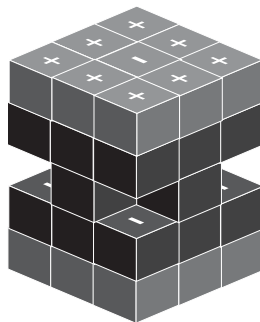
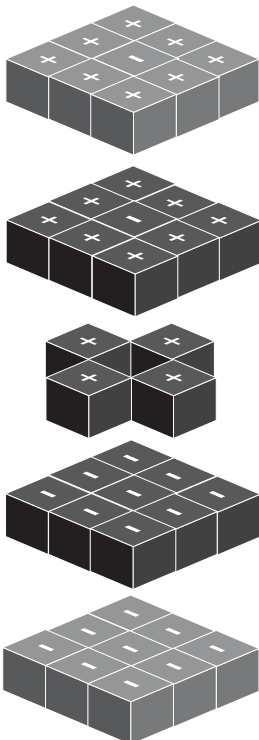
Ar 38
Proton: 18
Neutron: 20
Spin: 0
Stable



Ar 39
Proton: 18
Neutron: 21
Spin: -7/2
Half life: 269 years



Ar 40
Proton: 18
Neutron: 22
Spin: 0
Stable



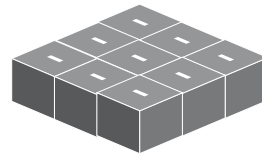
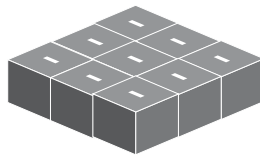
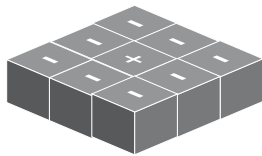
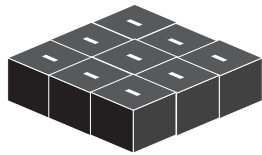
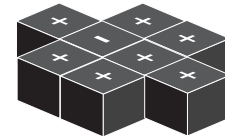
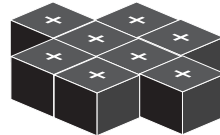
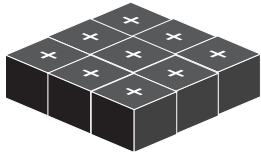
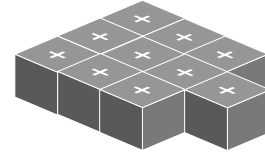
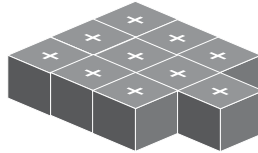
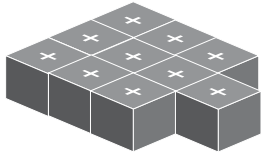
Potassium Nucleus

s^1

K 37
 Proton: 19
 Neutron: 18
 Spin: 3/2
 Half life: 1.226 s

K 38
 Proton: 19
 Neutron: 19
 Spin: 3
 Half life: 7.636 min

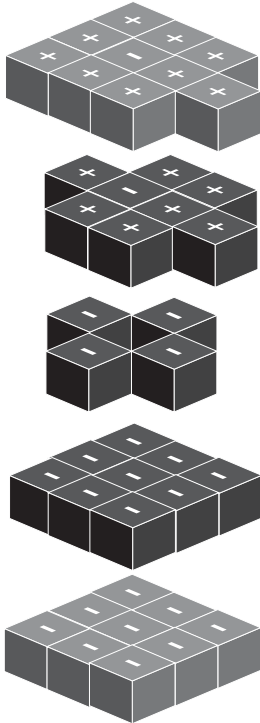
K 39
 Proton: 19
 Neutron: 20
 Spin: 3/2
 Stable



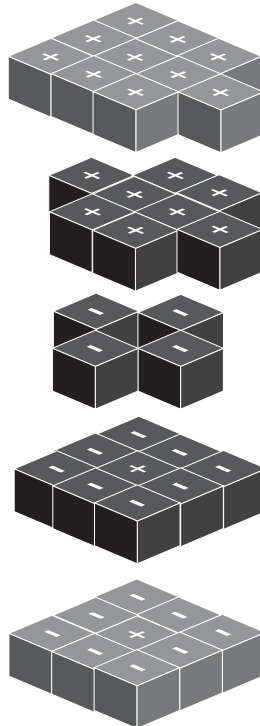
Potassium Nucleus

s^1

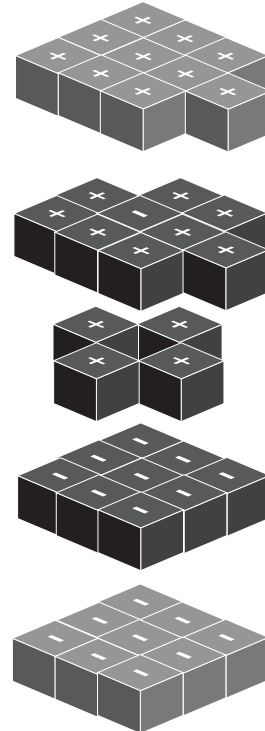
K 40
Proton: 19
Neutron: 21
Spin:-4



K 40m
Proton: 19
Neutron: 21
Spin:0



K 41
Proton: 19
Neutron: 22
Spin:3/2
Stable



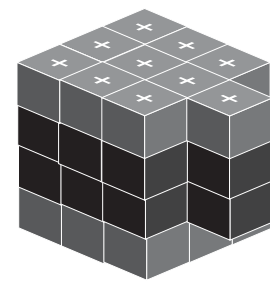
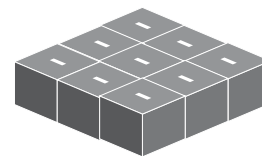
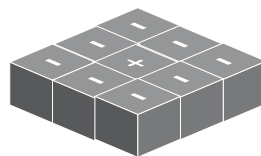
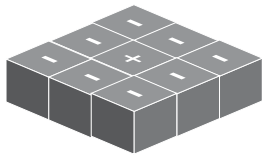
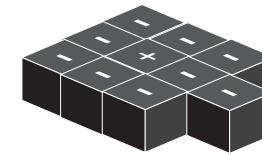
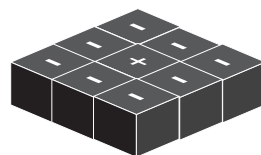
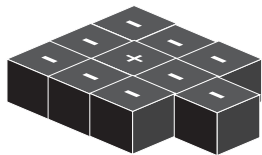
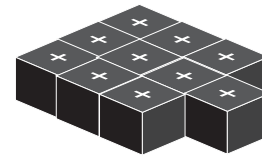
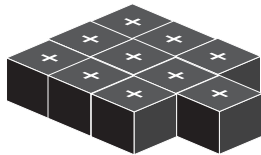
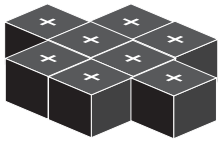
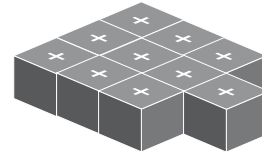
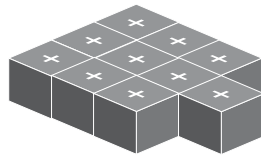
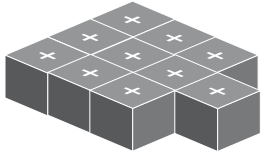
Potassium Nucleus

s^1

K 37
Proton: 19
Neutron: 18
Spin:3/2

K 37
Proton: 19
Neutron: 19
Spin:3

K 39
Proton: 19
Neutron: 20
Spin:3/2
Stable



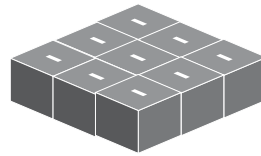
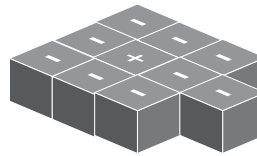
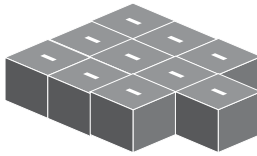
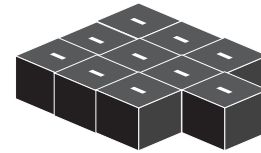
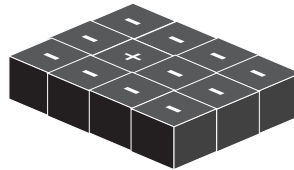
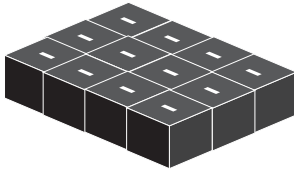
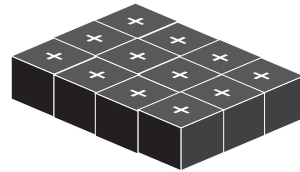
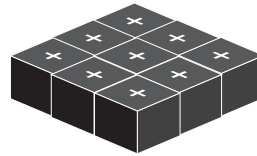
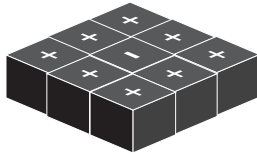
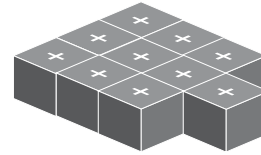
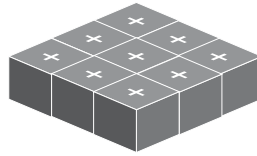
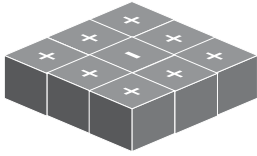
Potassium Nucleus

s^1

K 40
Proton: 19
Neutron: 21
Spin:-4

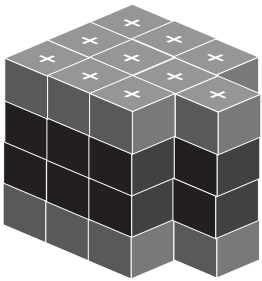
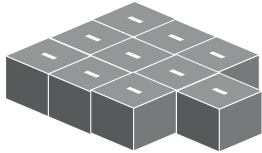
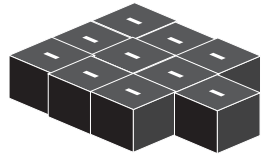
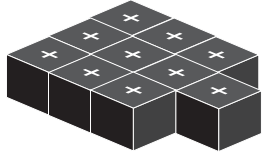
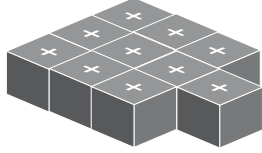
K 40m
Proton: 19
Neutron: 21
Spin:0

K 41
Proton: 19
Neutron: 22
Spin:3/2
Stable



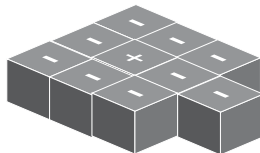
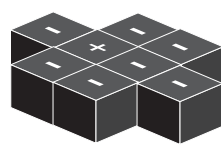
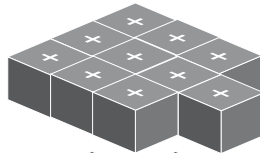
Calcium Nucleus

Ca 40
Proton: 20
Neutron: 20
Spin: 0
Stable

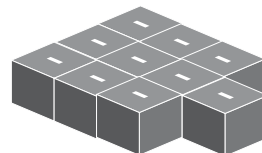
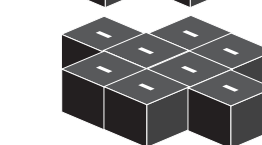
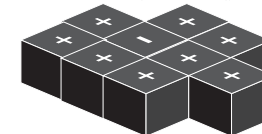
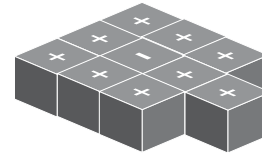


s^2

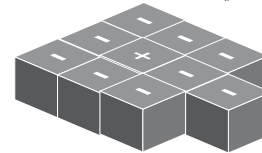
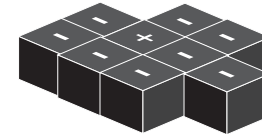
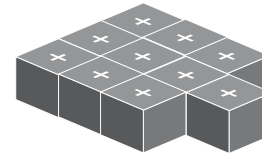
Ca 40
Proton: 20
Neutron: 20
Spin: 0
Stable



Ca 41
Proton: 20
Neutron: 21
Spin: -7/2
Stable



Ca 42
Proton: 20
Neutron: 22
Spin: 0
Stable



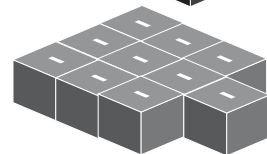
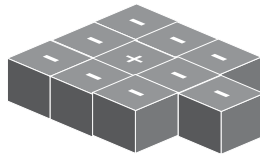
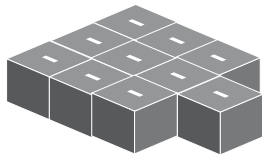
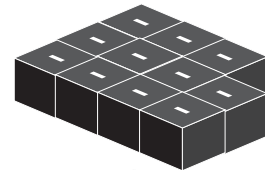
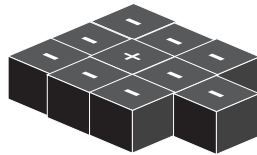
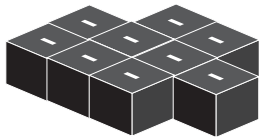
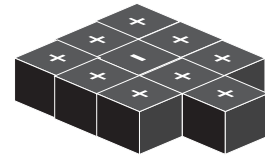
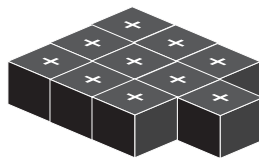
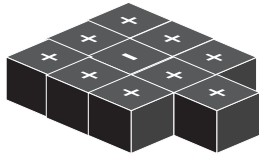
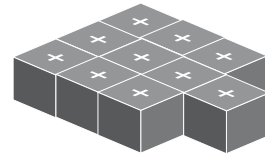
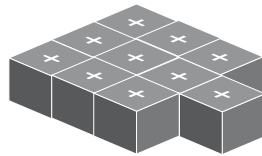
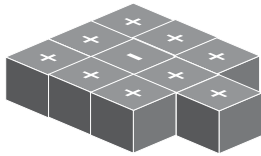
Calcium Nucleus

s^2

Ca 43
Proton: 20
Neutron: 23
Spin: $-7/2$
Stable

Ca 44
Proton: 20
Neutron: 24
Spin: 0
Stable

Ca 45
Proton: 20
Neutron: 25
Spin: $-7/2$



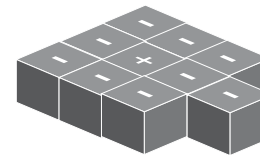
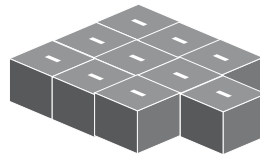
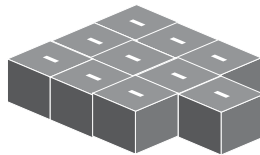
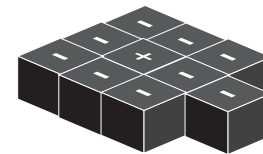
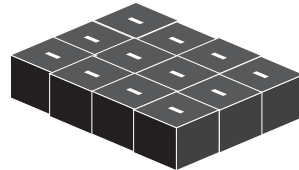
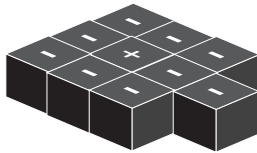
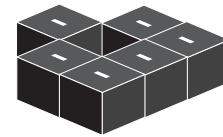
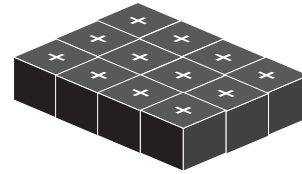
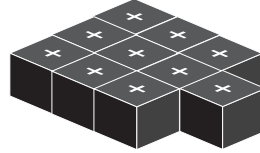
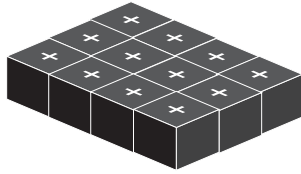
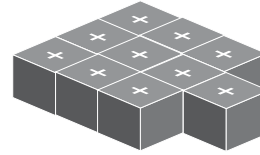
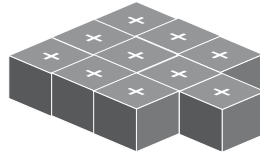
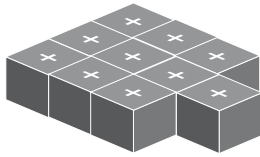
Calcium Nucleus

s^2

Ca 46
Proton: 20
Neutron: 26
Spin:0
Stable

Ca 47
Proton: 20
Neutron: 27
Spin:-7/2

Ca 48
Proton: 20
Neutron: 28
Spin:0
Stable



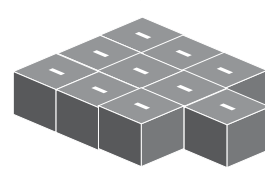
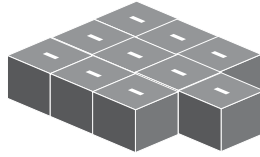
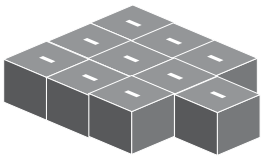
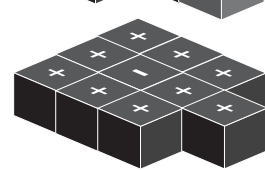
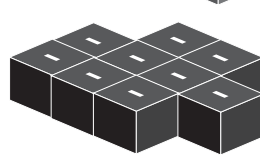
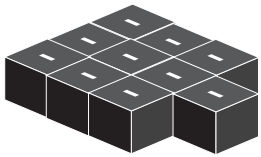
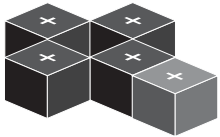
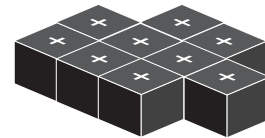
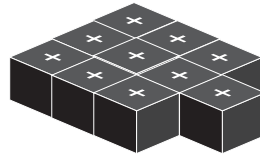
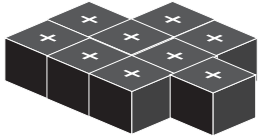
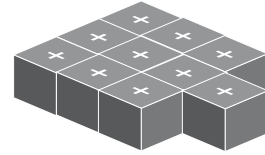
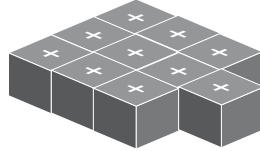
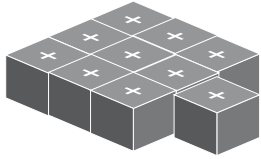
Scandium Nucleus

$$s^2 d^1$$

Sc 44
Proton: 21
Neutron: 23
Spin: 2

Sc 44m1
Proton: 21
Neutron: 23
Spin: -1

Sc 44m2
Proton: 21
Neutron: 23
Spin: 6



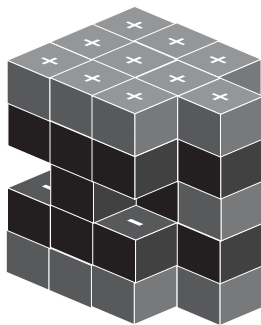
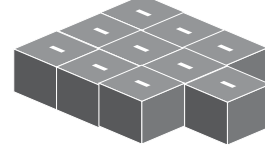
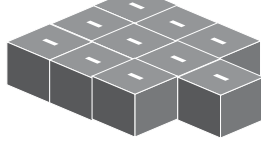
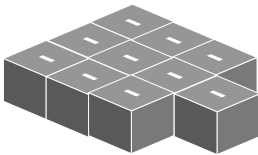
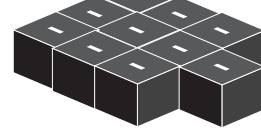
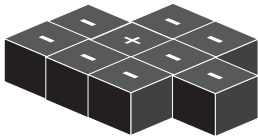
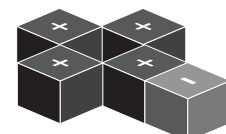
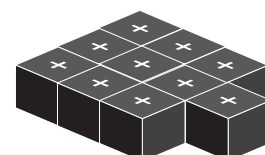
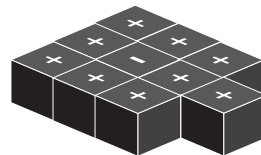
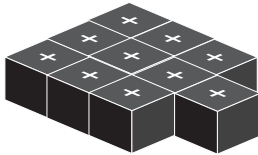
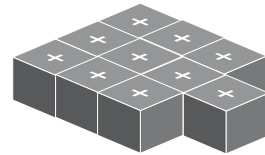
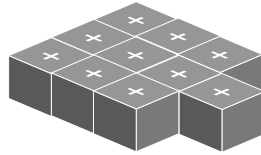
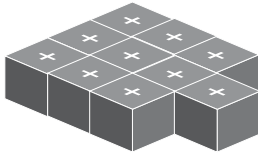
Scandium Nucleus

$s^2 d^1$

Sc 44m3
Proton: 21
Neutron: 23
Spin: 0

Sc 45
Proton: 21
Neutron: 24
Spin: $-7/2$
Stable

Sc 45m
Proton: 21
Neutron: 24
Spin: $3/2$



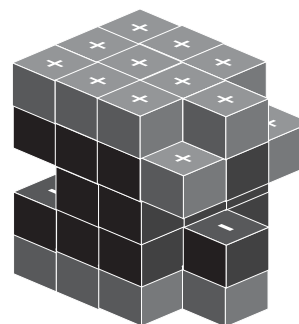
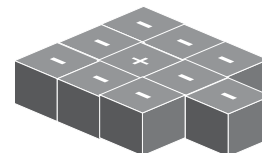
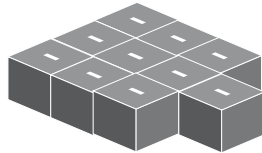
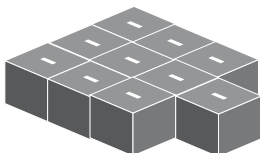
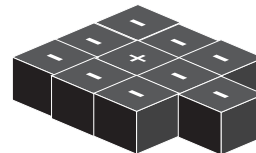
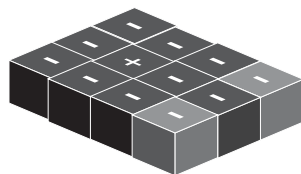
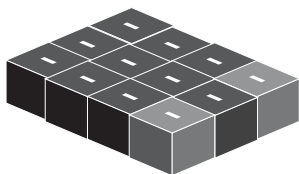
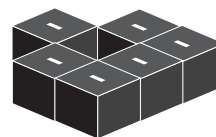
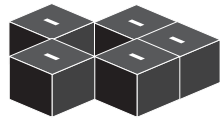
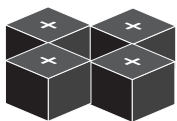
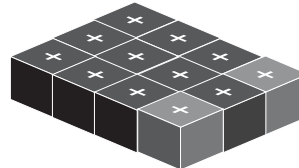
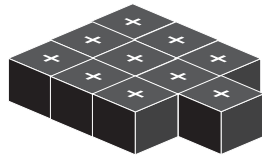
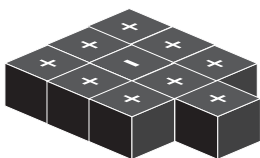
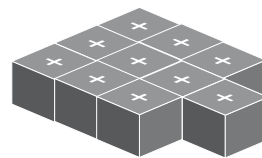
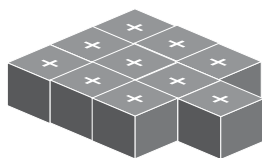
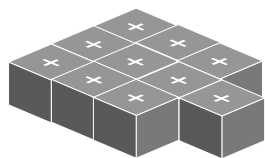
Titanium Nucleus

$s^2 d^2$

Ti 46
Proton: 22
Neutron: 24
Spin: 0
Stable

Ti 47
Proton: 22
Neutron: 25
Spin: -5/2
Stable

Ti 48
Proton: 22
Neutron: 26
Spin: 0
Stable

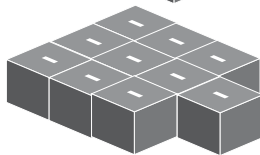
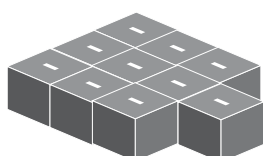
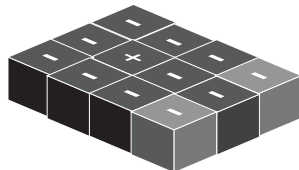
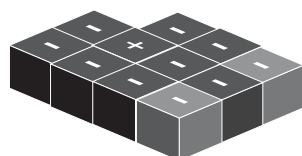
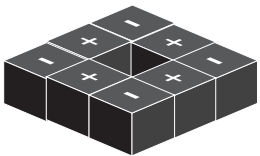
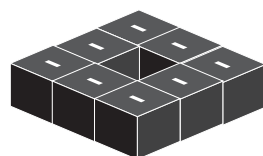
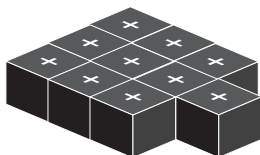
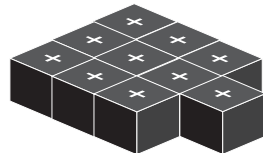
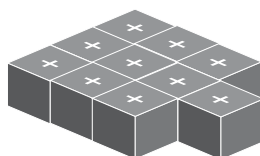
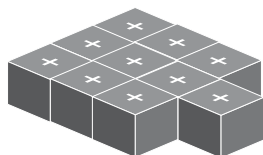


Titanium Nucleus

$s^2 d^2$

Ti 49
Proton: 22
Neutron: 27
Spin: $-7/2$
Stable

Ti 50
Proton: 22
Neutron: 28
Spin: 0
Stable

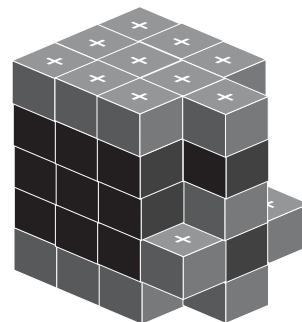
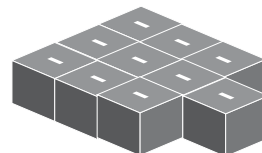
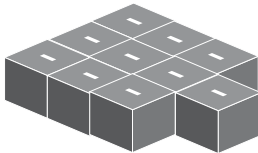
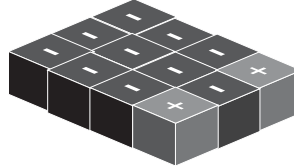
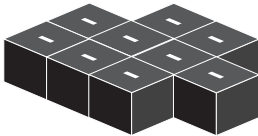
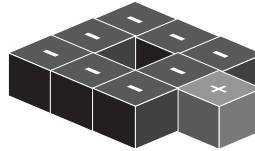
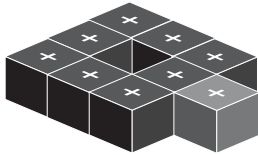
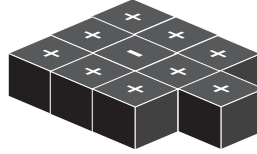
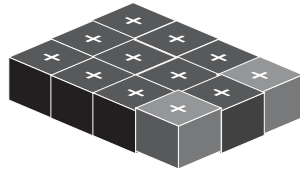
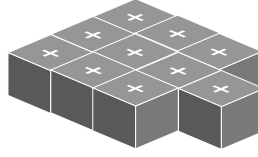
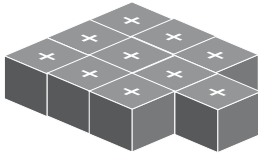


Vanadium Nucleus

$$s^2 d^3$$

V50
 Proton: 23
 Neutron: 27
 Spin: 6

V51
 Proton: 23
 Neutron: 28
 Spin: -7/2
 Stable



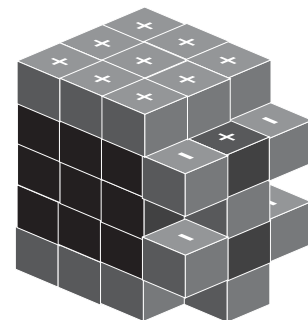
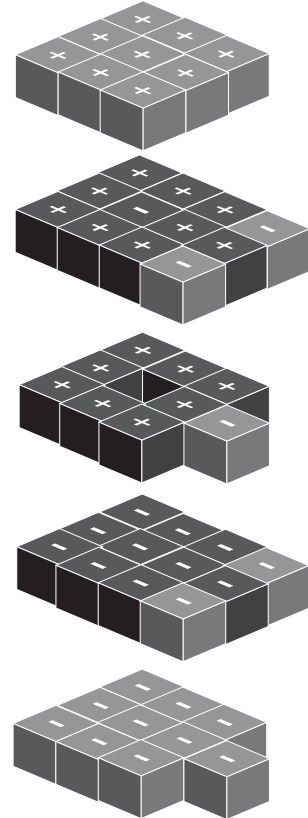
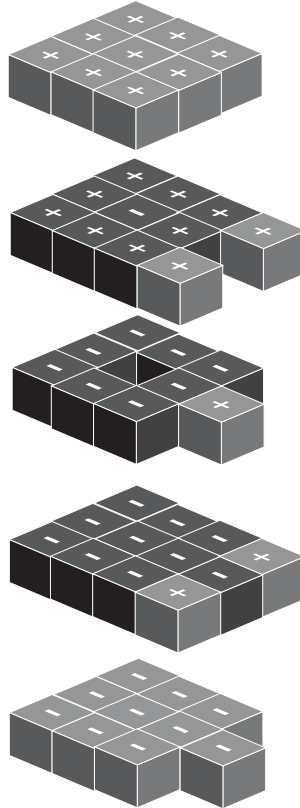
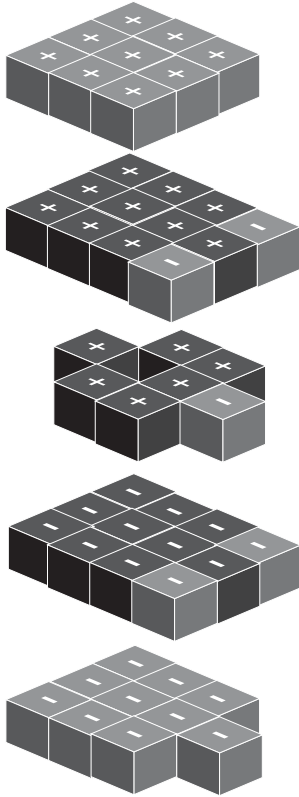
Chromium Nucleus

$s^1 d^5$

Cr 50
Proton: 24
Neutron: 26
Spin: 0
Stable

Cr 51
Proton: 24
Neutron: 27
Spin: $-7/2$

Cr 52
Proton: 24
Neutron: 28
Spin: 0
Stable

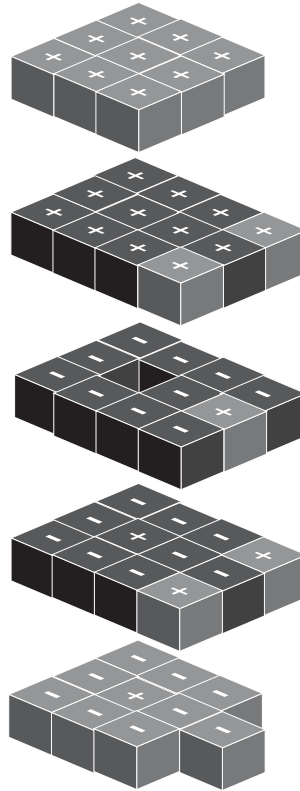
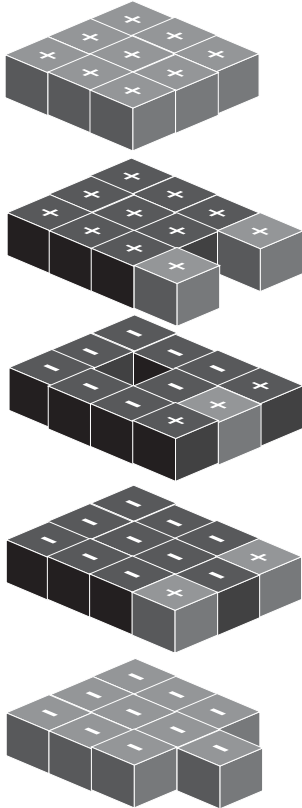


Chromium Nucleus

$s^1 d^5$

Cr 53
Proton: 24
Neutron: 29
Spin: $-3/2$
Stable

Cr 54
Proton: 24
Neutron: 30
Spin: 0
Stable



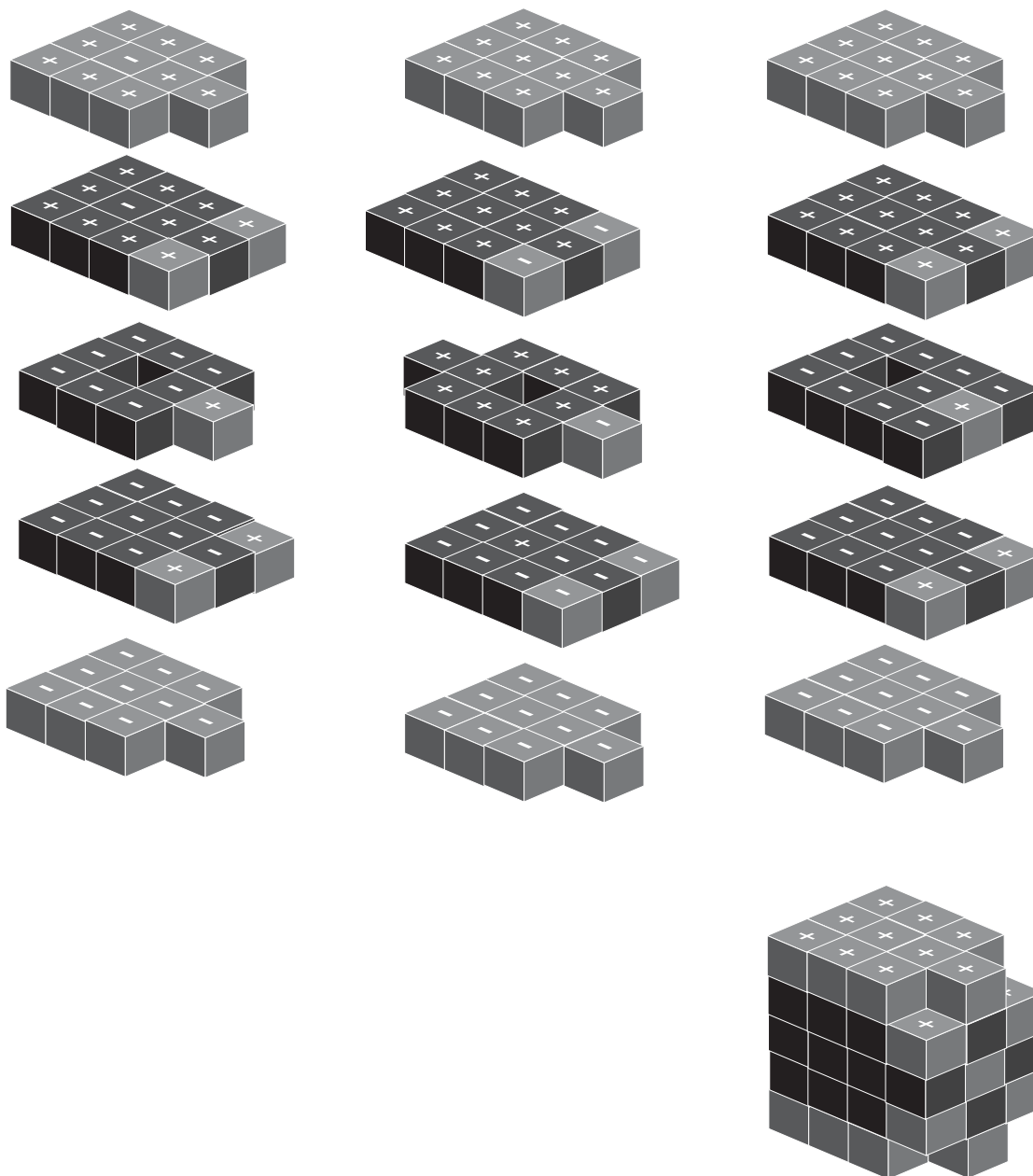
Manganese Nucleus

$$s^2 d^5$$

Mn 53
 Proton: 25
 Neutron: 28
 Spin: $-7/2$
 Half life: 3740000 years

Mn 54
 Proton: 25
 Neutron: 29
 Spin: 3
 Half life: 312.3 d

Mn 55
 Proton: 25
 Neutron: 30
 Spin: $-5/2$
 Stable



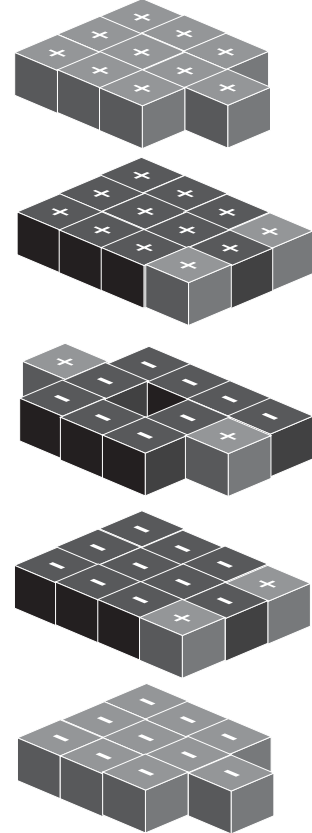
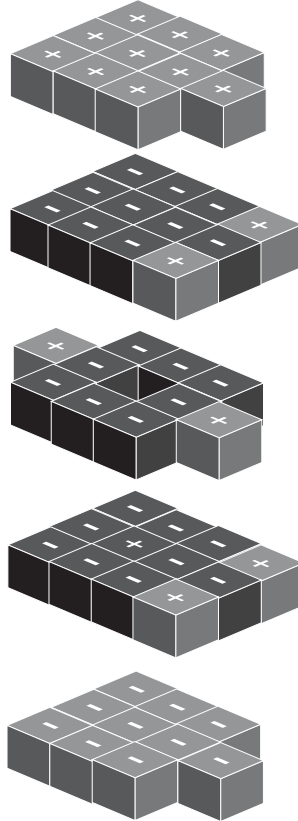
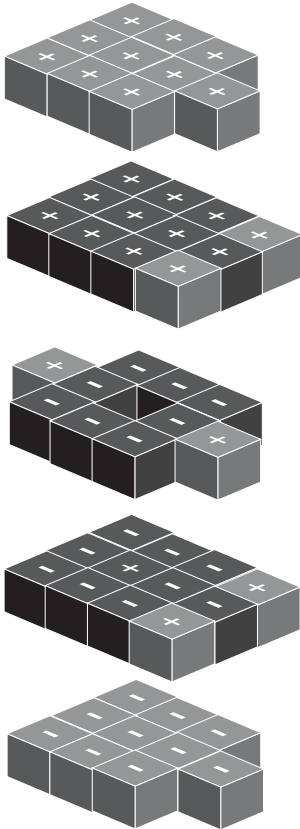
Iron Nucleus

$$s^2 d^6$$

Fe 54
 Proton: 26
 Neutron: 28
 Spin: 0
 Stable

Fe 54m
 Proton: 26
 Neutron: 28
 Spin: 10

Fe 55
 Proton: 26
 Neutron: 29
 Spin: -3/2



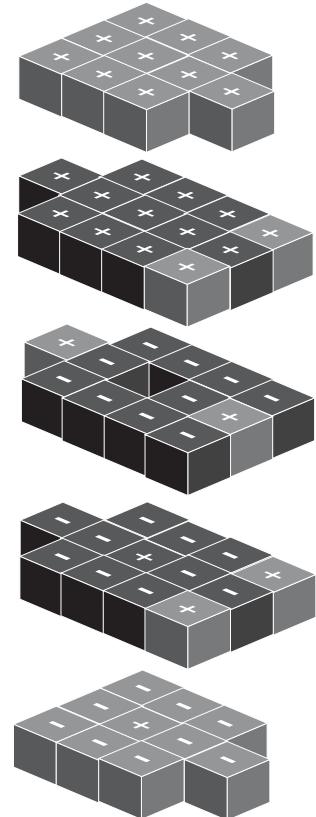
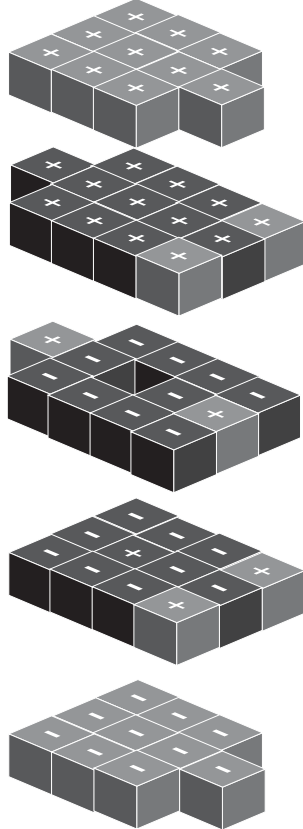
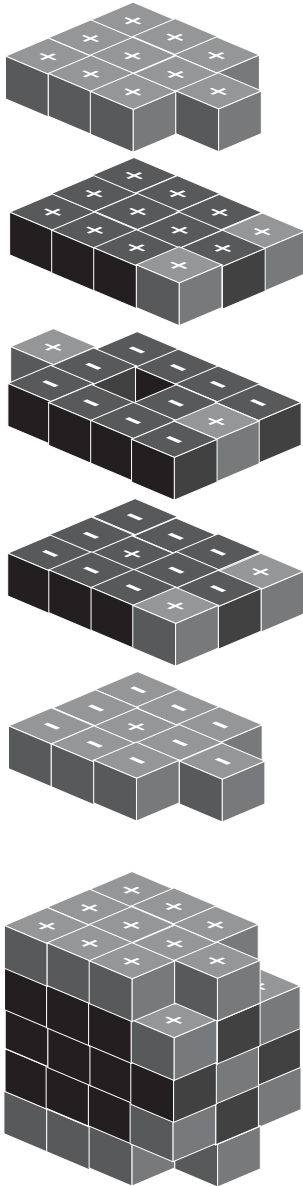
Iron Nucleus

$$s^2 d^6$$

Fe 56
 Proton: 26
 Neutron: 30
 Spin: 0
 Stable

Fe 57
 Proton: 26
 Neutron: 31
 Spin: -1/2
 Stable

Fe 58
 Proton: 26
 Neutron: 32
 Spin: 0
 Stable



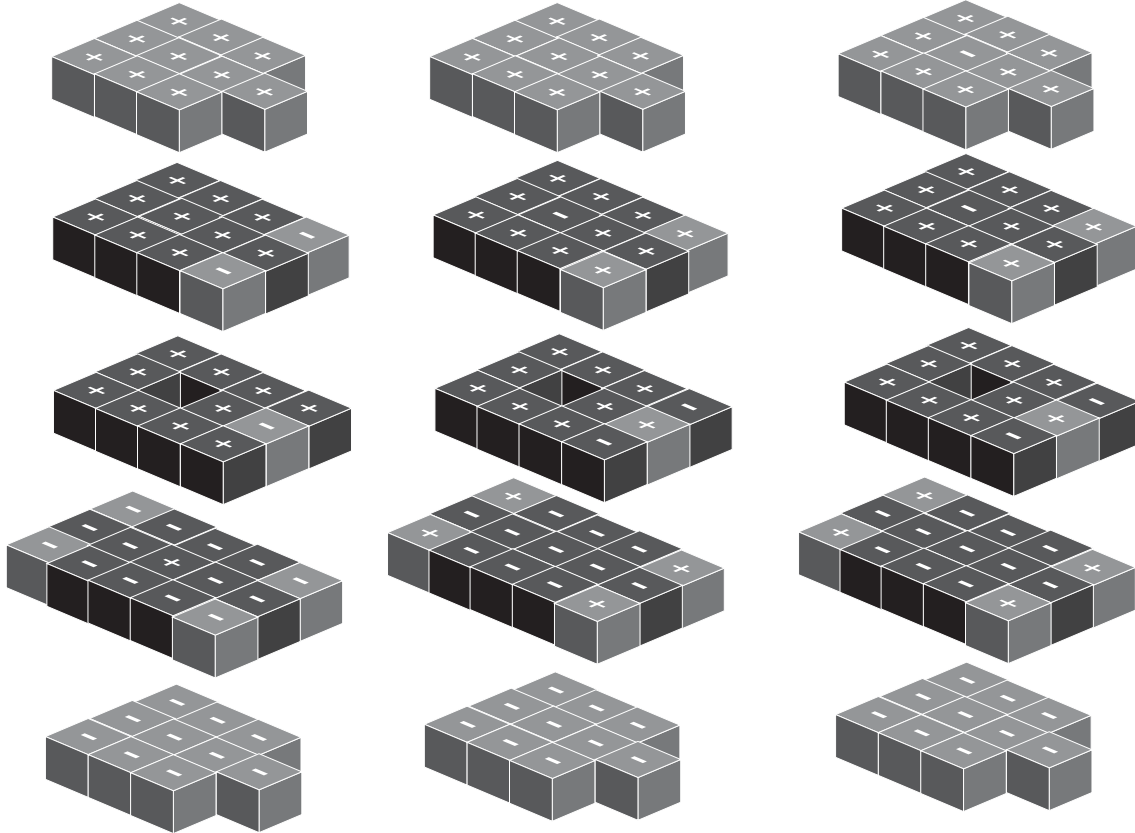
Cobalt Nucleus

$s^2 d^7$

Co 58
Proton 27
Neutron 31
Spin: 2

Co 58m1
Proton 27
Neutron 31
Spin: 5

Co 58m2
Proton 27
Neutron 31
Spin: 4



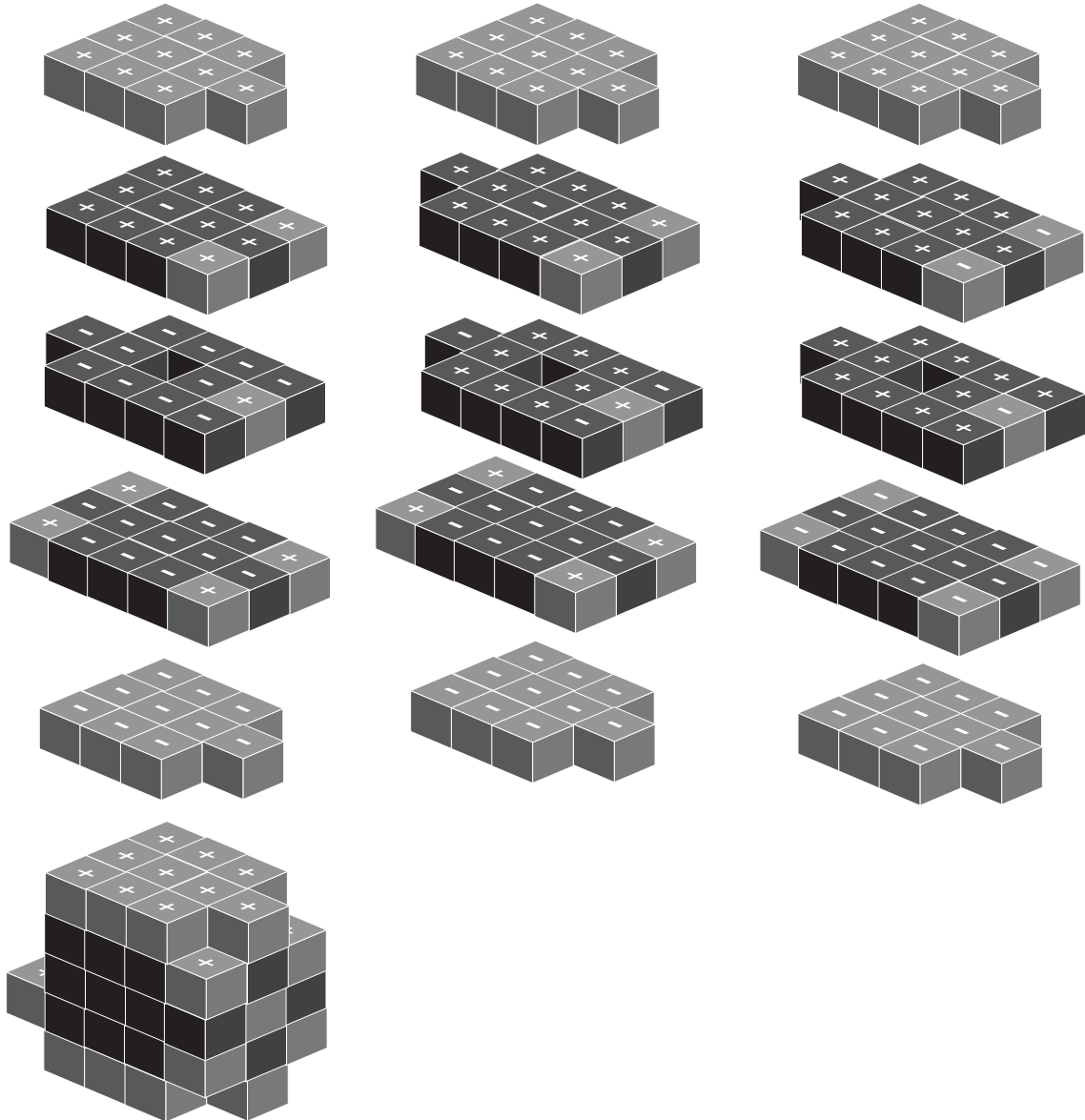
Cobalt Nucleus

$$s^2 d^7$$

Co 59
Proton 27
Neutron 32
Spin: $-7/2$
Stable

Co 60
Proton 27
Neutron 33
Spin: 5

Co 60m
Proton 27
Neutron 33
Spin: 2

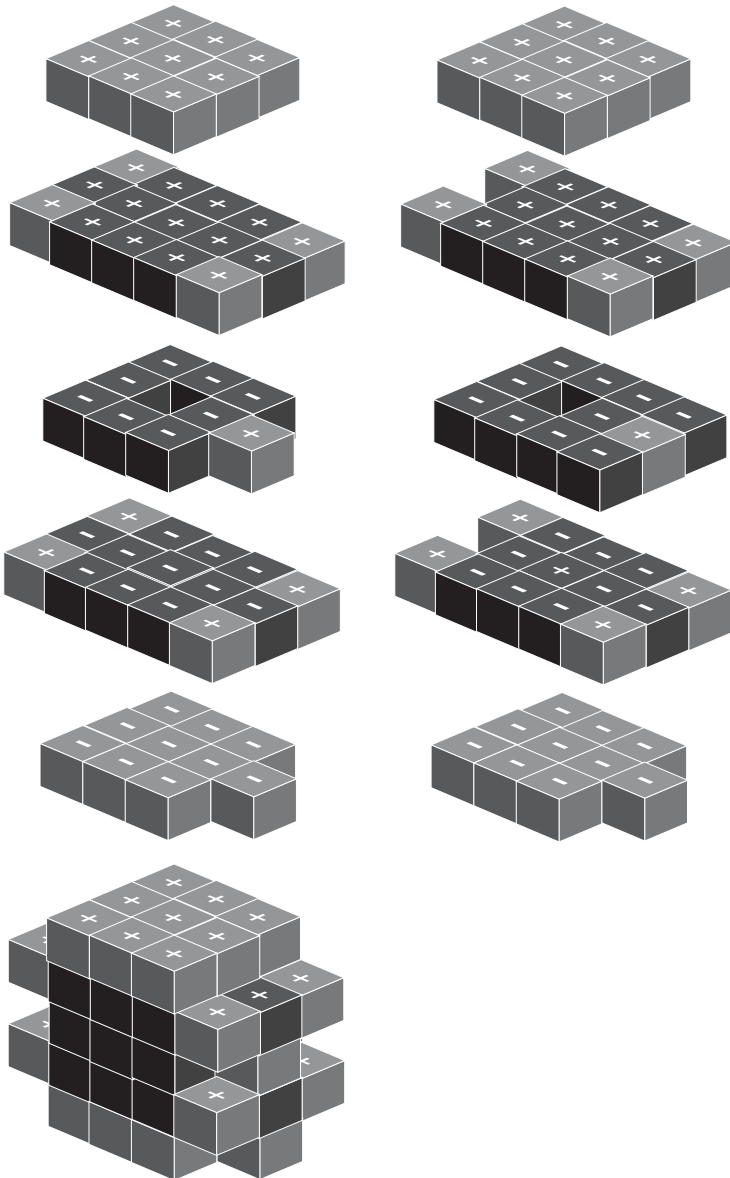


Nickel Nucleus

$s^1 d^9$

Ni 58
Proton: 28
Neutron: 30
Spin: 0
Stable

Ni 58
Proton: 28
Neutron: 30
Spin: 0
Stable



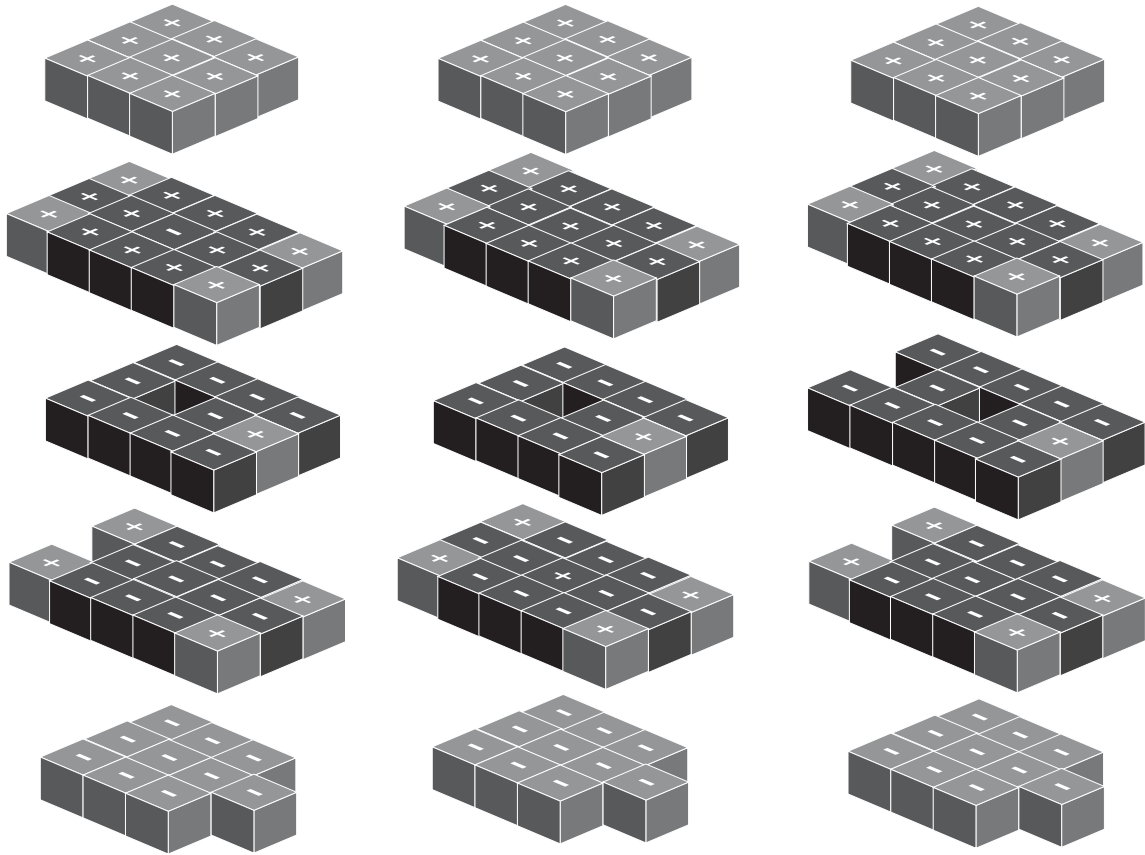
Nickel Nucleus

$s^1 d^9$

Ni 59
Proton 28
Neutron 31
Spin: $-3/2$

Ni 60
Proton: 28
Neutron: 32
Spin: 0
Stable

Ni 61
Proton: 28
Neutron: 33
Spin: $-3/2$
Stable



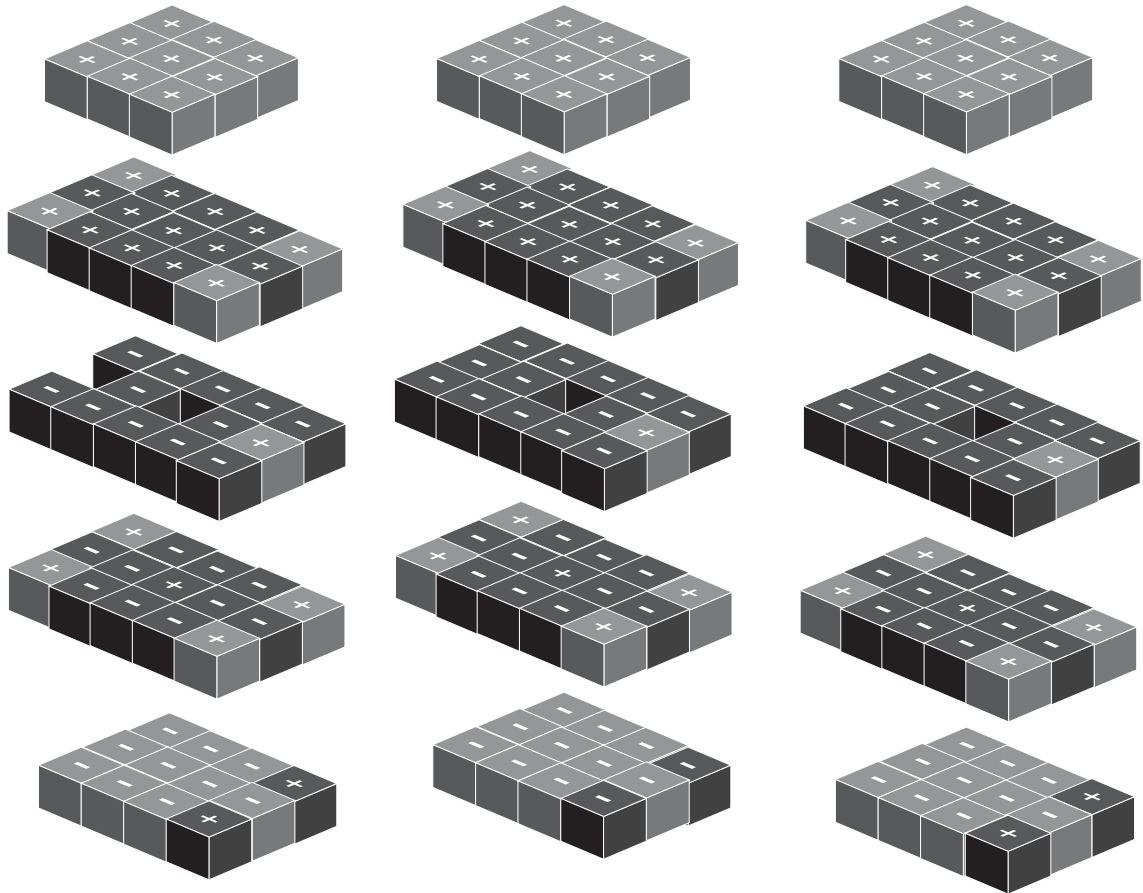
Nickel Nucleus

$s^1 d^9$

Ni 64
 Proton: 28
 Neutron: 36
 Spin: 0
 Stable

Ni 65
 Proton: 28
 Neutron: 37
 Spin: $-5/2$

Ni 65m1
 Proton: 28
 Neutron: 37
 Spin: $-1/2$



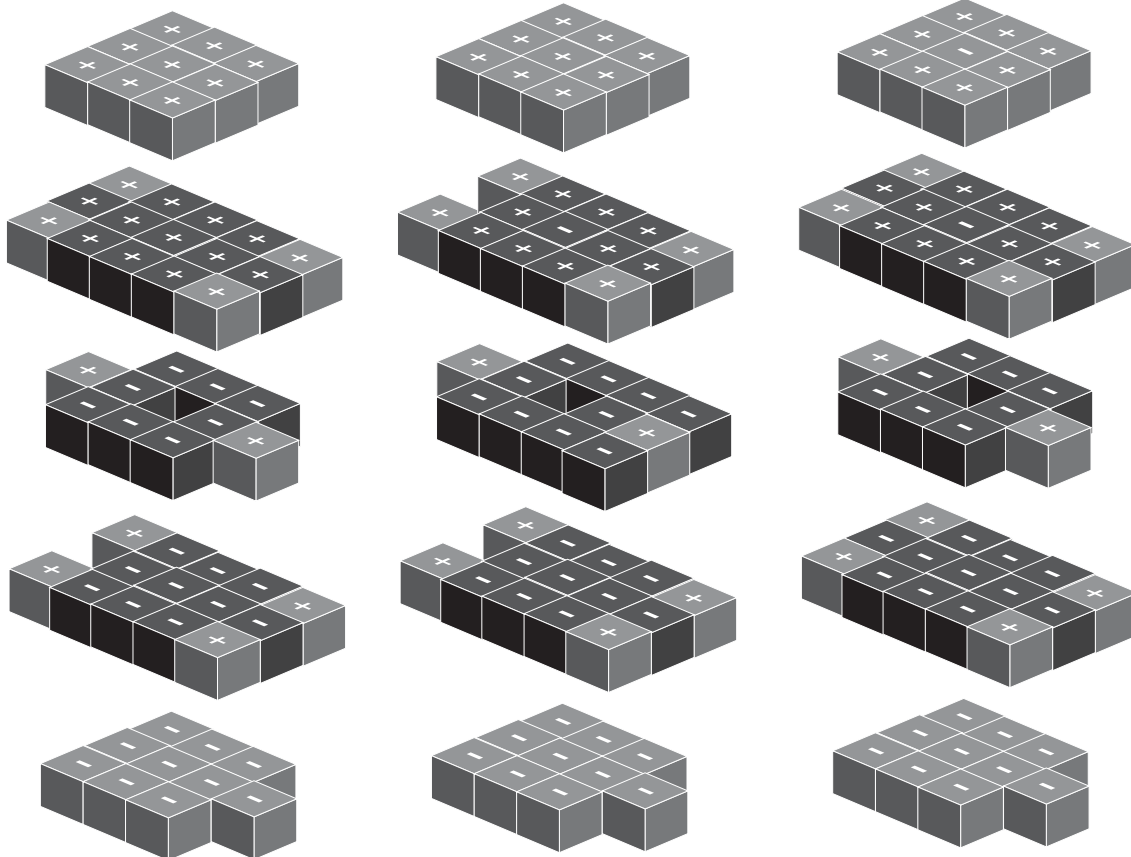
Copper Nucleus

$s^1 d^{10}$

Cu 58
Proton 29
Neutron 29
Spin: 1

Cu 59
Proton 29
Neutron 30
Spin: $-3/2$

Cu 59
Proton 29
Neutron 30
Spin: $-3/2$



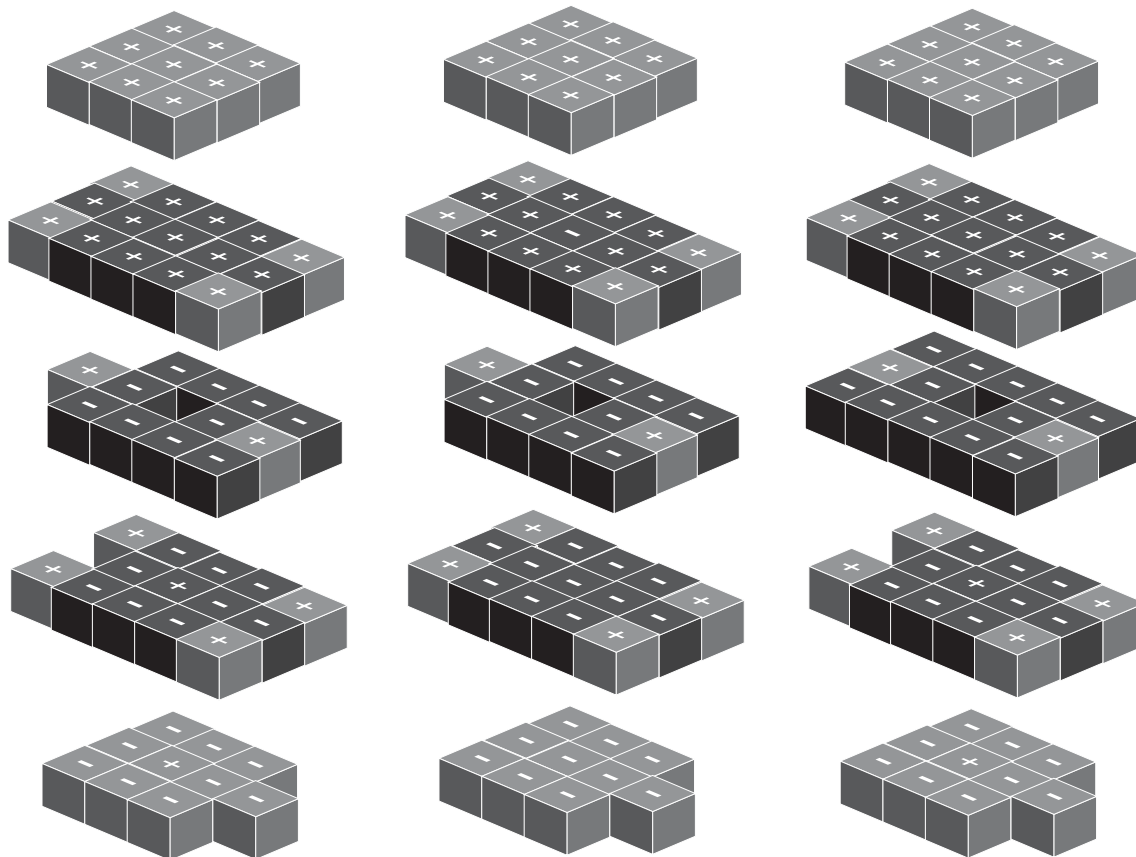
Copper Nucleus

$s^1 d^{10}$

Cu 60
Proton 29
Neutron 31
Spin:2

Cu 61
Proton 29
Neutron 32
Spin:-3/2

Cu 62
Proton 29
Neutron 33
Spin:1



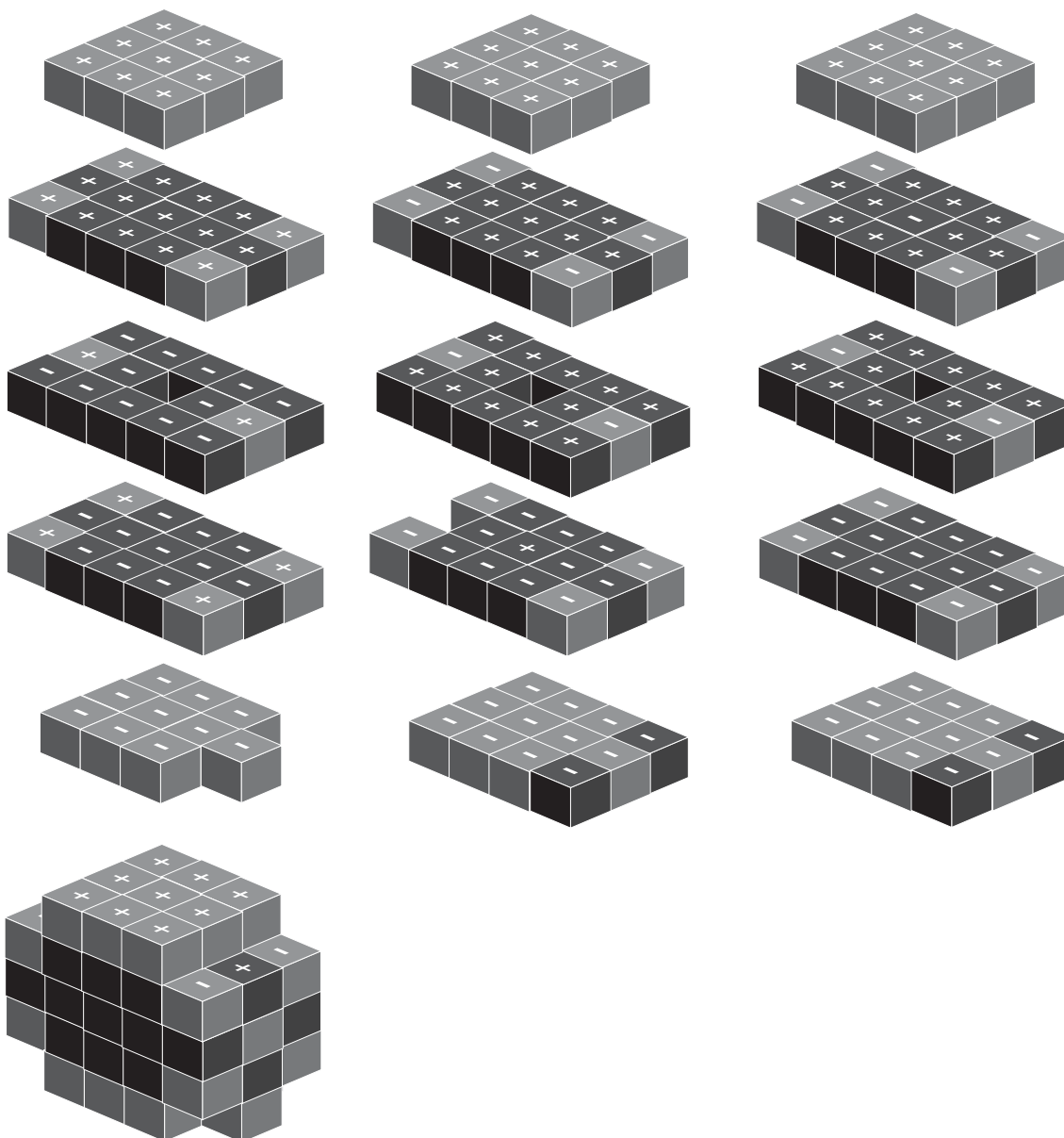
Copper Nucleus

$s^1 d^{10}$

Cu 63
Proton 29
Neutron 34
Spin: $-3/2$
Stable

Cu 64
Proton 29
Neutron 35
Spin: 1

Cu 65
Proton 29
Neutron 36
Spin: $-3/2$
Stable



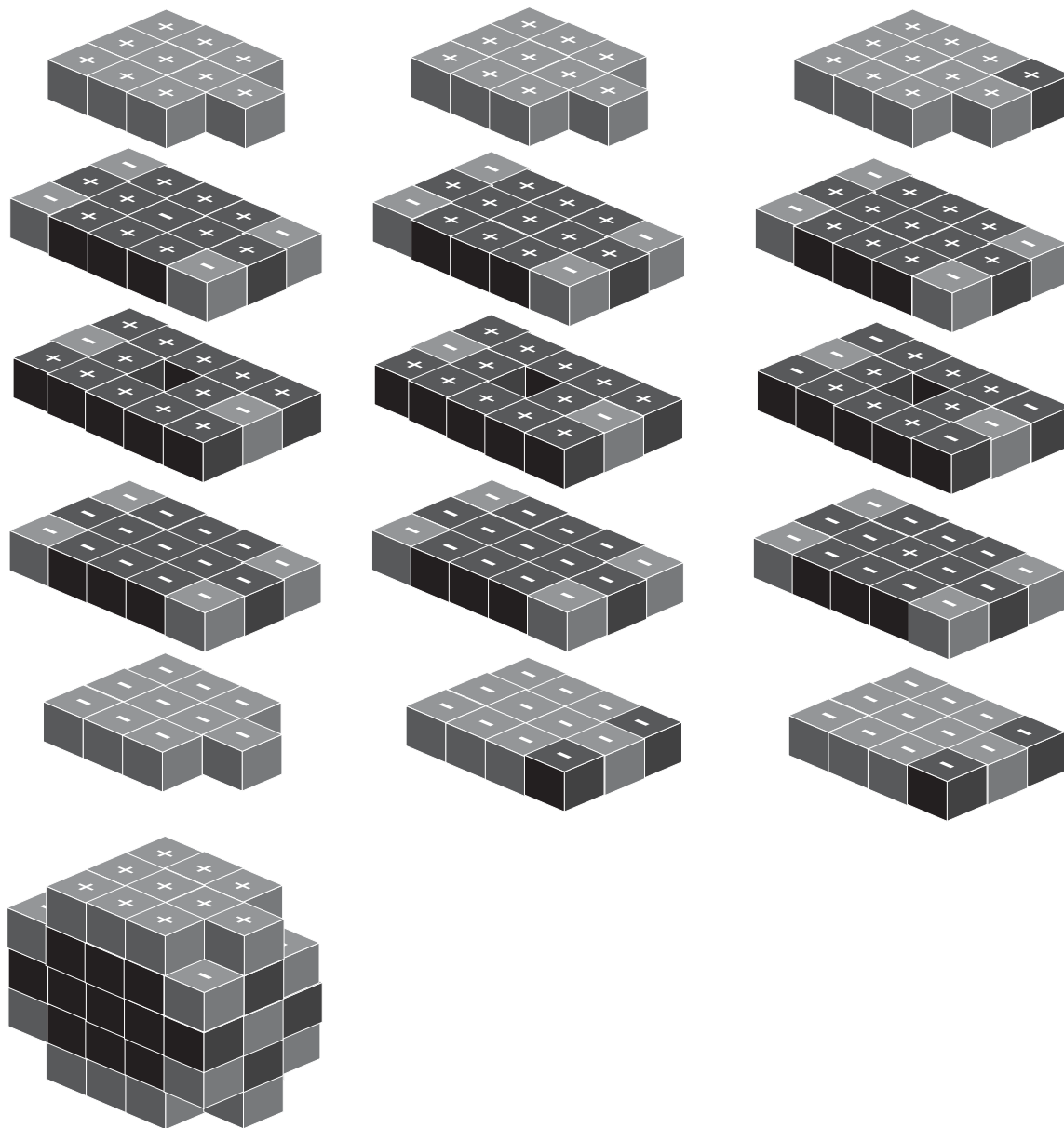
Zinc Nucleus

$$s^2 d^{10}$$

Zn 64
Proton 30
Neutron 34
Spin: 0
Stable

Zn 66
Proton 30
Neutron 36
Spin: 0
Stable

Zn 67
Proton 30
Neutron 37
Spin: -5/2
Stable

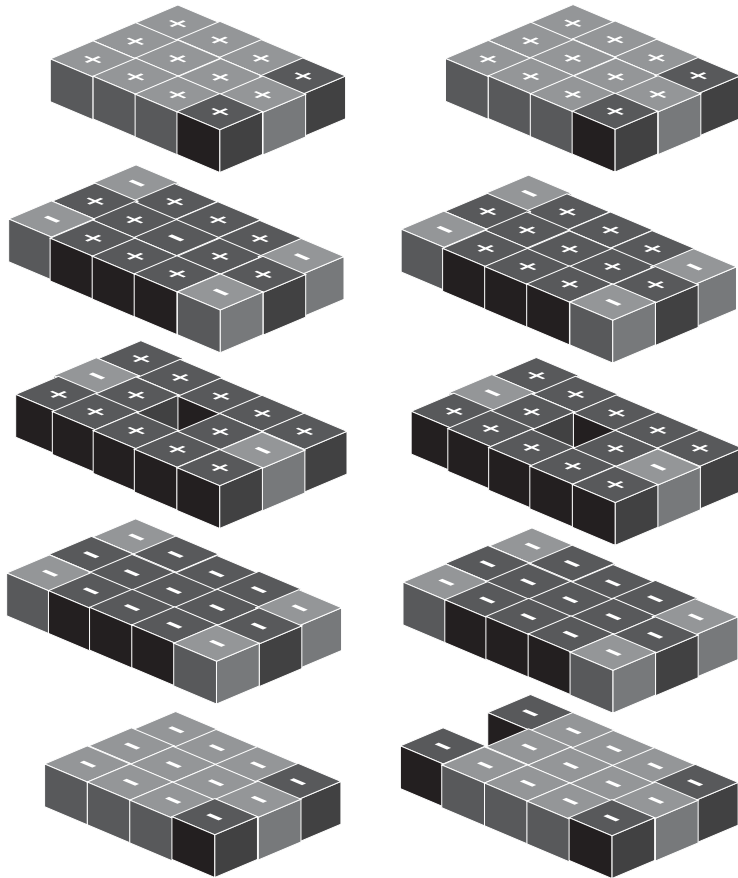


Zinc Nucleus

$$s^2 d^{10}$$

Zn 68
 Proton 30
 Neutron 38
 Spin: 0
 Stable

Zn 70
 Proton 30
 Neutron 40
 Spin: 0
 Stable

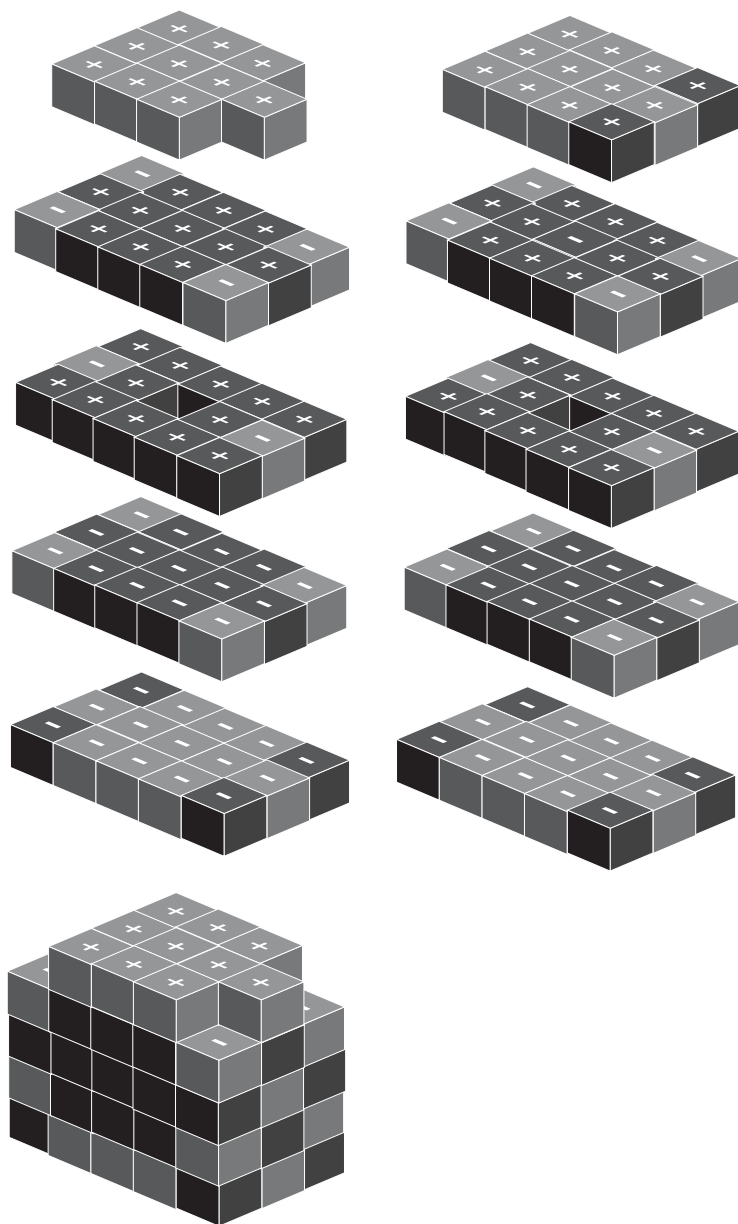


Gallium Nucleus

$$s^2 d^{10} p^1$$

Ga 69
Proton 31
Neutron 38
Spin: $-3/2$
Stable

Ga71
Proton 31
Neutron 40
Spin: $-3/2$
Stable



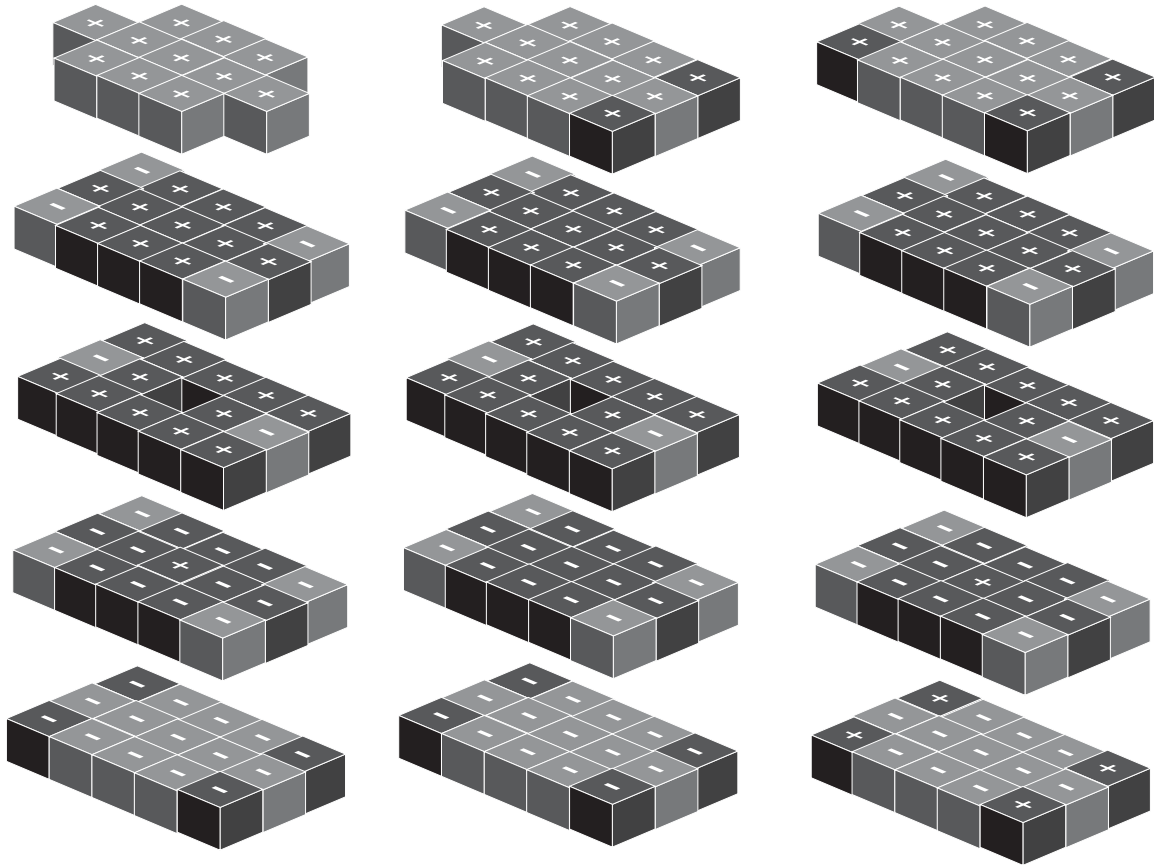
Germanium Nucleus

$$s^2 d^{10} p^2$$

Ge 70
Proton 32
Neutron 38
Spin: 0
Stable

Ge 72
Proton 32
Neutron 40
Spin: 0
Stable

Ge 73
Proton 32
Neutron 41
Spin: 9/2
Stable



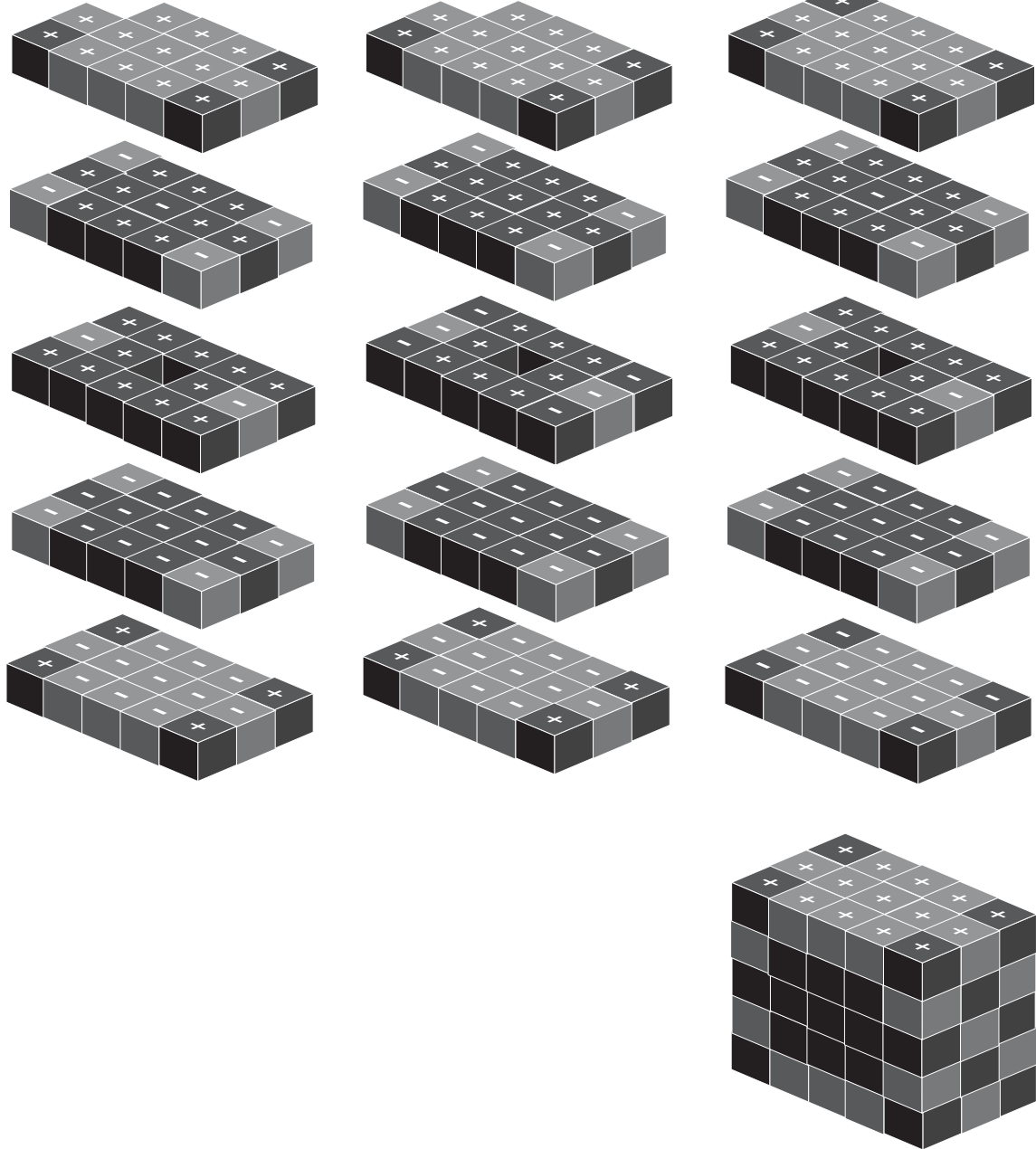
Germanium Nucleus

$$s^2 d^{10} p^2$$

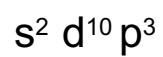
Ge 73m1
Proton 32
Neutron 41
Spin: 5/2

Ge 73m2
Proton 32
Neutron 41
Spin: -1/2

Ge 74
Proton 32
Neutron 42
Spin: 0
Stable

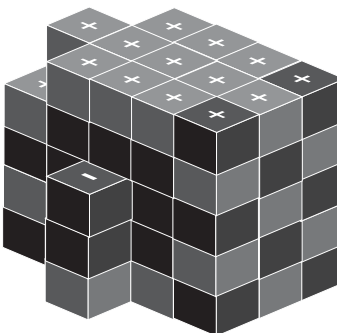
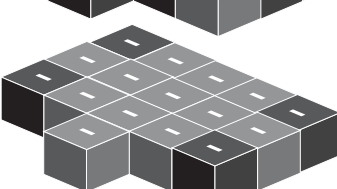
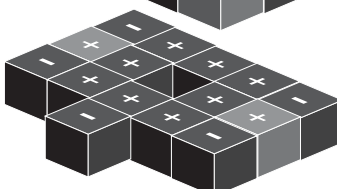
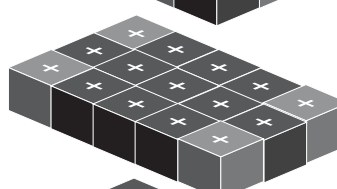
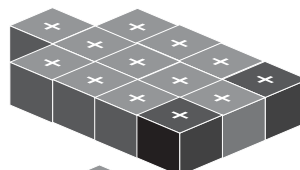
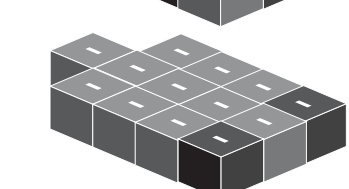
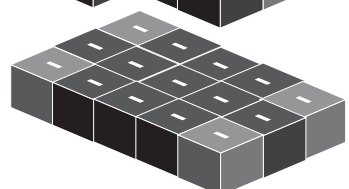
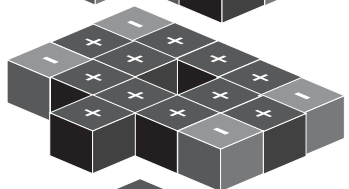
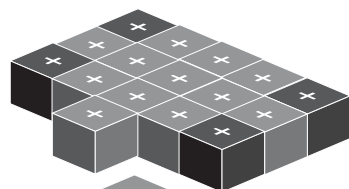


Arsenic Nucleus

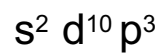


As 75
Proton: 33
Neutron: 42
Spin: $-3/2$
Stable

As 75m
Proton: 33
Neutron: 42
Spin: $9/2$

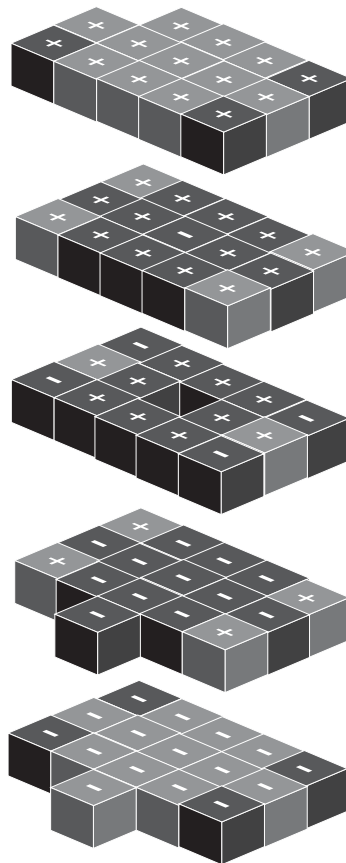
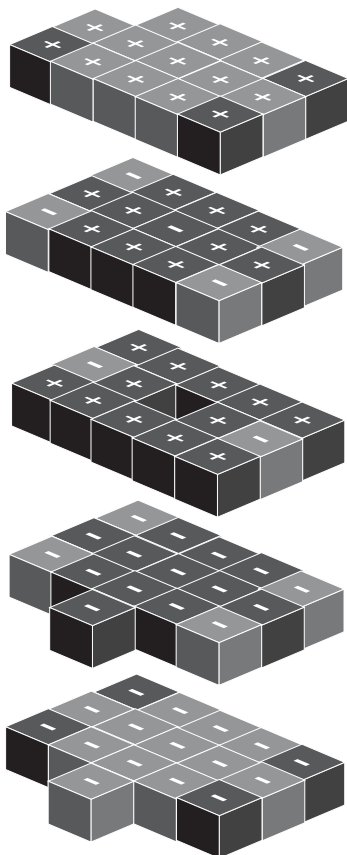


Arsenic Nucleus



As 75
Proton: 33
Neutron: 42
Spin: $-3/2$
Stable

As 75m
Proton: 33
Neutron: 42
Spin: $9/2$



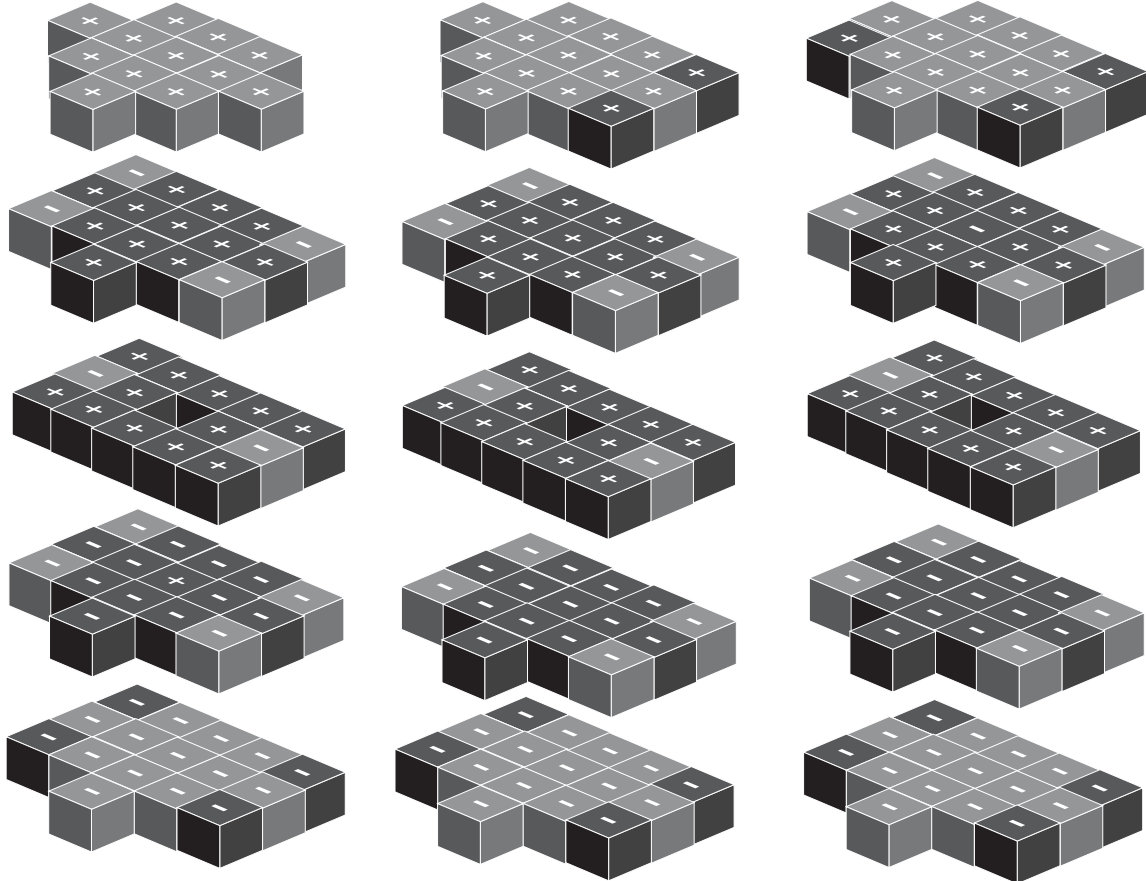
Selenium Nucleus

$$s^2 d^{10} p^4$$

Se 74
Proton:34
Neutron:40
Spin: 0
Stable

Se76
Proton:34
Neutron:42
Spin: 0
Stable

Se 77
Proton:34
Neutron:43
Spin: -1/2
Stable



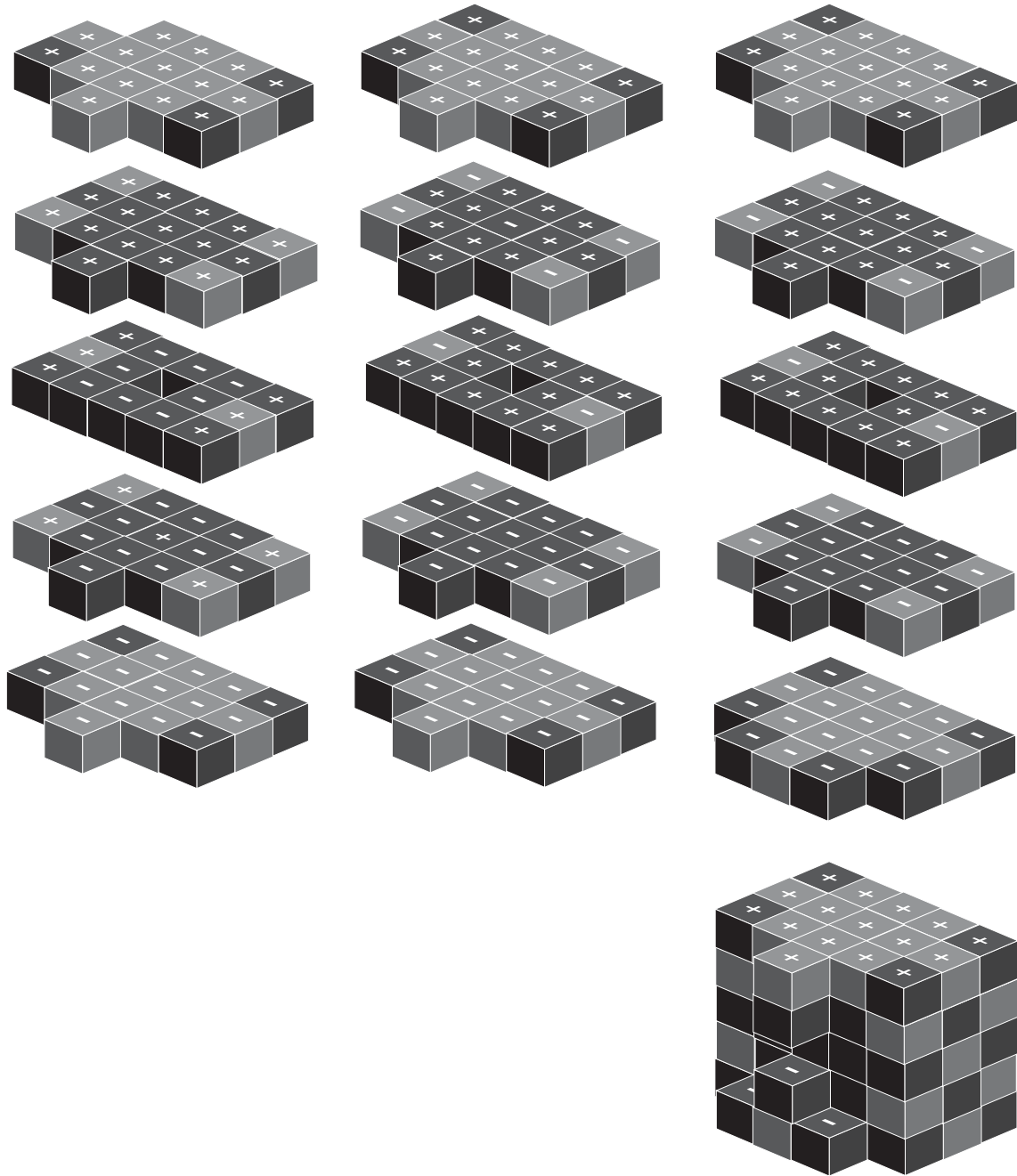
Selenium Nucleus

$$s^2 d^{10} p^4$$

Se 77m
Proton:34
Neutron:43
Spin: 7/2

Se78
Proton:34
Neutron:44
Spin: 0
Stable

Se 80
Proton:34
Neutron:46
Spin: 0
Stable



Selenium Nucleus

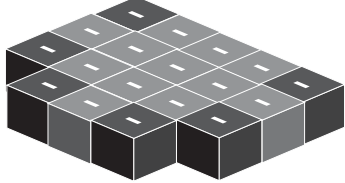
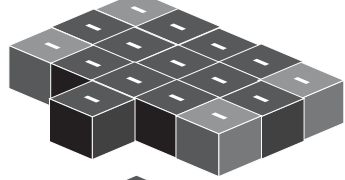
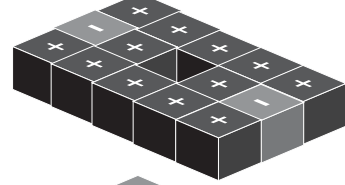
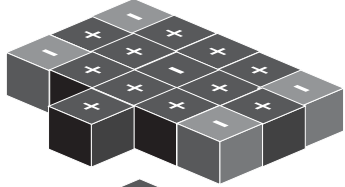
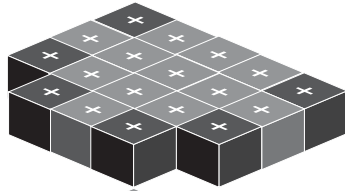
$s^2 d^{10} p^4$

Se 82

Proton:34

Neutron:48

Spin: 0



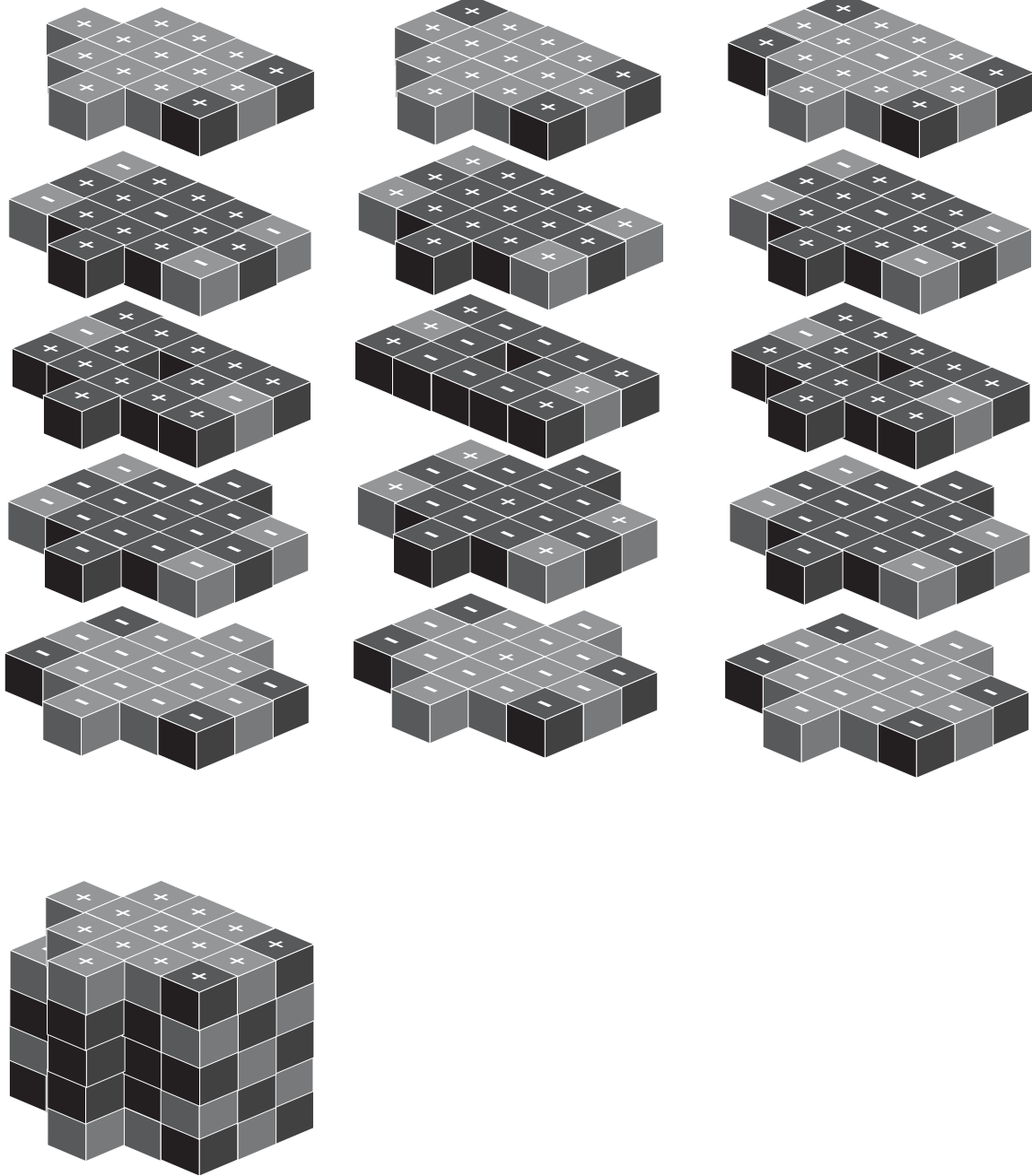
Bromine Nucleus

$$s^2 d^{10} p^5$$

Br 79
 Proton: 35
 Neutron: 44
 Spin: $-3/2$
 Stable

Br 79m
 Proton: 35
 Neutron: 44
 Spin: $9/2$

Br 81
 Proton: 35
 Neutron: 46
 Spin: $-3/2$
 Stable



Bromine Nucleus

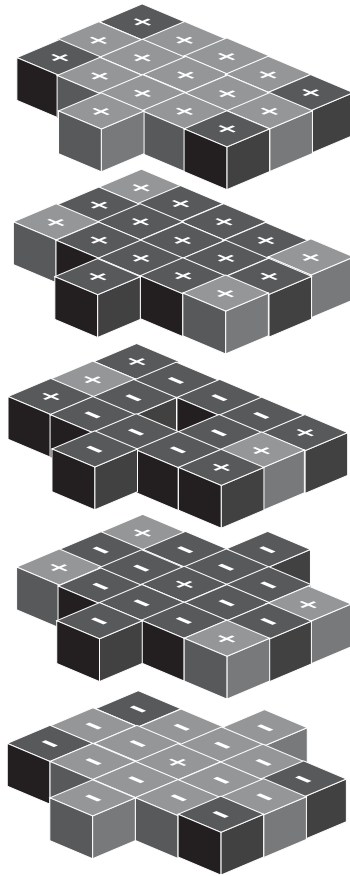
$s^2 d^{10} p^5$

Br 81m

Proton: 35

Neutron: 46

Spin: 9/2



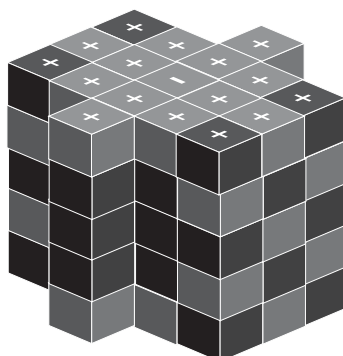
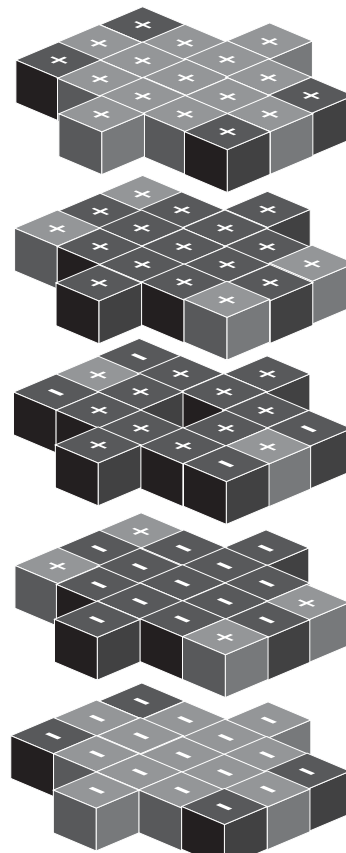
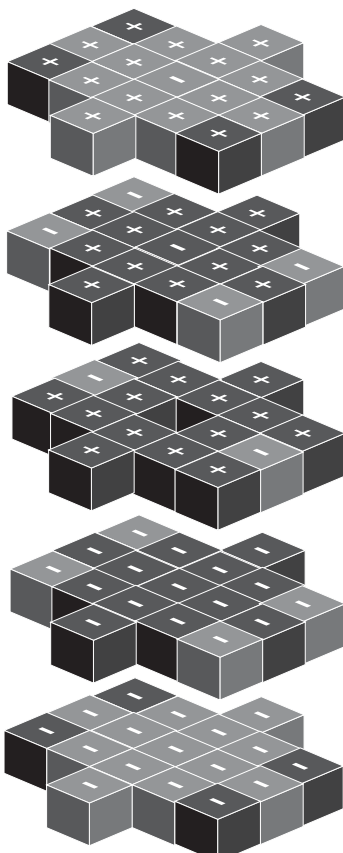
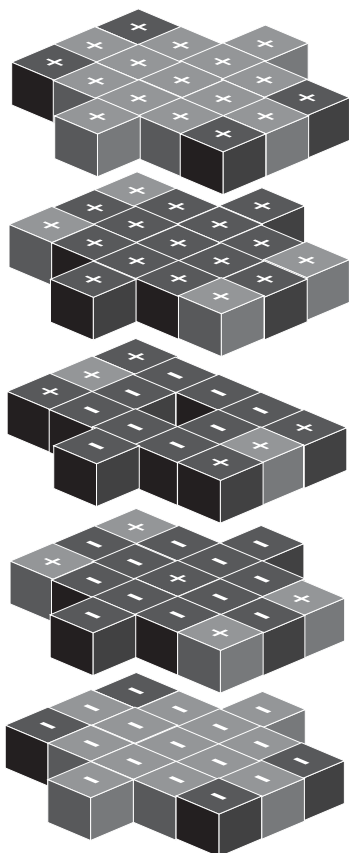
Krypton Nucleus

$$s^2 d^{10} p^6$$

Kr 83
 Proton: 36
 Neutron: 47
 Spin: 9/2
 Stable

Kr 84
 Proton: 36
 Neutron: 48
 Spin: 0
 Stable

Kr 84m
 Proton: 36
 Neutron: 48
 Spin: 8



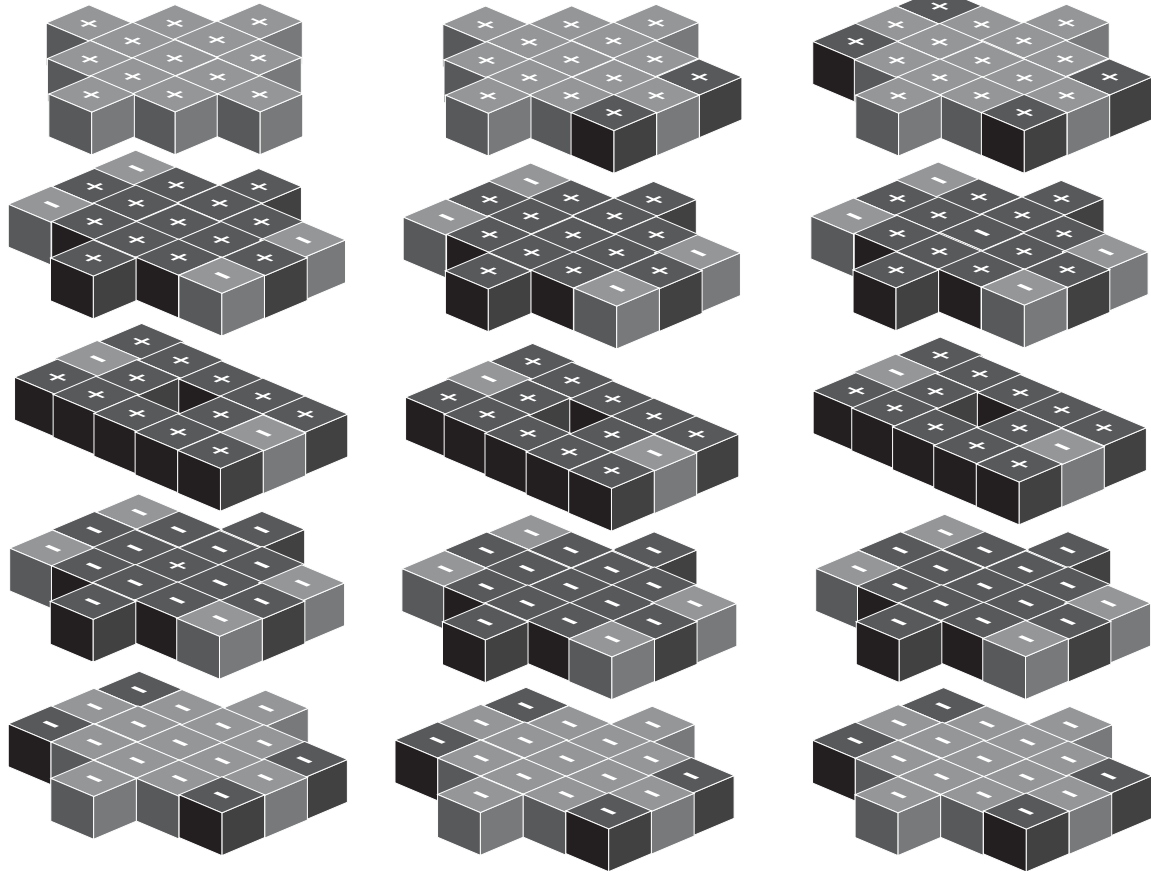
Krypton Nucleus

$$s^2 d^{10} p^6$$

Kr 78
 Proton: 36
 Neutron: 42
 Spin: 0
 Stable

Kr 80
 Proton: 36
 Neutron: 44
 Spin: 0
 Stable

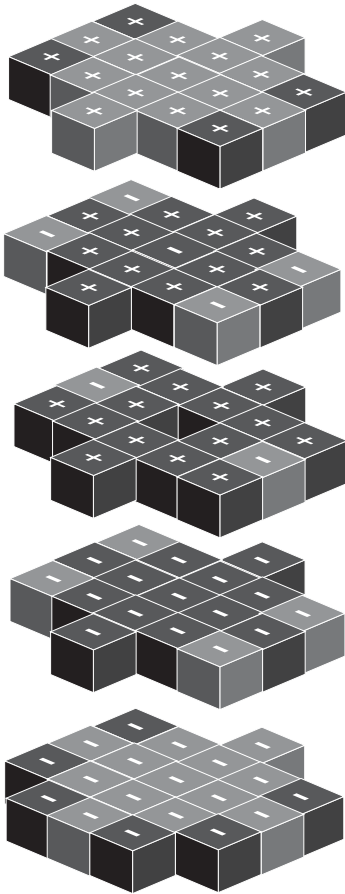
Kr 82
 Proton: 36
 Neutron: 46
 Spin: 0
 Stable



Krypton Nucleus

$s^2 d^{10} p^6$

Kr 86
Proton: 36
Neutron: 50
Spin: 0
Stable



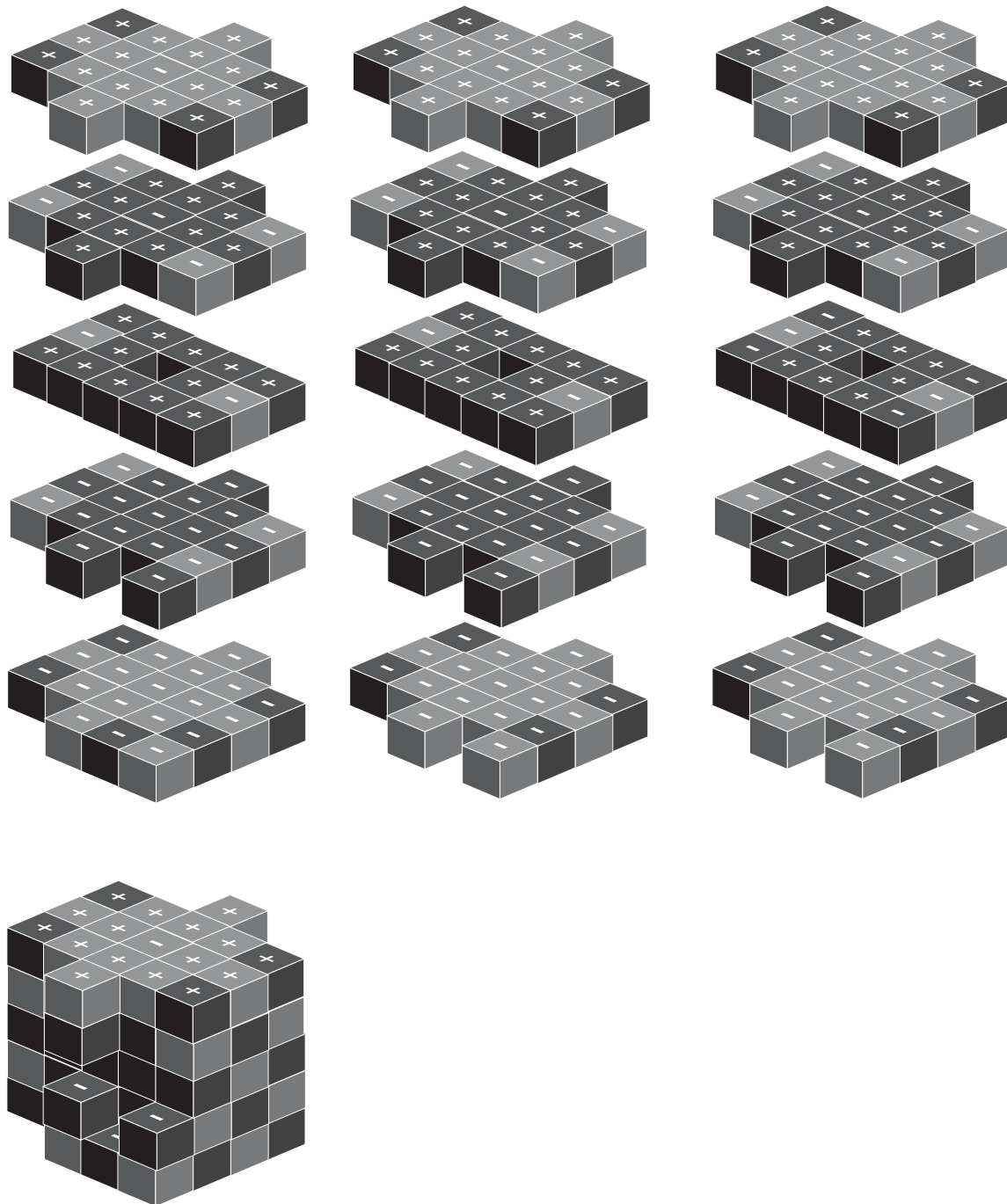
Rubidium Nucleus

s^1

Rb 85
 Proton: 37
 Neutron: 48
 Spin: $-5/2$
 Stable

Rb 86
 Proton: 37
 Neutron: 49
 Spin: -2

Rb 86m
 Proton: 37
 Neutron: 49
 Spin: -6



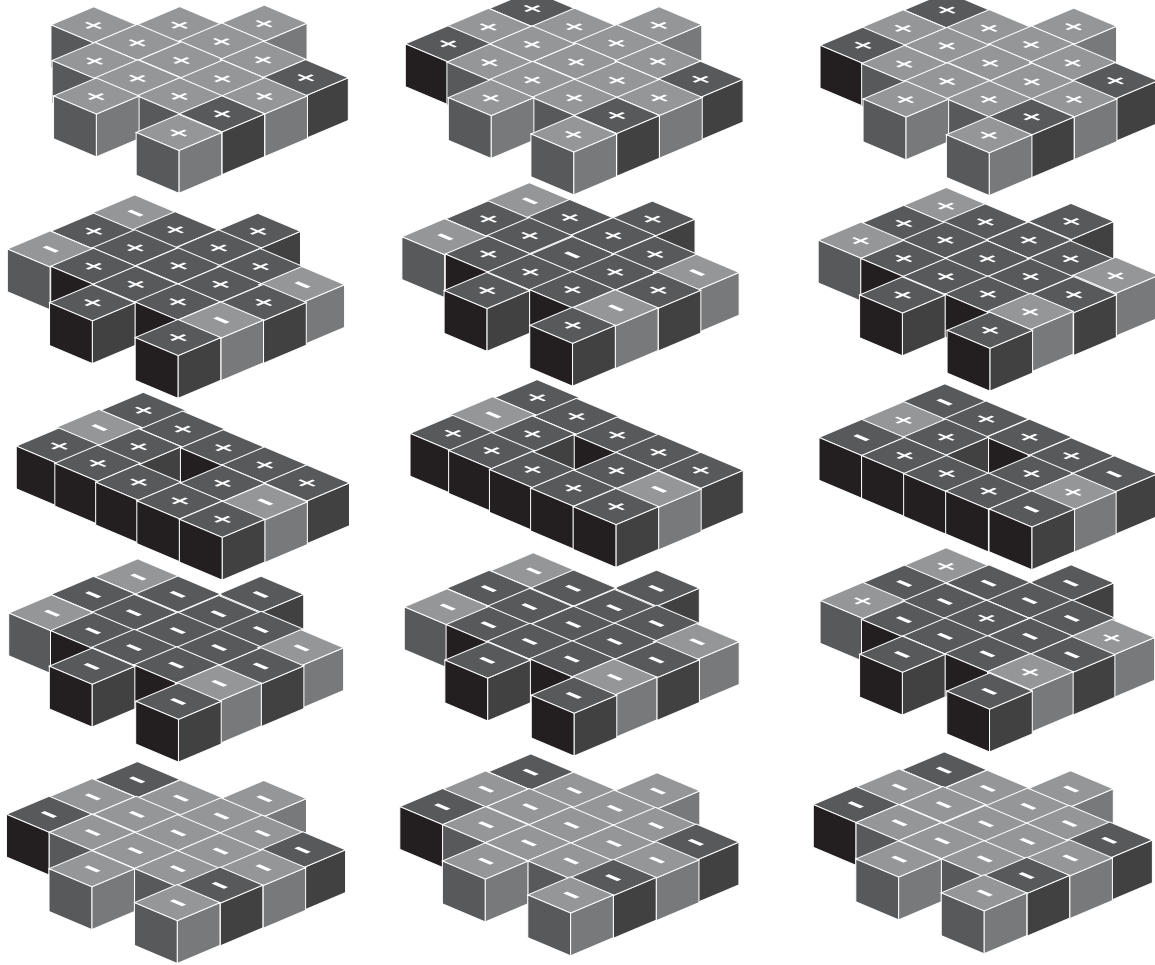
Strontium Nucleus

s^2

Sr 84
Proton: 38
Neutron: 46
Spin:0
Stable

Sr 86
Proton: 38
Neutron: 48
Spin:0
Stable

Sr 86m1
Proton: 38
Neutron: 48
Spin:8



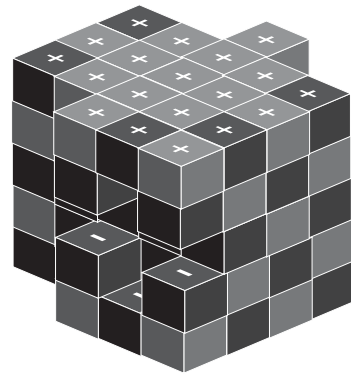
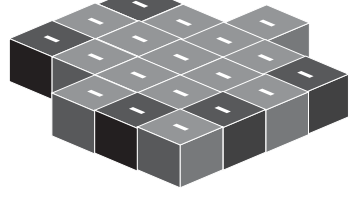
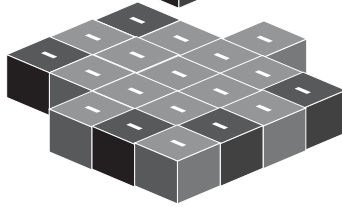
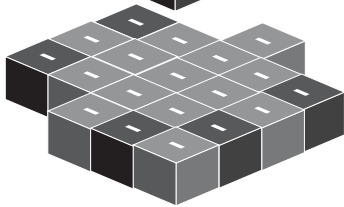
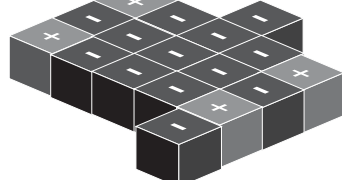
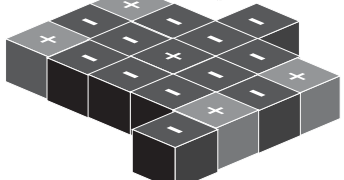
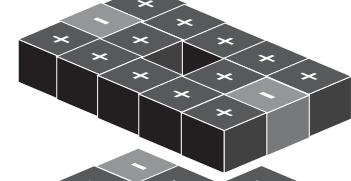
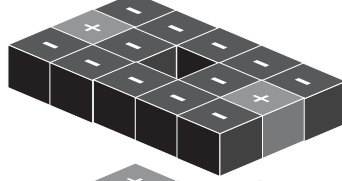
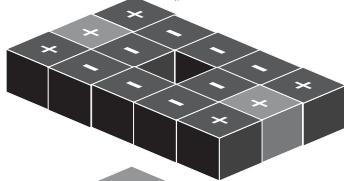
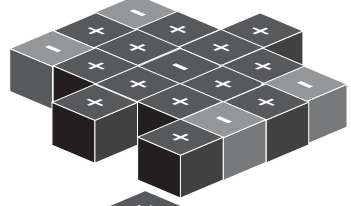
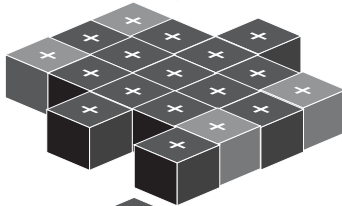
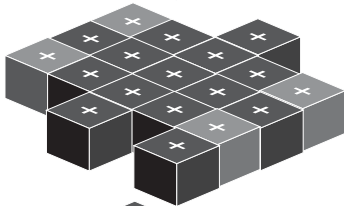
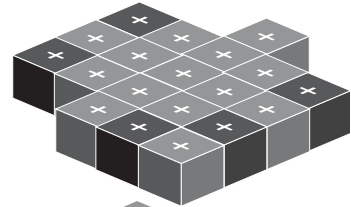
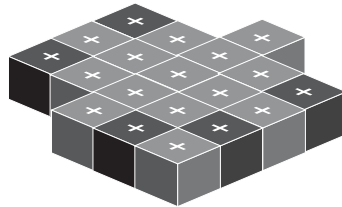
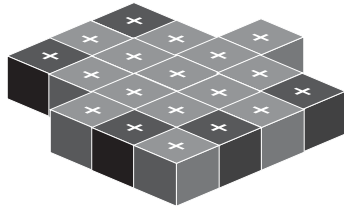
Strontium Nucleus

s^2

Sr 87
Proton: 38
Neutron: 49
Spin: 9/2
Stable

Sr 87m1
Proton: 38
Neutron: 49
Spin: -1/2

Sr 88
Proton: 38
Neutron: 50
Spin: 0
Stable



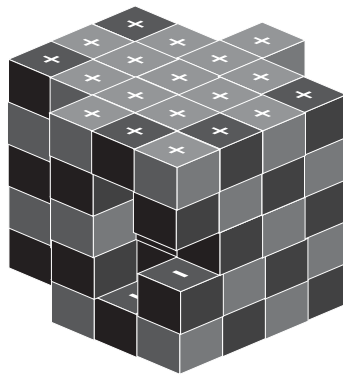
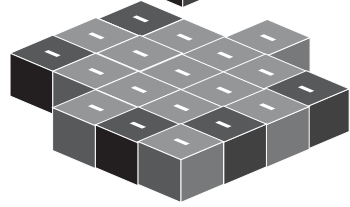
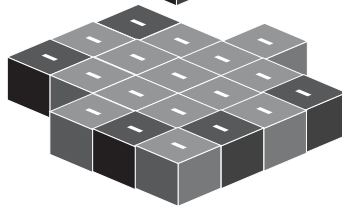
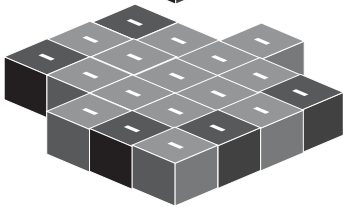
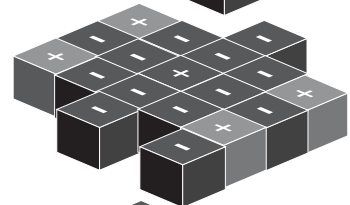
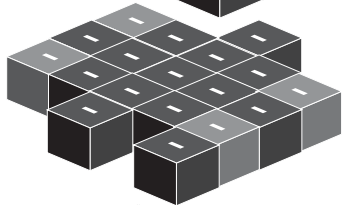
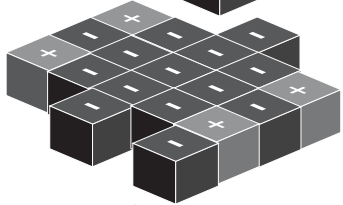
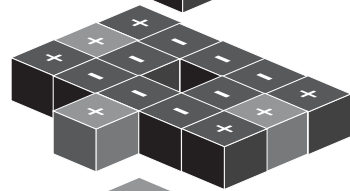
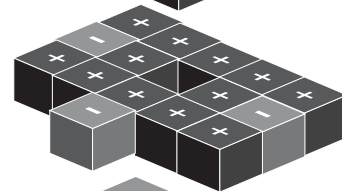
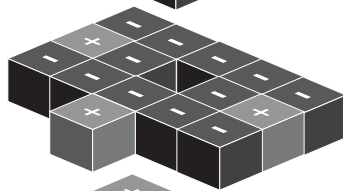
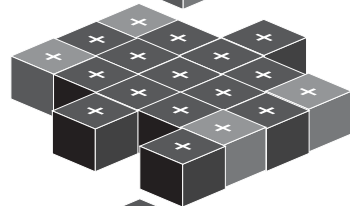
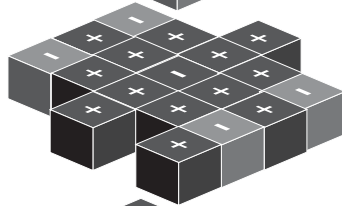
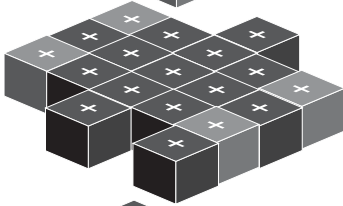
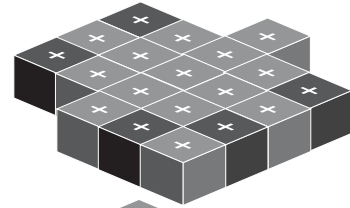
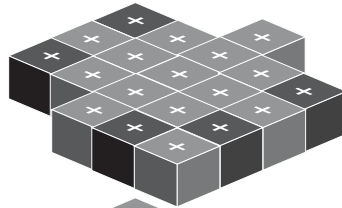
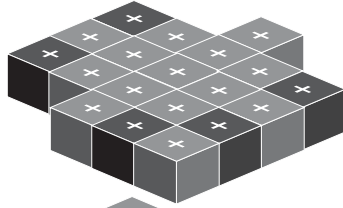
Yttrium Nucleus

$s^2 d^1$

Y 89
Proton: 39
Neutron: 50
Spin:-1/2
Stable

Y 89
Proton: 39
Neutron: 50
Spin:-1/2
Stable

Y 89m1
Proton: 39
Neutron: 50
Spin:9/2



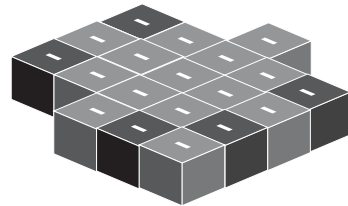
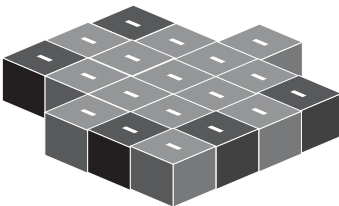
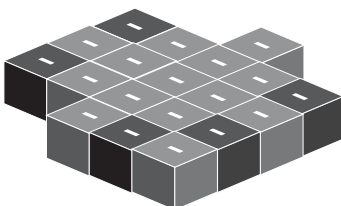
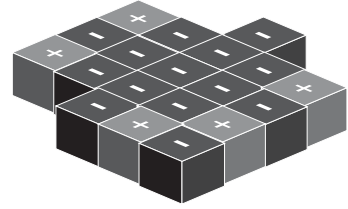
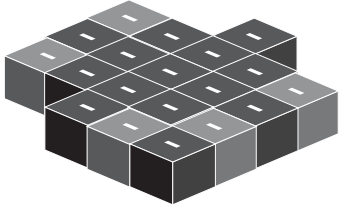
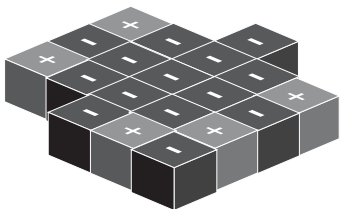
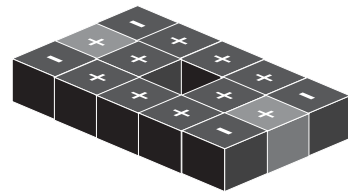
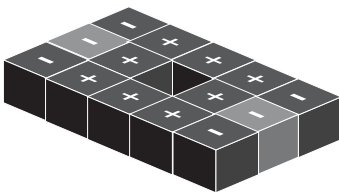
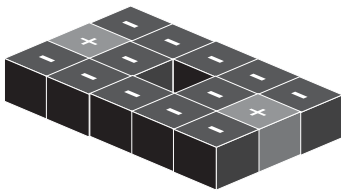
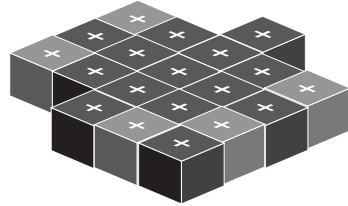
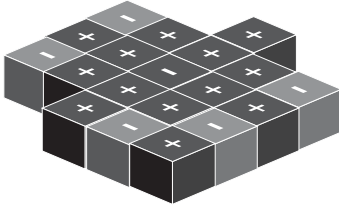
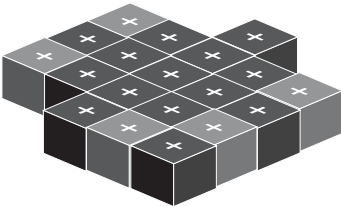
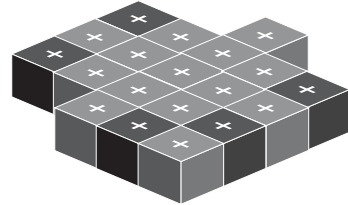
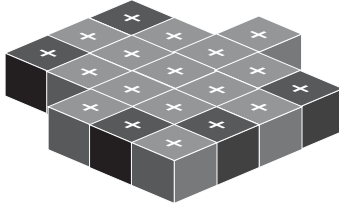
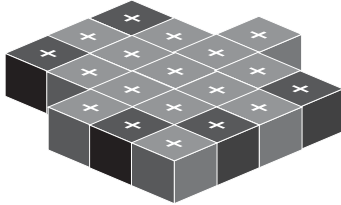
Zirconium Nucleus

$s^2 d^2$

Zr 90
Proton: 40
Neutron: 50
Spin:0
Stable

Zr 90m1
Proton: 40
Neutron: 50
Spin:-5

Zr 90m2
Proton: 40
Neutron: 50
Spin:8



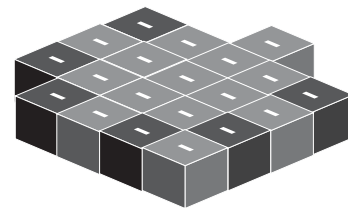
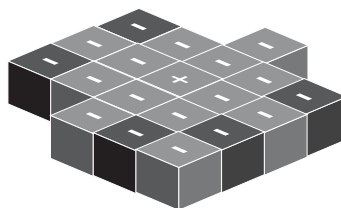
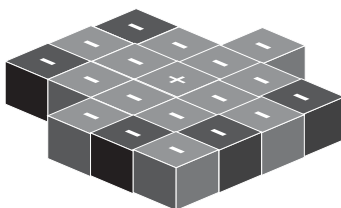
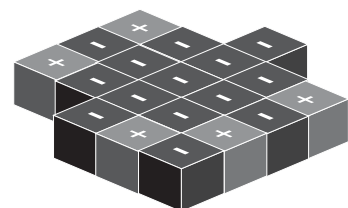
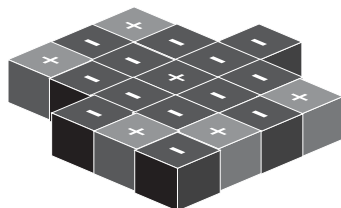
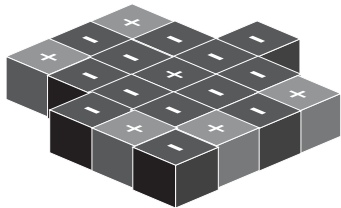
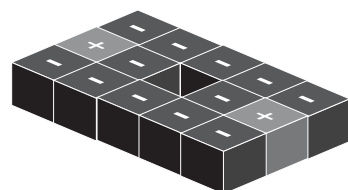
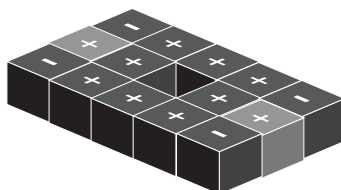
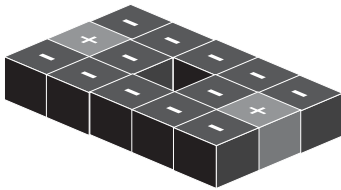
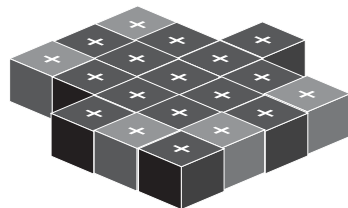
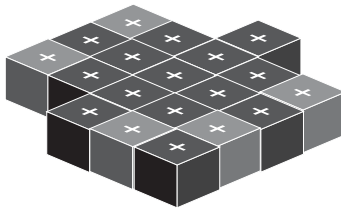
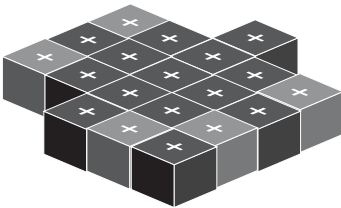
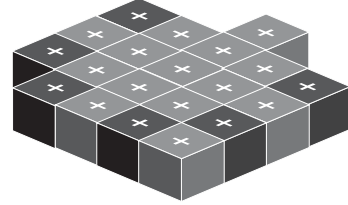
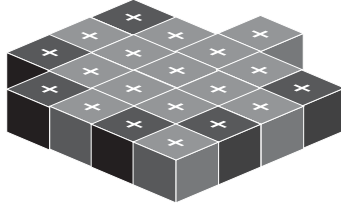
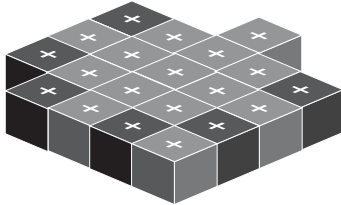
Zirconium Nucleus

$$s^2 d^2$$

Zr 91
Proton: 40
Neutron: 51
Spin: 5/2
Stable

Zr 91m1
Proton: 40
Neutron: 51
Spin: 21/2

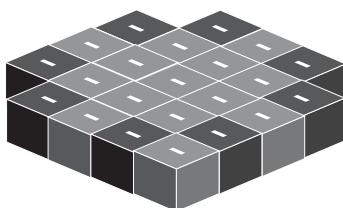
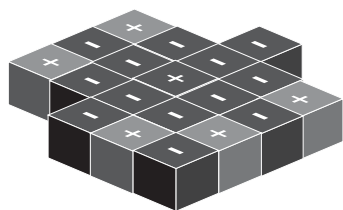
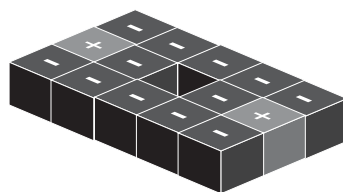
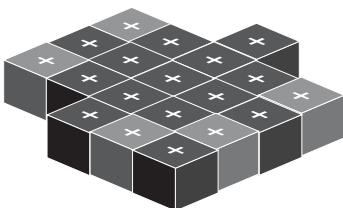
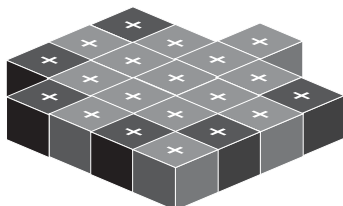
Zr 92
Proton: 40
Neutron: 52
Spin: 0
Stable



Zirconium Nucleus

$s^2 d^2$

Zr 94
Proton: 40
Neutron: 54
Spin: 0
Stable

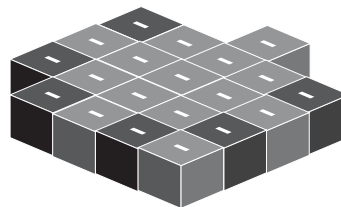
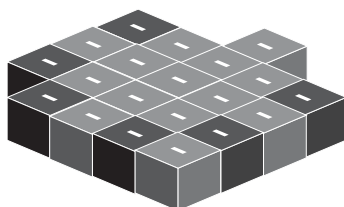
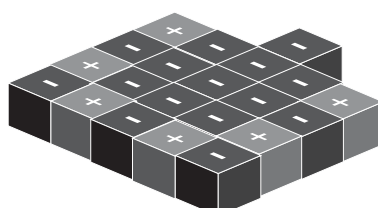
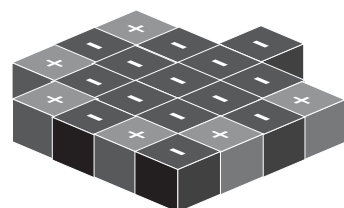
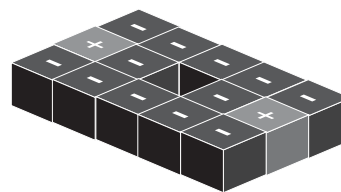
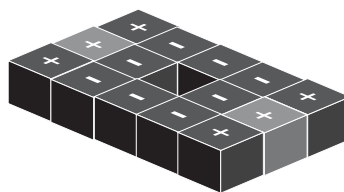
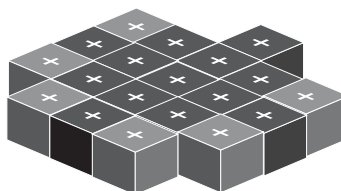
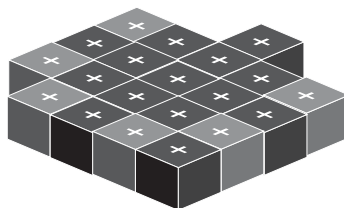
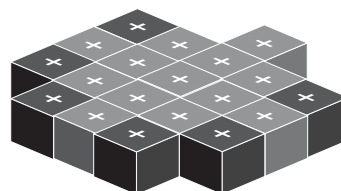
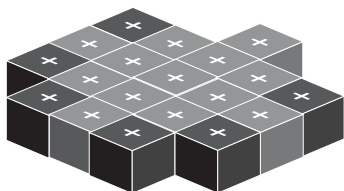


Niobium Nucleus

$s^1 d^4$

Nb 93
 Proton: 41
 Neutron: 52
 Spin: 9/2
 Stable

Nb 93m1
 Proton: 41
 Neutron: 52
 Spin: -1/2



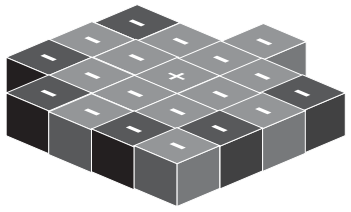
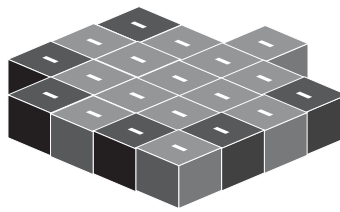
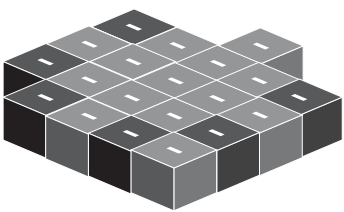
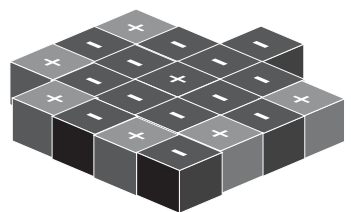
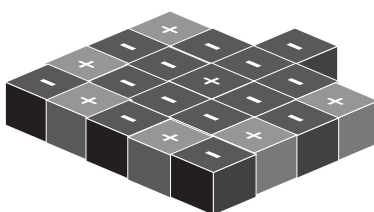
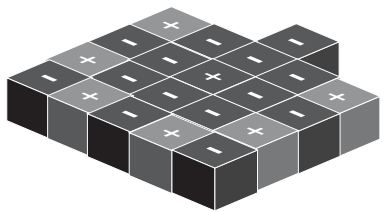
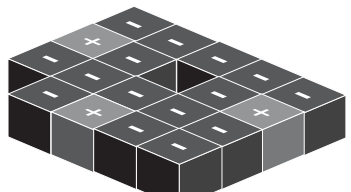
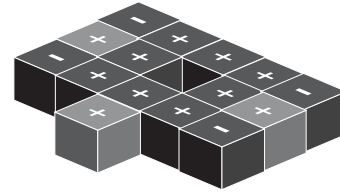
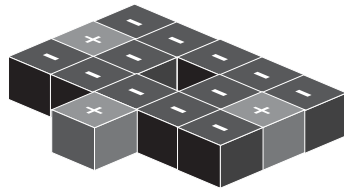
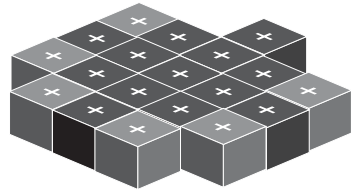
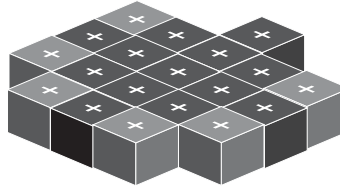
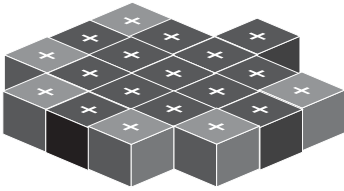
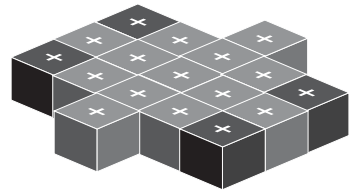
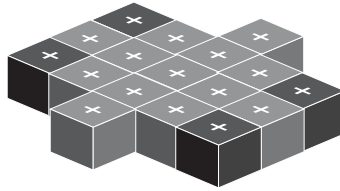
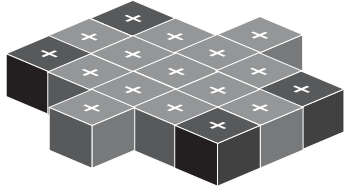
Molybdenum Nucleus

$s^1 d^5$

Mo 92
Proton: 42
Neutron: 50
Spin: 0
Stable

Mo 92m
Proton: 42
Neutron: 50
Spin: 8

Mo 94
Proton: 42
Neutron: 52
Spin: 0
Stable



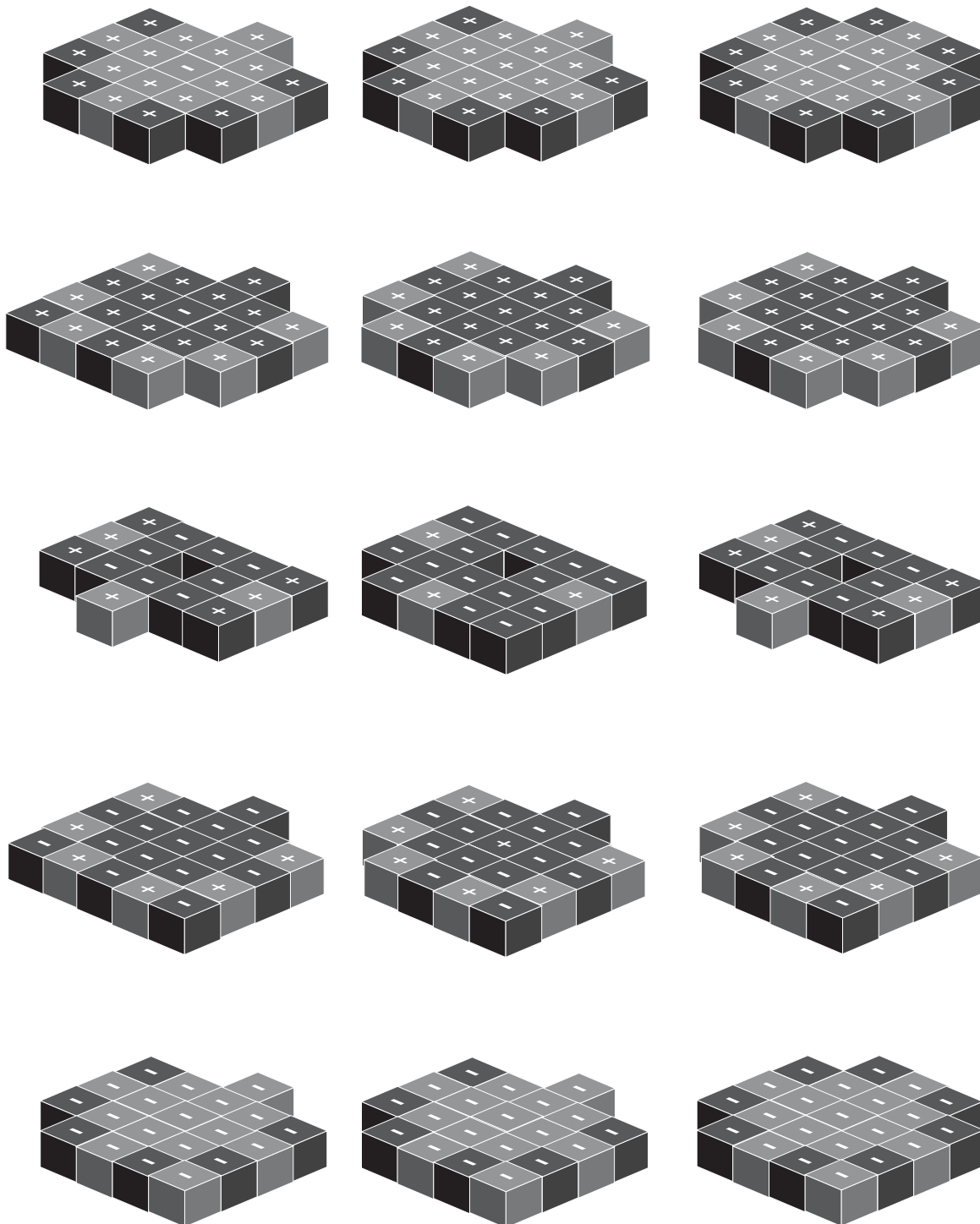
Molybdenum Nucleus

$s^1 d^5$

Mo 95
Proton: 42
Neutron: 53
Spin: 5/2
Stable

Mo 96
Proton: 42
Neutron: 54
Spin: 0
Stable

Mo 97
Proton: 42
Neutron: 55
Spin: 5/2
Stable



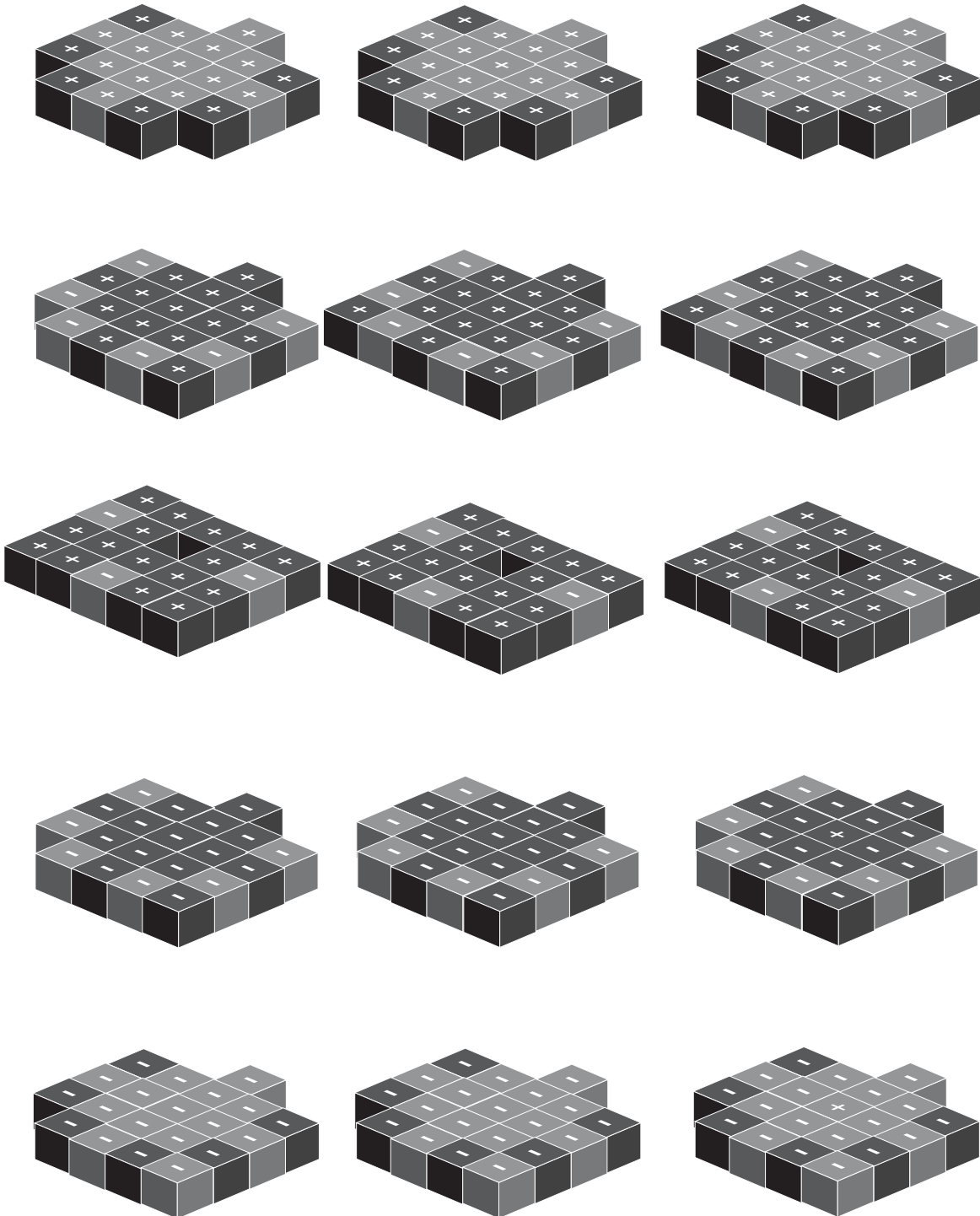
Molybdenum Nucleus

$s^1 d^5$

Mo 98
 Proton: 42
 Neutron: 56
 Spin: 0
 Stable

Mo 99
 Proton: 42
 Neutron: 57
 Spin: 1/2

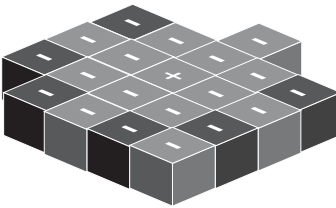
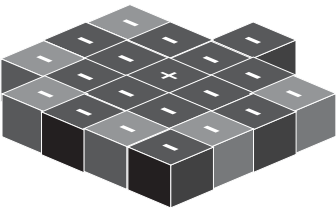
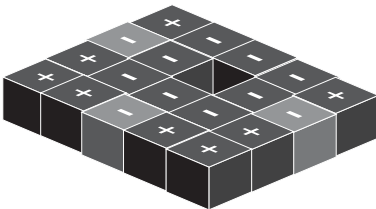
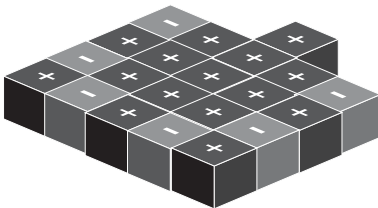
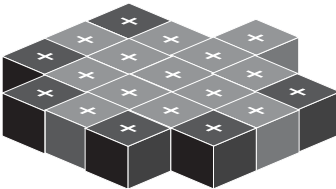
Mo 99m1
 Proton: 42
 Neutron: 57
 Spin: 5/2



Molybdenum Nucleus

$$s^1 d^5$$

Mo 99m2
Proton: 42
Neutron: 57
Spin: -11/2



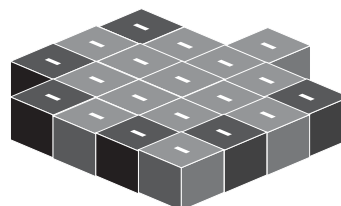
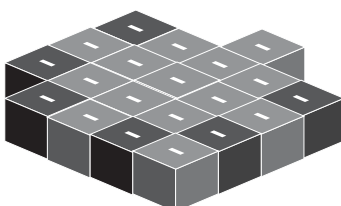
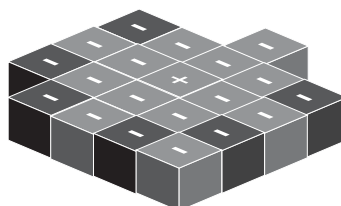
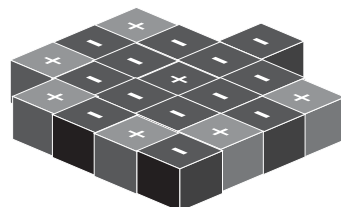
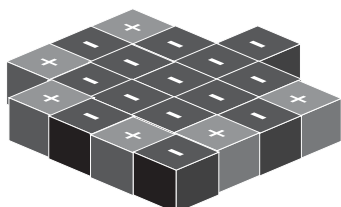
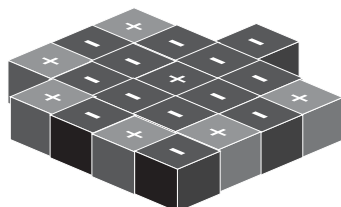
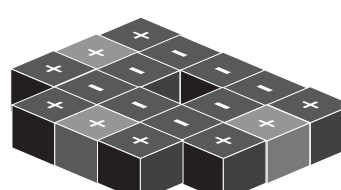
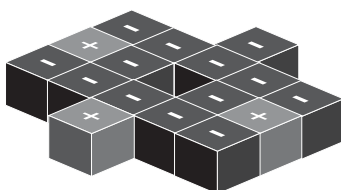
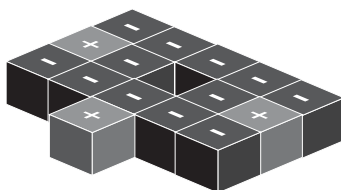
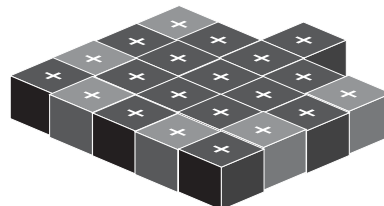
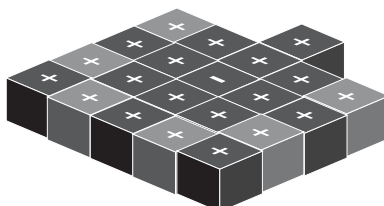
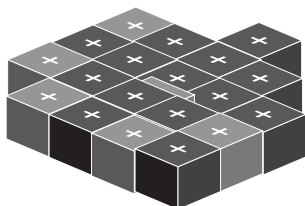
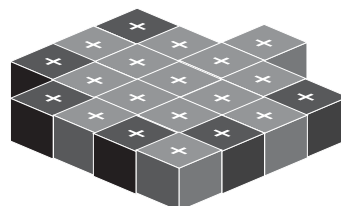
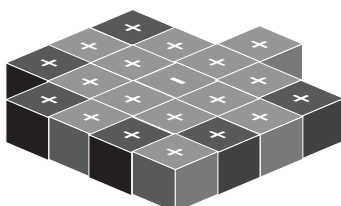
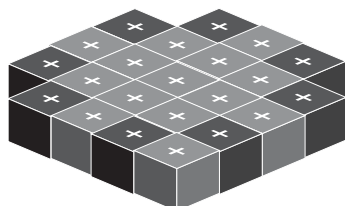
Technetium Nucleus

$$s^2 d^5$$

Tc 97
Proton: 43
Neutron: 54
Spin: 9/2

Tc 97m
Proton: 43
Neutron: 54
Spin: -1/2

Tc 98
Proton: 43
Neutron: 55
Spin: 6



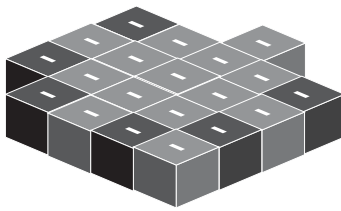
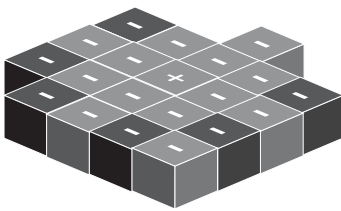
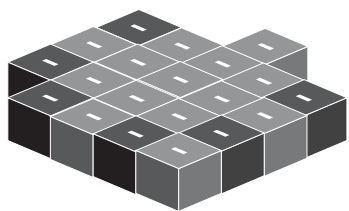
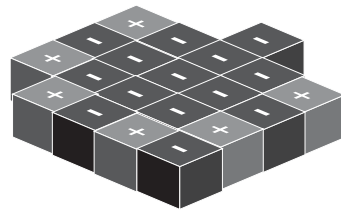
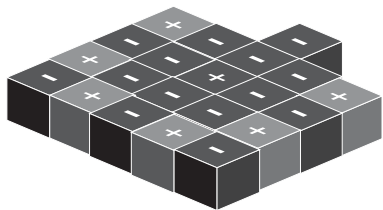
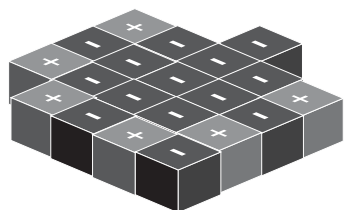
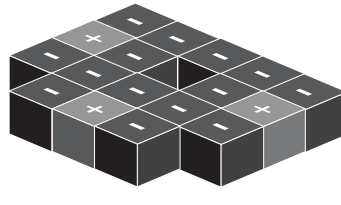
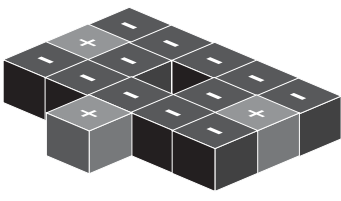
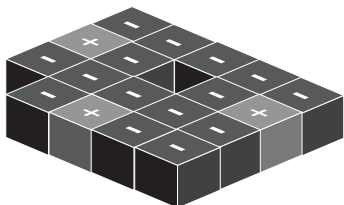
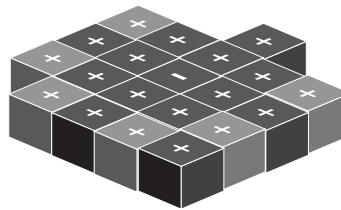
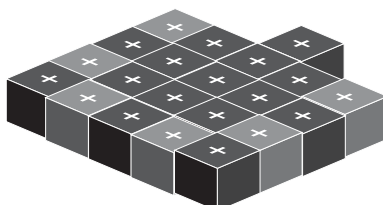
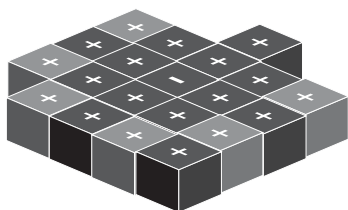
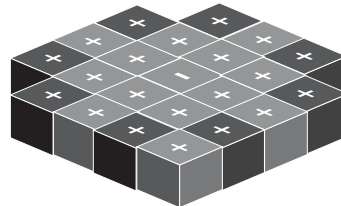
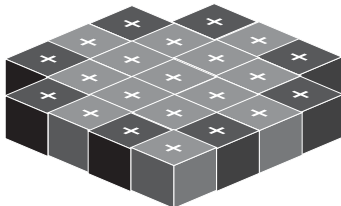
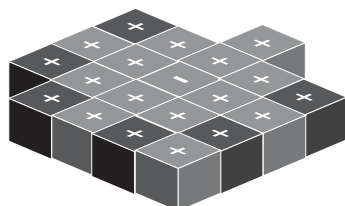
Technetium Nucleus

$$s^2 d^5$$

Tc 98m
Proton: 43
Neutron: 55
Spin: -2

Tc 99
Proton: 43
Neutron: 56
Spin: 9/2

Tc 99m
Proton: 43
Neutron: 56
Spin: -1/2



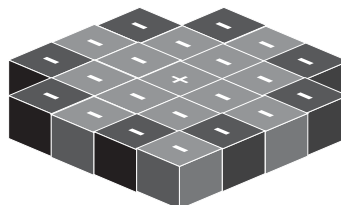
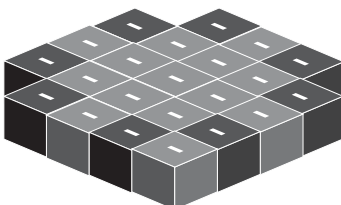
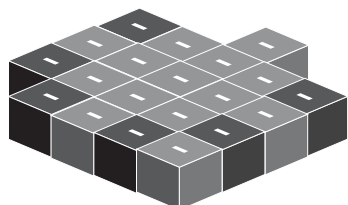
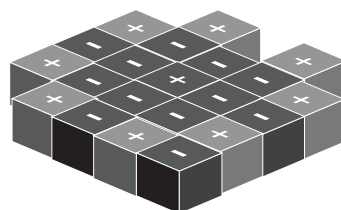
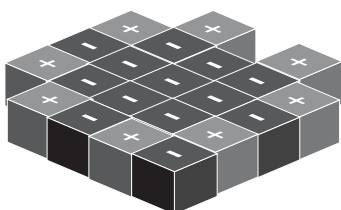
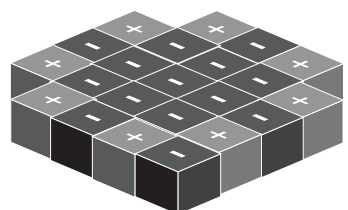
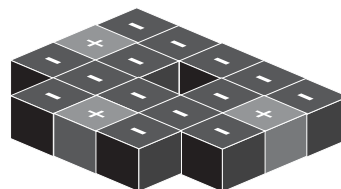
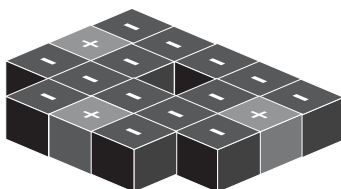
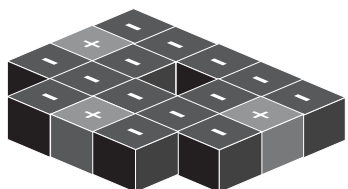
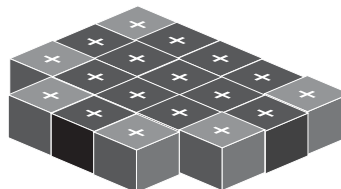
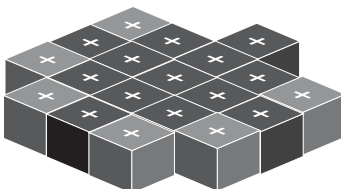
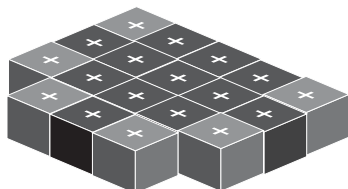
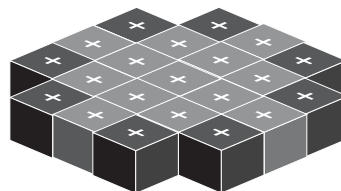
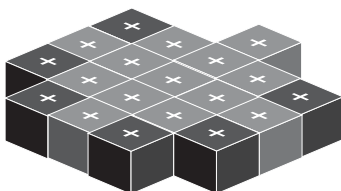
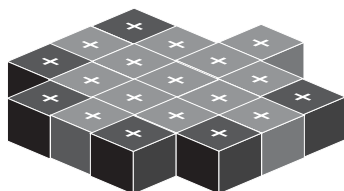
Ruthenium Nucleus

$s^1 d^7$

Ru 96
Proton: 44
Neutron: 52
Spin: 0
Stable

Ru 98
Proton: 44
Neutron: 54
Spin: 0
Stable

Ru 99
Proton: 44
Neutron: 55
Spin: 5/2
Stable



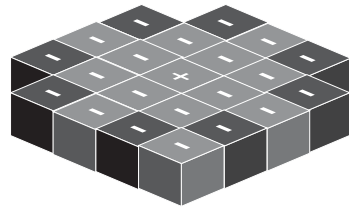
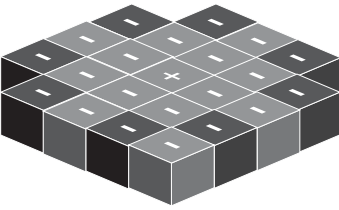
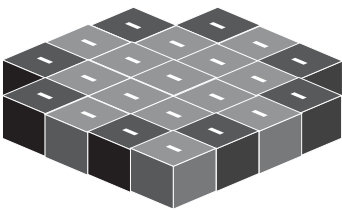
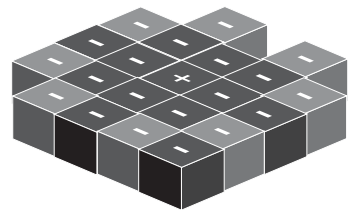
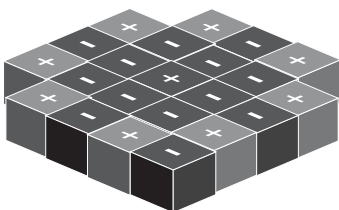
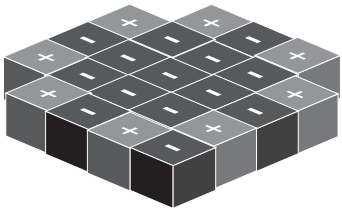
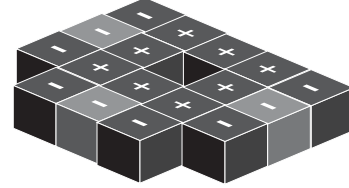
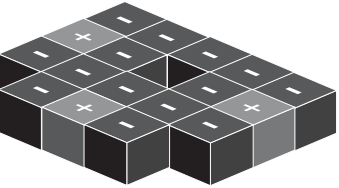
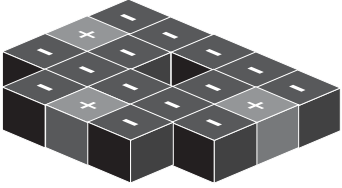
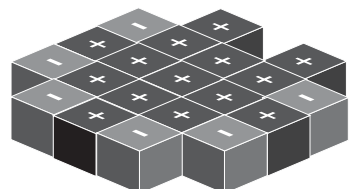
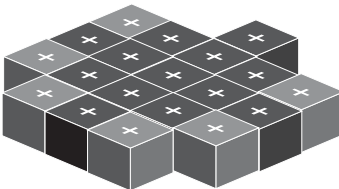
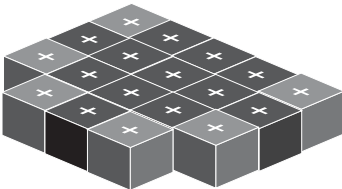
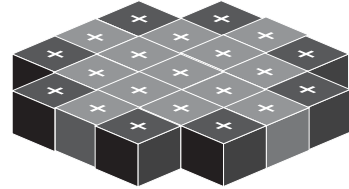
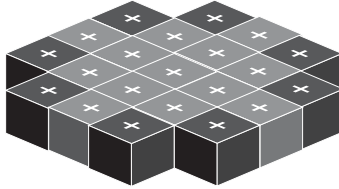
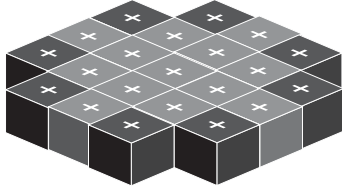
Ruthenium Nucleus

$s^1 d^7$

Ru 100
Proton: 44
Neutron: 56
Spin: 0
Stable

Ru 101
Proton: 44
Neutron: 57
Spin: 5/2
Stable

Ru 101m
Proton: 44
Neutron: 57
Spin: -11/2



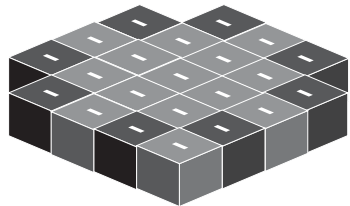
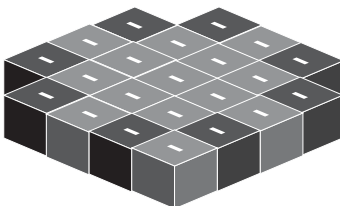
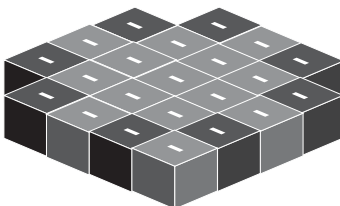
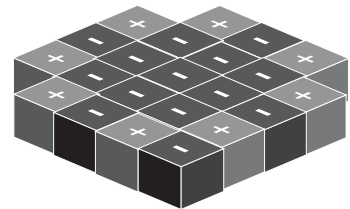
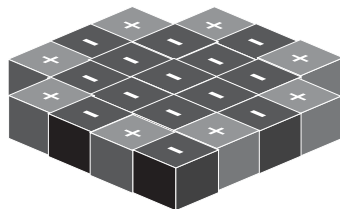
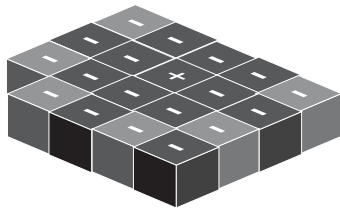
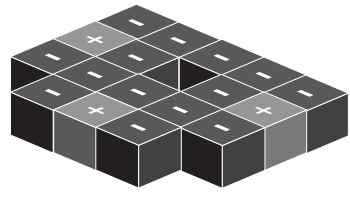
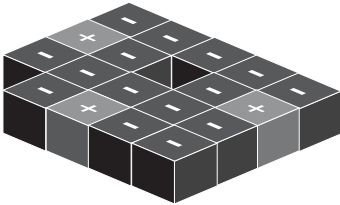
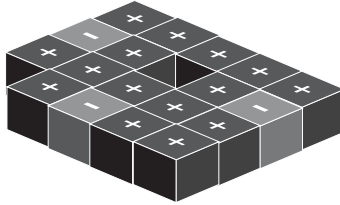
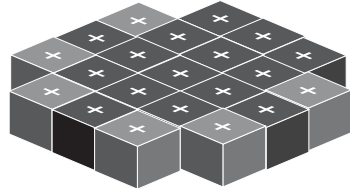
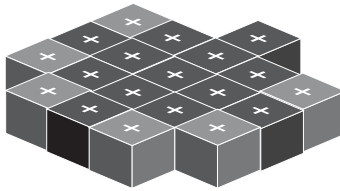
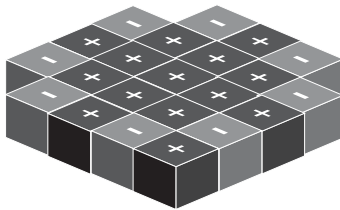
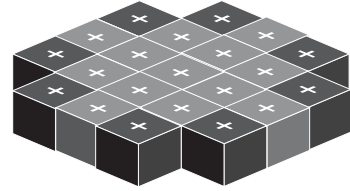
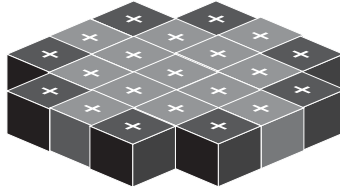
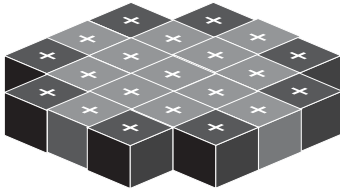
Ruthenium Nucleus

$s^1 d^7$

Ru 102
Proton: 44
Neutron: 58
Spin: 0
Stable

Ru 102
Proton: 44
Neutron: 58
Spin: 0
Stable

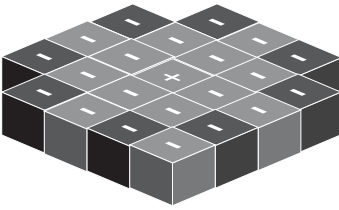
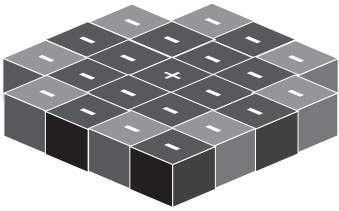
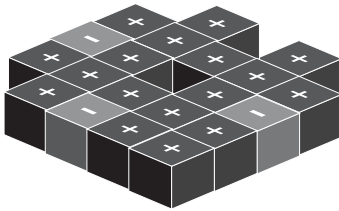
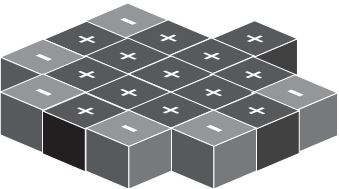
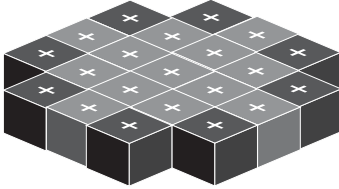
Ru 103
Proton: 44
Neutron: 59
Spin: 3/2



Ruthenium Nucleus

$s^1 d^7$

Ru 104
Proton: 44
Neutron: 60
Spin: 0
Stable



Rhodium Nucleus

$s^1 d^8$

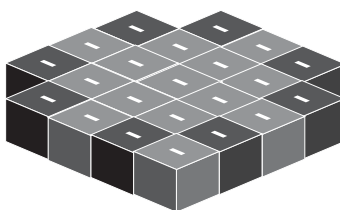
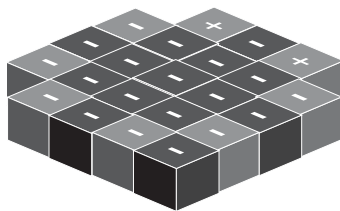
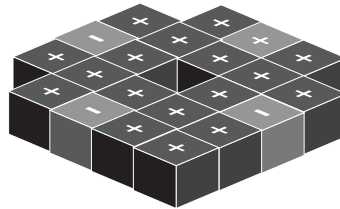
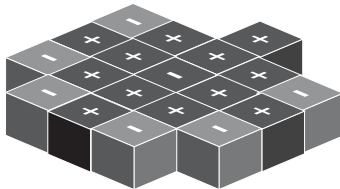
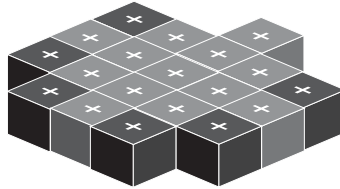
Rh 103

Proton: 45

Neutron: 58

Spin: $-1/2$

Stable



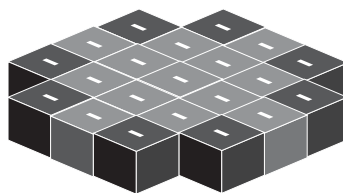
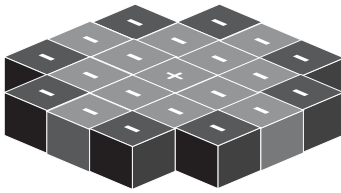
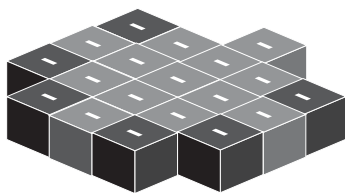
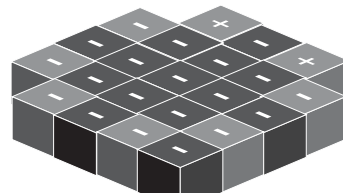
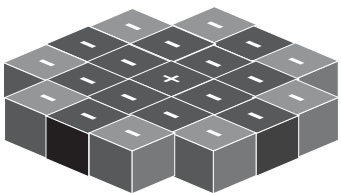
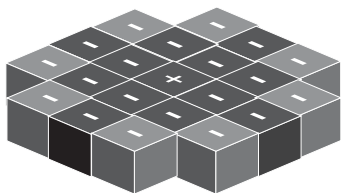
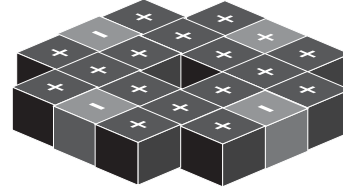
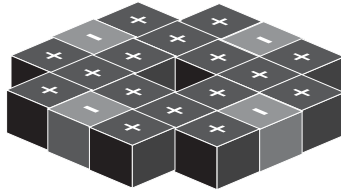
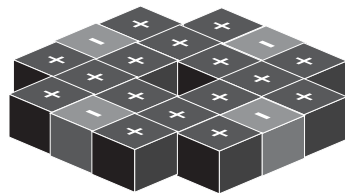
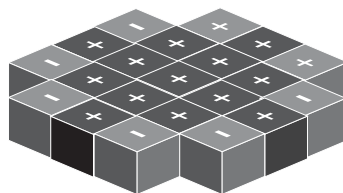
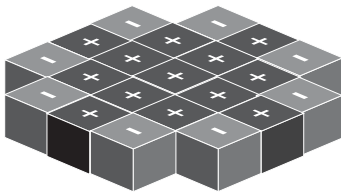
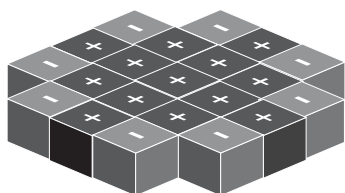
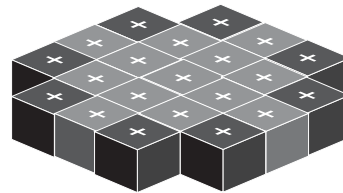
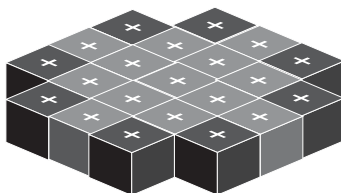
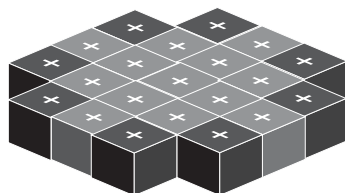
Palladium Nucleus

d^{10}

Pd 102
Proton: 46
Neutron: 56
Spin: 0
Stable

Pd 104
Proton: 46
Neutron: 58
Spin: 0
Stable

Pd 105
Proton: 46
Neutron: 59
Spin: 5/2
Stable



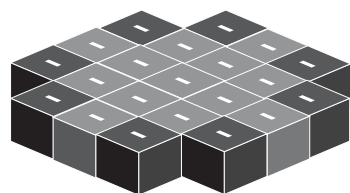
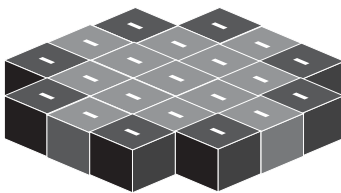
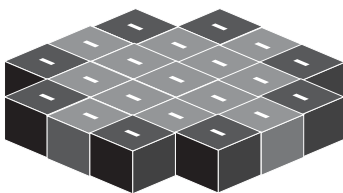
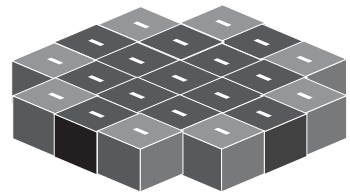
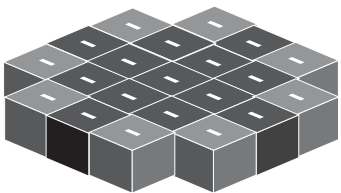
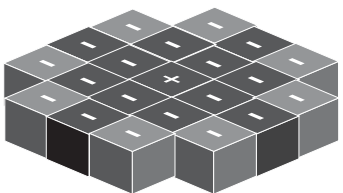
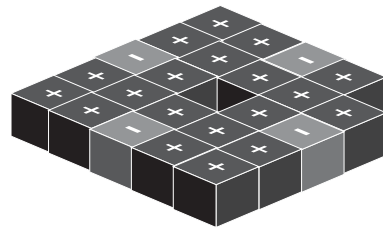
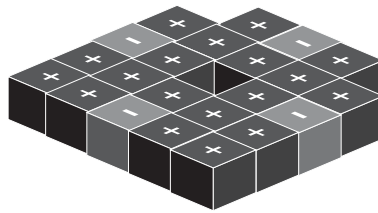
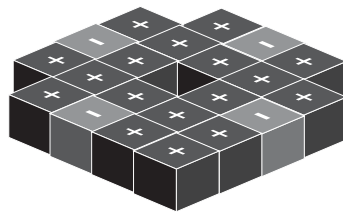
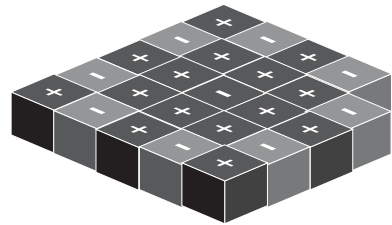
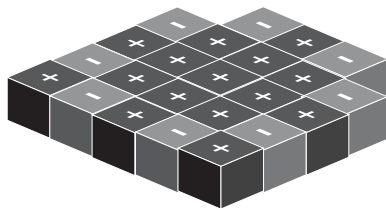
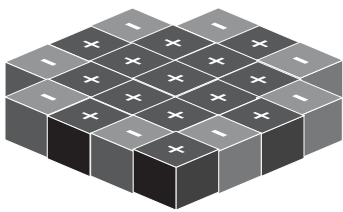
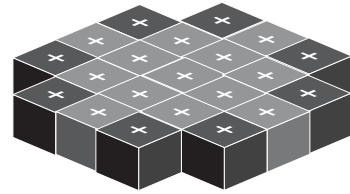
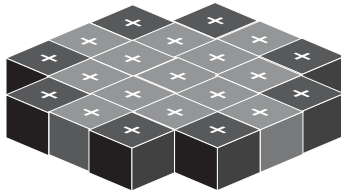
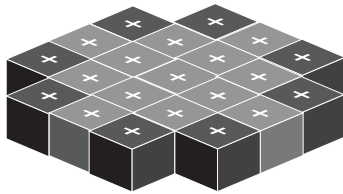
Palladium Nucleus

d^{10}

Pd 106
Proton: 46
Neutron: 60
Spin: 0
Stable

Pd 108
Proton: 46
Neutron: 62
Spin: 0
Stable

Pd 110
Proton: 46
Neutron: 64
Spin: 0
Stable

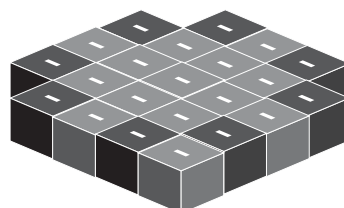
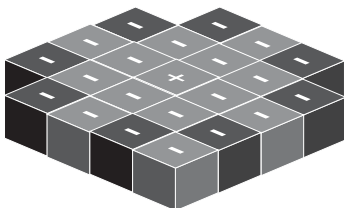
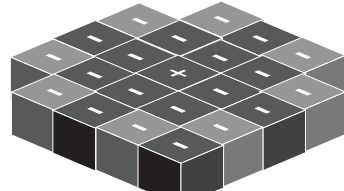
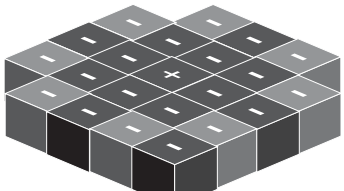
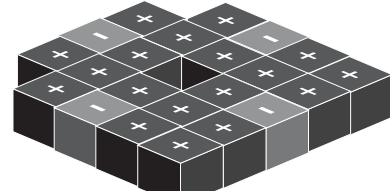
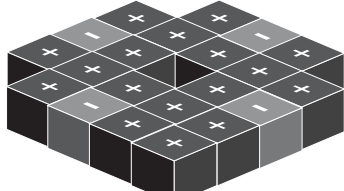
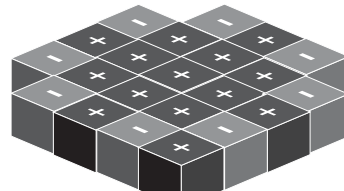
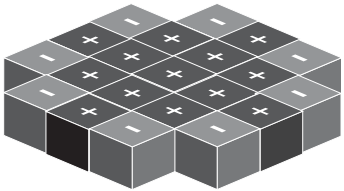
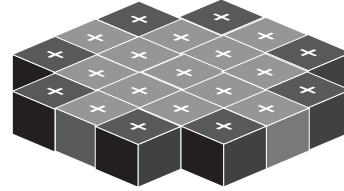
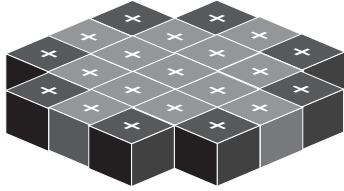


Silver Nucleus

$s^1 d^{10}$

Ag 107
Proton: 47
Neutron: 60
Spin: $-1/2$
Stable

Ag 109
Proton: 47
Neutron: 62
Spin: $-1/2$
Stable



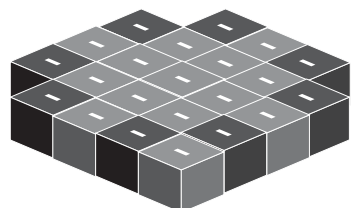
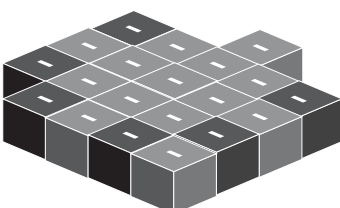
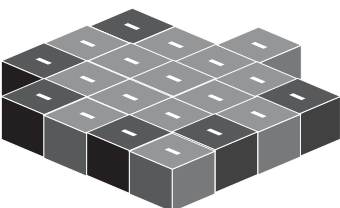
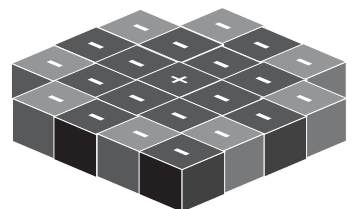
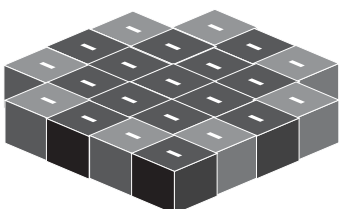
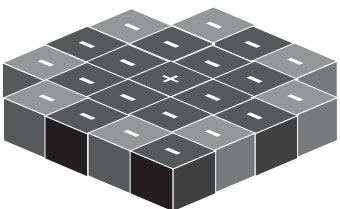
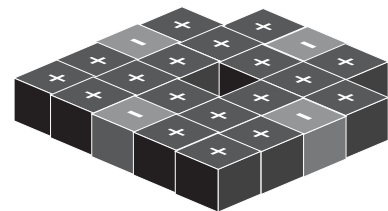
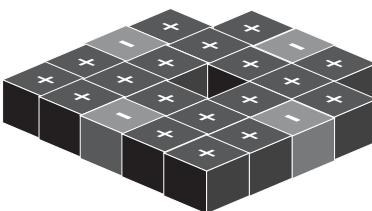
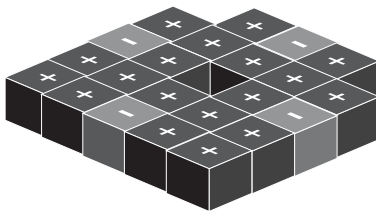
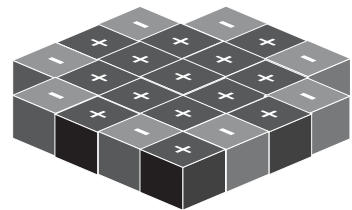
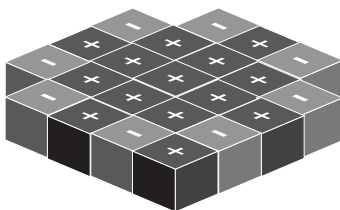
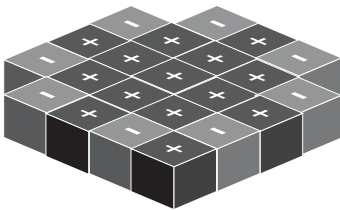
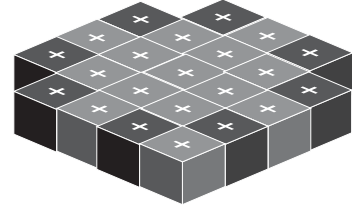
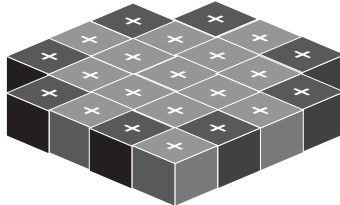
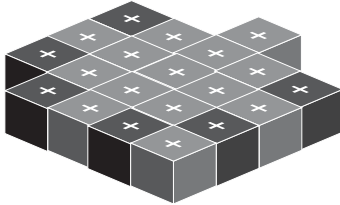
Cadmium Nucleus

$s^2 d^{10}$

Cd 106
Proton: 48
Neutron: 58
Spin: 0
Stable

Cd 108
Proton: 48
Neutron: 60
Spin: 0
Stable

Cd 110
Proton: 48
Neutron: 62
Spin: 0
Stable



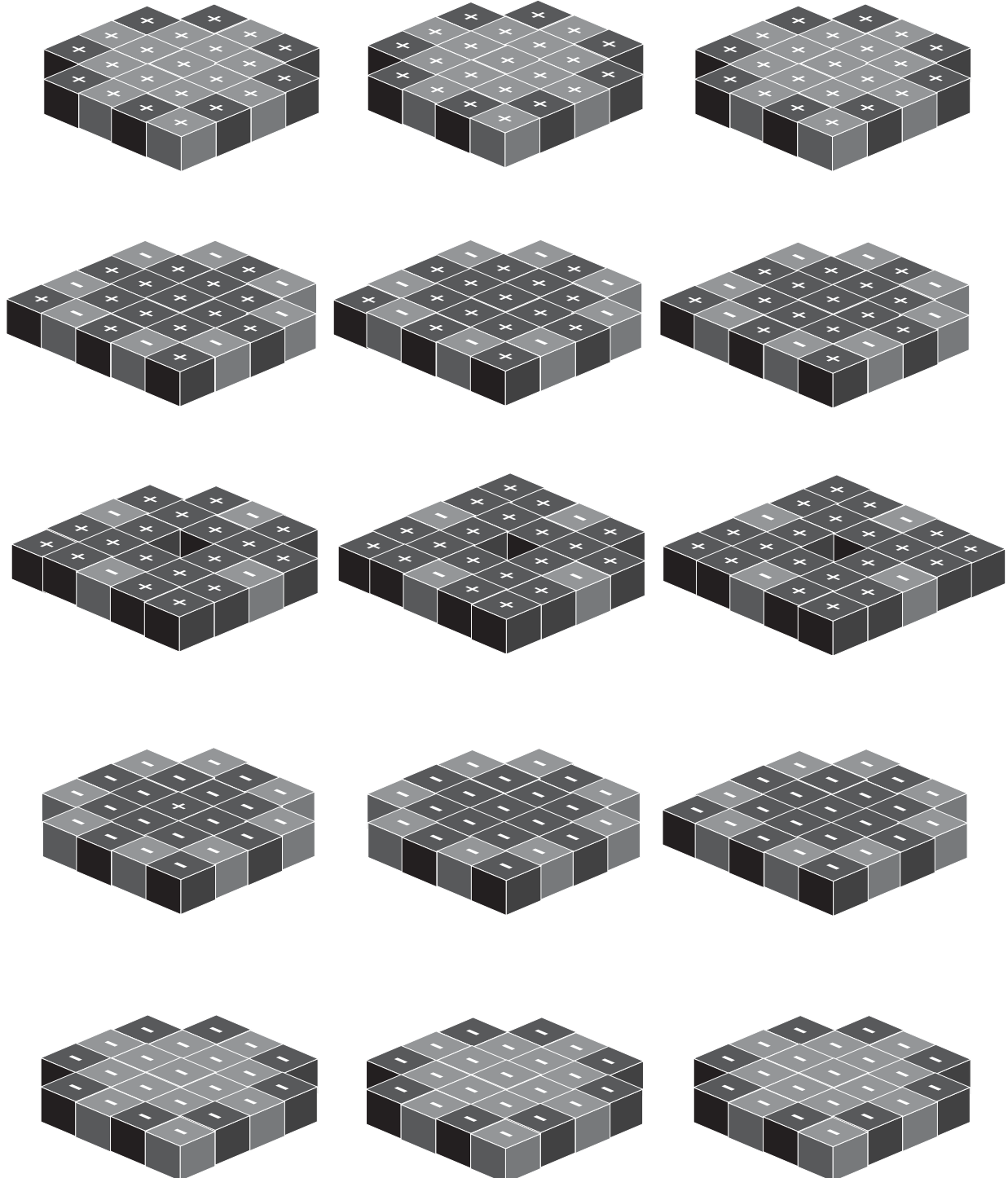
Cadmium Nucleus

$$s^2 d^{10}$$

Cd 111
 Proton: 48
 Neutron: 63
 Spin: 1/2
 Stable

Cd 112
 Proton: 48
 Neutron: 64
 Spin: 0
 Stable

Cd 114
 Proton: 48
 Neutron: 66
 Spin: 0
 Stable

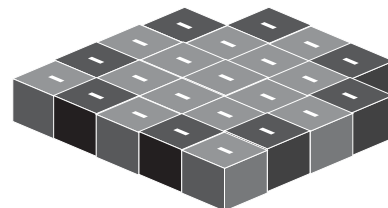
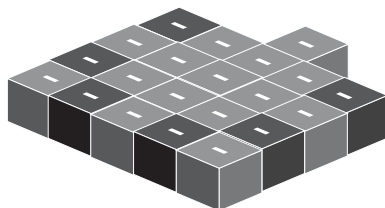
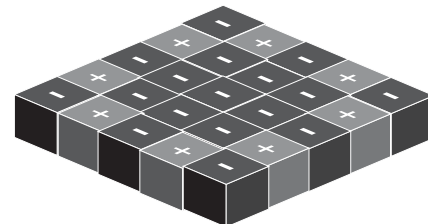
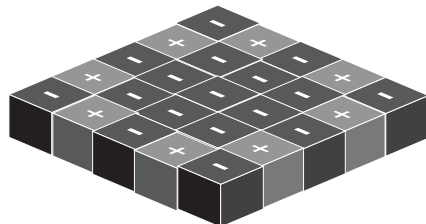
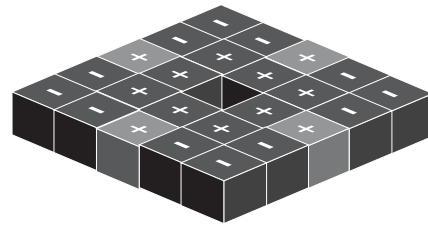
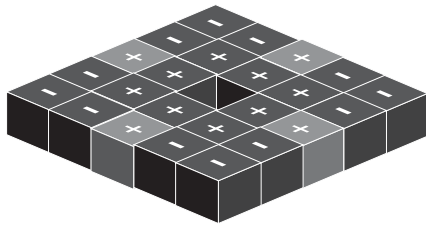
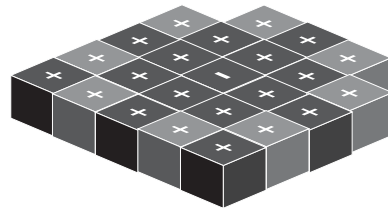
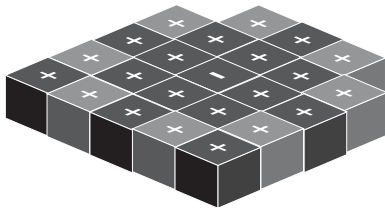
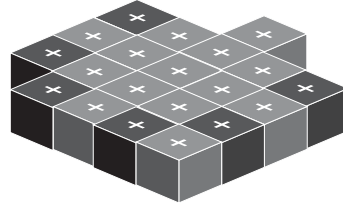
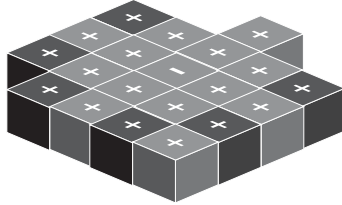


Indium Nucleus

$$s^2 d^{10} p^1$$

In 113
 Proton: 49
 Neutron: 64
 Spin: 9/2

In 115
 Proton: 49
 Neutron: 66
 Spin: 9/2



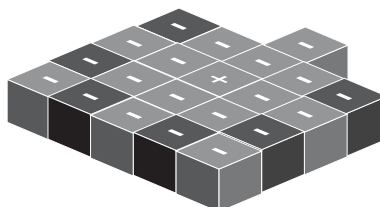
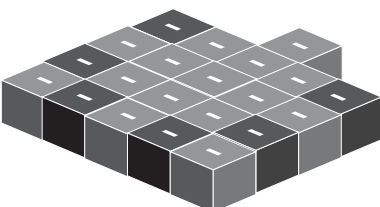
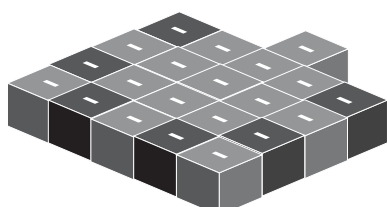
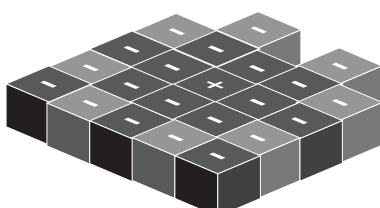
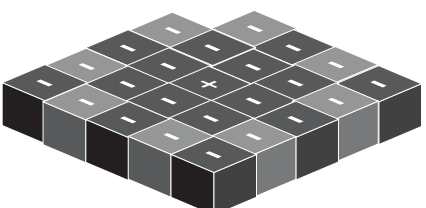
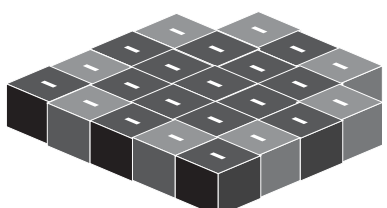
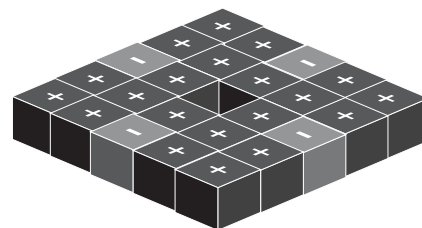
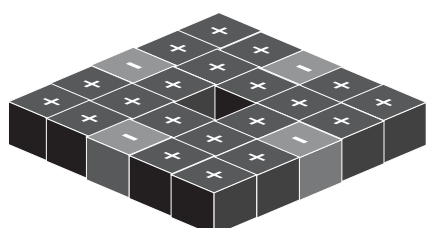
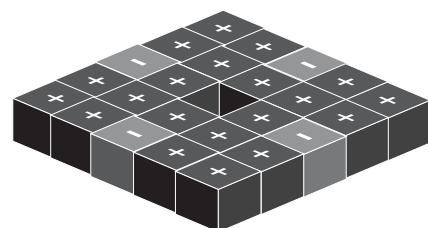
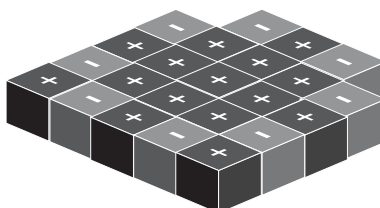
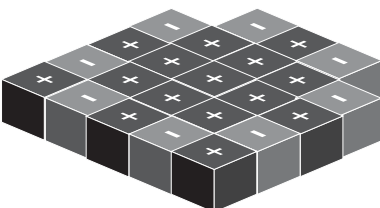
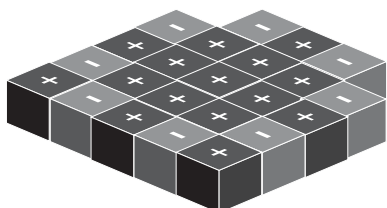
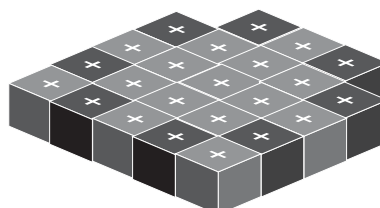
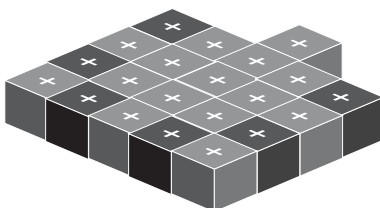
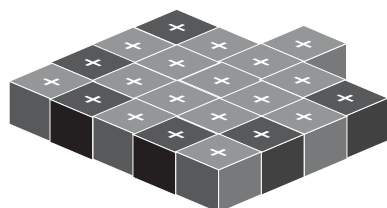
Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 112
 Proton: 50
 Neutron: 62
 Spin:0
 Stable

Sn 113
 Proton: 50
 Neutron: 63
 Spin:1/2

Sn 113m
 Proton: 50
 Neutron: 63
 Spin:7/2

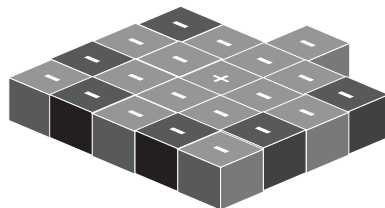
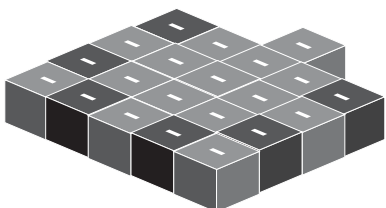
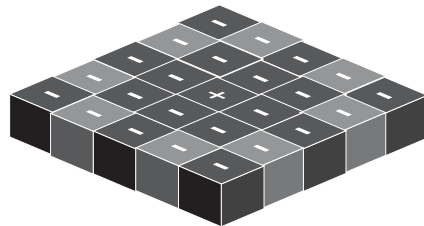
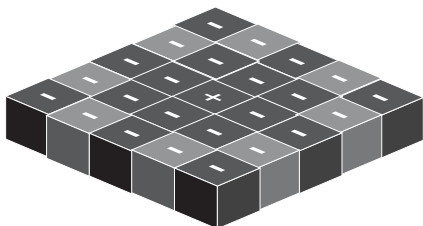
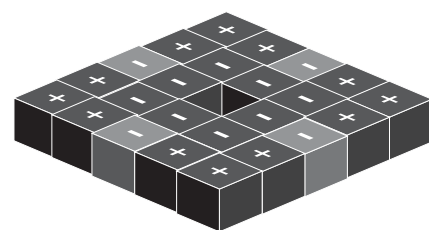
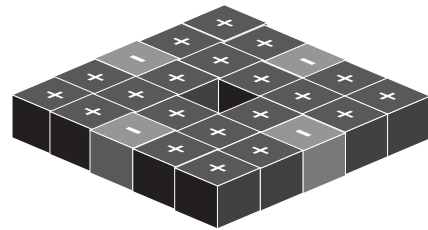
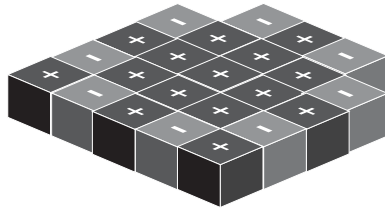
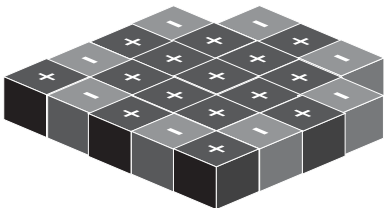
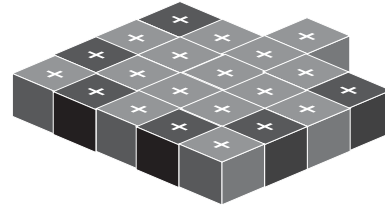
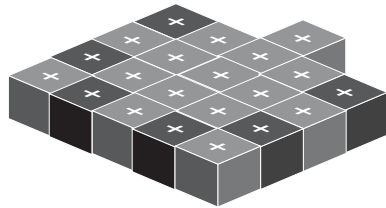


Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 114
Proton: 50
Neutron: 64
Spin: 0
Stable

Sn 114m
Proton: 50
Neutron: 64
Spin: -7



Tin Nucleus

$s^2 d^{10} p^2$

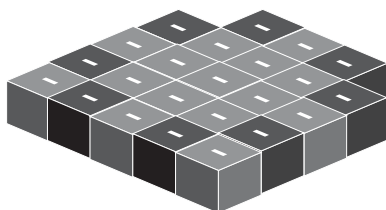
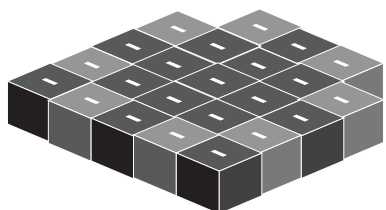
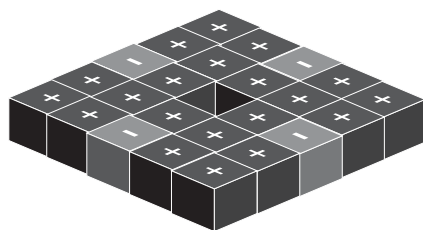
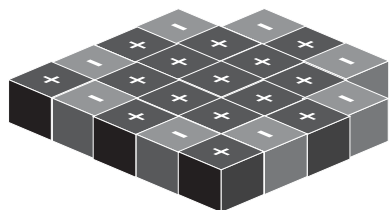
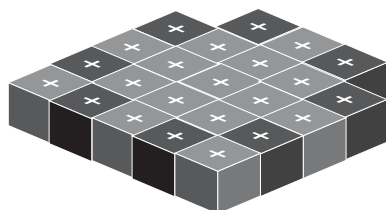
Sn 116

Proton: 50

Neutron: 66

Spin: 0

Stable



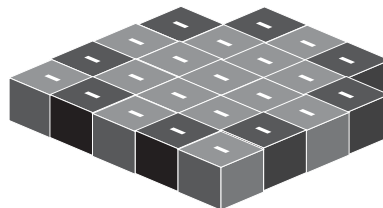
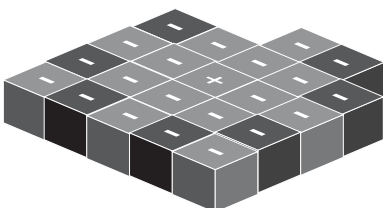
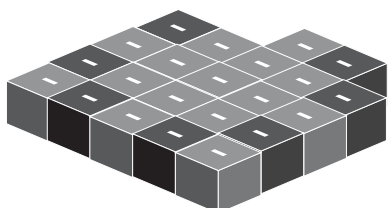
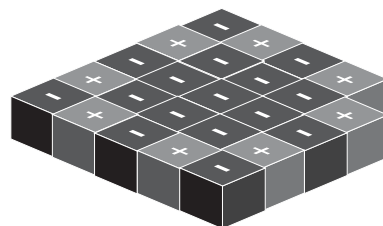
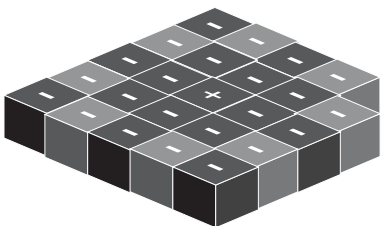
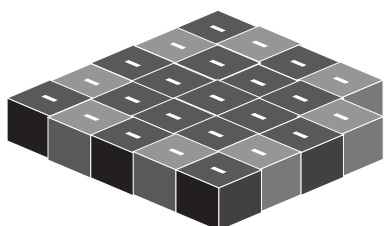
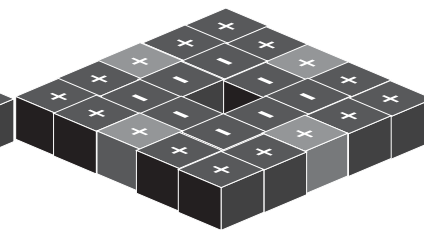
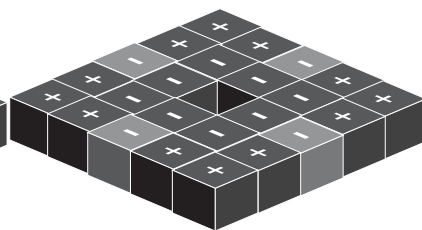
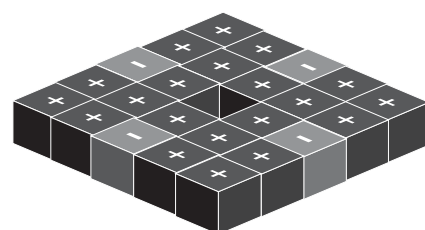
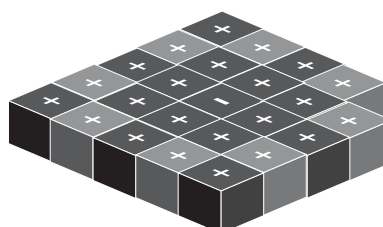
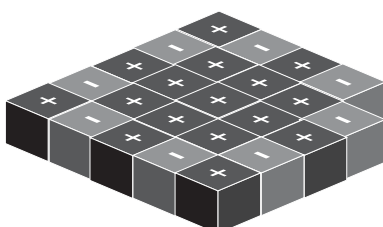
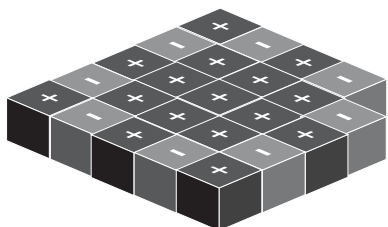
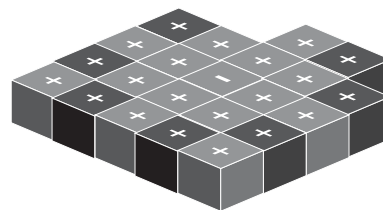
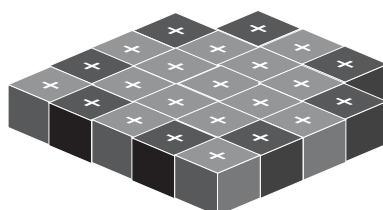
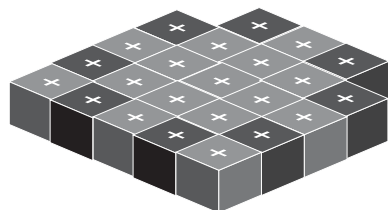
Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 117
 Proton: 50
 Neutron: 67
 Spin: 1/2
 Stable

Sn 117m1
 Proton: 50
 Neutron: 67
 Spin: -11/2

Sn 117m2
 Proton: 50
 Neutron: 67
 Spin: 19/2



Tin Nucleus

$s^2 d^{10} p^2$

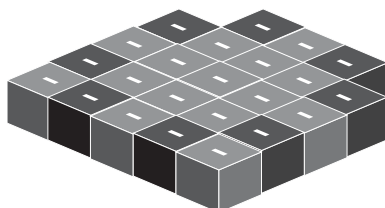
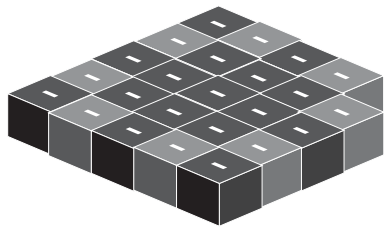
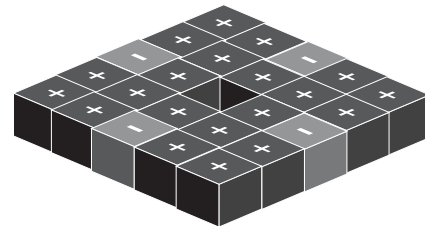
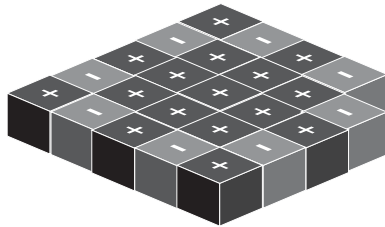
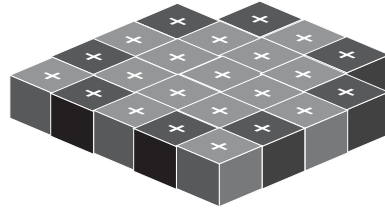
Sn 118

Proton: 50

Neutron: 68

Spin: 0

Stable



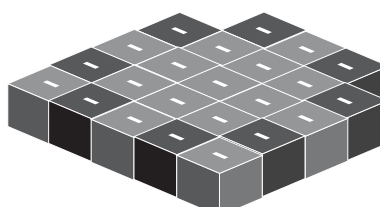
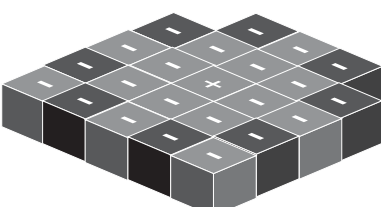
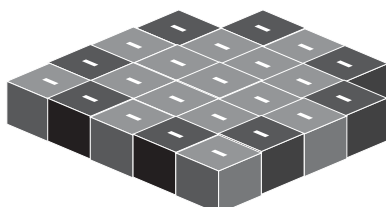
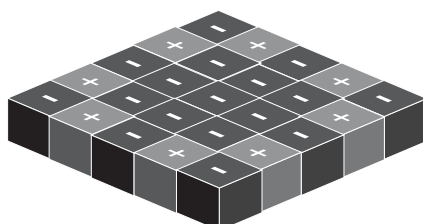
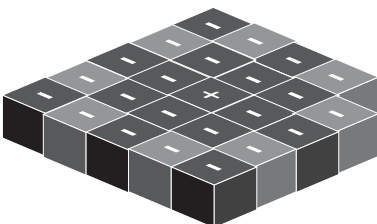
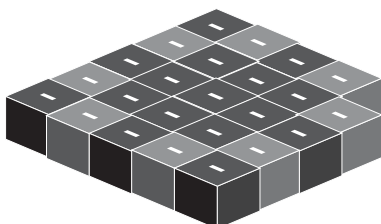
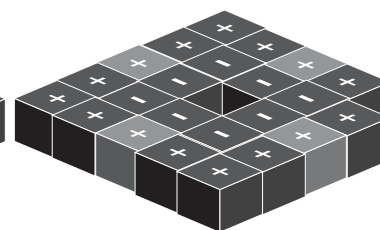
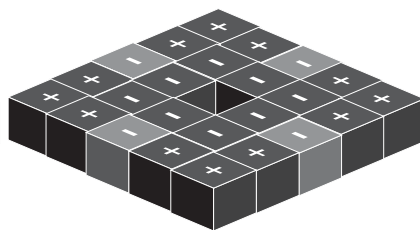
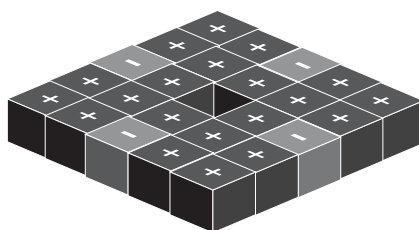
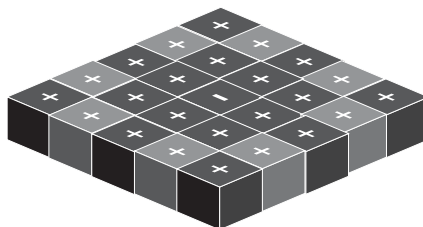
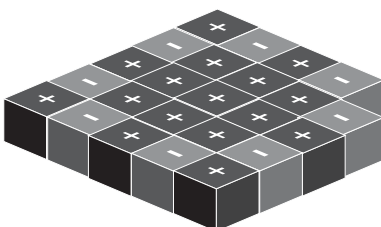
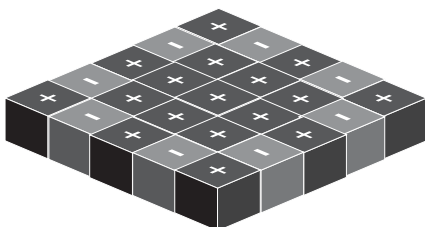
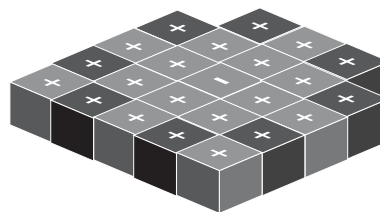
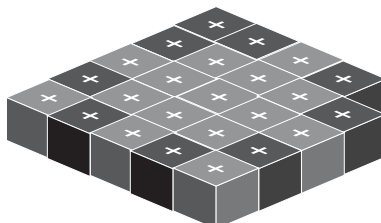
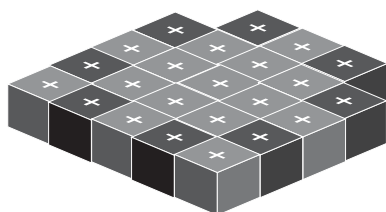
Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 119
 Proton: 50
 Neutron: 69
 Spin: 1/2
 Stable

Sn 119m1
 Proton: 50
 Neutron: 69
 Spin: -11/2

Sn 119m2
 Proton: 50
 Neutron: 69
 Spin: 19/2



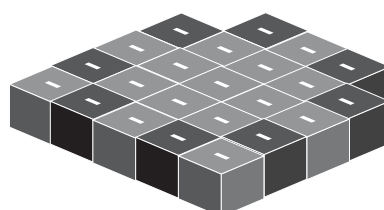
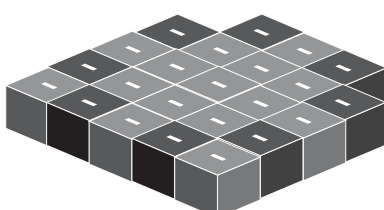
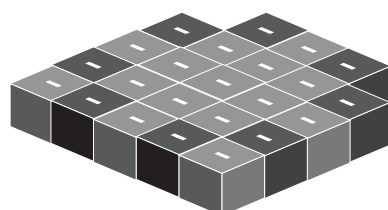
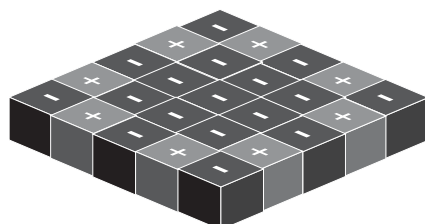
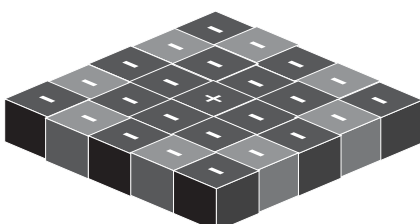
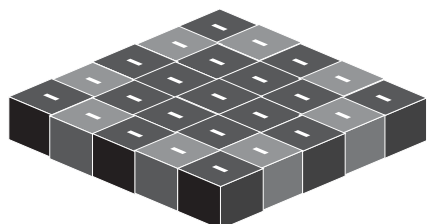
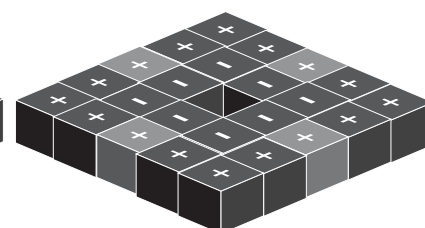
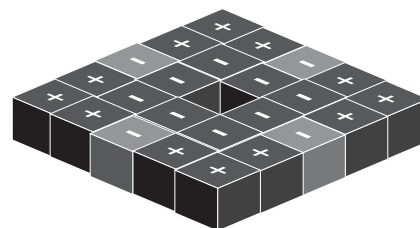
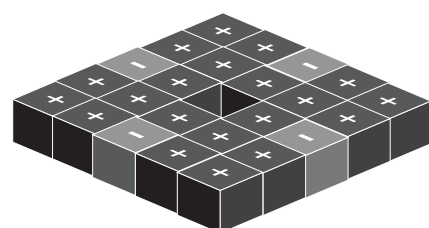
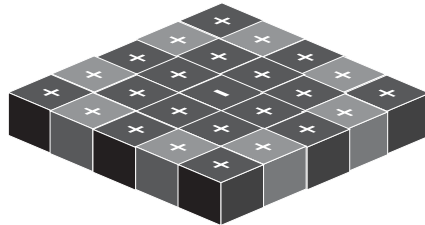
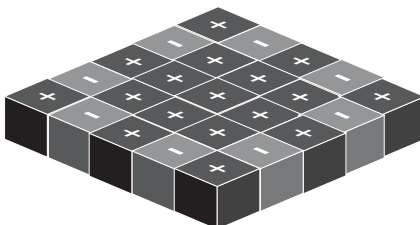
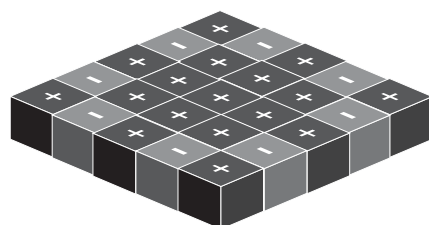
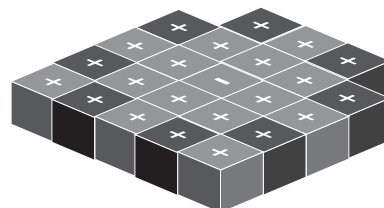
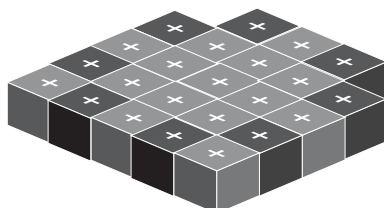
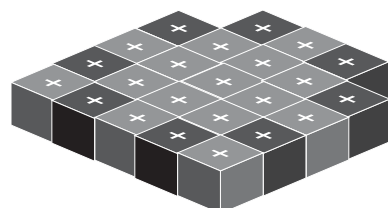
Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 120
Proton: 50
Neutron: 70
Spin:0
Stable

Sn 120m1
Proton: 50
Neutron: 70
Spin:-7

Sn 120m2
Proton: 50
Neutron: 70
Spin:10



Tin Nucleus

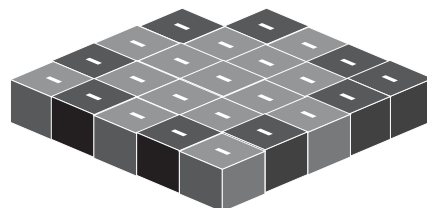
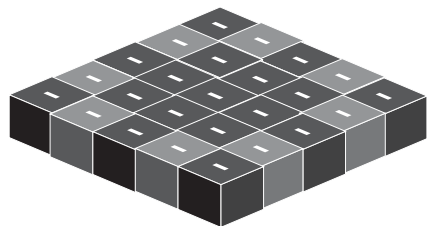
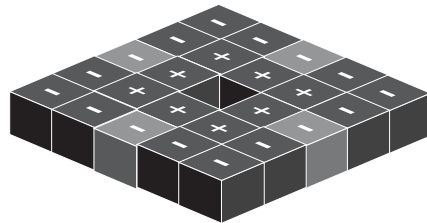
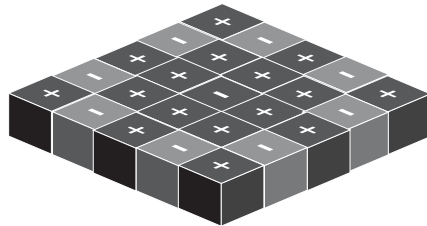
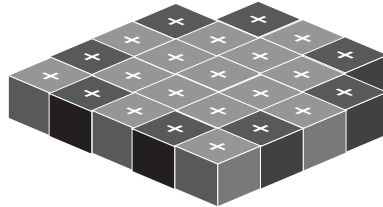
$s^2 d^{10} p^2$

Sn 121m3

Proton: 50

Neutron: 71

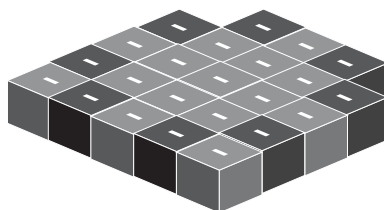
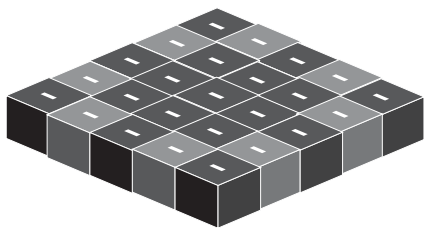
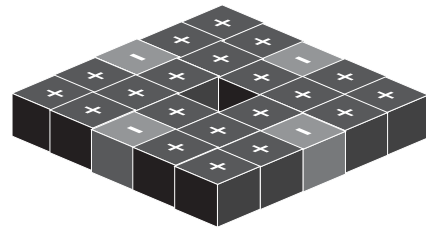
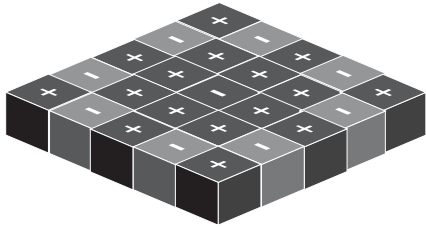
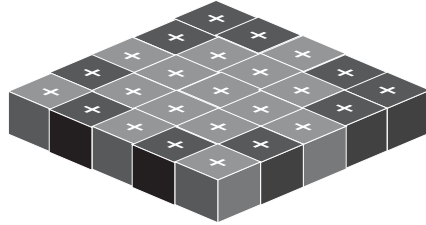
Spin: $-27/2$



Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 122
Proton: 50
Neutron: 72
Spin: 0
Stable



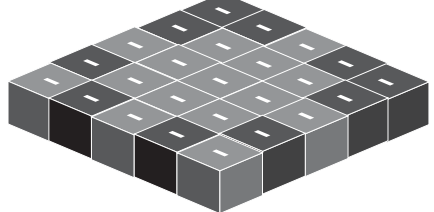
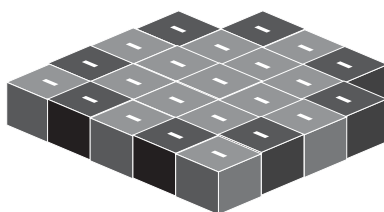
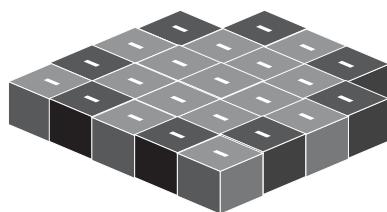
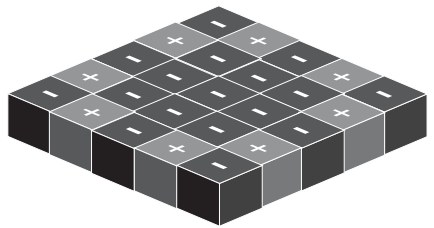
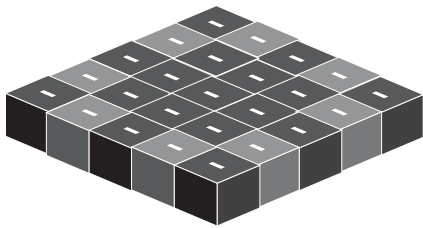
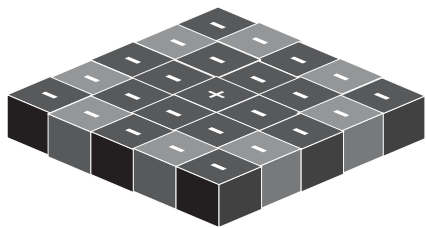
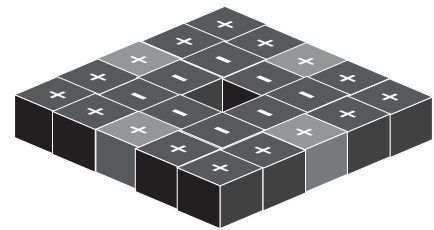
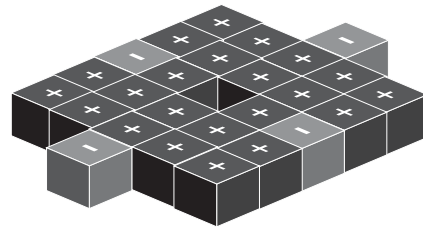
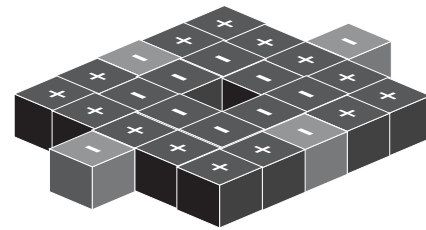
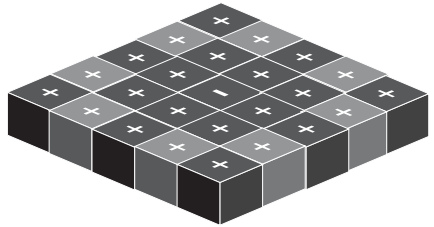
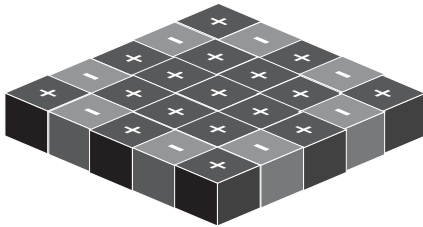
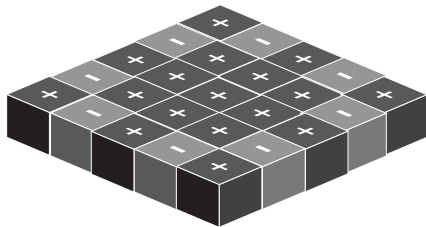
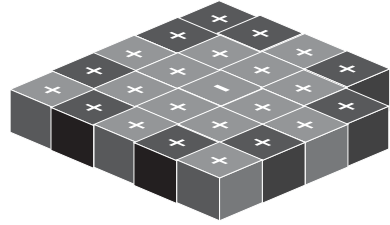
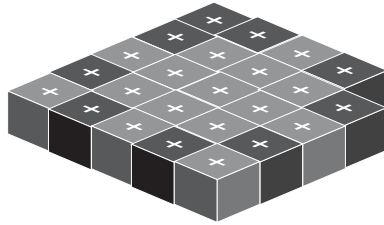
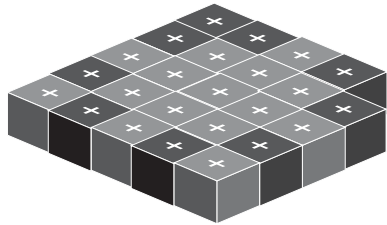
Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 123
 Proton: 50
 Neutron: 73
 Spin: -11/2
 Stable

Sn 123m1
 Proton: 50
 Neutron: 73
 Spin: 3/2

Sn 123m2
 Proton: 50
 Neutron: 73
 Spin: 19/2

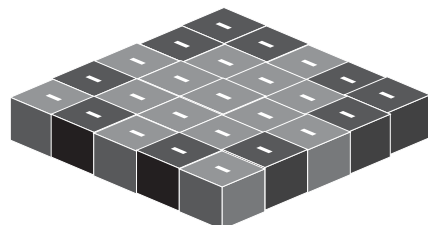
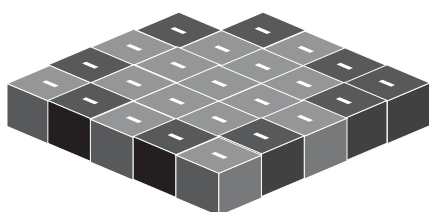
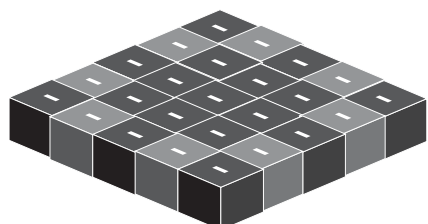
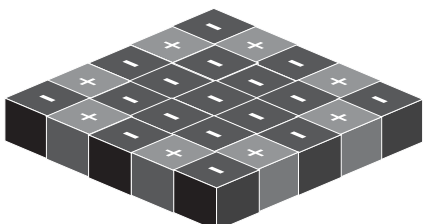
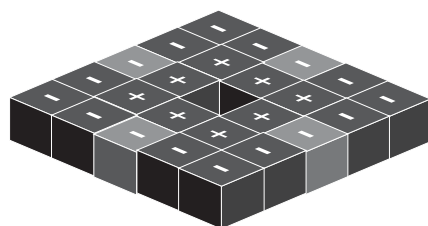
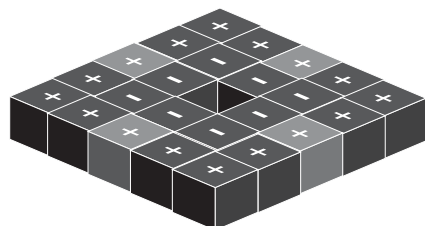
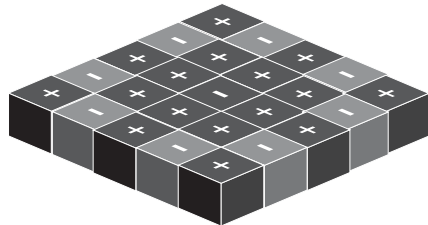
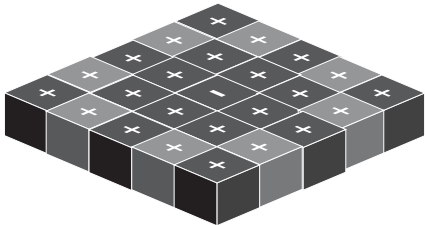
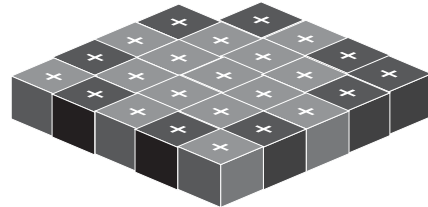
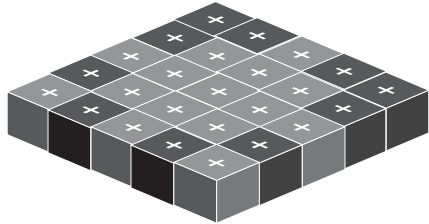


Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 123m3
 Proton: 50
 Neutron: 73
 Spin: 23/2

Sn 123m4
 Proton: 50
 Neutron: 73
 Spin: -27/2

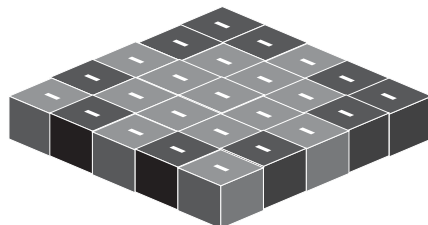
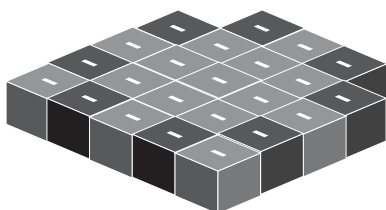
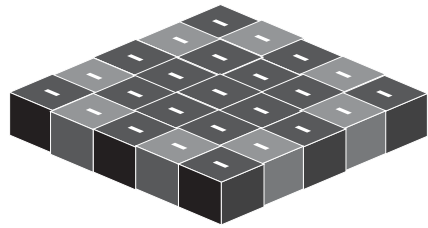
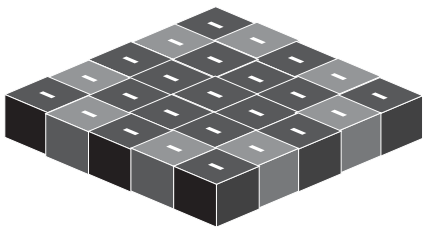
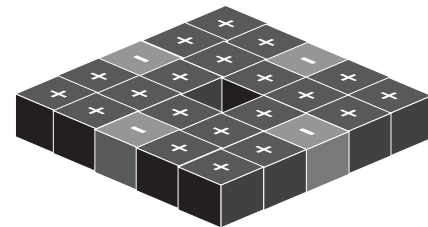
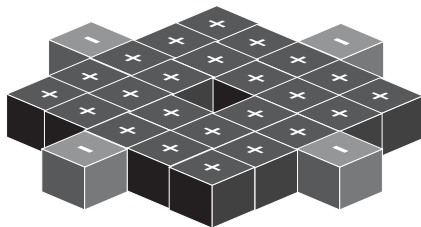
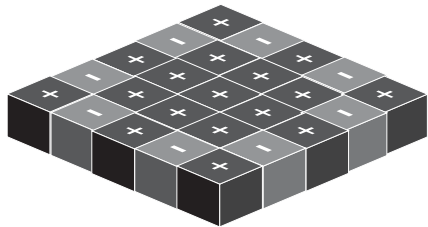
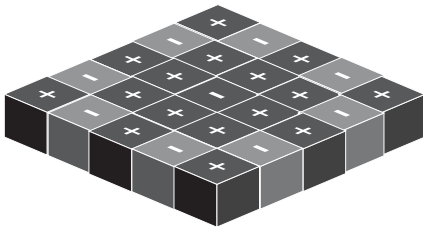
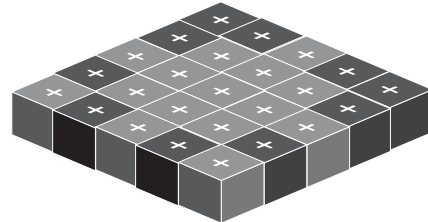
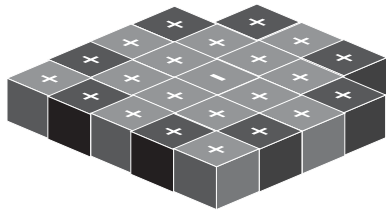


Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 124
Proton: 50
Neutron: 74
Spin:0
Stable

Sn 124
Proton: 50
Neutron: 74
Spin:0
Stable

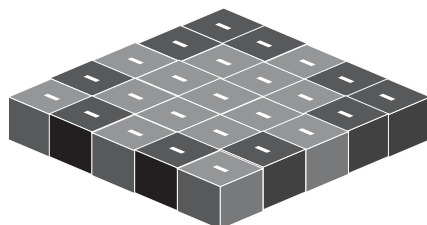
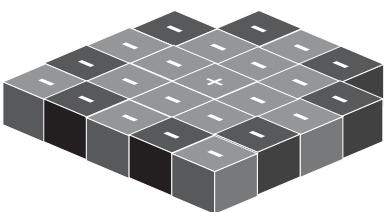
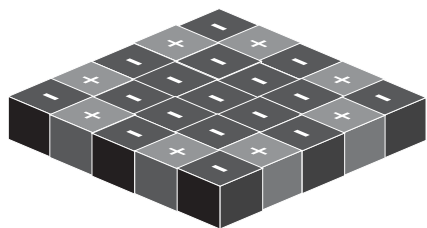
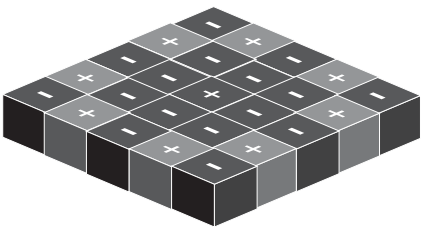
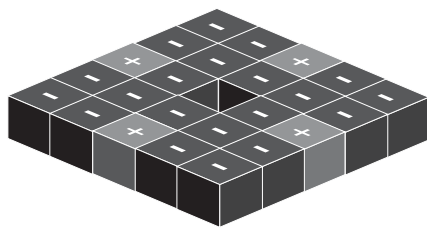
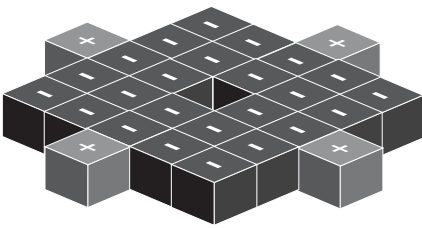
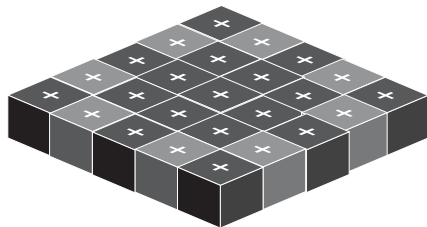
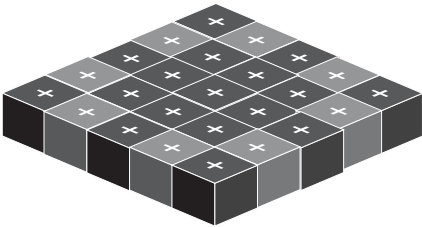
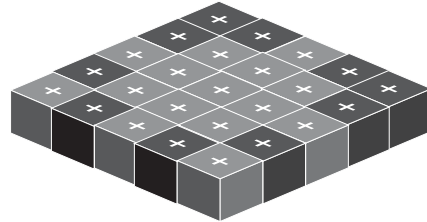
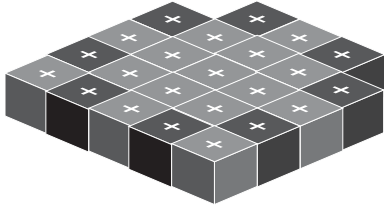


Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 124
 Proton: 50
 Neutron: 74
 Spin:0
 Stable

Sn 124
 Proton: 50
 Neutron: 74
 Spin:0
 Stable



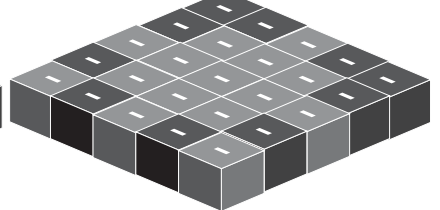
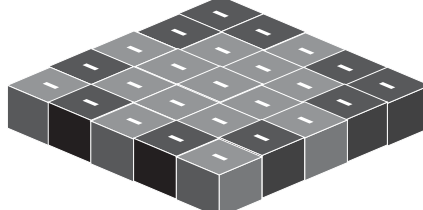
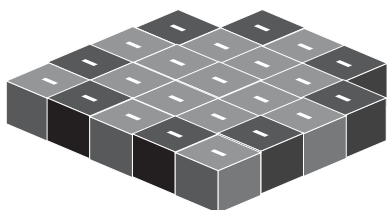
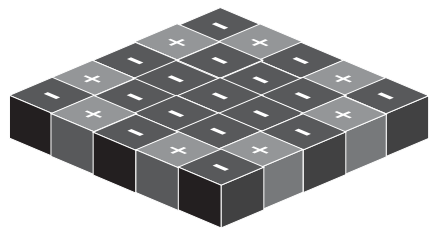
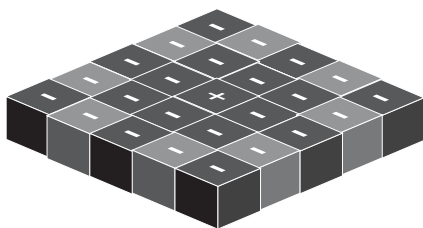
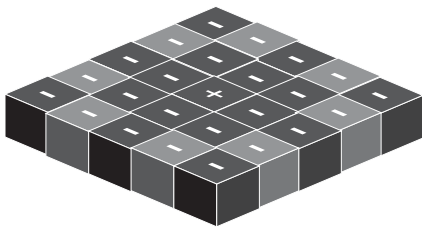
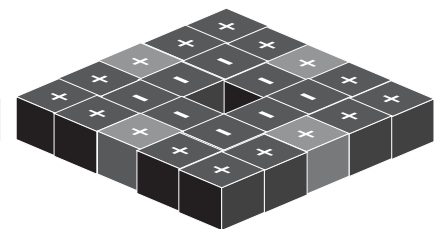
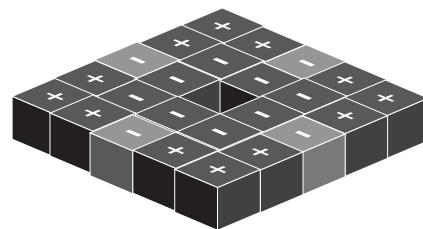
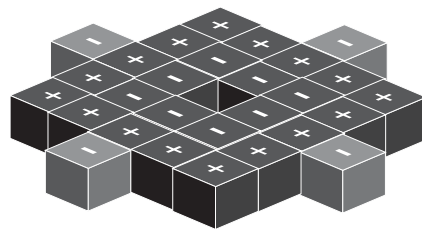
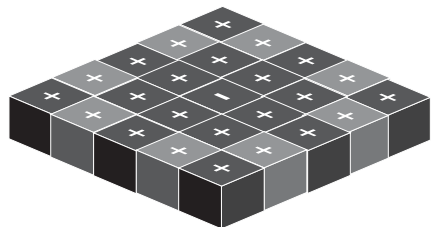
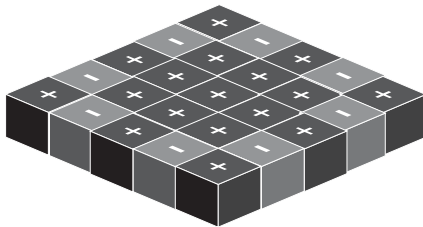
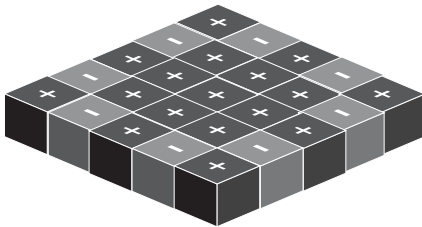
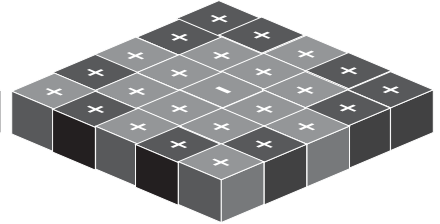
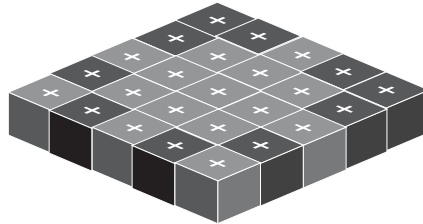
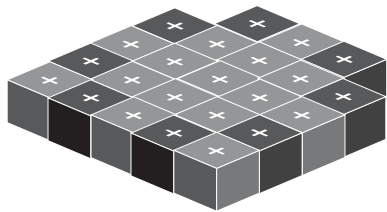
Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 124m1
Proton: 50
Neutron: 74
Spin:-5

Sn 124m2
Proton: 50
Neutron: 74
Spin:-7

Sn 124m3
Proton: 50
Neutron: 74
Spin:10

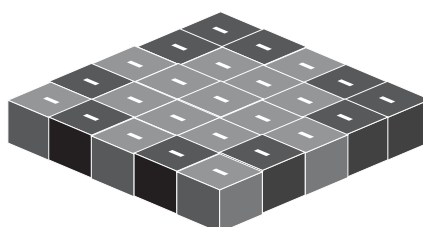
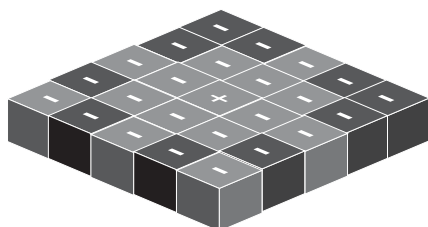
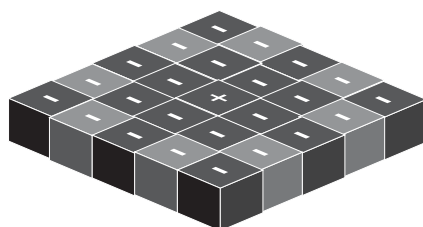
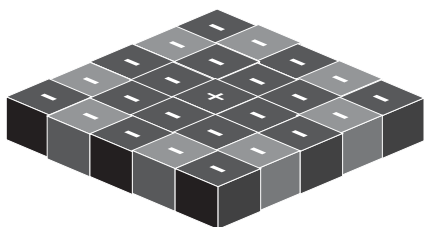
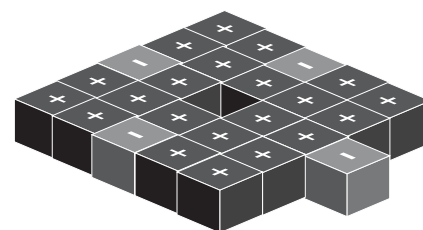
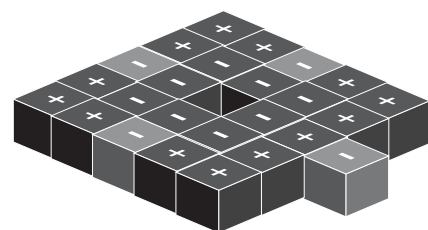
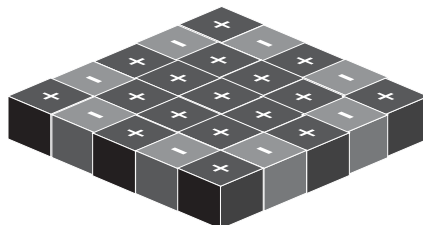
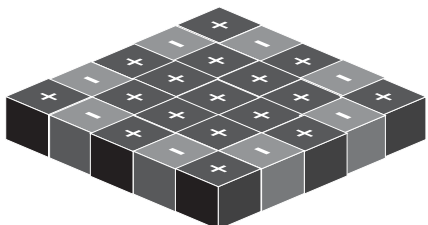
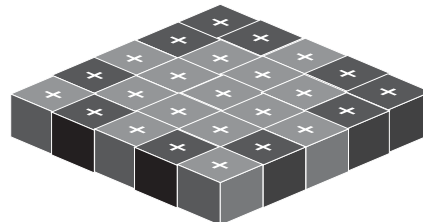
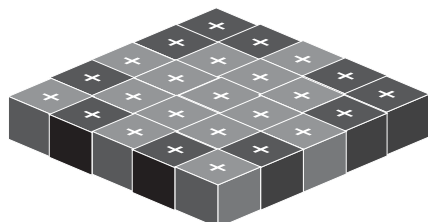


Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 125
 Proton: 50
 Neutron: 75
 Spin: -11/2

Sn 125m
 Proton: 50
 Neutron: 75
 Spin: 3/2



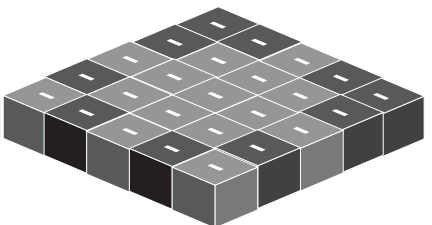
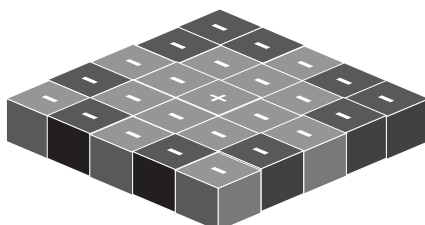
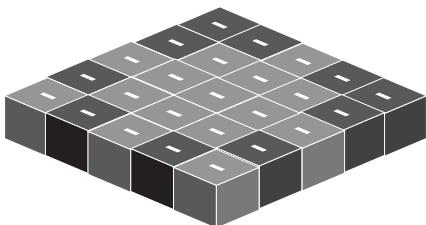
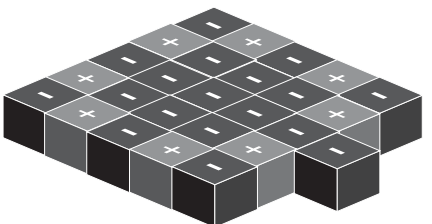
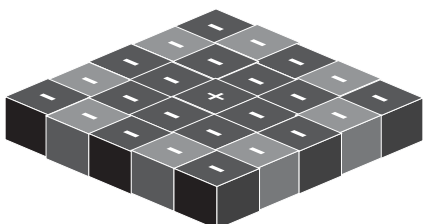
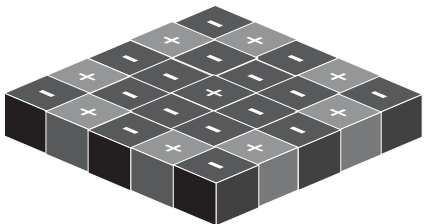
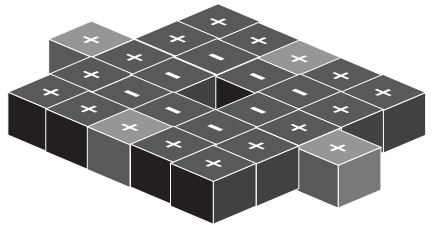
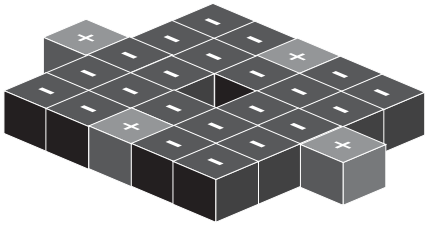
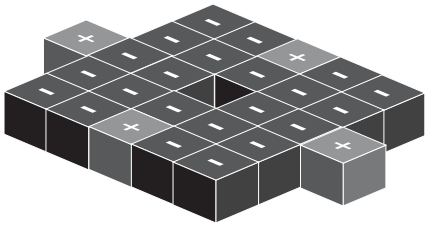
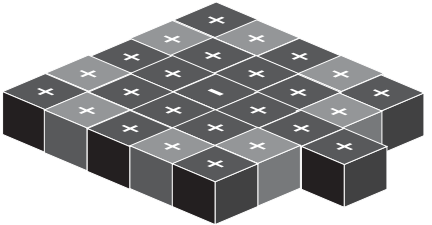
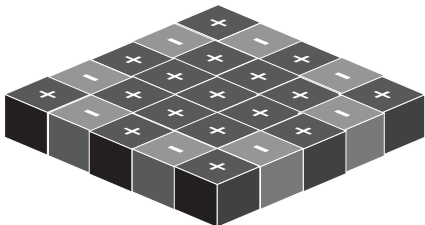
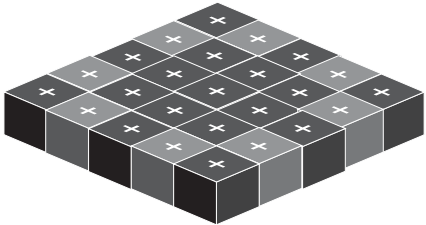
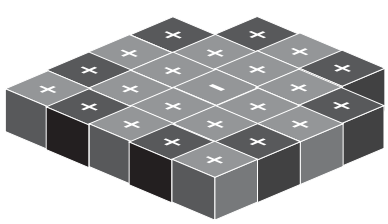
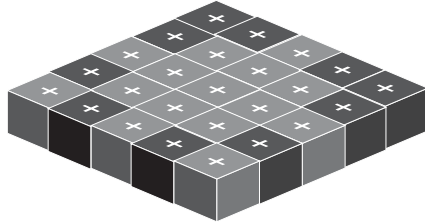
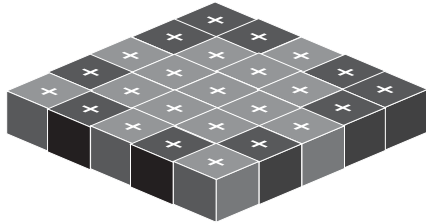
Tin Nucleus

$$s^2 d^{10} p^2$$

Sn 126
Proton: 50
Neutron: 76
Spin:0

Sn 126m1
Proton: 50
Neutron: 76
Spin:-7

Sn 126m2
Proton: 50
Neutron: 76
Spin:10

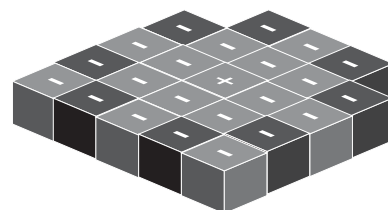
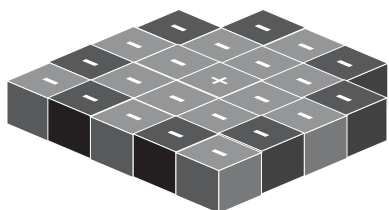
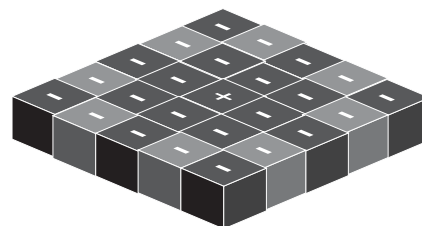
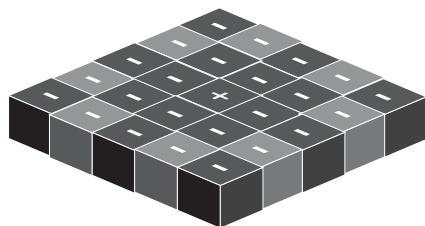
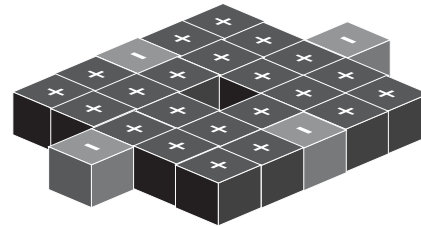
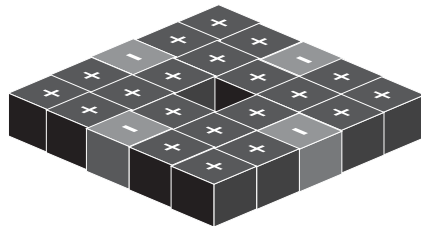
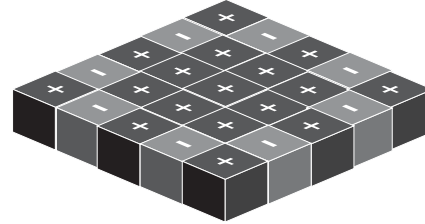
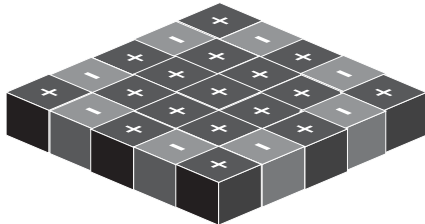
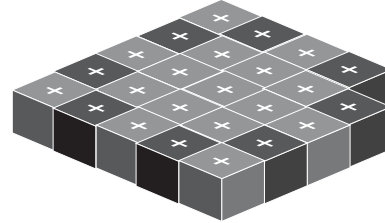
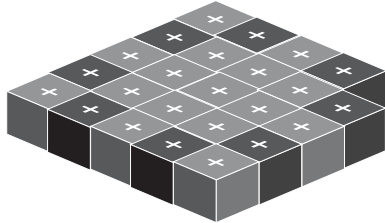


Antimony Nucleus

$$s^2 d^{10} p^3$$

Sb 121
 Proton: 51
 Neutron: 70
 Spin: 5/2
 Stable

Sb 123
 Proton: 51
 Neutron: 72
 Spin: 7/2
 Stable



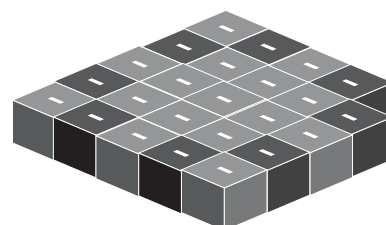
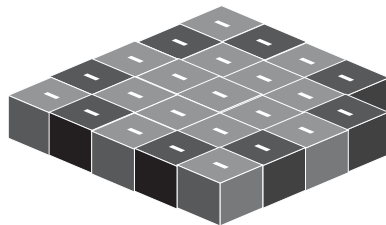
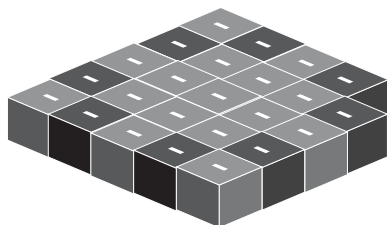
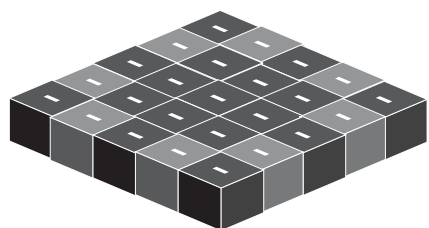
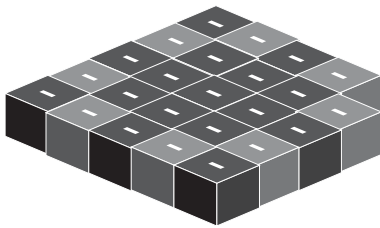
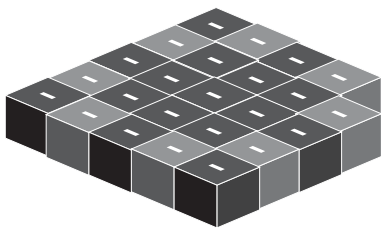
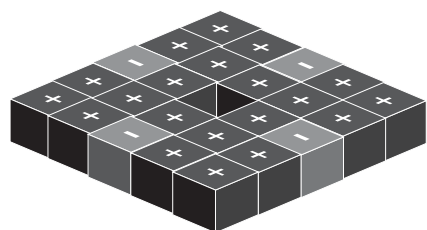
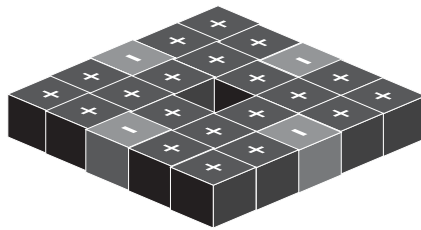
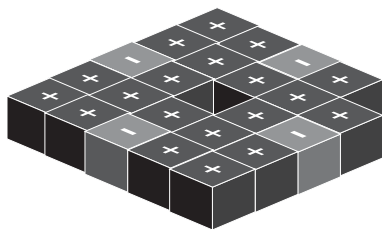
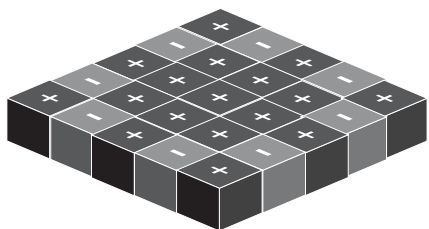
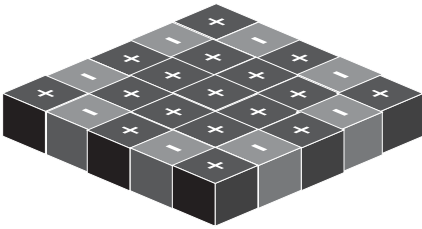
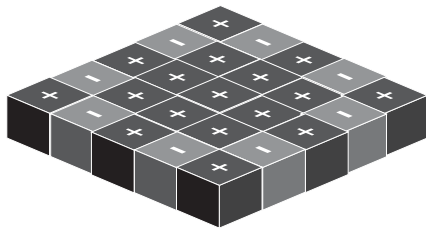
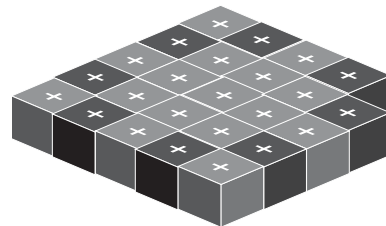
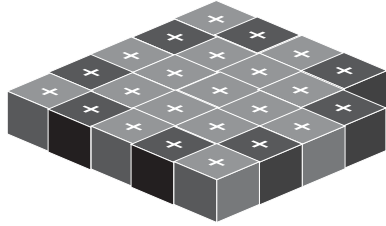
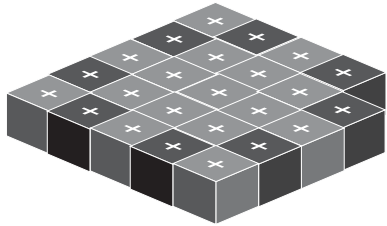
Tellurium Nucleus

$$s^2 d^{10} p^4$$

Te 120
Proton: 52
Neutron: 68
Spin:0
Stable

Te 121
Proton: 52
Neutron: 69
Spin:1/2
Stable

Te 122
Proton: 52
Neutron: 70
Spin:0
Stable



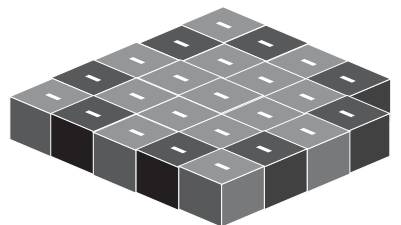
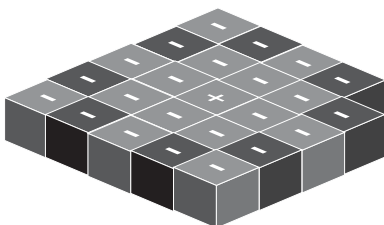
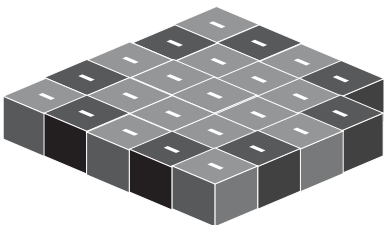
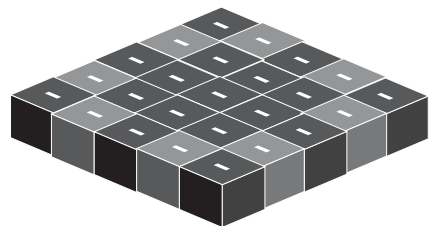
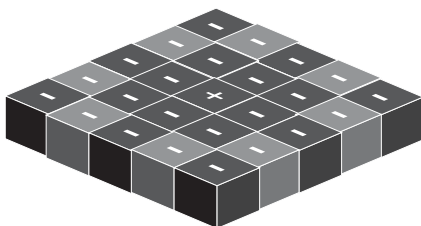
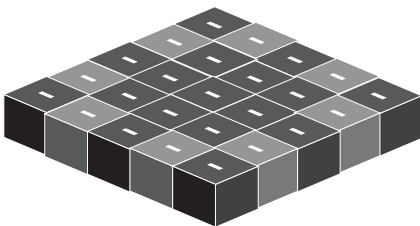
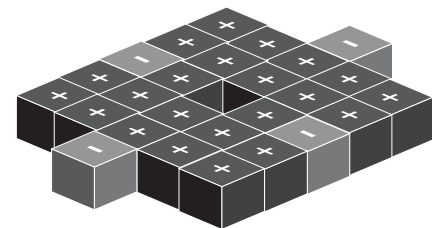
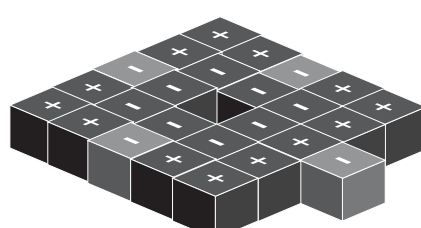
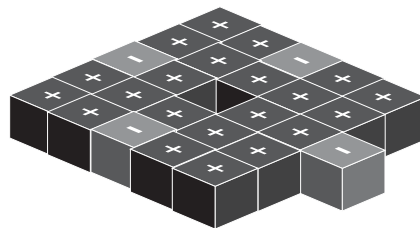
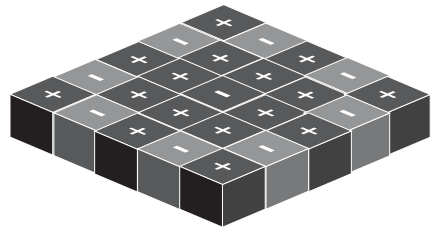
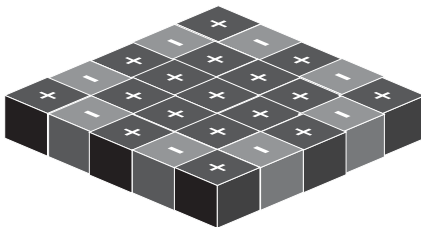
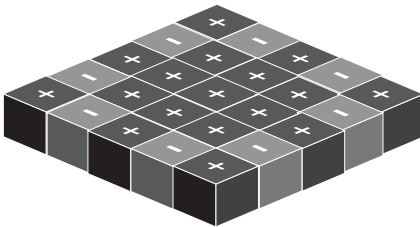
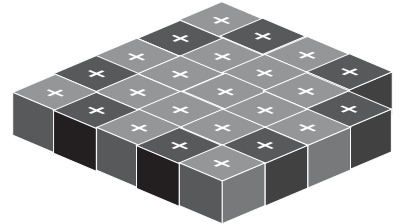
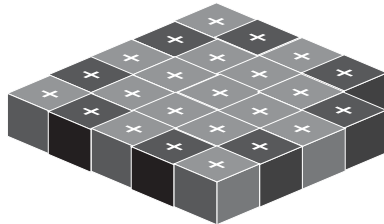
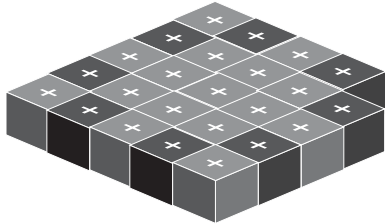
Tellurium Nucleus

$$s^2 d^{10} p^4$$

Te 123
Proton: 52
Neutron: 71
Spin: 1/2
Stable

Te 123m
Proton: 52
Neutron: 71
Spin: -11/2

Te 124
Proton: 52
Neutron: 72
Spin: 0
Stable



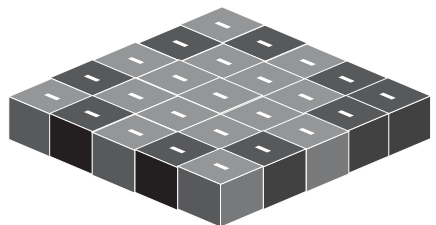
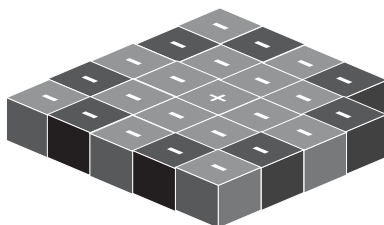
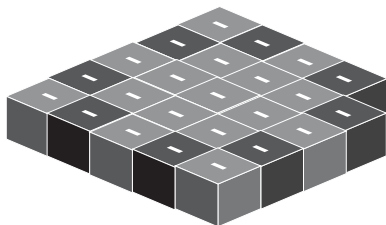
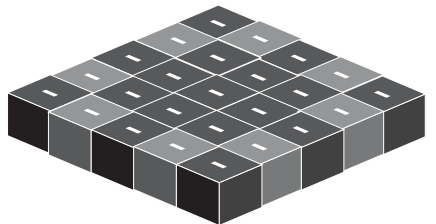
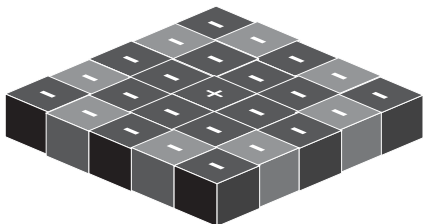
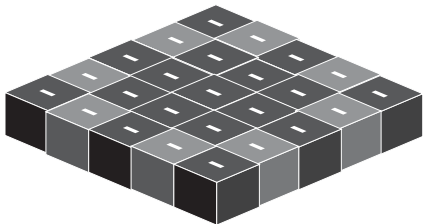
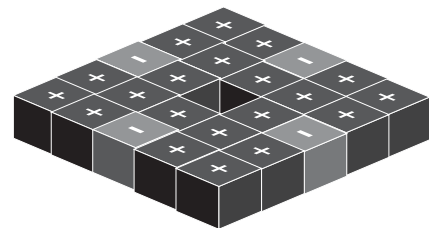
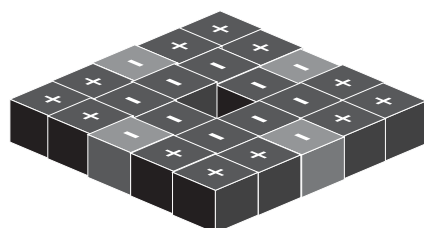
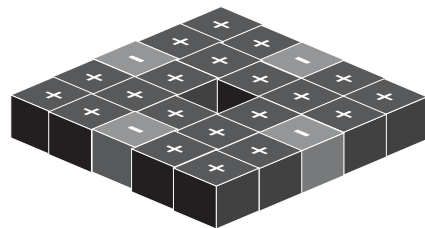
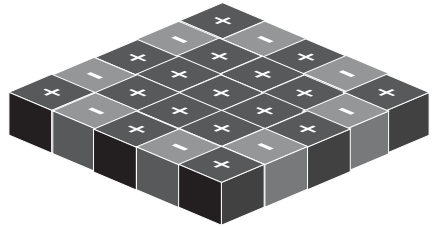
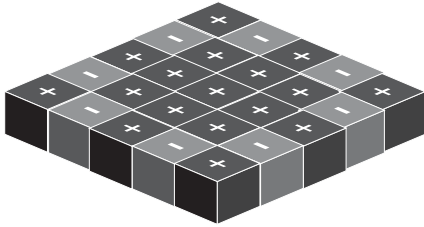
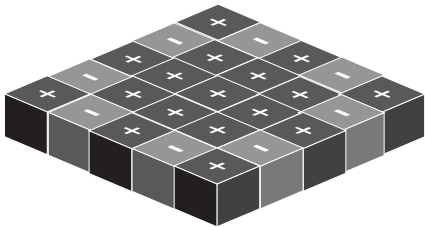
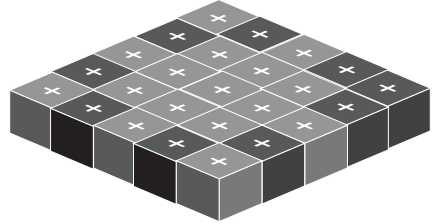
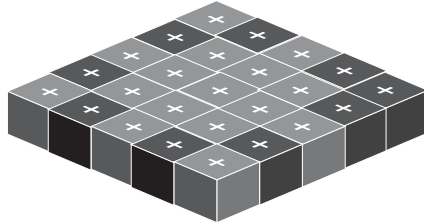
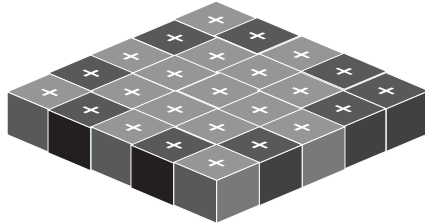
Tellurium Nucleus

$$s^2 d^{10} p^4$$

Te 123
 Proton: 52
 Neutron: 71
 Spin: 1/2
 Stable

Te 123m
 Proton: 52
 Neutron: 71
 Spin: -11/2

Te 124
 Proton: 52
 Neutron: 72
 Spin: 0
 Stable



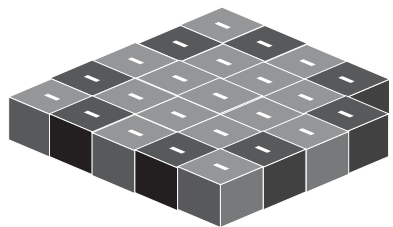
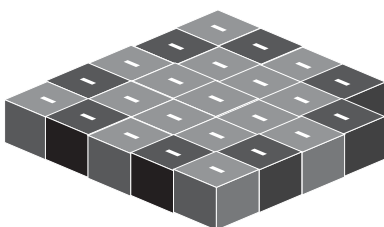
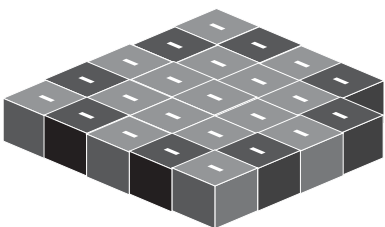
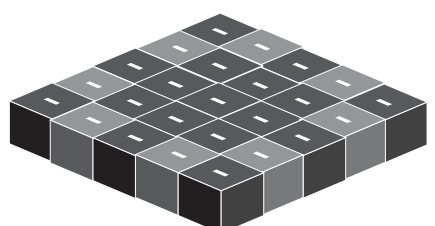
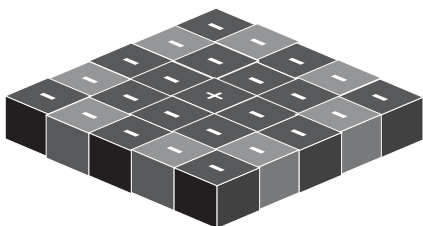
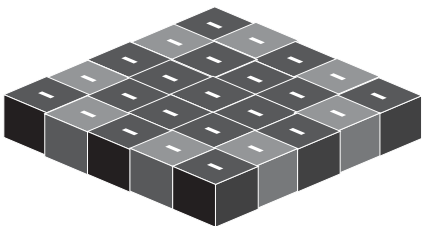
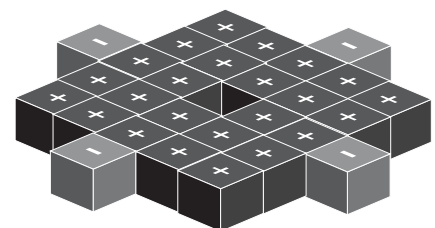
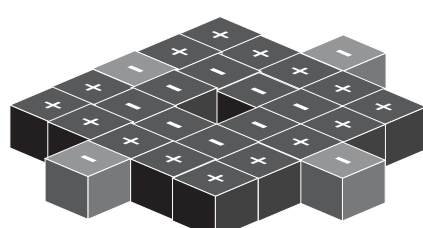
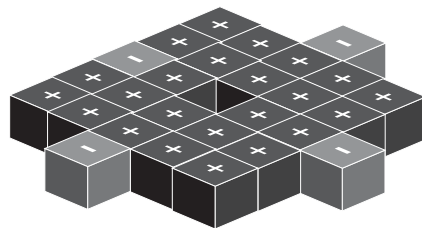
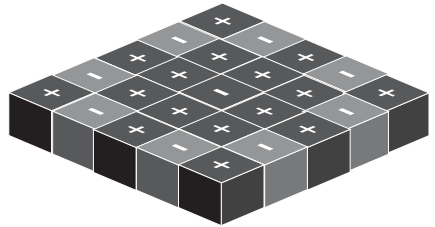
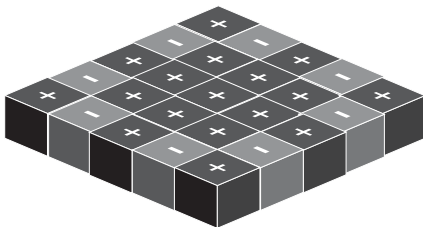
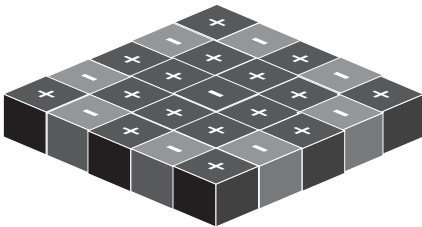
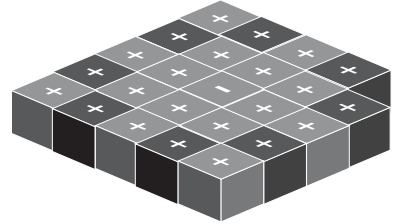
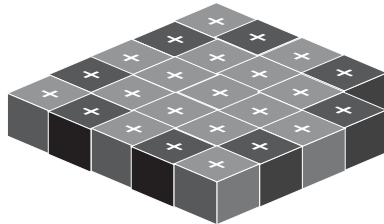
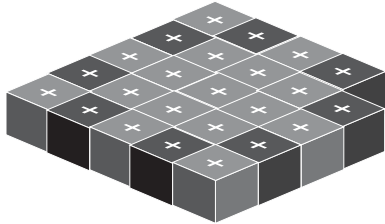
Tellurium Nucleus

$$s^2 d^{10} p^4$$

Te 125
Proton: 52
Neutron: 73
Spin: 1/2
Stable

Te 125m
Proton: 52
Neutron: 73
Spin: -11/2

Te 126
Proton: 52
Neutron: 74
Spin: 0
Stable

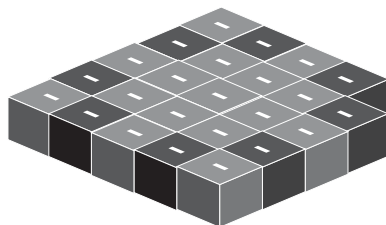
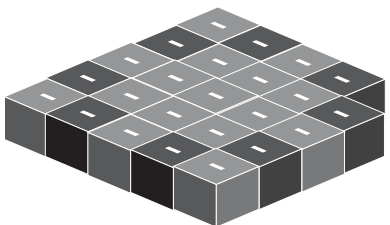
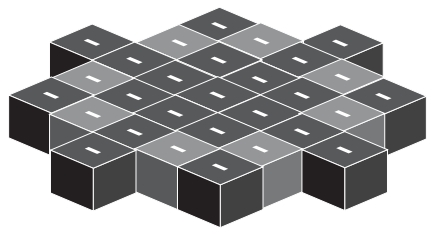
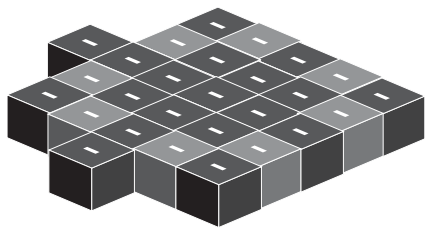
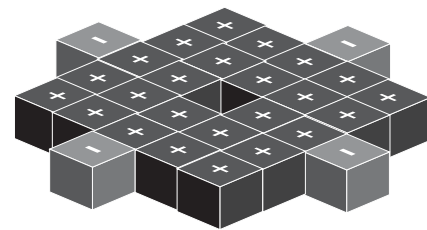
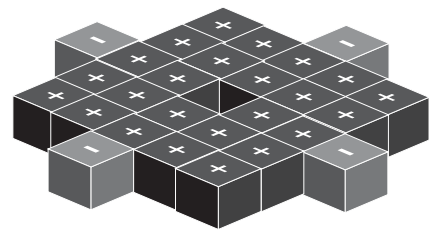
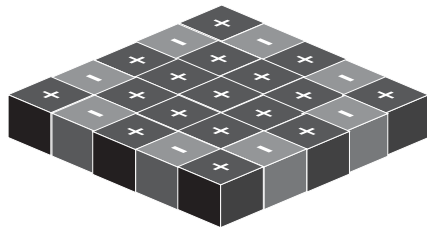
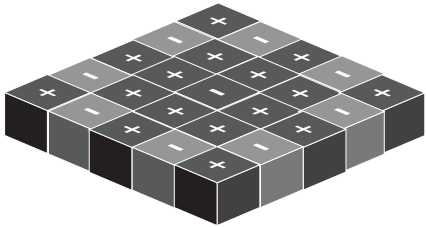
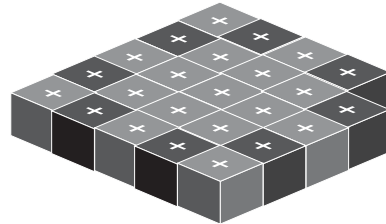
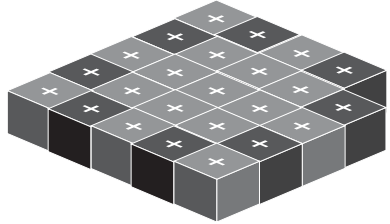


Tellurium Nucleus

$$s^2 d^{10} p^4$$

Te 128
Proton: 52
Neutron: 76
Spin:0

Te 130
Proton: 52
Neutron: 78
Spin:0



Iodine Nucleus

$s^2 d^{10} p^5$

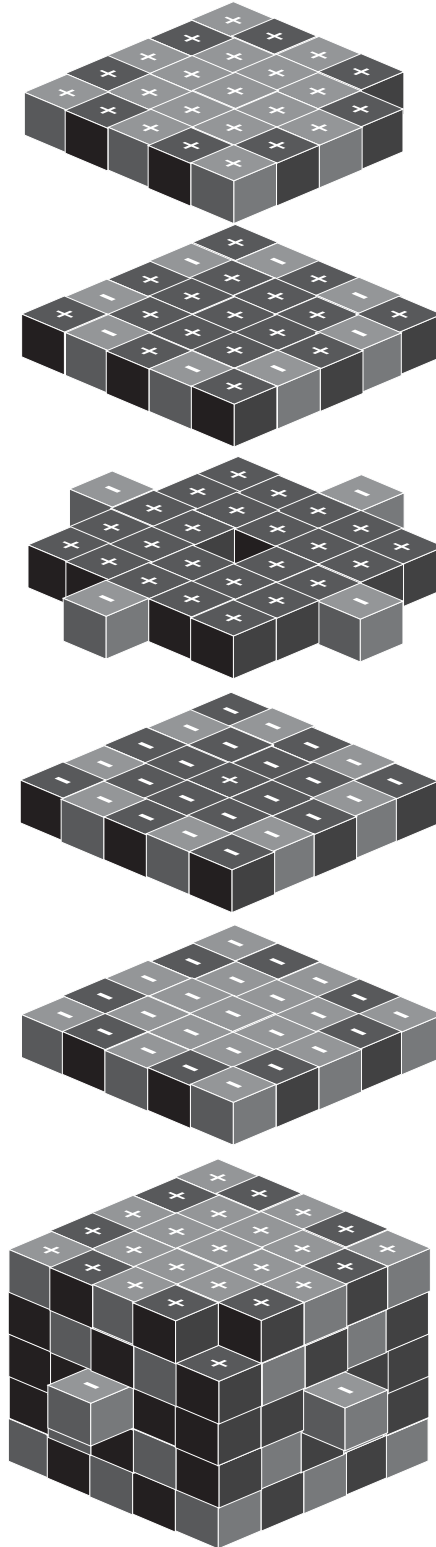
I 127

Proton: 53

Neutron: 74

Spin: 5/2

Stable



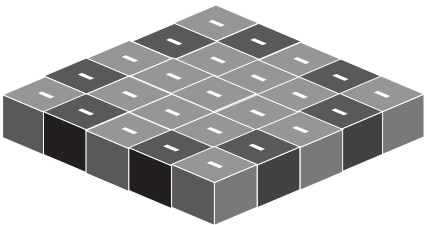
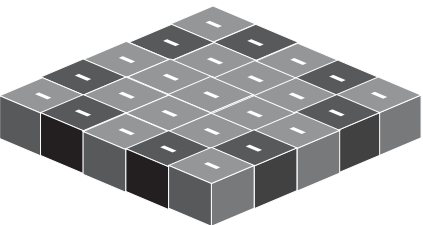
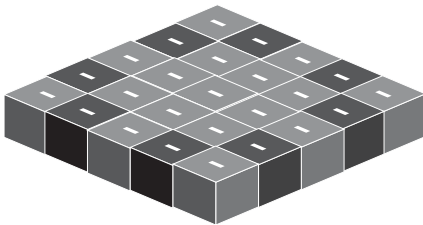
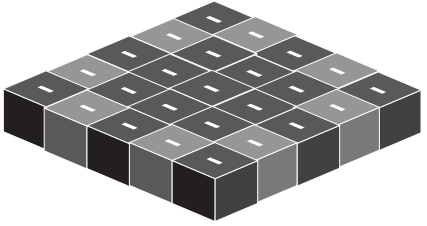
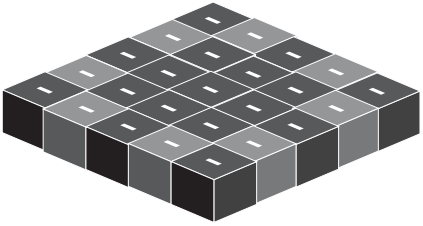
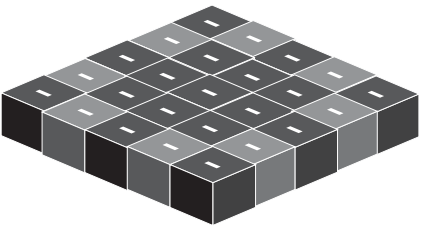
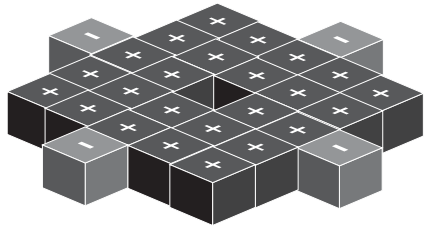
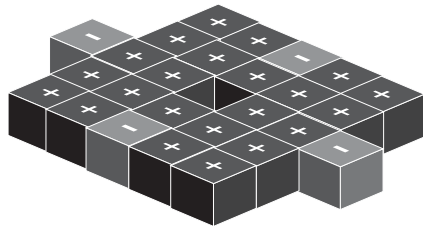
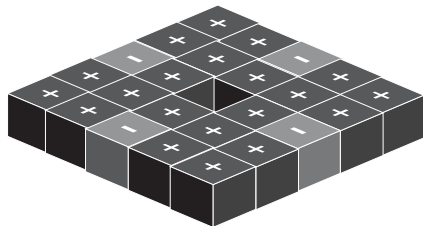
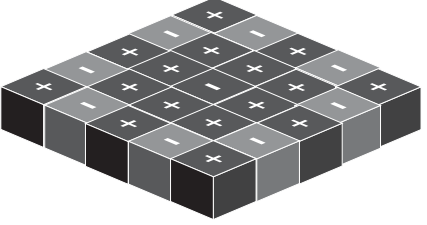
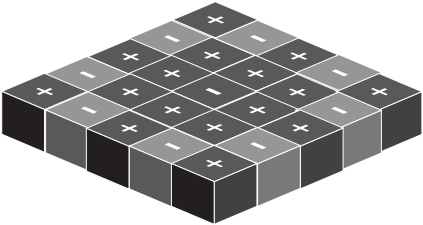
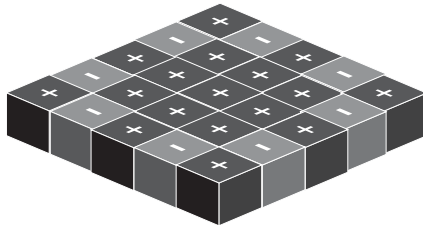
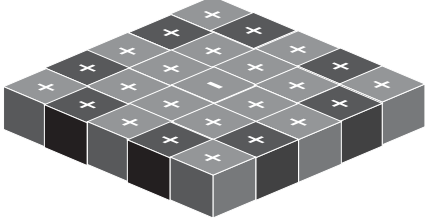
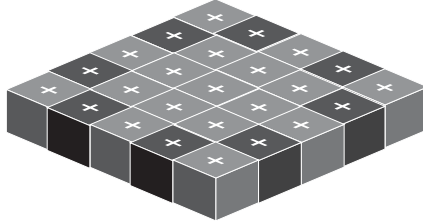
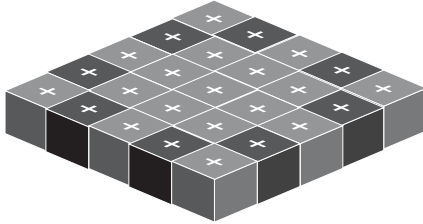
Xenon Nucleus

$$s^2 d^{10} p^6$$

Xe124
 Proton: 54
 Neutron: 70
 Spin:0
 Stable

Xe126
 Proton: 54
 Neutron: 72
 Spin:0
 Stable

Xe128
 Proton: 54
 Neutron: 74
 Spin:0
 Stable



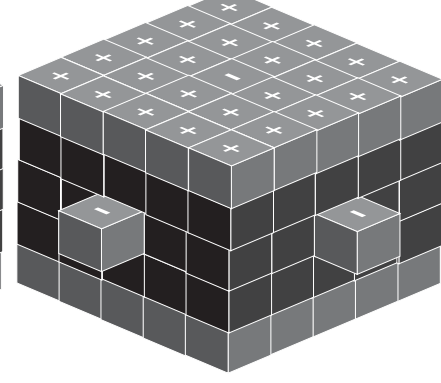
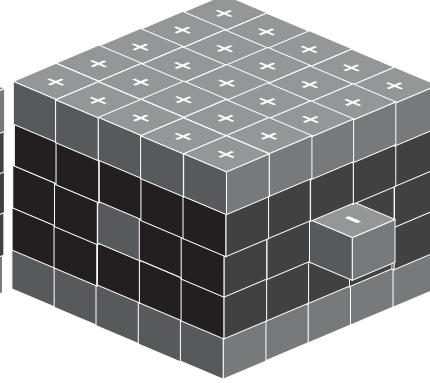
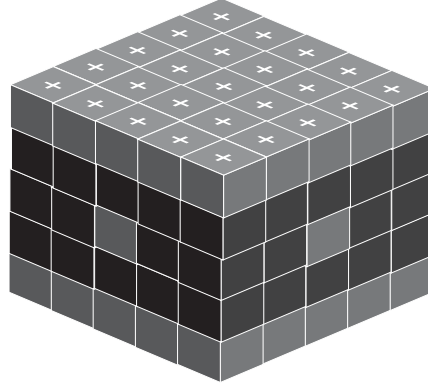
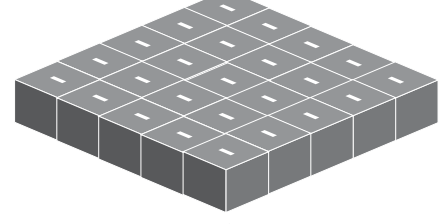
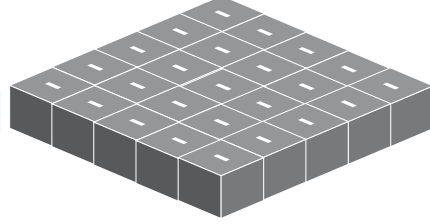
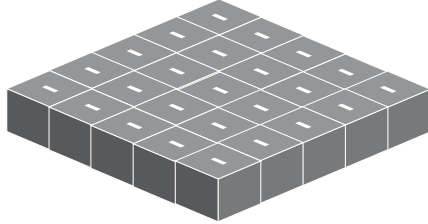
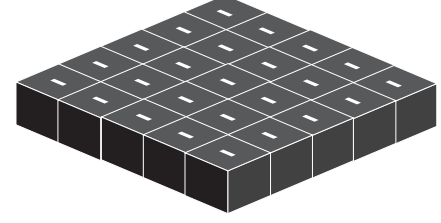
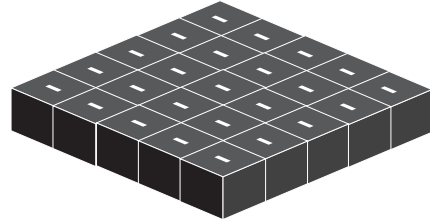
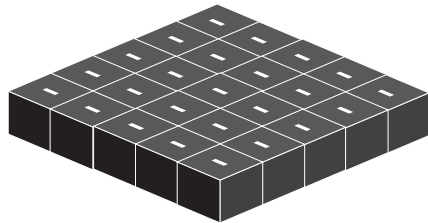
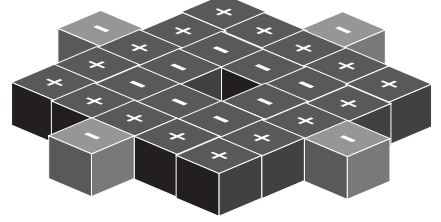
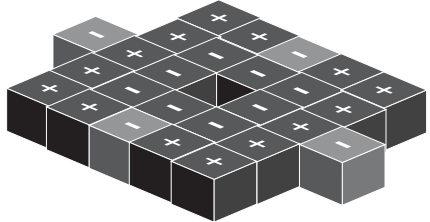
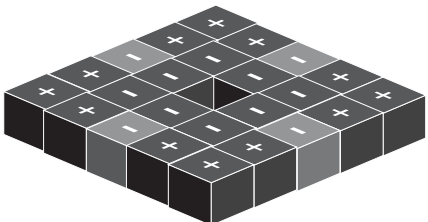
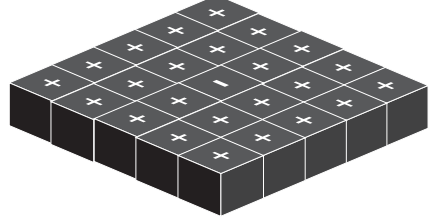
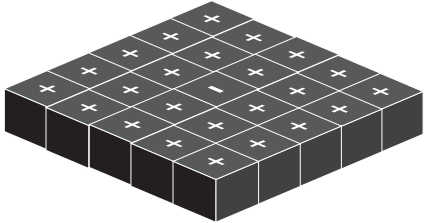
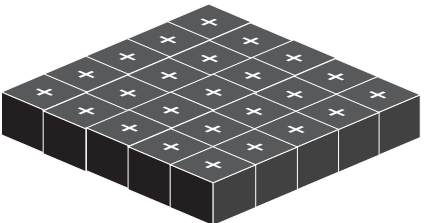
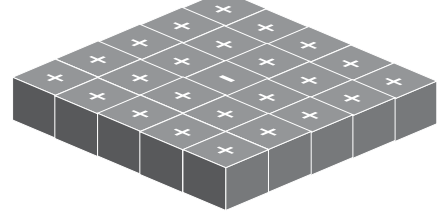
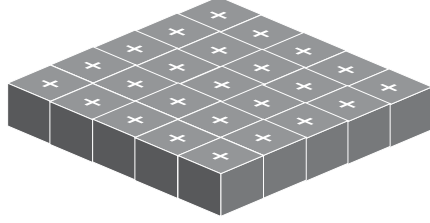
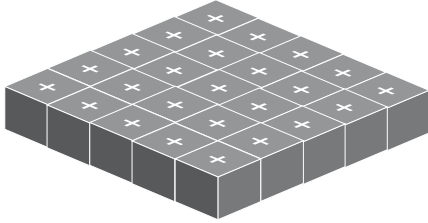
Xenon Nucleus

$$s^2 d^{10} p^6$$

Xe124
Proton: 54
Neutron: 70
Spin:0
Stable

Xe126
Proton: 54
Neutron: 72
Spin:0
Stable

Xe128
Proton: 54
Neutron: 74
Spin:0
Stable



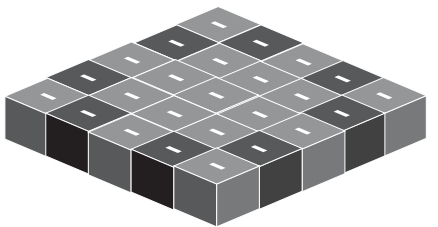
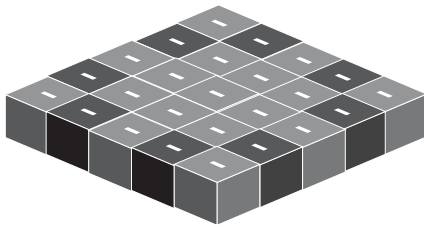
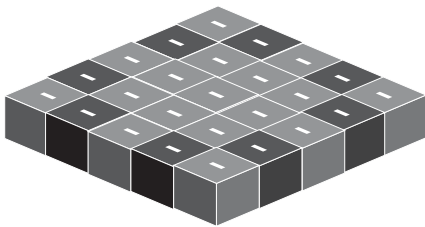
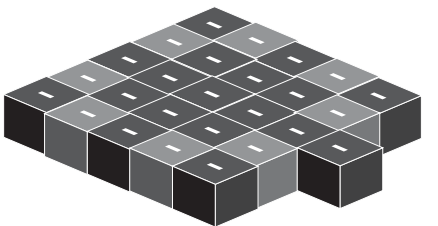
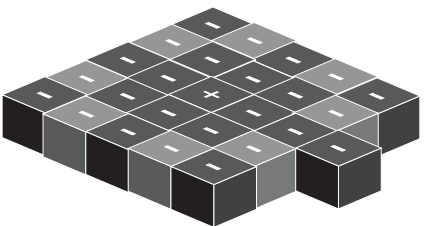
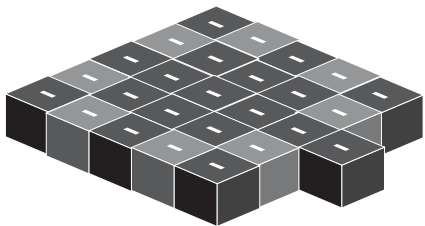
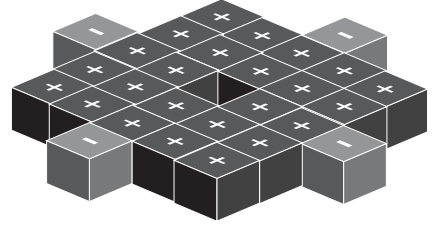
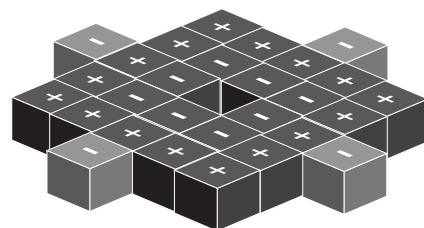
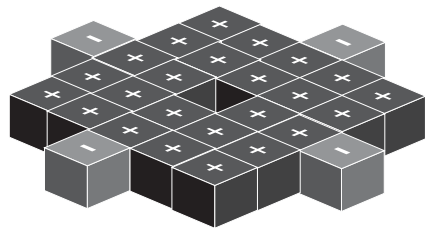
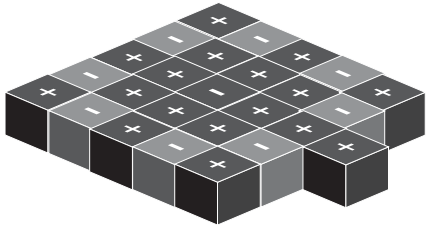
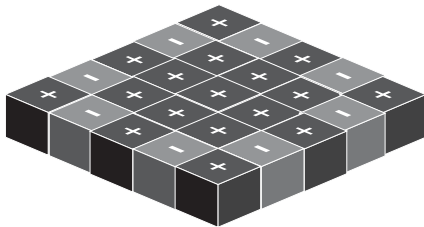
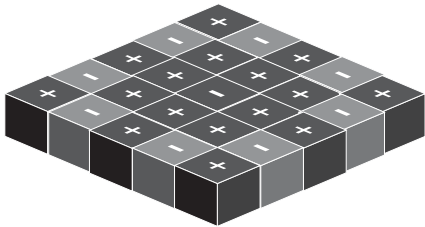
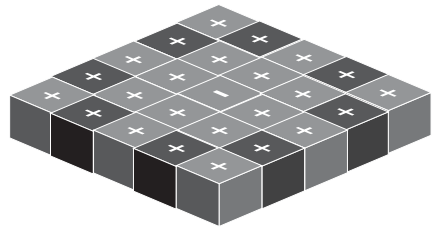
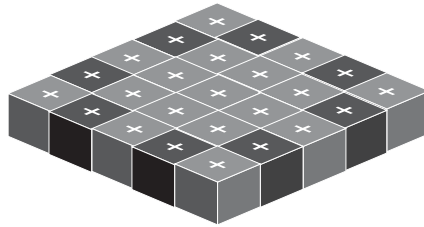
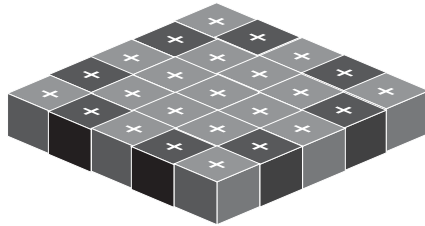
Xenon Nucleus

$$s^2 d^{10} p^6$$

Xe129
 Proton: 54
 Neutron: 75
 Spin: 1/2
 Stable

Xe129m
 Proton: 54
 Neutron: 75
 Spin: -11/2

Xe130
 Proton: 54
 Neutron: 76
 Spin: 0
 Stable



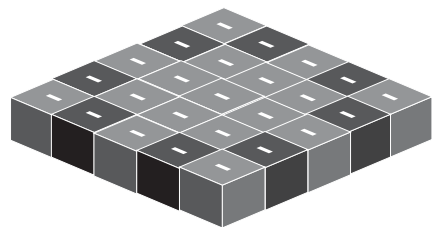
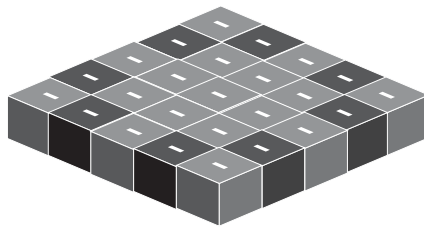
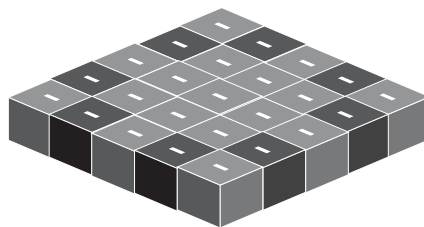
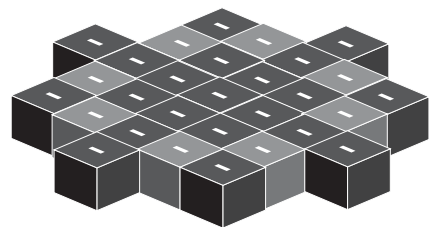
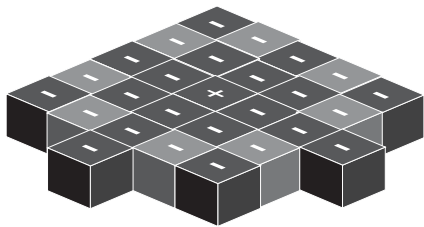
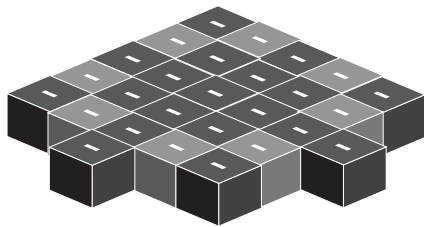
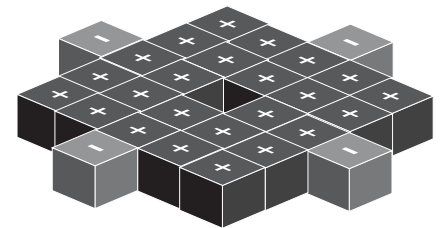
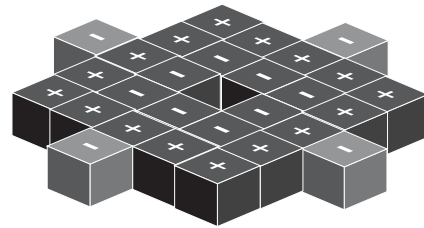
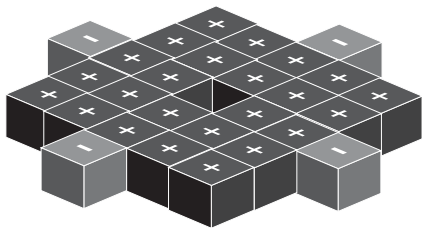
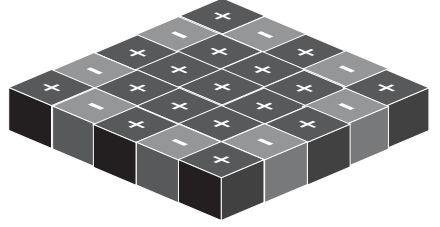
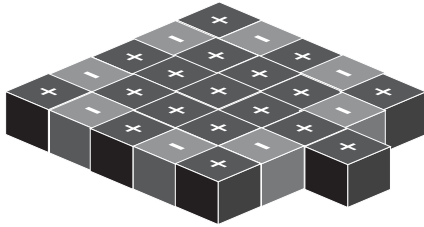
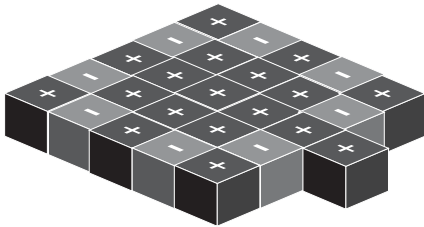
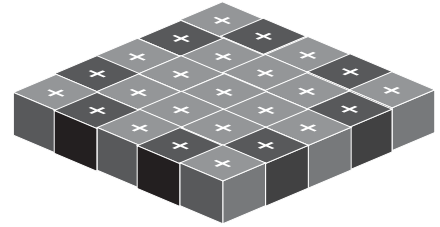
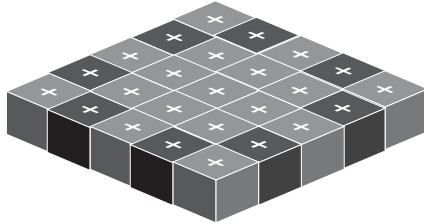
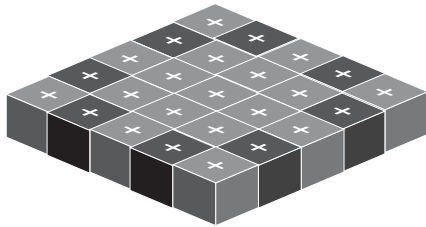
Xenon Nucleus

$$s^2 d^{10} p^6$$

Xe131
 Proton: 54
 Neutron: 77
 Spin: 3/2
 Stable

Xe131m
 Proton: 54
 Neutron: 77
 Spin: -11/2

Xe132
 Proton: 54
 Neutron: 78
 Spin: 0
 Stable

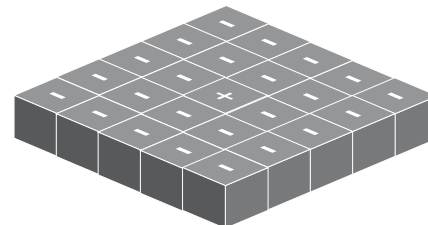
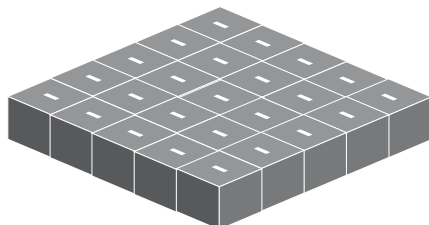
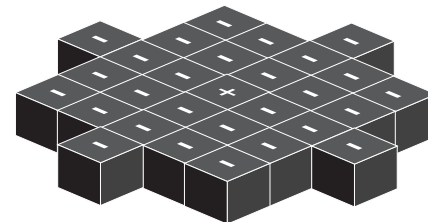
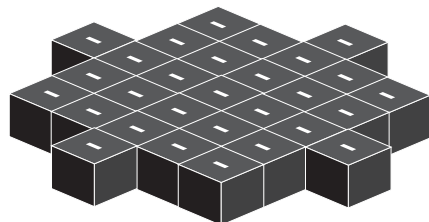
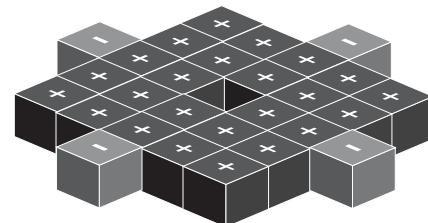
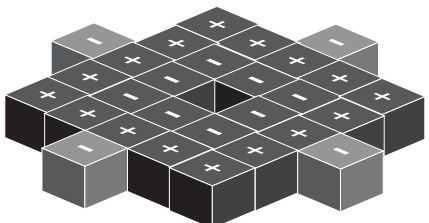
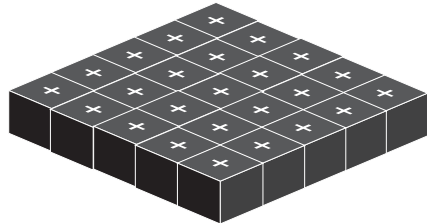
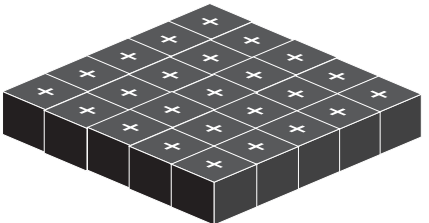
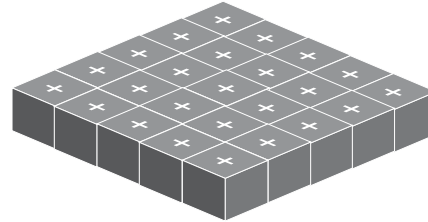
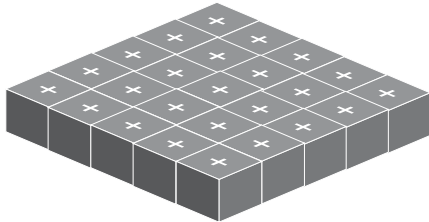


Xenon Nucleus

$$s^2 d^{10} p^6$$

Xe132
 Proton: 54
 Neutron: 78
 Spin:0
 Stable

Xe132m
 Proton: 54
 Neutron: 78
 Spin:10



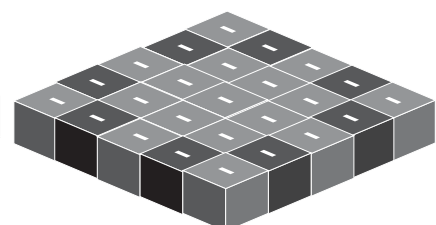
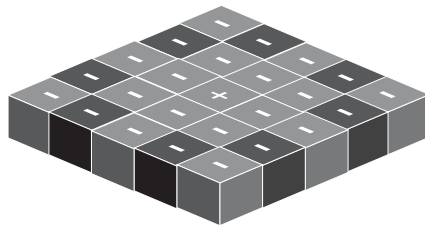
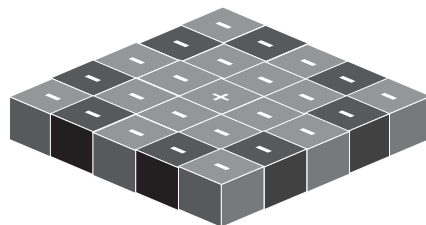
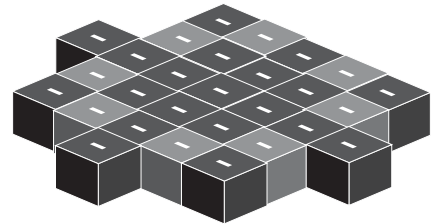
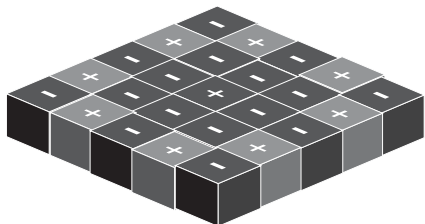
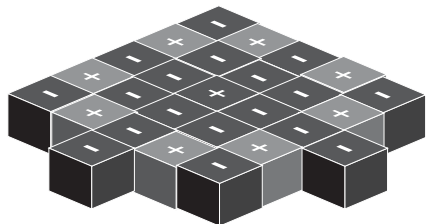
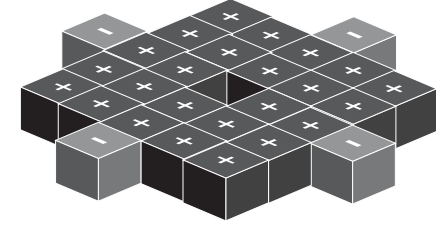
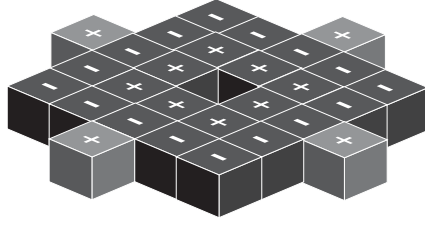
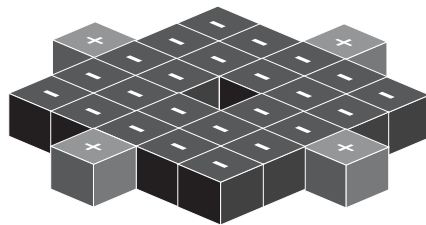
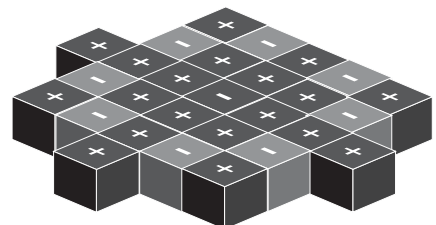
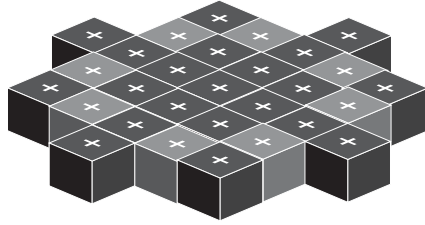
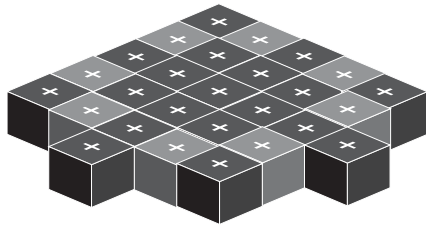
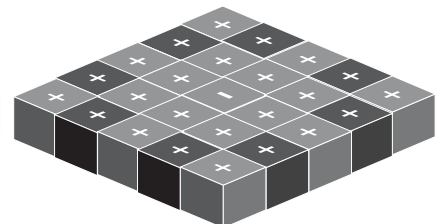
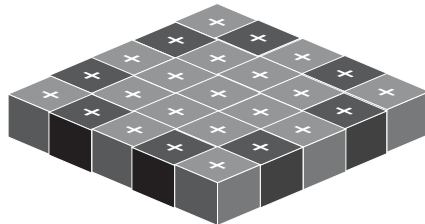
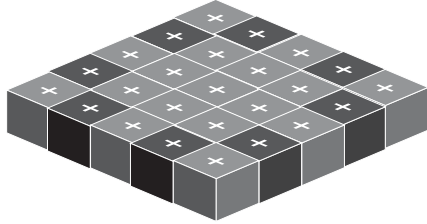
Xenon Nucleus

$$s^2 d^{10} p^6$$

Xe132
 Proton: 54
 Neutron: 78
 Spin:0
 Stable

Xe132m
 Proton: 54
 Neutron: 78
 Spin:10

Xe134
 Proton: 54
 Neutron: 80
 Spin:0
 Stable



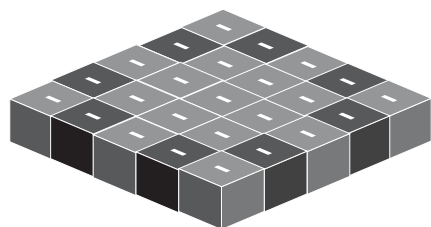
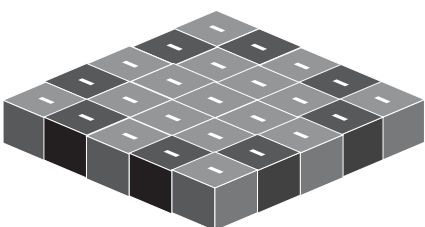
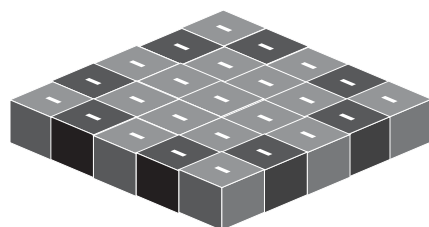
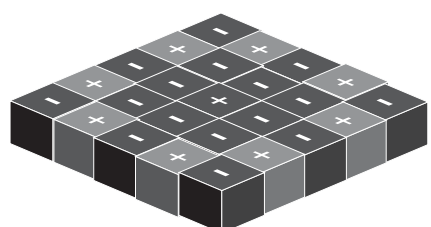
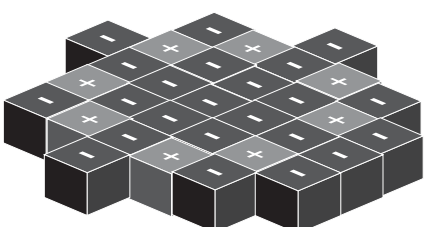
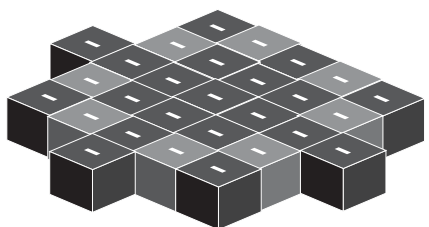
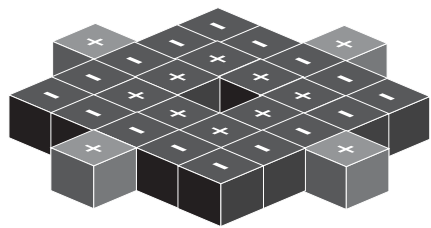
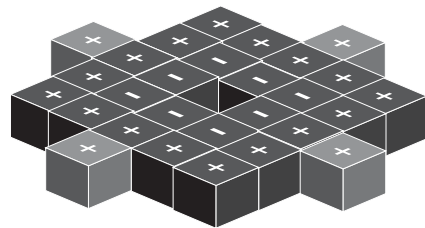
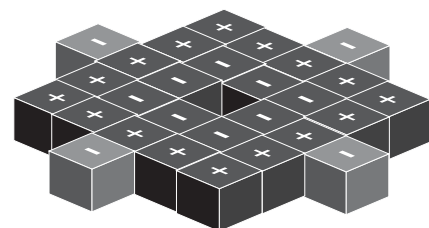
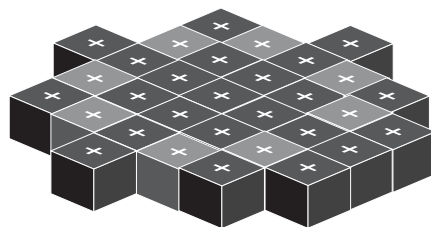
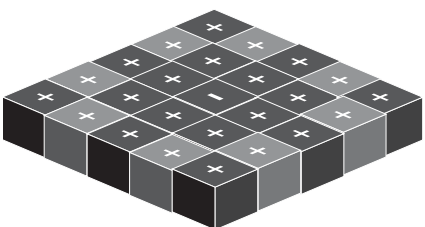
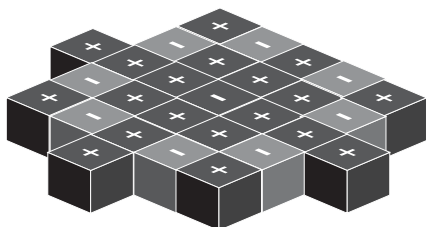
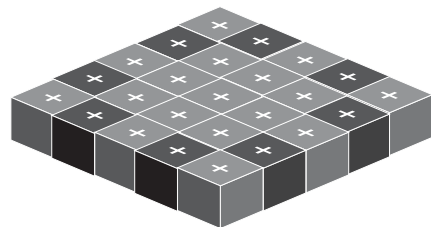
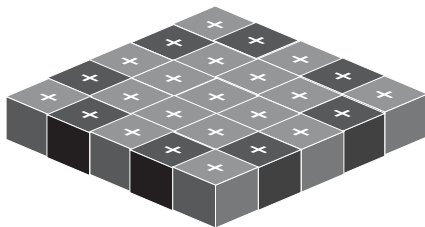
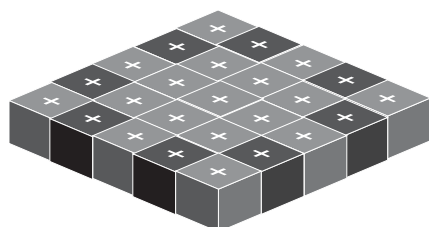
Xenon Nucleus

$$s^2 d^{10} p^6$$

Xe134m1
Proton: 54
Neutron: 80
Spin:-7

Xe134m2
Proton: 54
Neutron: 80
Spin:10

Xe134m2
Proton: 54
Neutron: 80
Spin:10



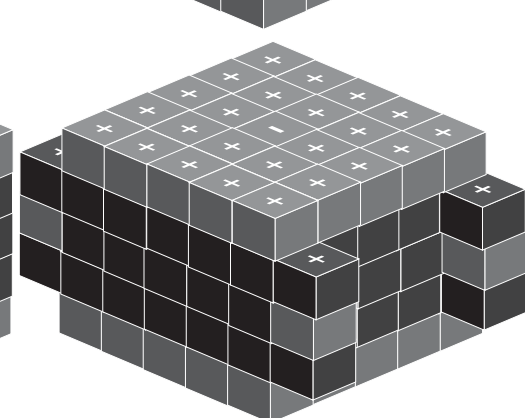
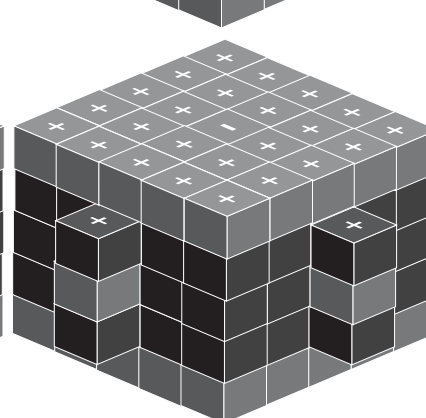
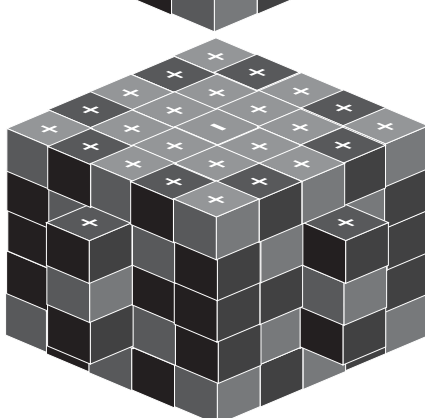
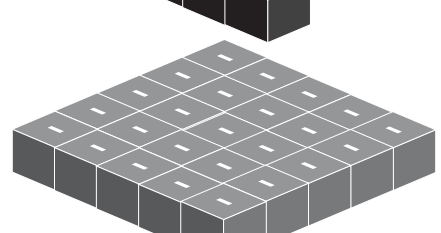
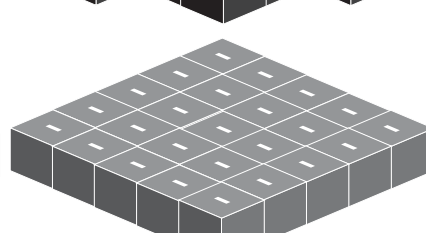
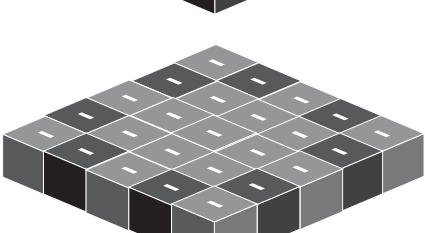
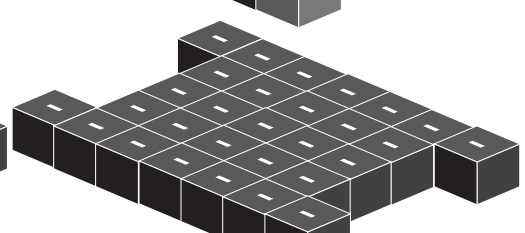
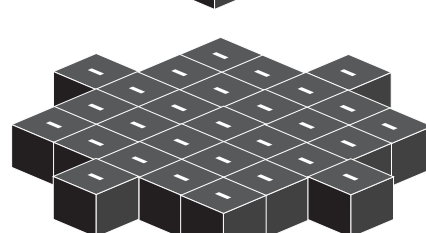
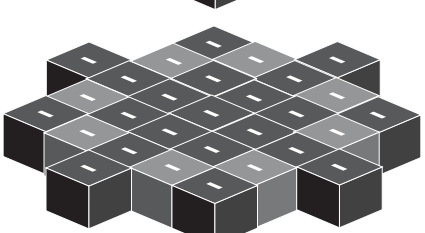
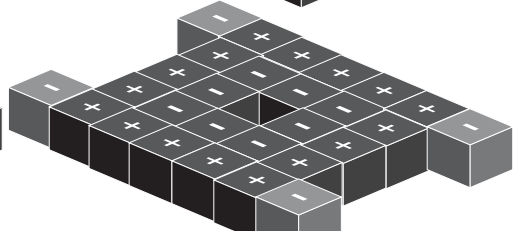
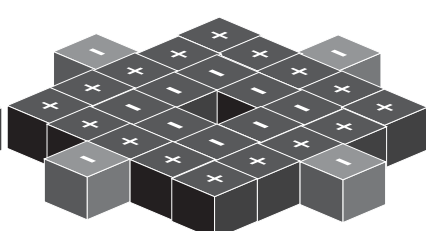
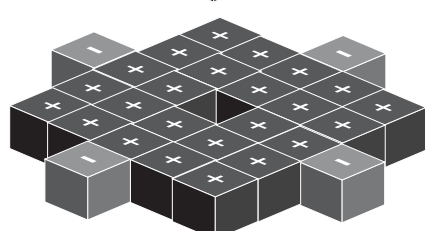
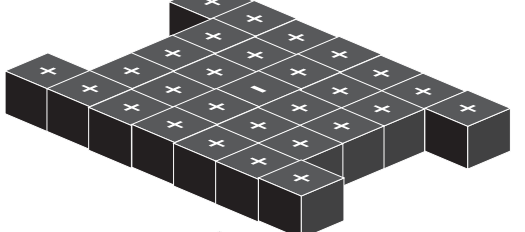
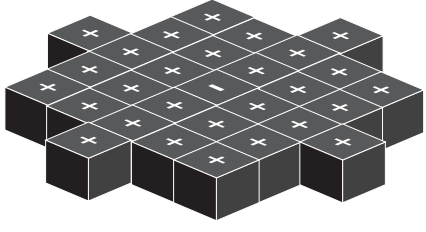
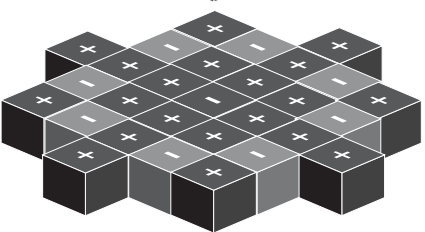
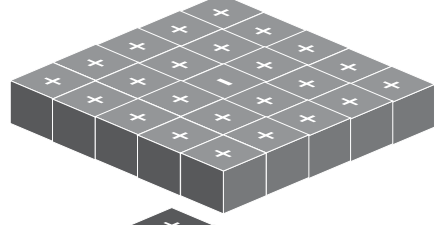
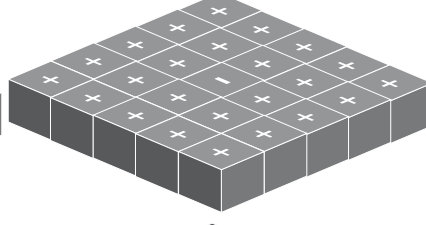
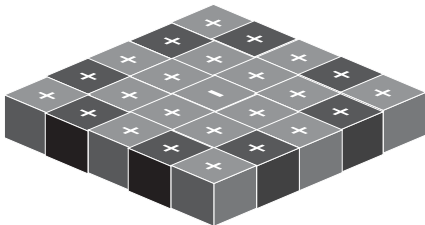
Xenon Nucleus

$$s^2 d^{10} p^6$$

Xe136
Proton: 54
Neutron: 82
Spin:0
Stable

Xe136
Proton: 54
Neutron: 82
Spin:0
Stable

Xe136
Proton: 54
Neutron: 82
Spin:0
Stable

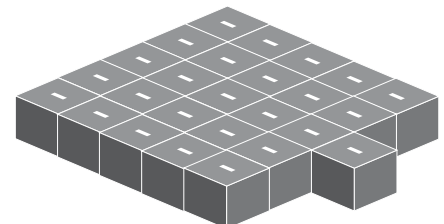
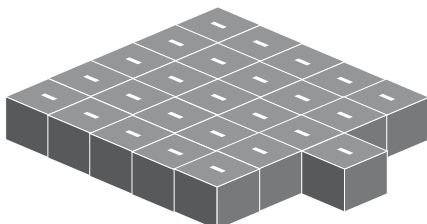
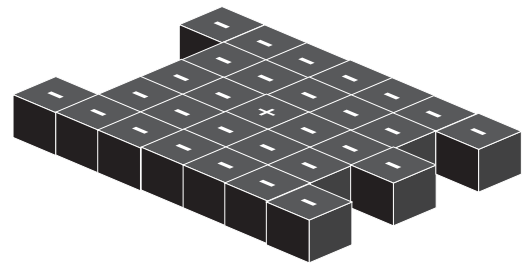
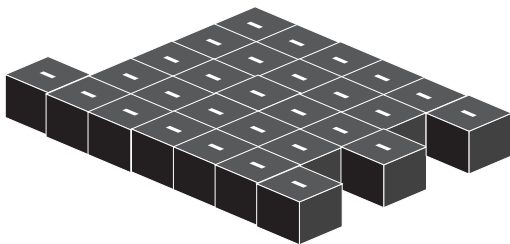
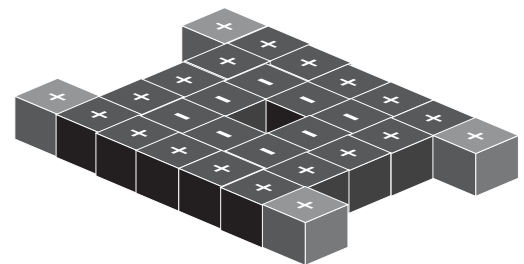
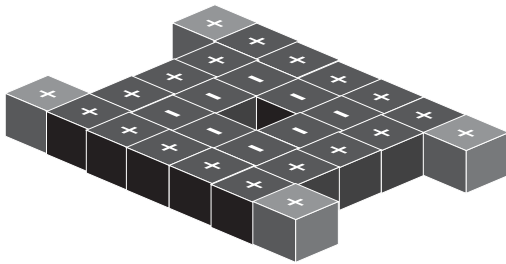
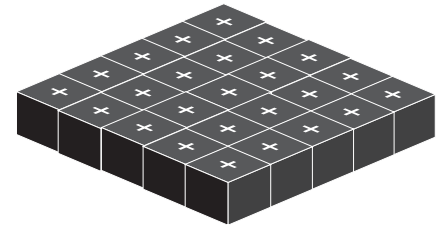
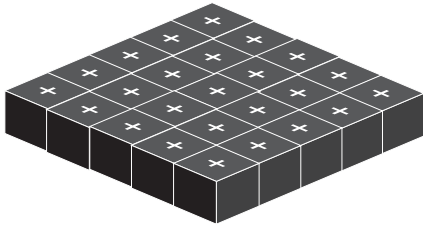
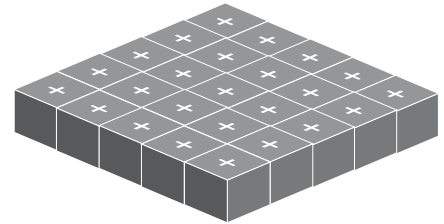
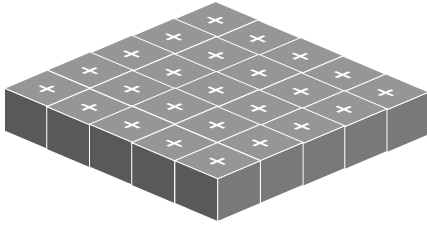


Caesium Nucleus

s^1

Cs 133
Proton: 55
Neutron: 78
Spin: $7/2$
Stable

Cs 134
Proton: 55
Neutron: 79
Spin: 4

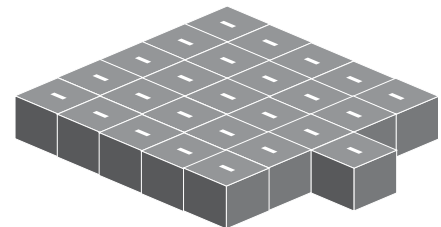
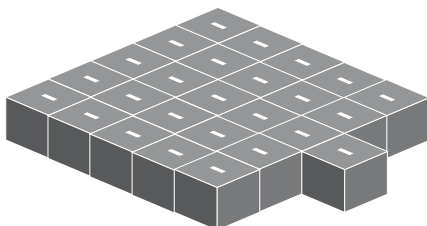
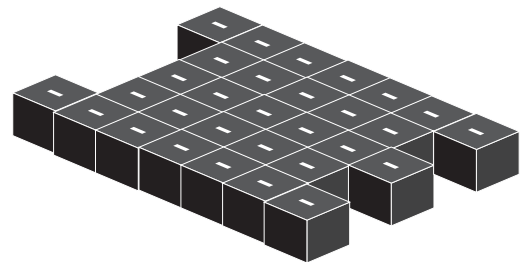
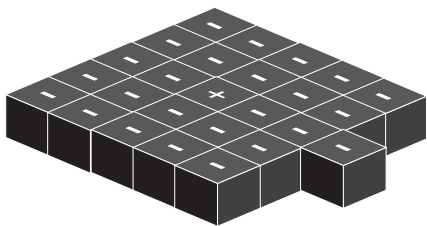
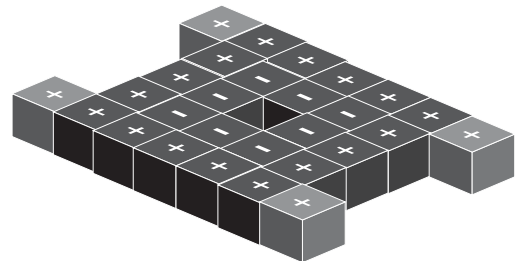
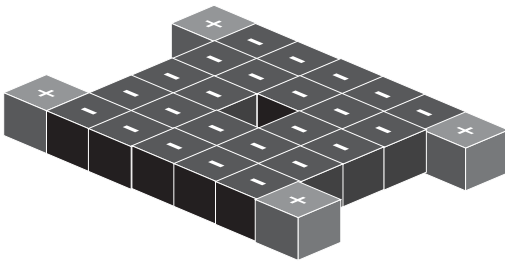
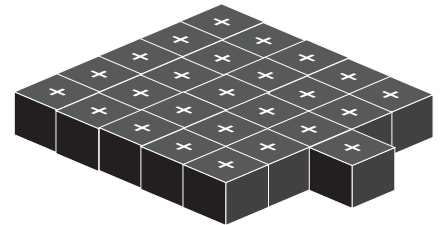
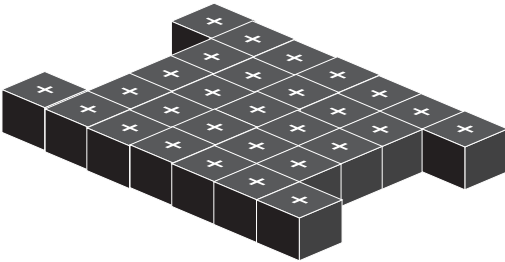
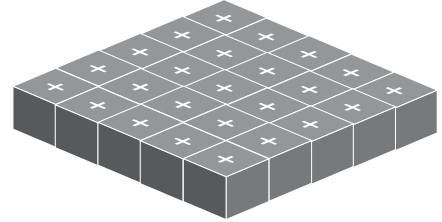
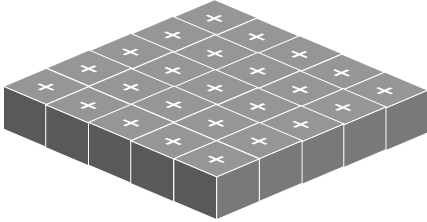


Caesium Nucleus

s^1

Cs 134m
 Proton: 55
 Neutron: 79
 Spin: -8

Cs 135
 Proton: 55
 Neutron: 80
 Spin: 7/2

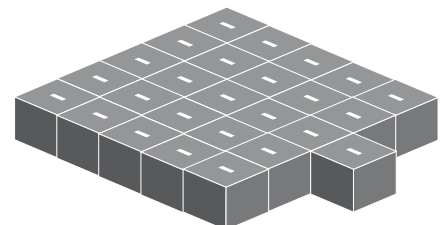
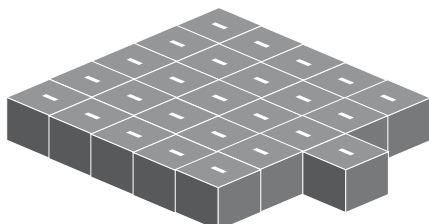
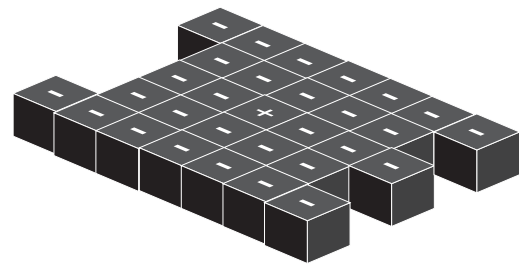
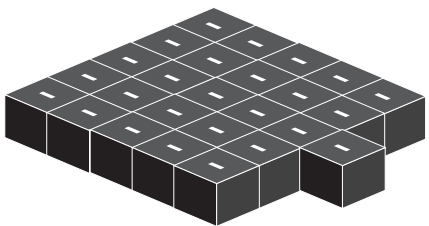
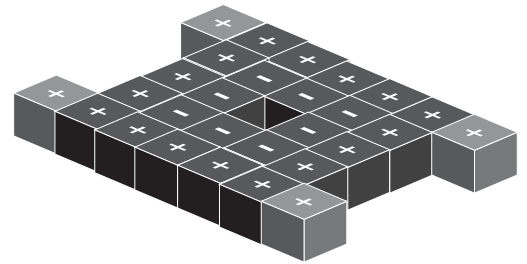
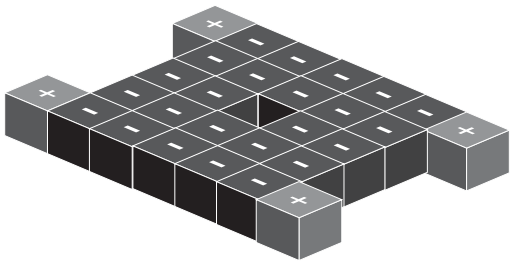
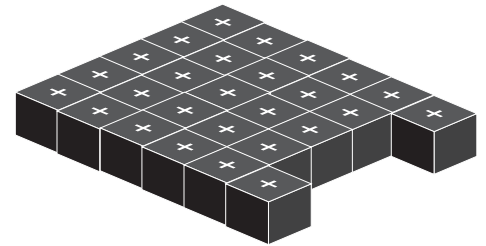
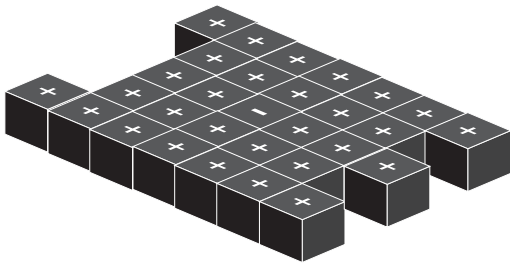
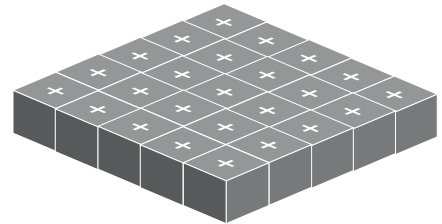
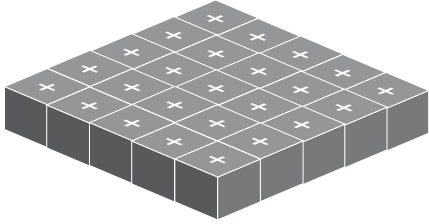


Caesium Nucleus

s^1

Cs 135m
Proton: 55
Neutron: 80
Spin: $-19/2$

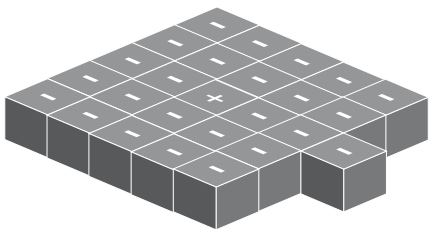
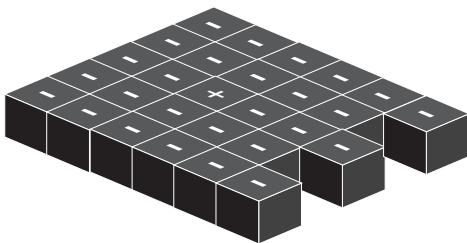
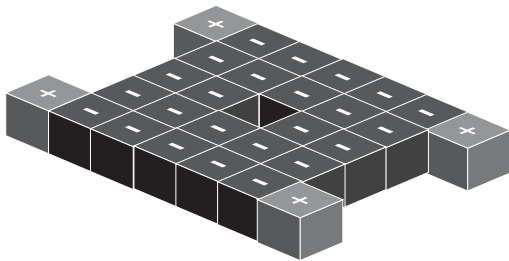
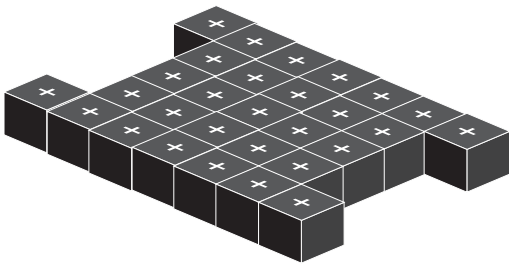
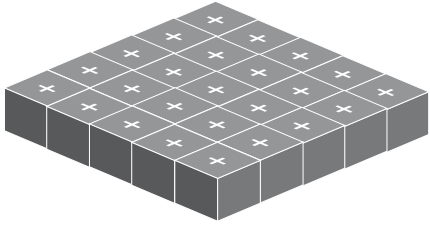
Cs 136
Proton: 55
Neutron: 81
Spin: 5



Caesium Nucleus

s^1

Cs 136m
Proton: 55
Neutron: 81
Spin: -8

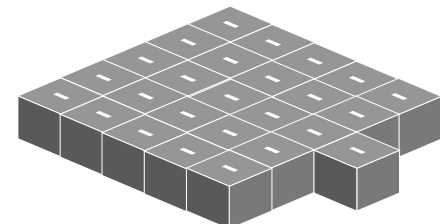
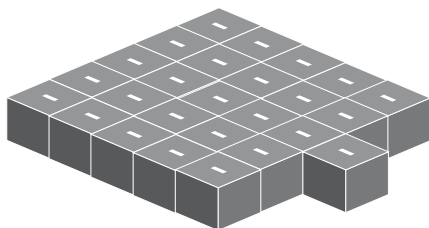
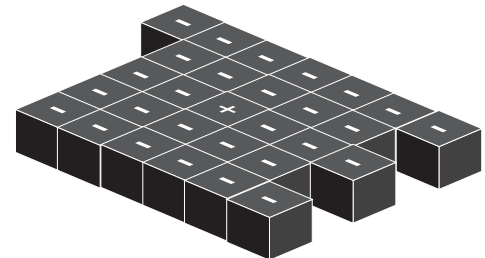
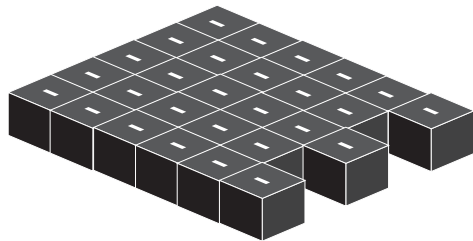
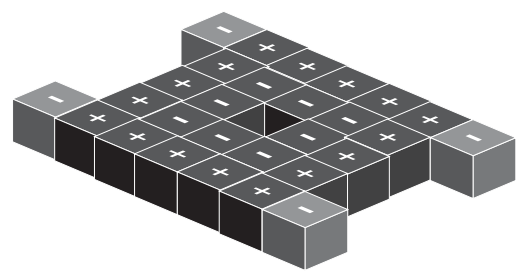
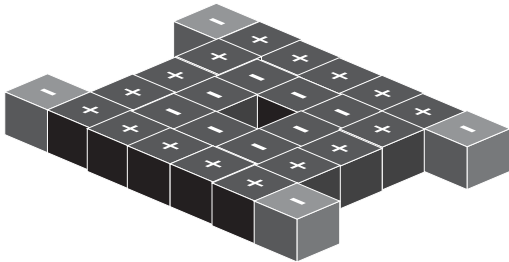
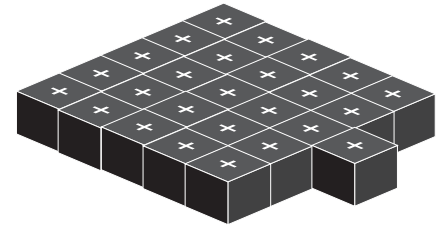
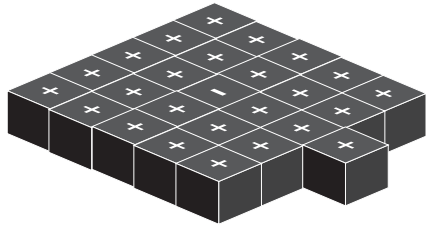
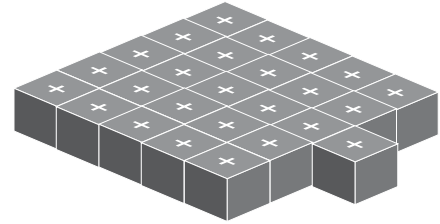
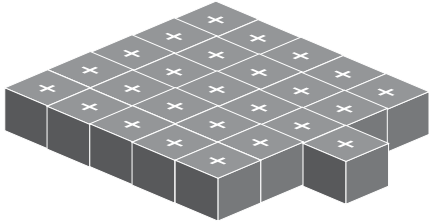


Barium Nucleus

s^2

Ba134
Proton: 56
Neutron: 78
Spin:0
Stable

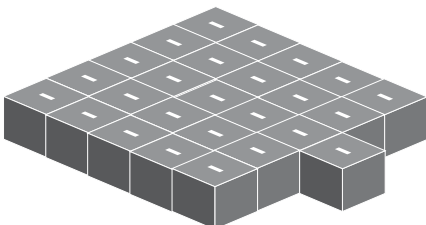
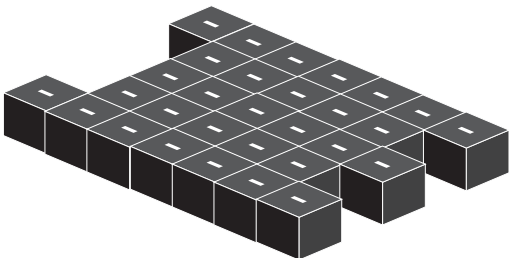
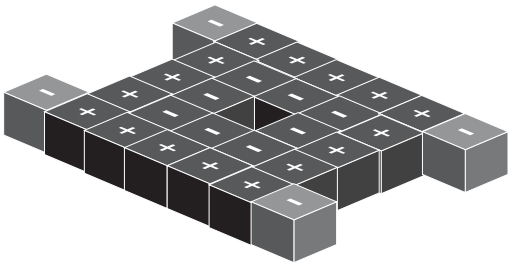
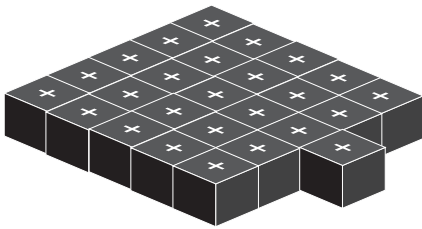
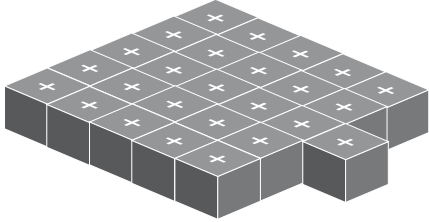
Ba135
Proton: 56
Neutron: 79
Spin:3/2
Stable



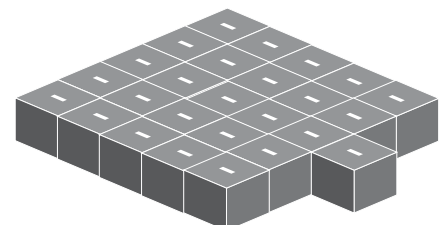
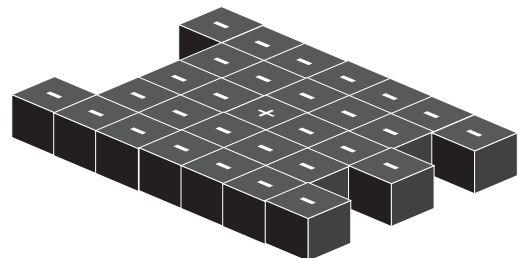
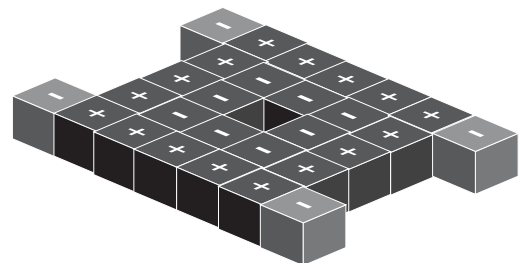
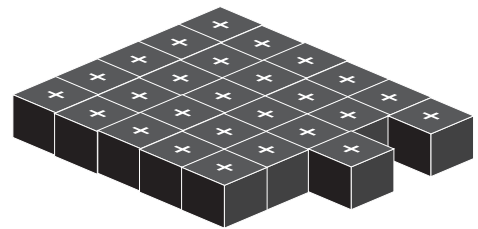
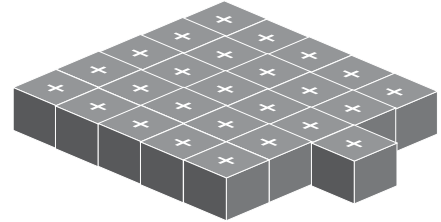
Barium Nucleus

s^2

Ba136
Proton: 56
Neutron: 80
Spin:0
Stable



Ba137
Proton: 56
Neutron: 81
Spin:3/2
Stable

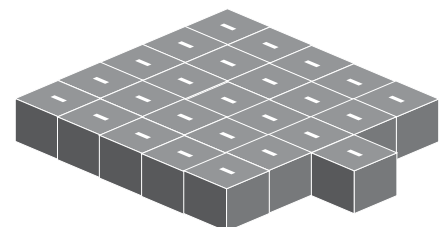
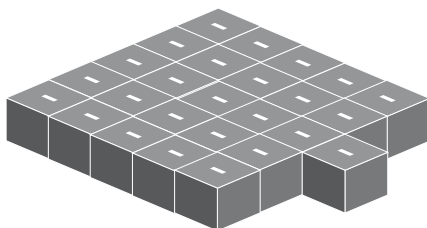
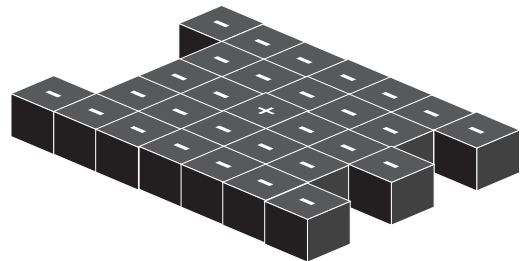
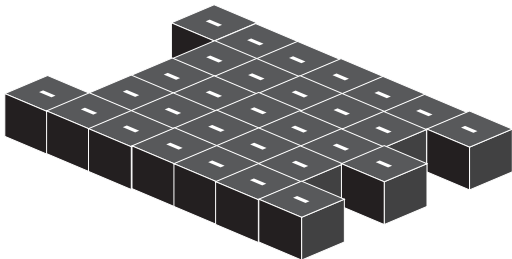
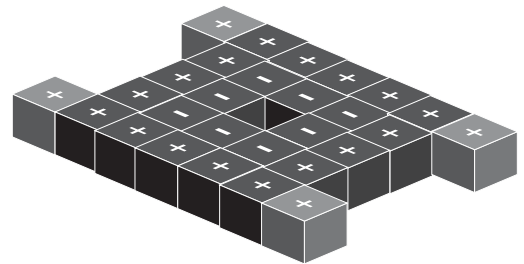
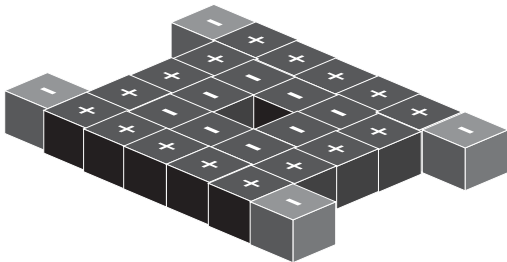
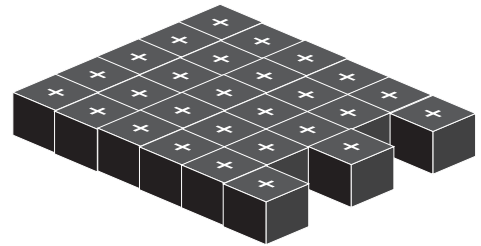
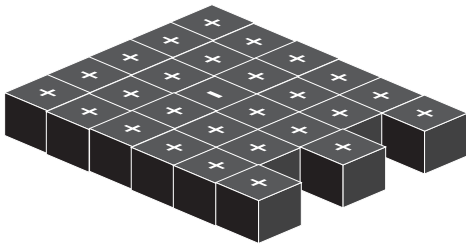
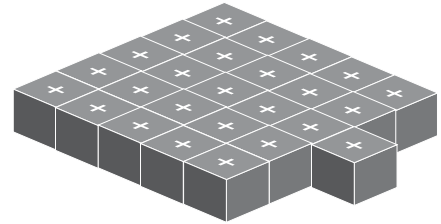
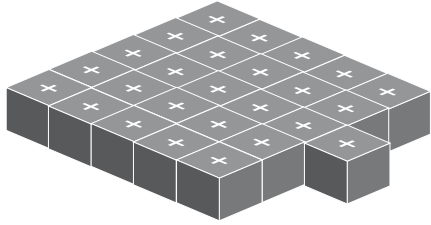


Barium Nucleus

s^2

Ba138
 Proton: 56
 Neutron: 82
 Spin:0
 Stable

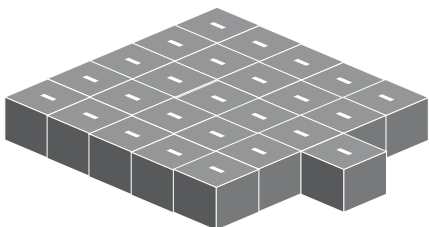
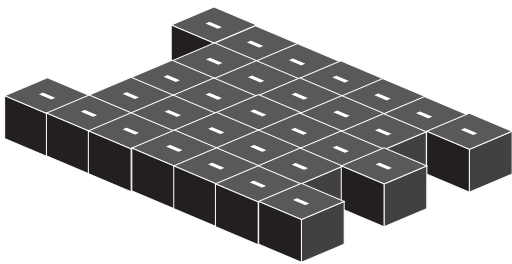
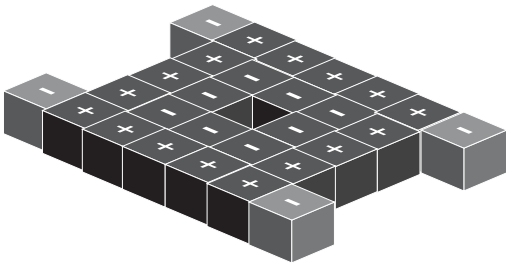
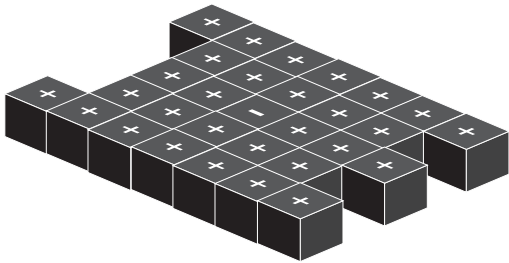
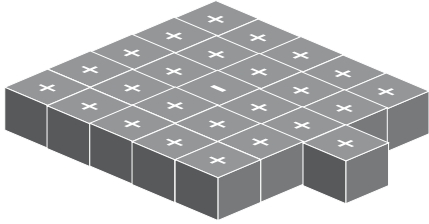
Ba138m
 Proton: 56
 Neutron: 82
 Spin:6



Barium Nucleus

s^2

Ba140
Proton: 56
Neutron: 84
Spin:0

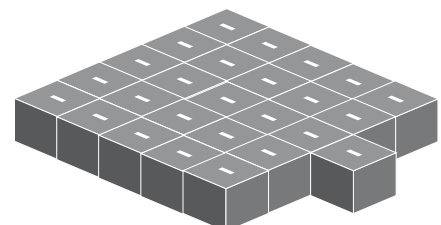
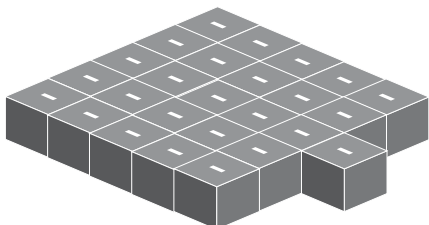
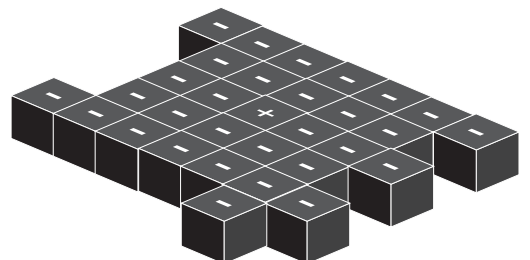
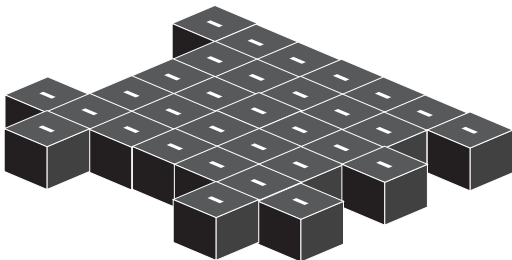
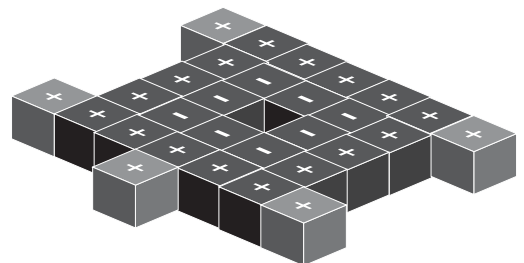
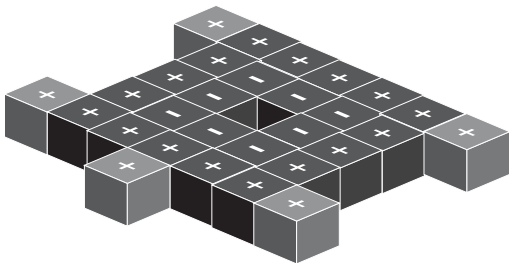
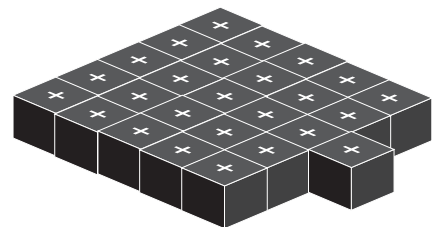
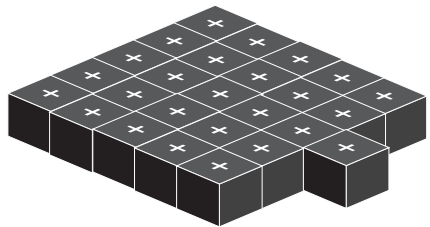
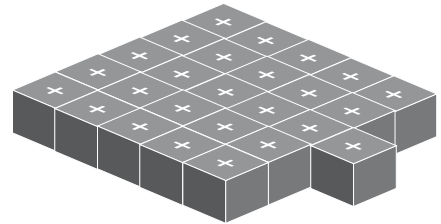
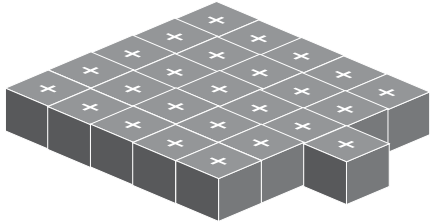


Lanthanum Nucleus

$s^2 d^1$

La137
Proton: 57
Neutron: 80
Spin: 7/2

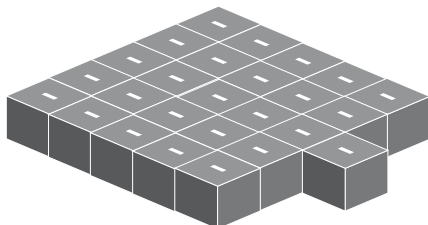
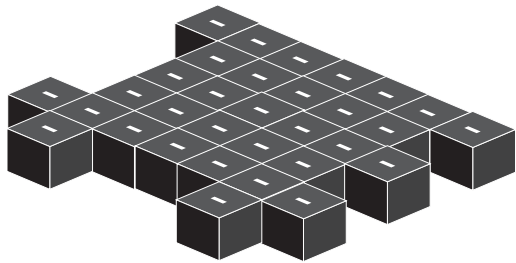
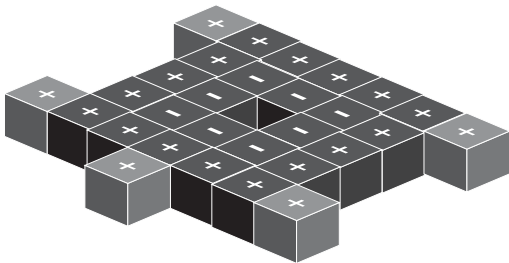
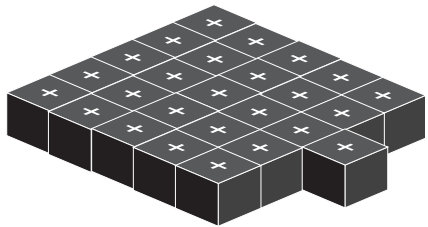
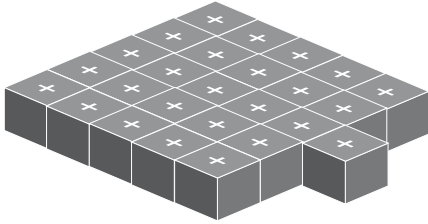
La138
Proton: 57
Neutron: 81
Spin: 5



Lanthanum Nucleus

$s^2 d^1$

La139
Proton: 57
Neutron: 82
Spin: 7/2
Stable

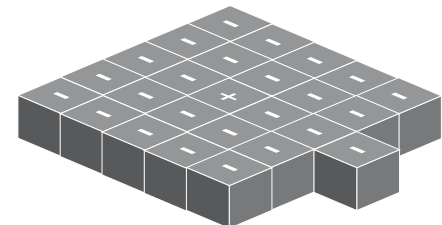
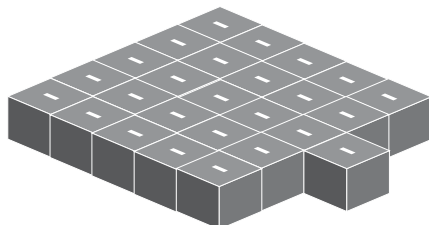
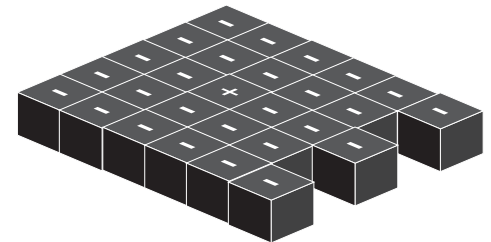
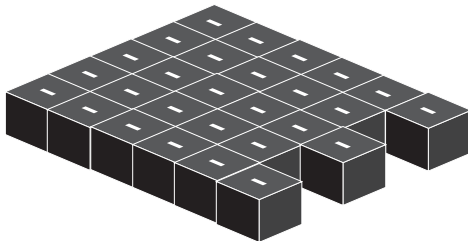
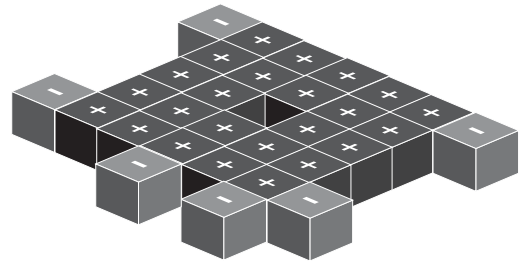
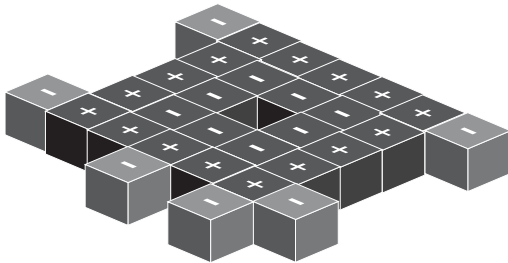
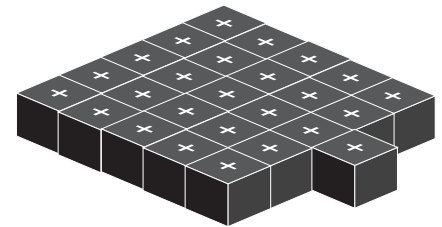
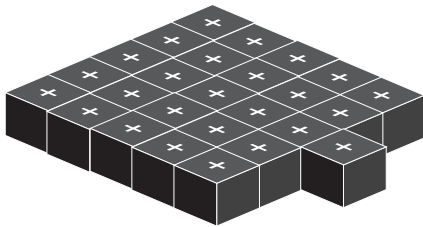
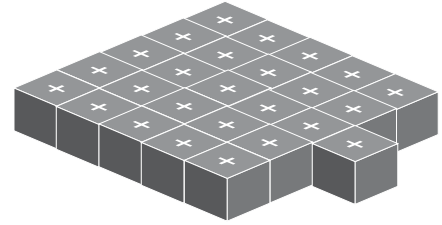
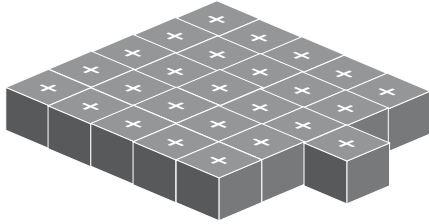


Cerium Nucleus

$s^2 f^1 d^1$

Ce 136
 Proton: 58
 Neutron: 78
 Spin:0
 Stable

Ce 136m
 Proton: 58
 Neutron: 78
 Spin:10

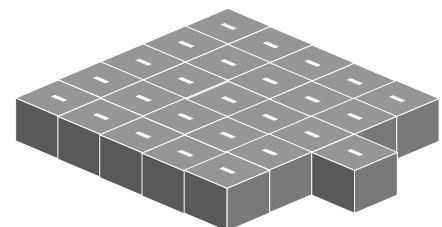
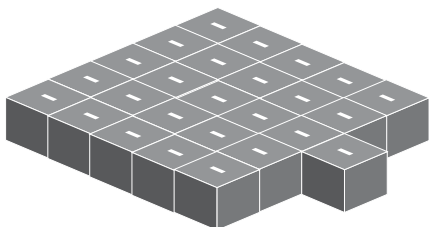
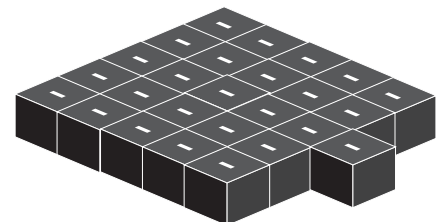
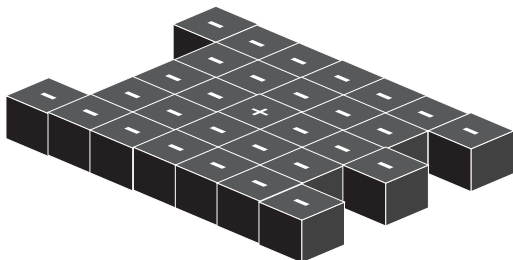
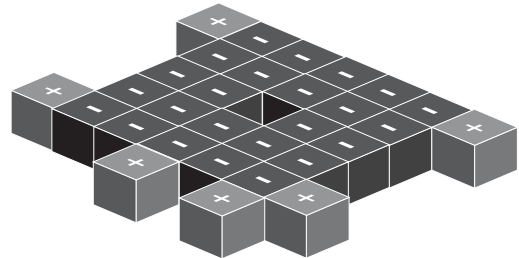
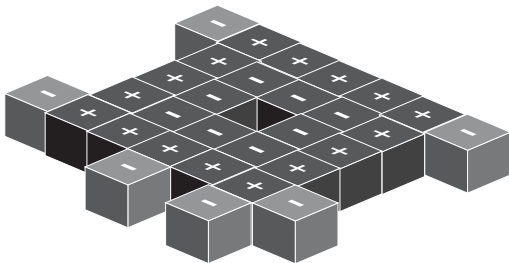
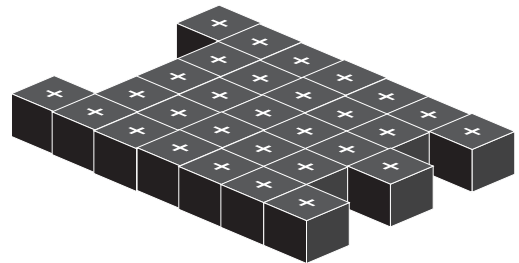
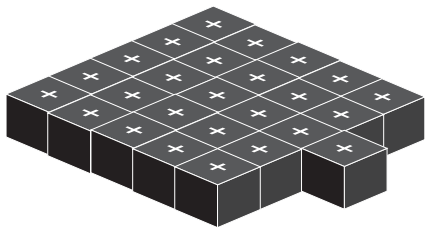
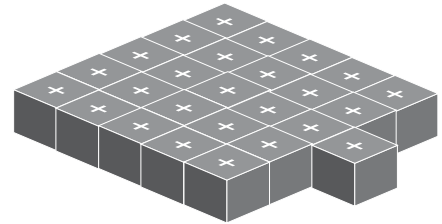
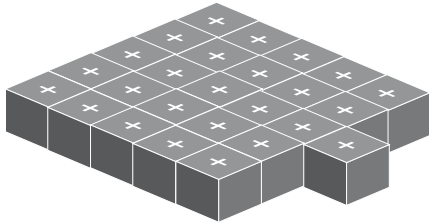


Cerium Nucleus

$s^2 f^1 d^1$

Ce 138
 Proton: 58
 Neutron: 80
 Spin:0
 Stable

Ce 138m
 Proton: 58
 Neutron: 80
 Spin:-7

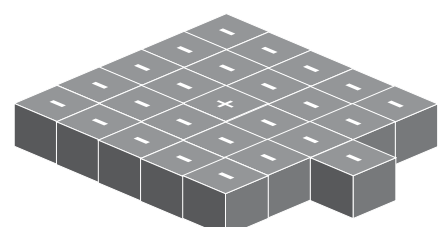
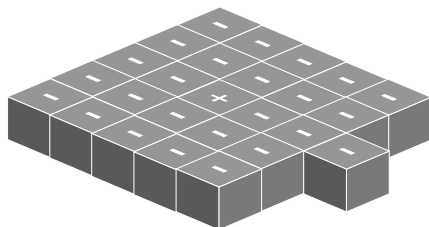
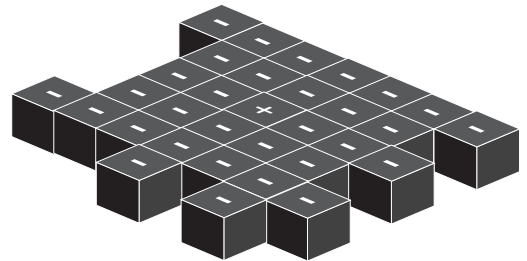
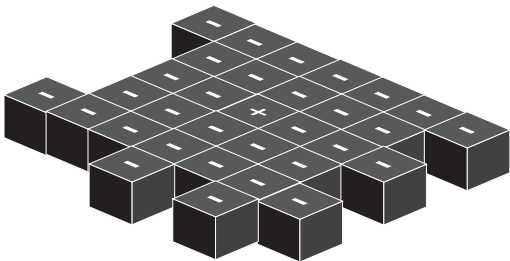
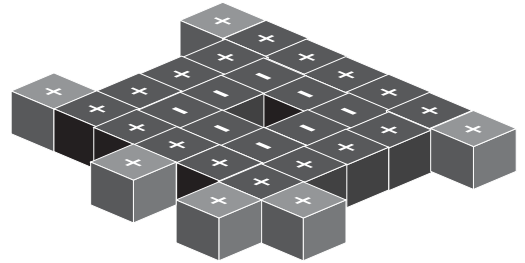
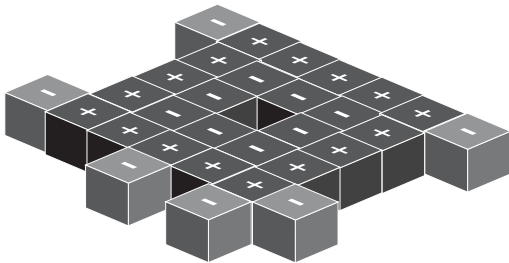
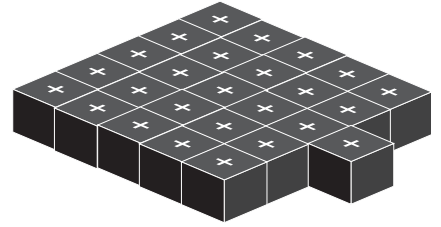
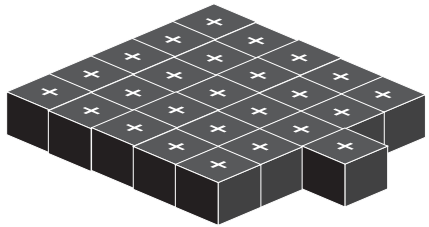
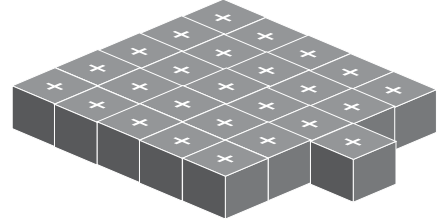
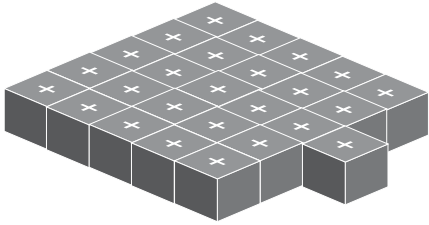


Cerium Nucleus

$s^2 f^1 d^1$

Ce 140
Proton: 58
Neutron: 82
Spin:0
Stable

Ce 140m
Proton: 58
Neutron: 82
Spin:6

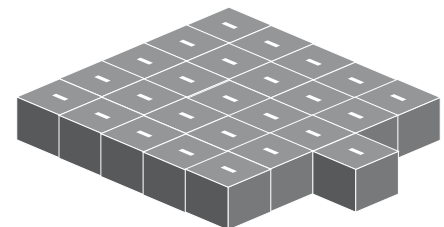
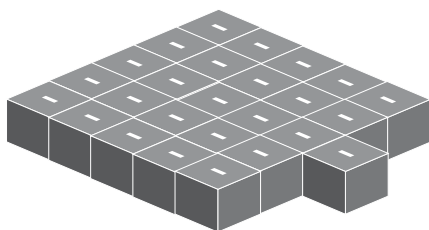
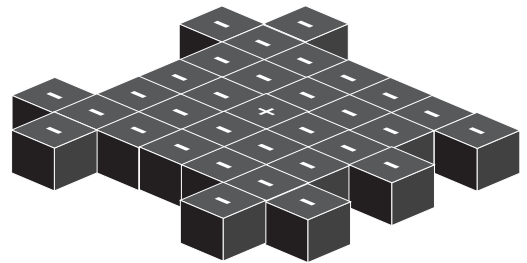
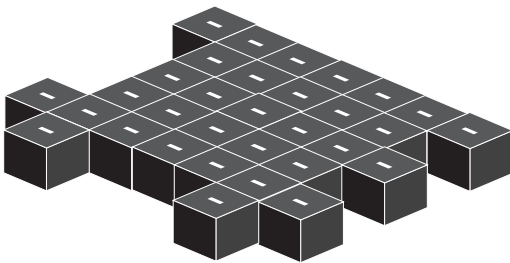
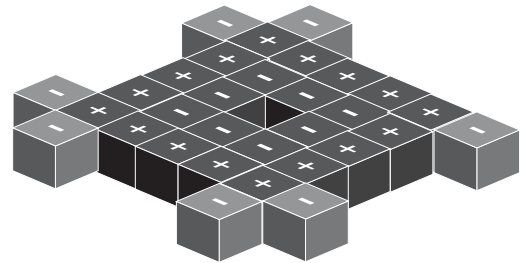
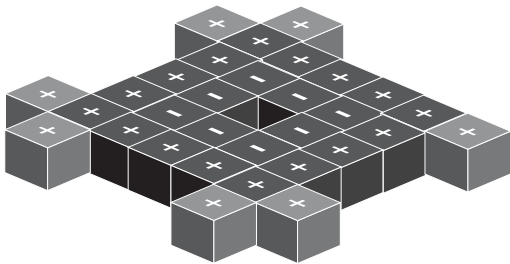
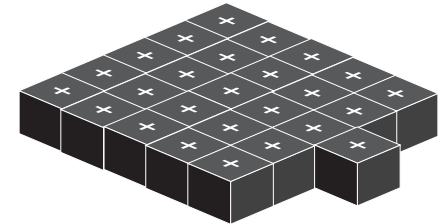
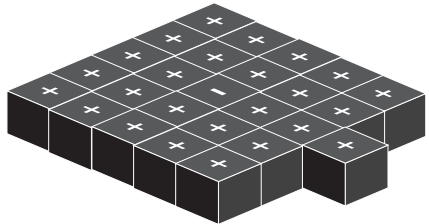
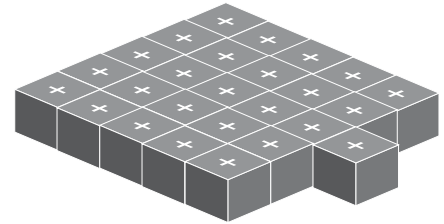
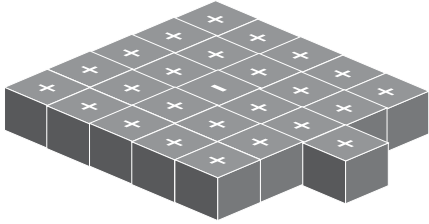


Praseodymium Nucleus

$$s^2 f^3$$

Pr 141
 Proton: 59
 Neutron: 82
 Spin: 5/2
 Stable

Pr 142
 Proton: 59
 Neutron: 83
 Spin: -2

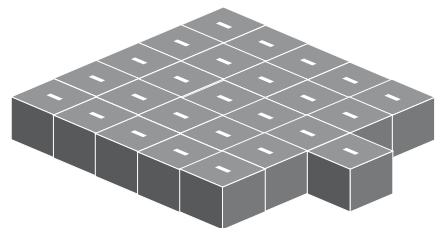
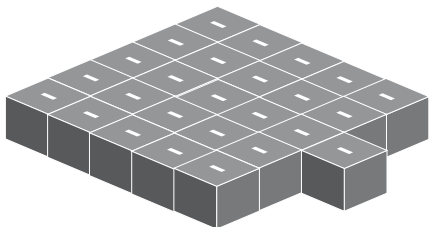
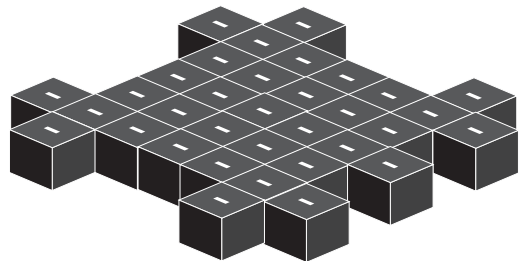
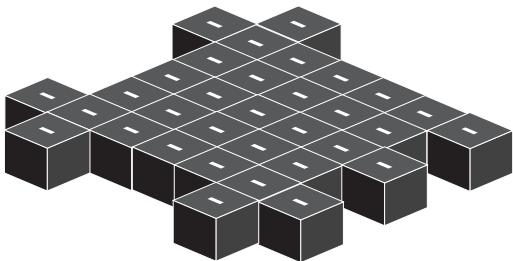
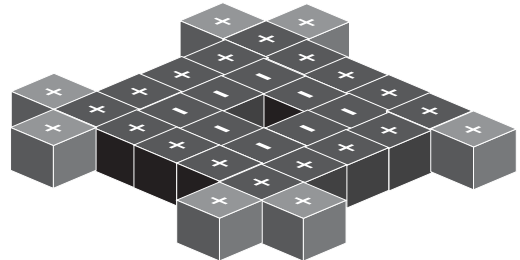
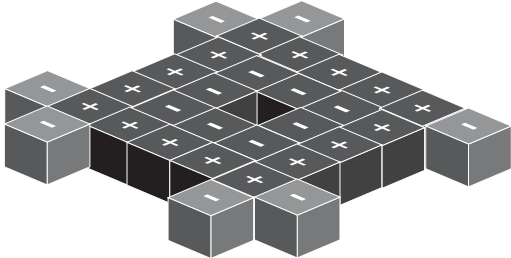
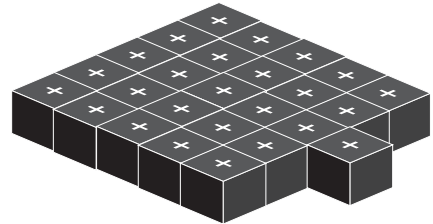
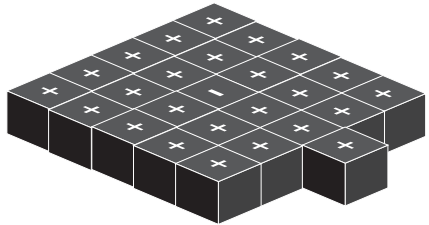
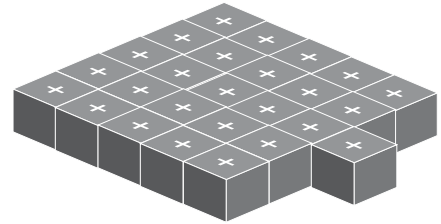
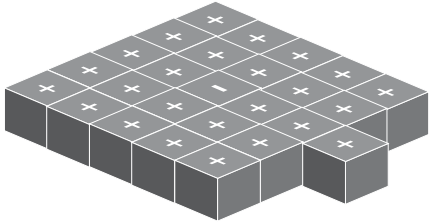


Praseodymium Nucleus

$$s^2 f^3$$

Pr 142m
 Proton: 59
 Neutron: 83
 Spin: -5

Pr 143
 Proton: 59
 Neutron: 84
 Spin: 7/2

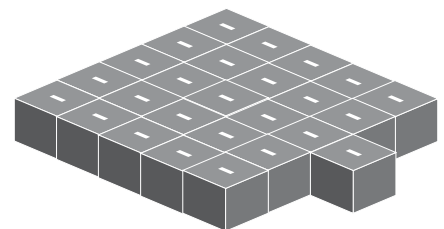
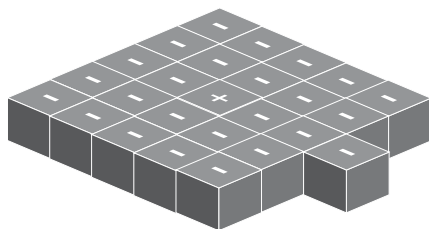
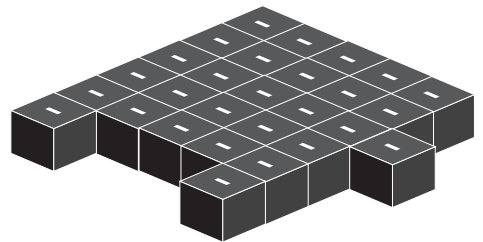
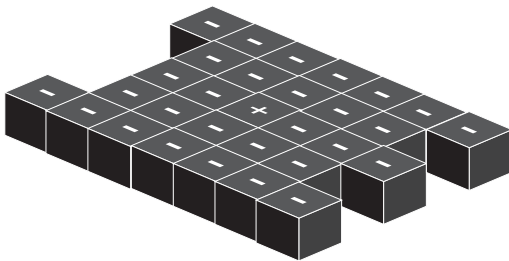
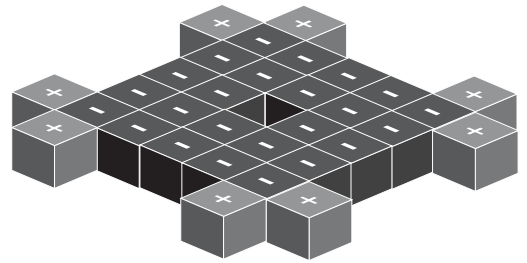
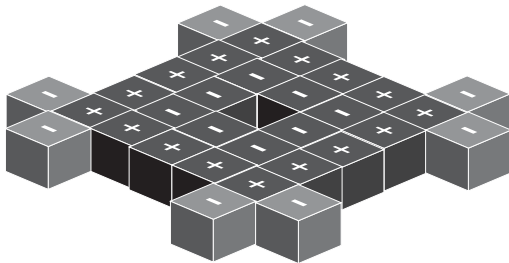
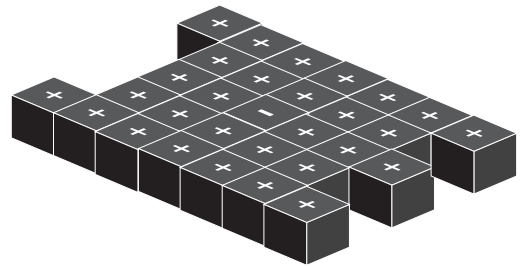
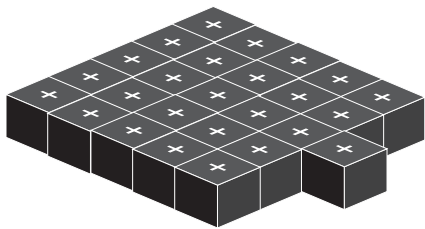
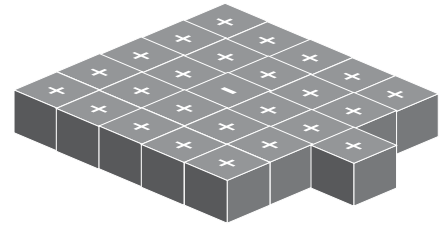
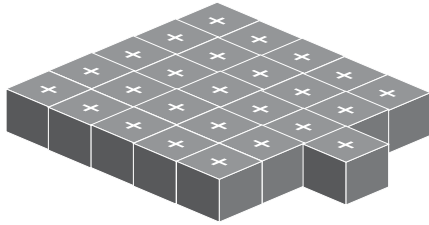


Neodymium Nucleus

$$s^2 f^4$$

Nd 140
Proton: 60
Neutron: 80
Spin:0

Nd 140m
Proton: 60
Neutron: 80
Spin:-7

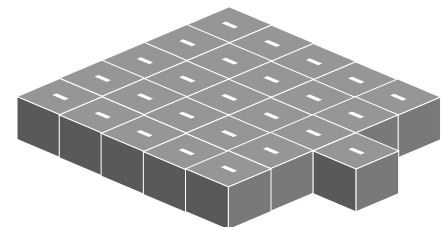
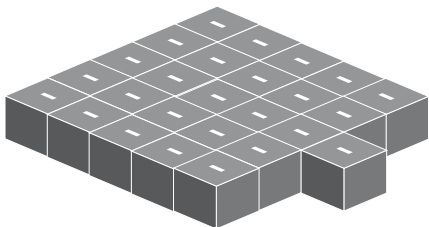
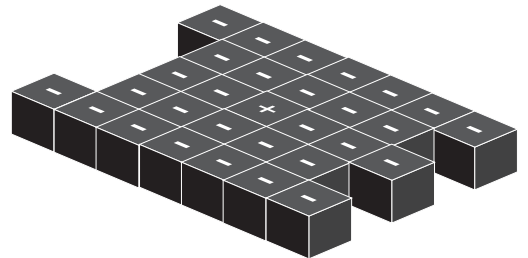
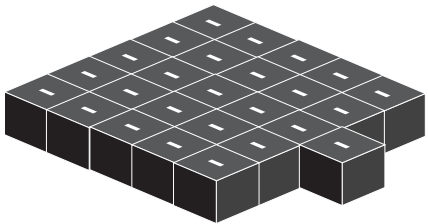
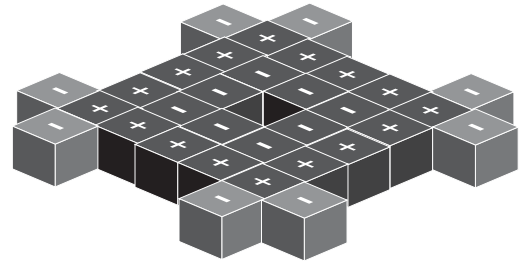
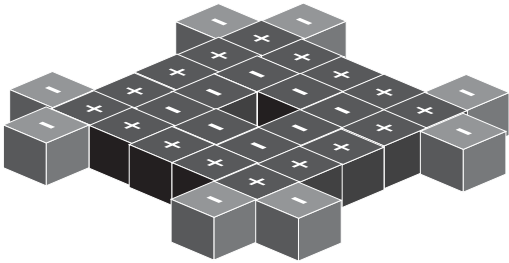
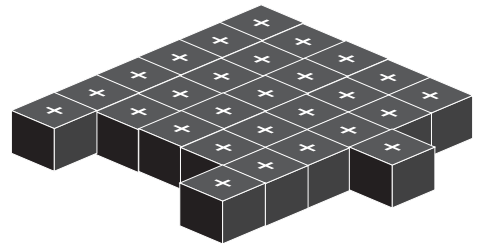
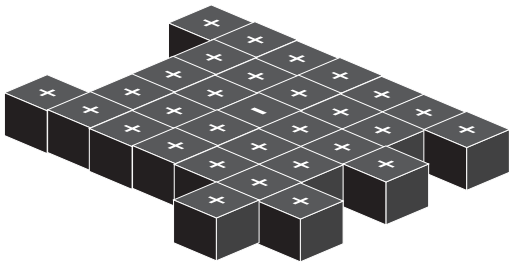
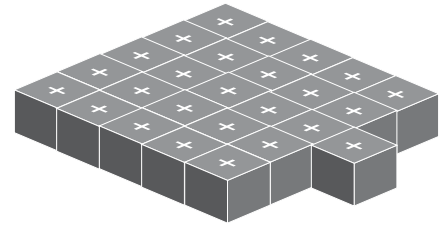
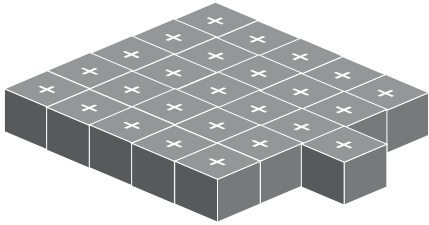


Neodymium Nucleus

$s^2 f^4$

Nd 141
Proton: 60
Neutron: 81
Spin: 3/2

Nd 142
Proton: 60
Neutron: 82
Spin: 0
Stable

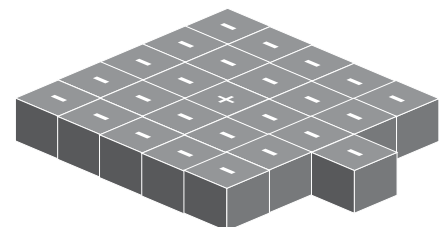
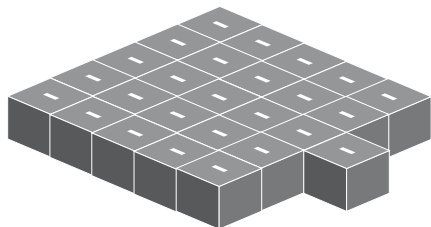
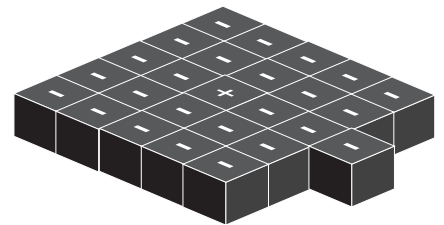
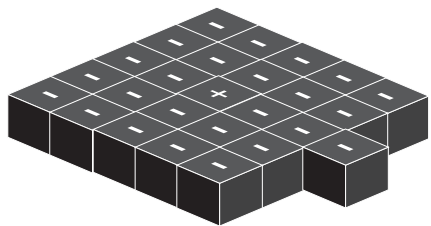
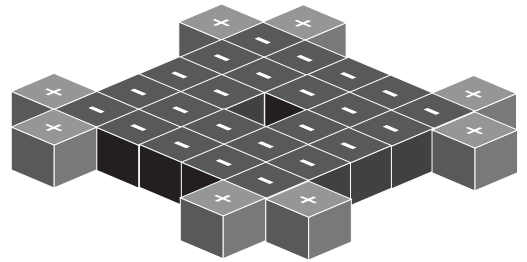
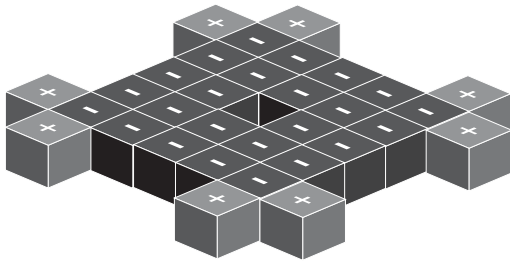
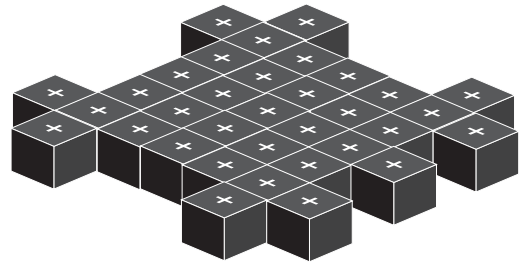
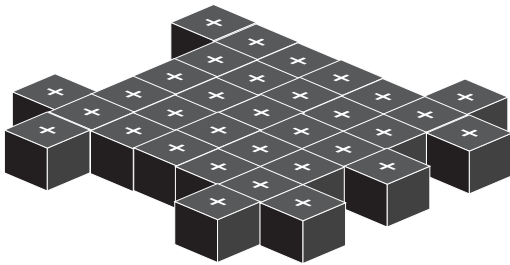
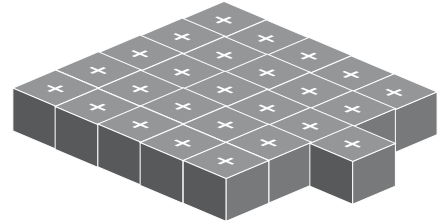
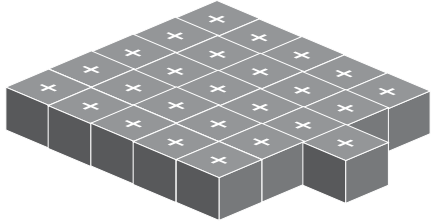


Neodymium Nucleus

$$s^2 f^4$$

Nd 143
 Proton: 60
 Neutron: 83
 Spin:-7/2
 Stable

Nd 144
 Proton: 60
 Neutron: 84
 Spin:0

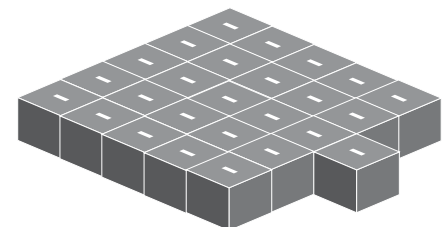
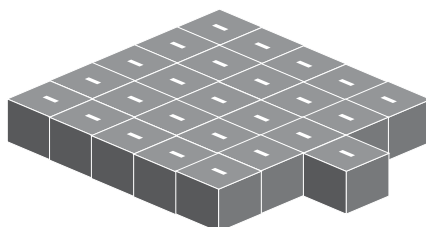
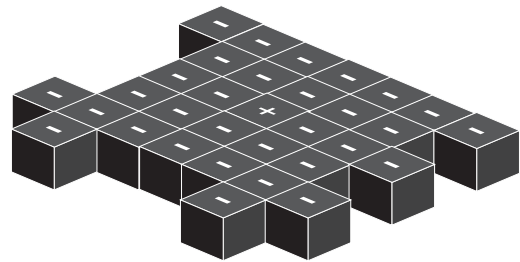
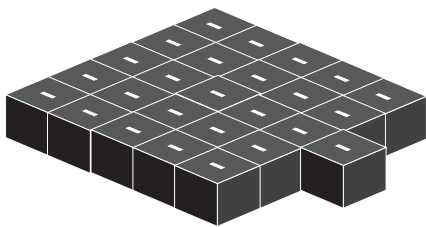
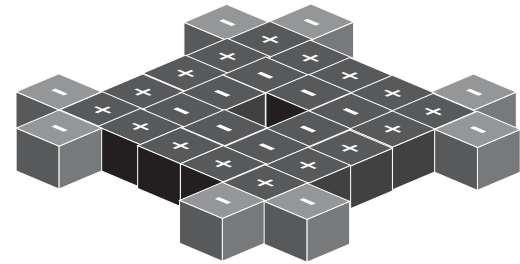
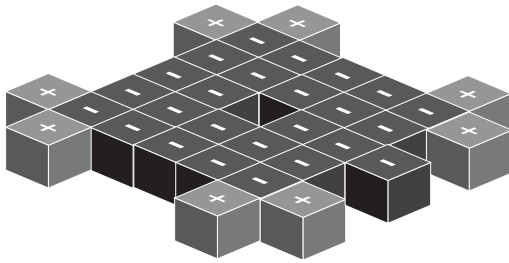
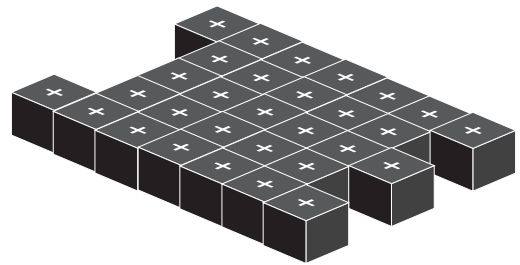
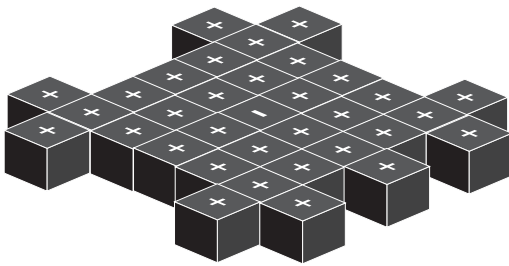
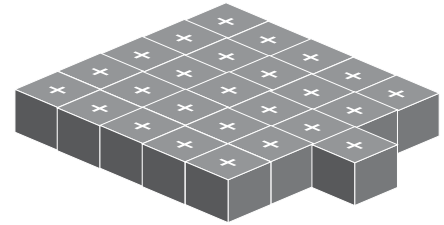
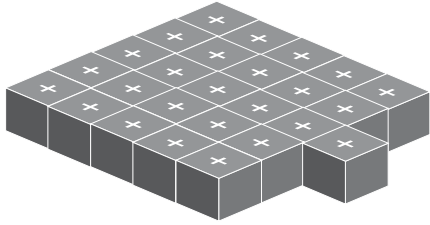


Neodymium Nucleus

$s^2 f^4$

Nd 145
 Proton: 60
 Neutron: 85
 Spin: -7/2
 Stable

Nd 146
 Proton: 60
 Neutron: 86
 Spin: 0
 Stable

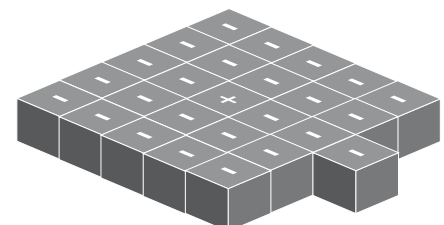
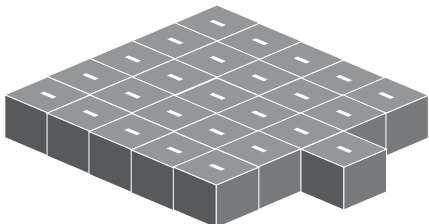
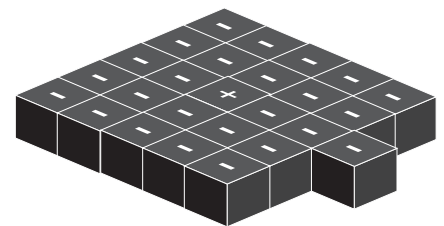
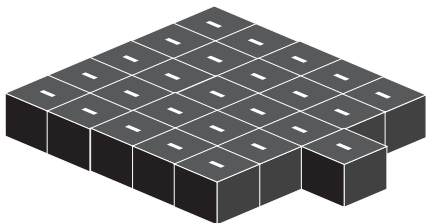
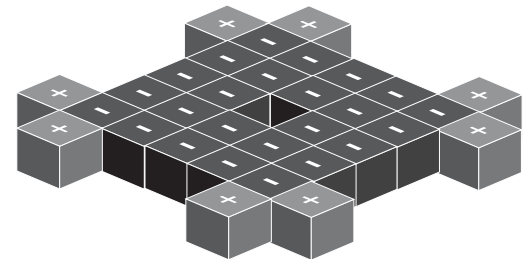
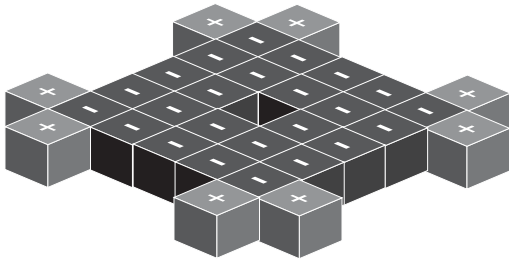
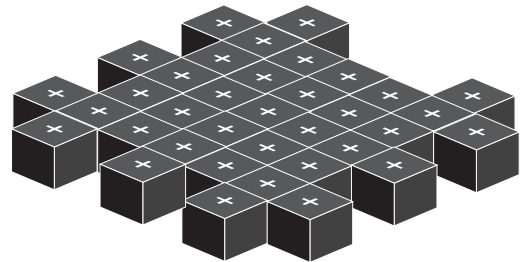
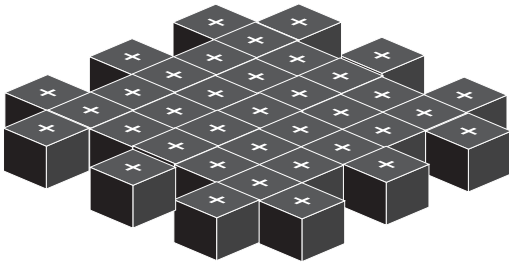
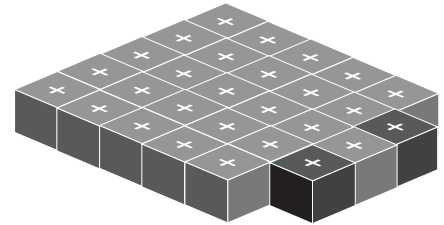
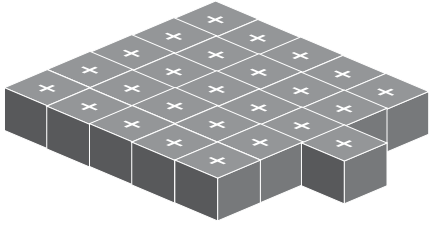


Neodymium Nucleus

$$s^2 f^4$$

Nd 147
 Proton: 60
 Neutron: 87
 Spin: -5/2

Nd 148
 Proton: 60
 Neutron: 88
 Spin: 0
 Stable

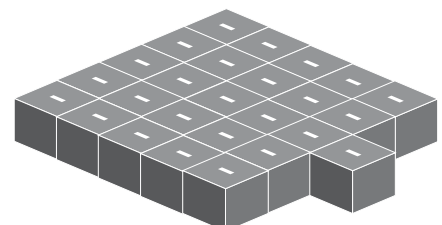
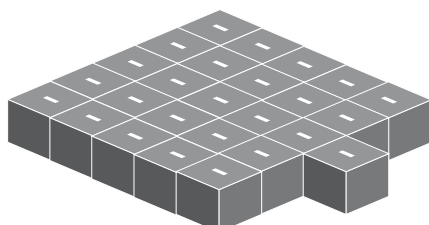
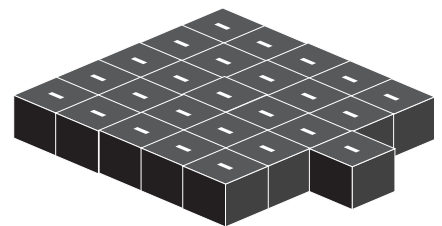
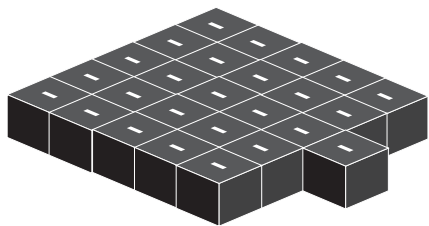
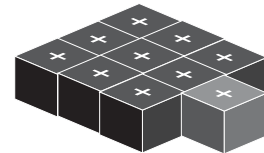
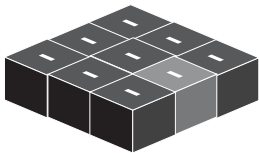
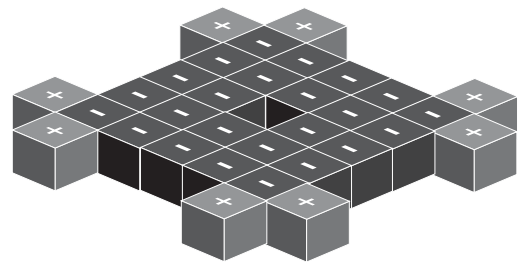
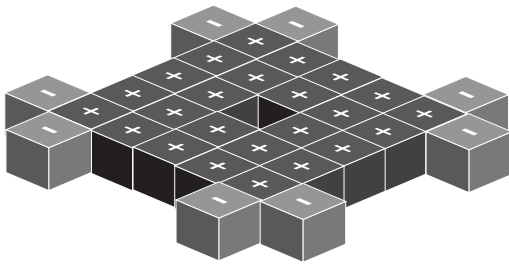
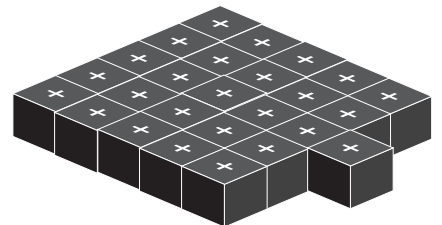
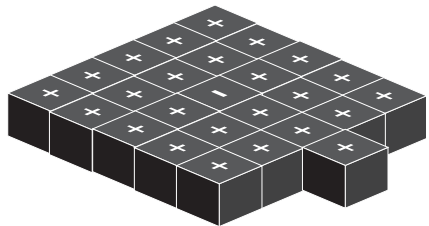
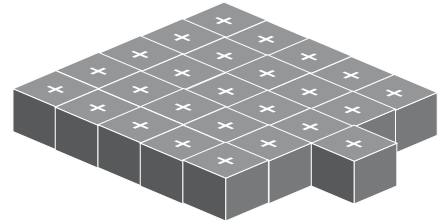
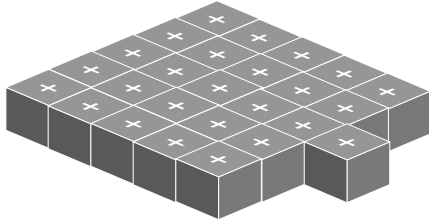


Promethium Nucleus

$$s^2 f^4 d^1$$

Pm 145
 Proton: 61
 Neutron: 84
 Spin: 5/2

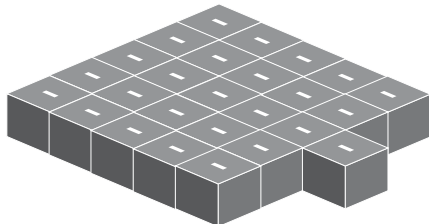
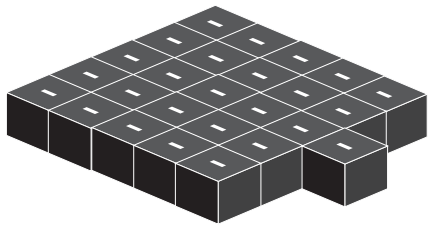
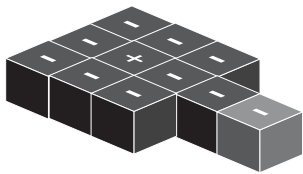
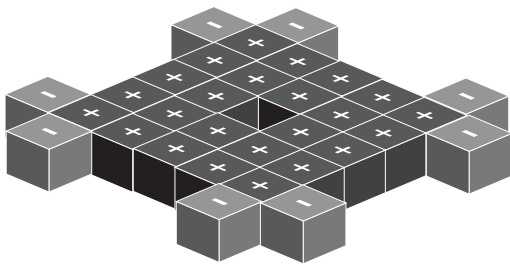
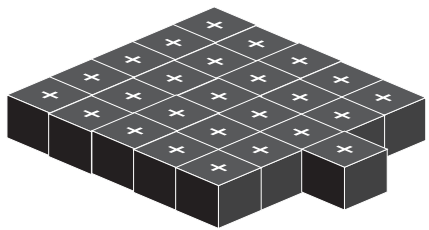
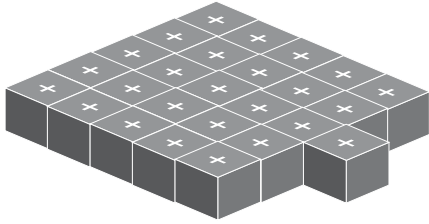
Pm 146
 Proton: 61
 Neutron: 85
 Spin: -3



Promethium Nucleus

$s^2 f^4 d^1$

Pm 147
Proton: 61
Neutron: 86
Spin: 7/2

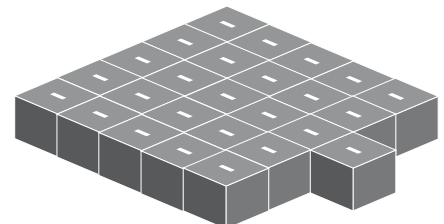
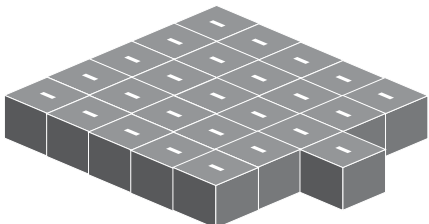
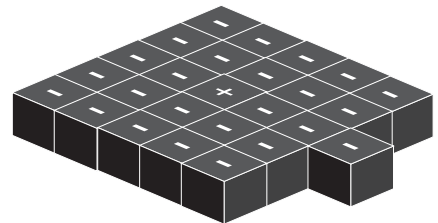
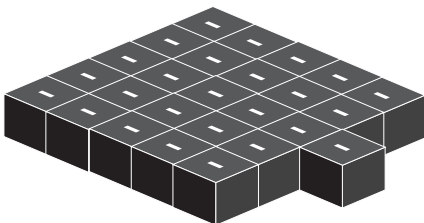
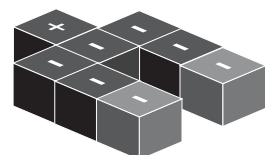
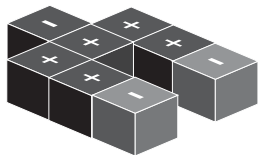
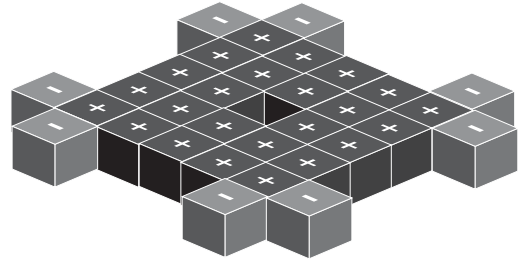
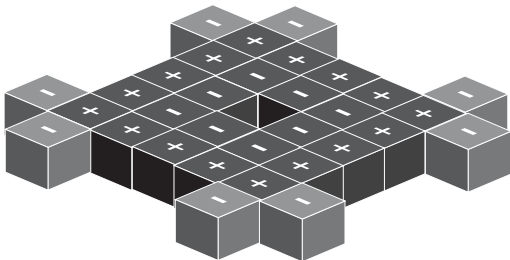
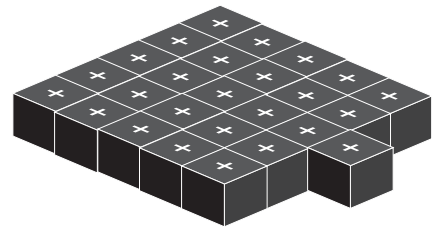
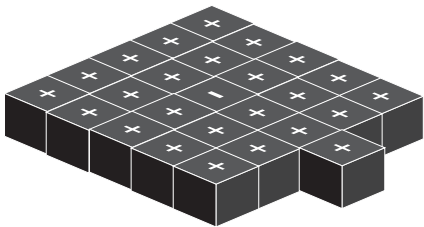
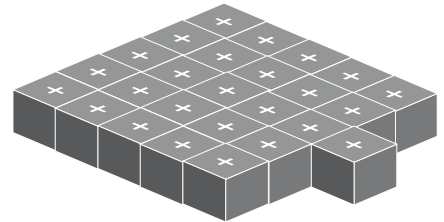
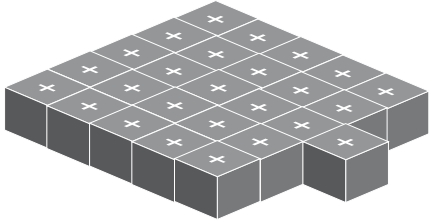


Samarium Nucleus

$$s^2 f^4 d^2$$

Sm 144
 Proton: 62
 Neutron: 82
 Spin:0
 Stable

Sm 144m
 Proton: 62
 Neutron: 82
 Spin:6

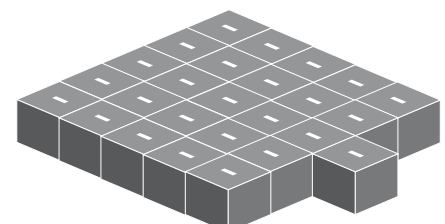
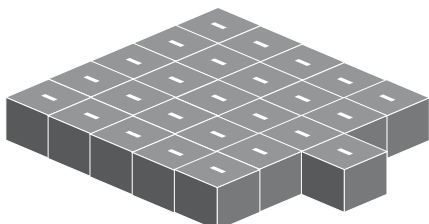
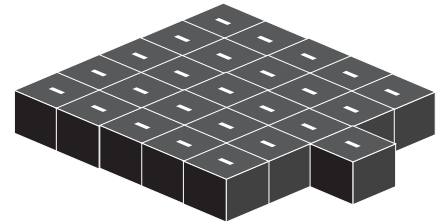
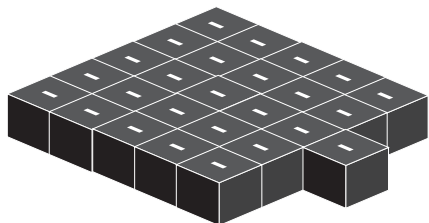
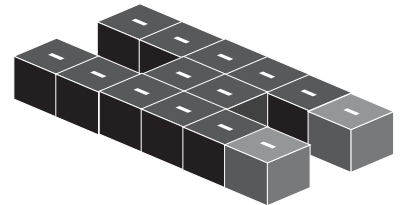
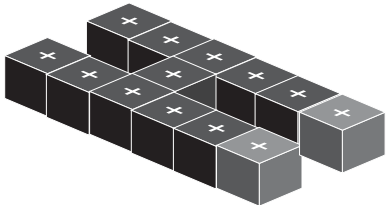
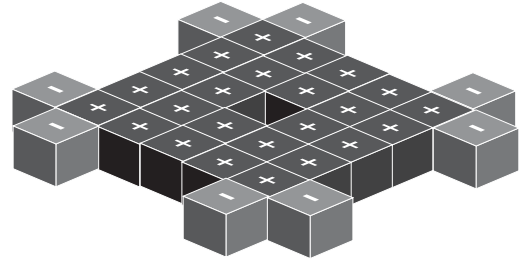
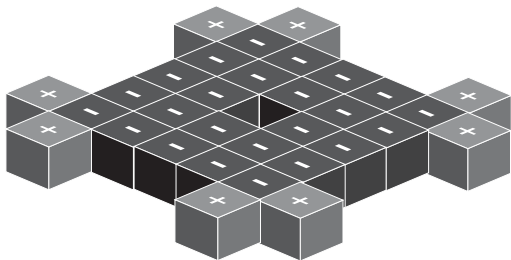
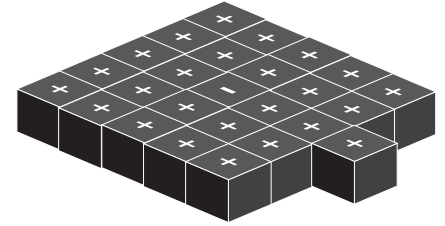
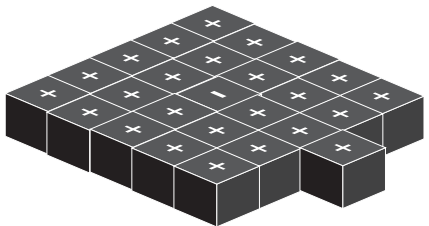
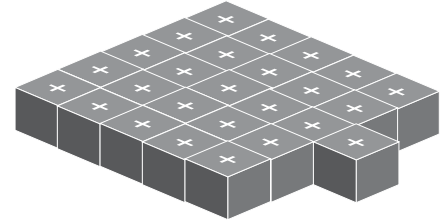
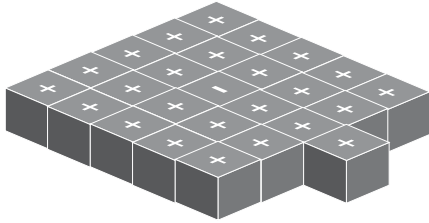


Samarium Nucleus

$$s^2 f^4 d^2$$

Sm 149
 Proton: 62
 Neutron: 87
 Spin: -7/2
 Stable

Sm 150
 Proton: 62
 Neutron: 88
 Spin: 0
 Stable

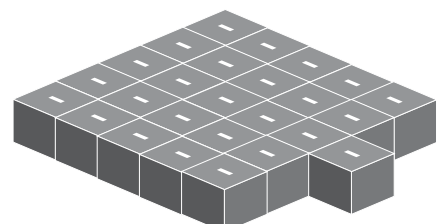
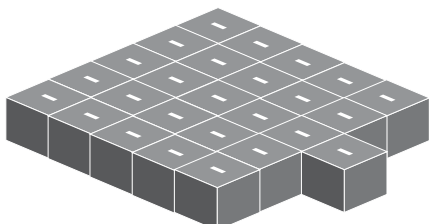
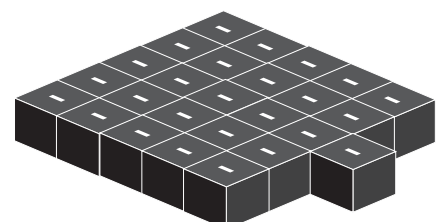
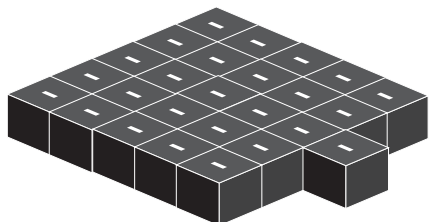
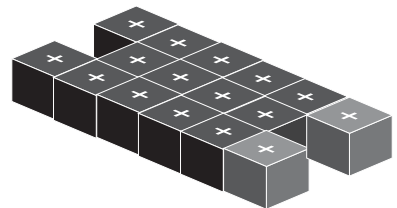
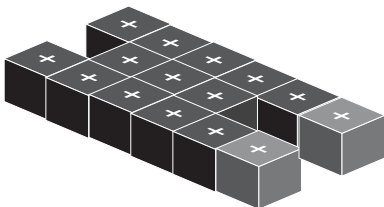
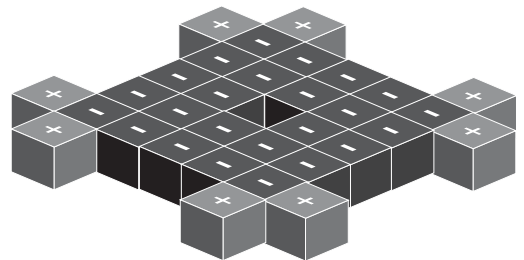
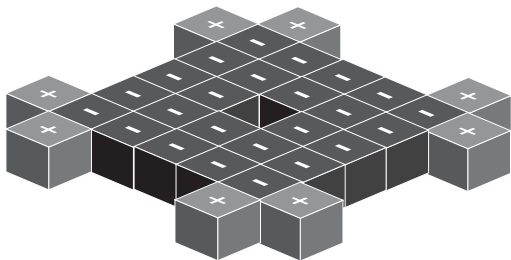
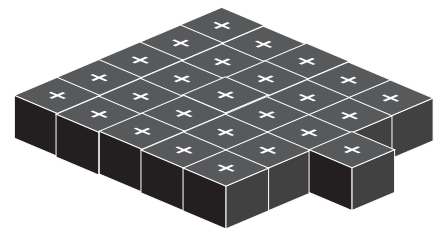
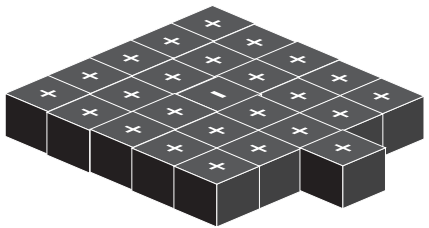
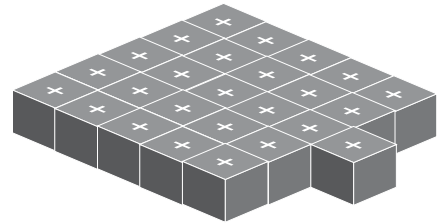
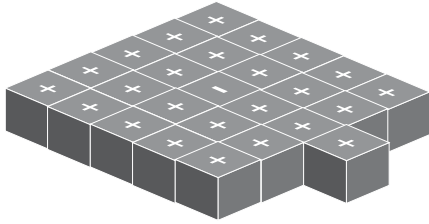


Samarium Nucleus

$$s^2 f^4 d^2$$

Sm 151
 Proton: 62
 Neutron: 89
 Spin: -5/2

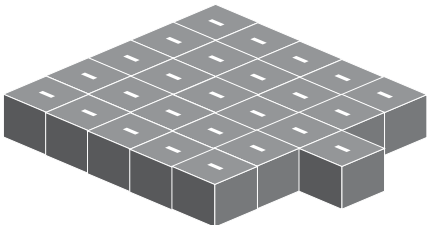
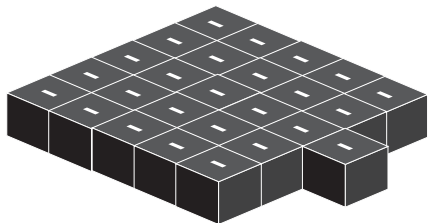
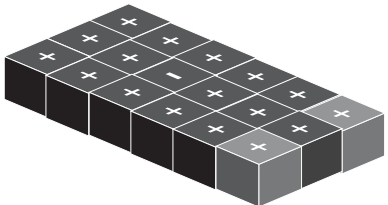
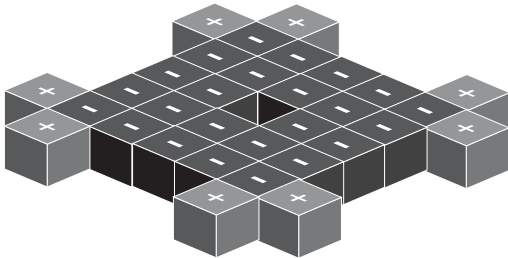
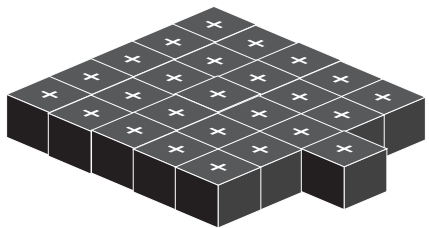
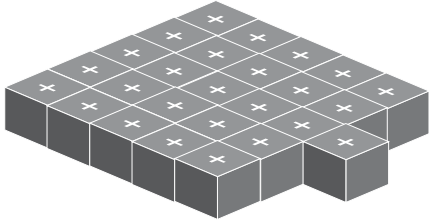
Sm 152
 Proton: 62
 Neutron: 90
 Spin: 0
 Stable



Samarium Nucleus

$s^2 f^4 d^2$

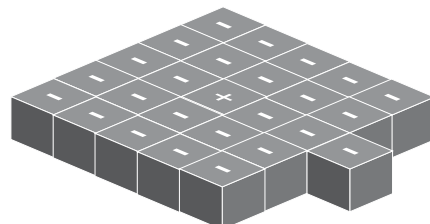
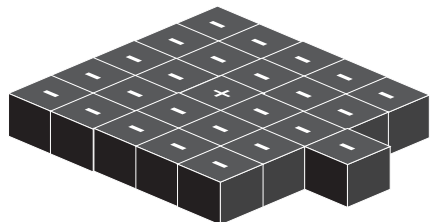
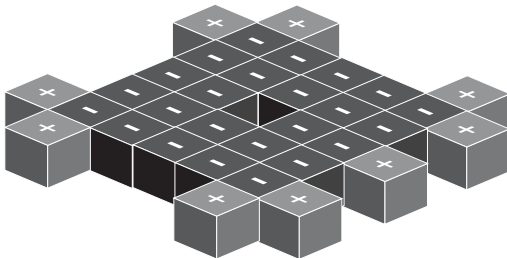
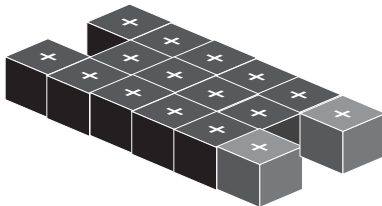
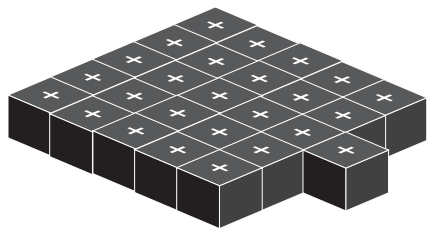
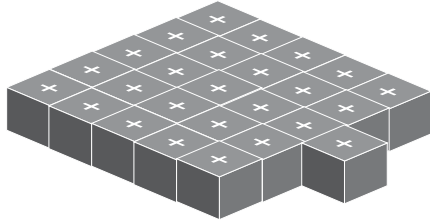
Sm 154
Proton: 62
Neutron: 92
Spin:0
Stable



Europium Nucleus

$s^2 f^4 d^3$

Eu 153
Proton: 63
Neutron: 90
Spin: 5/2
Stable

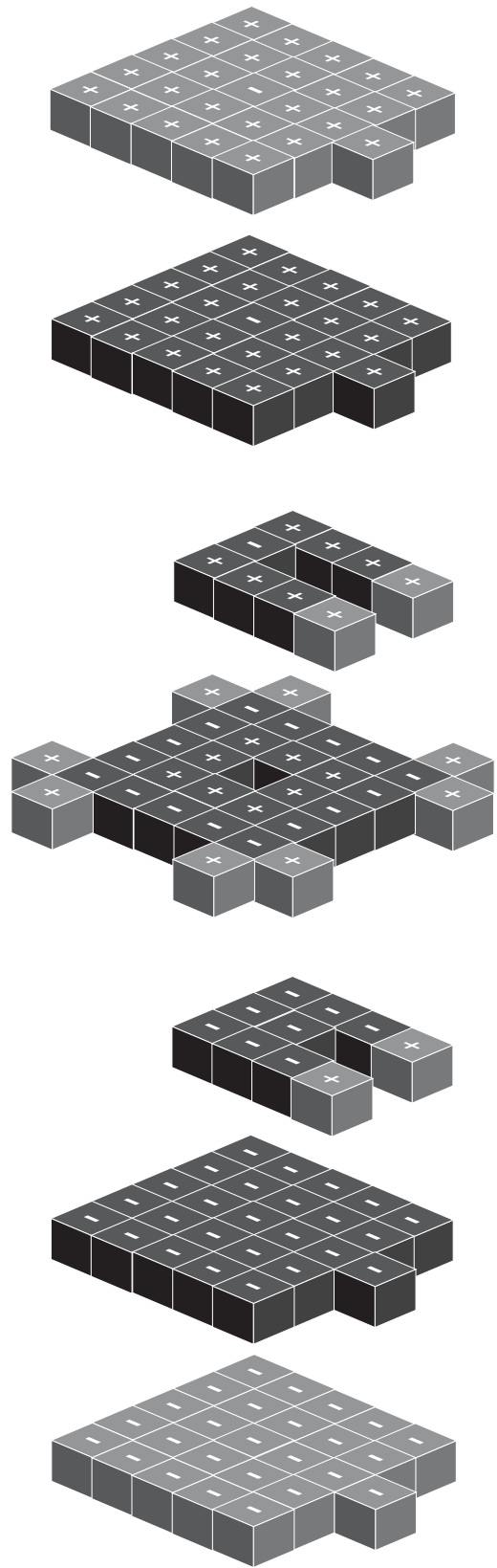
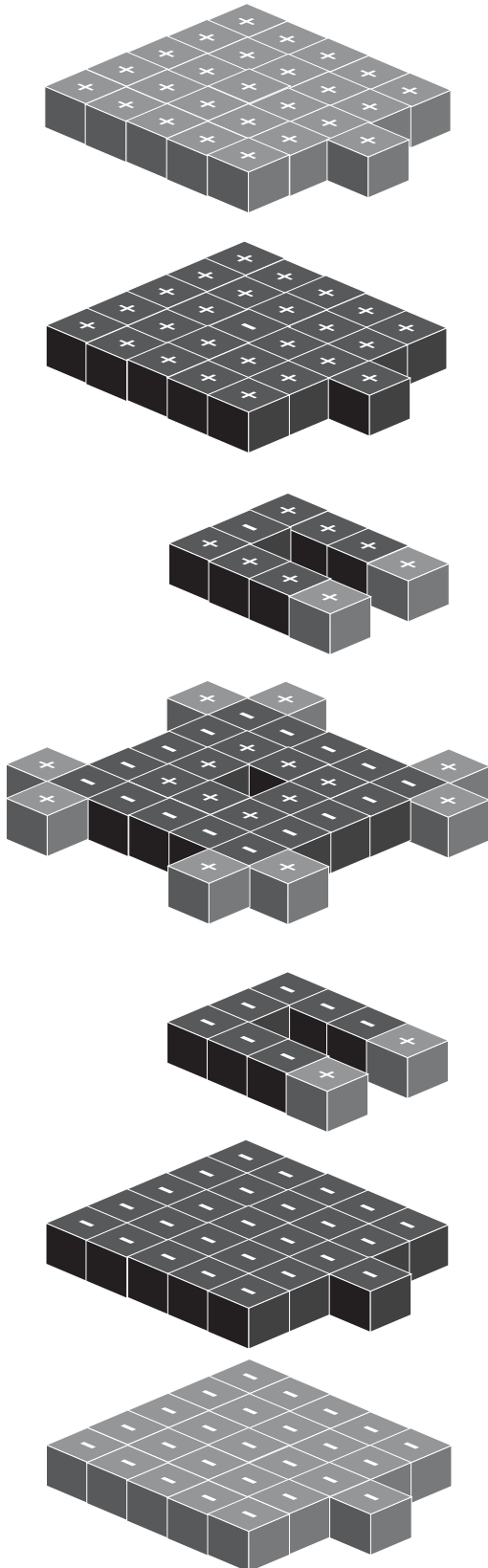


Gadolinium Nucleus

$$s^2 f^4 d^4$$

Gd 154
 Proton: 64
 Neutron: 90
 Spin:0
 Stable

Gd 155
 Proton: 64
 Neutron: 91
 Spin:-3/2
 Stable

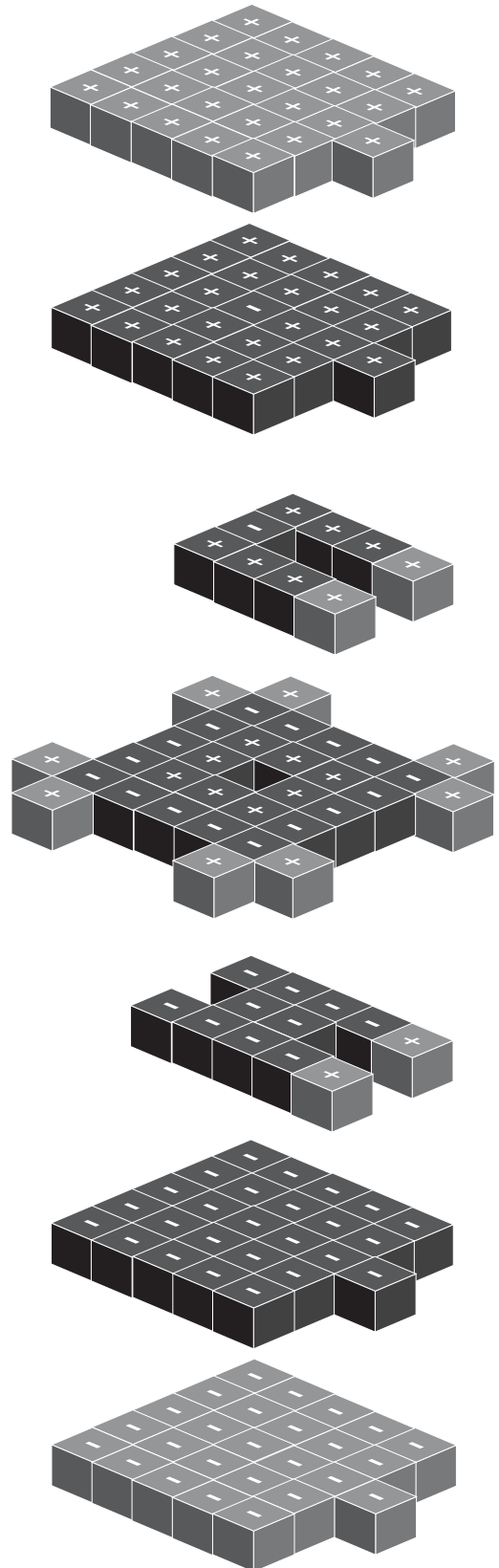
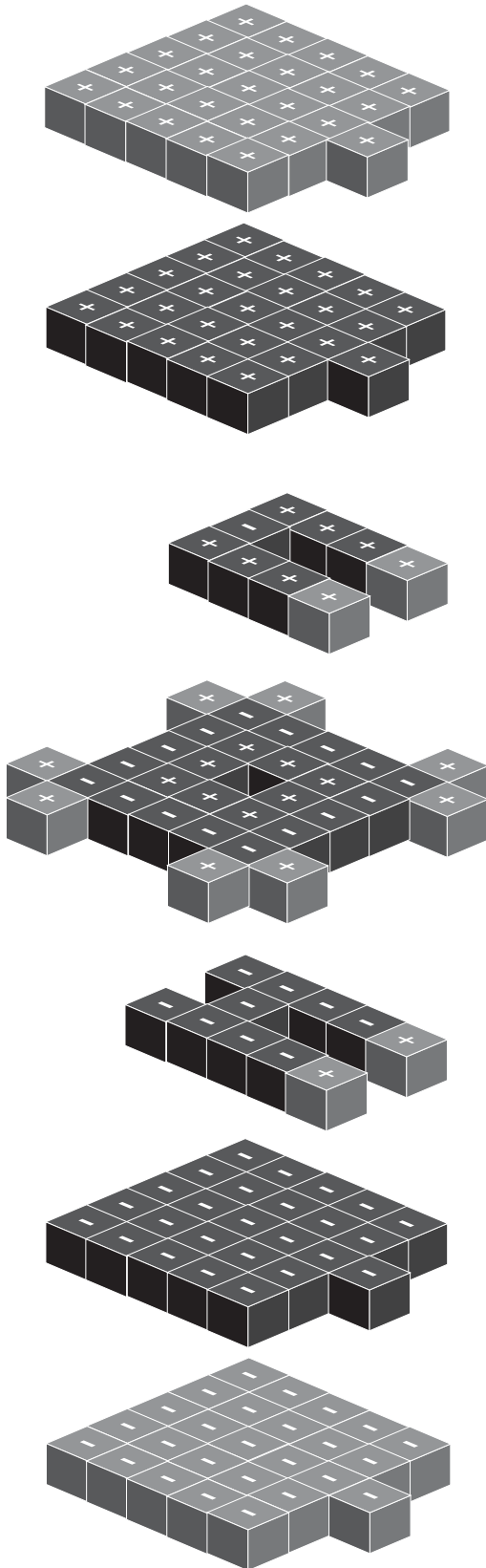


Gadolinium Nucleus

$$s^2 f^4 d^4$$

Gd 156
 Proton: 64
 Neutron: 92
 Spin: 0
 Stable

Gd 157
 Proton: 64
 Neutron: 93
 Spin: -3/2
 Stable

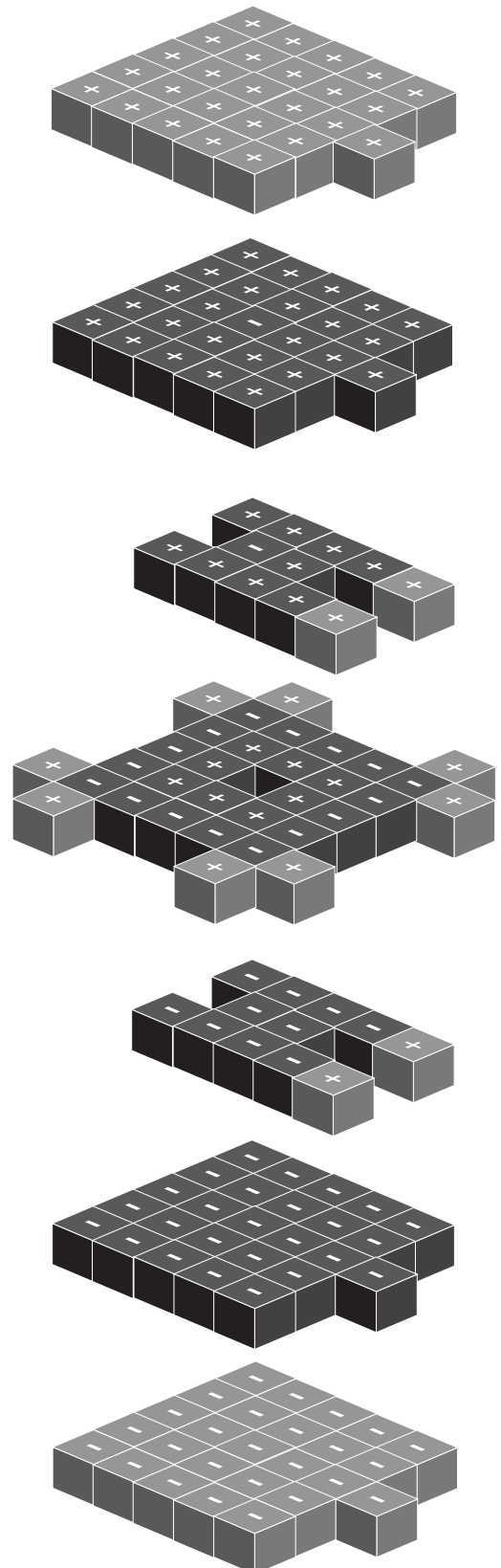
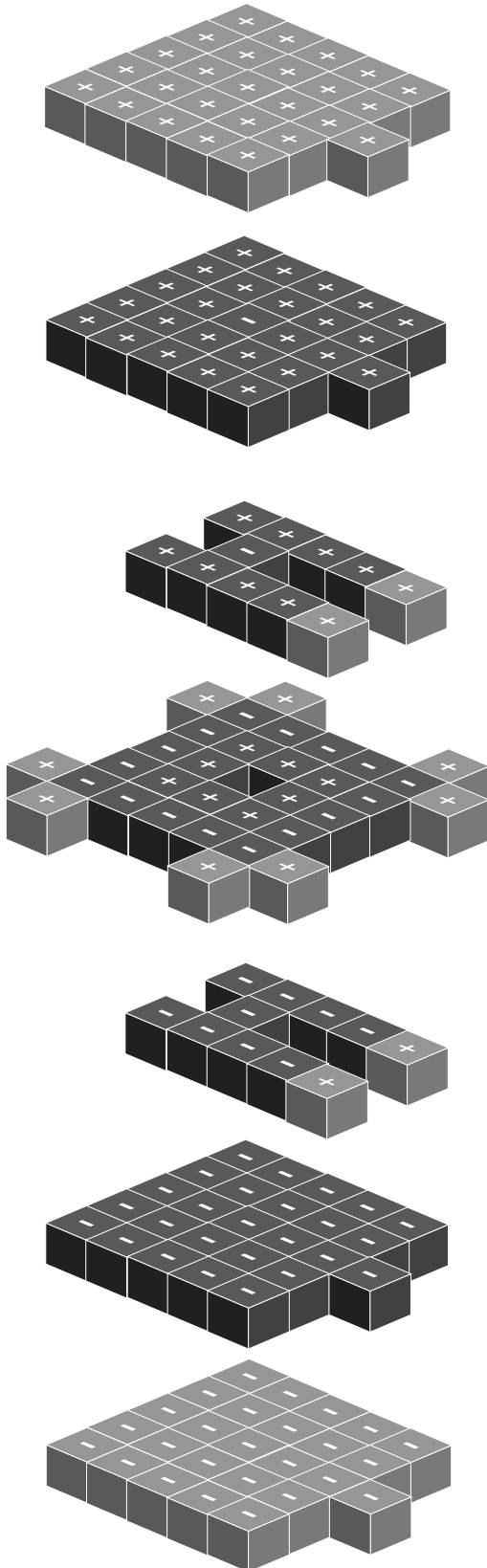


Gadolinium Nucleus

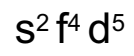
$$s^2 f^4 d^4$$

Gd 158
 Proton: 64
 Neutron: 94
 Spin:0
 Stable

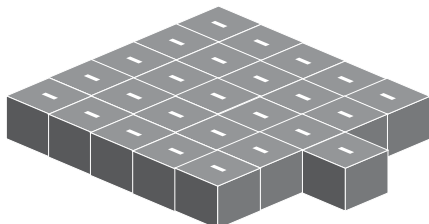
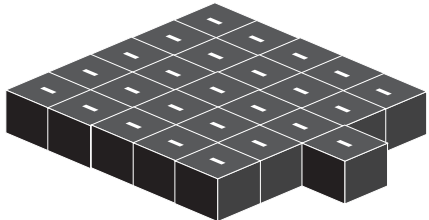
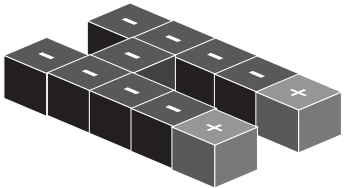
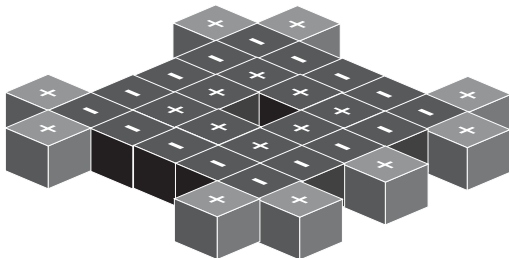
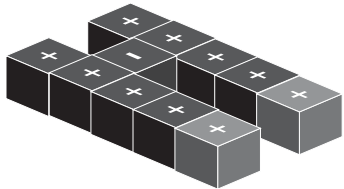
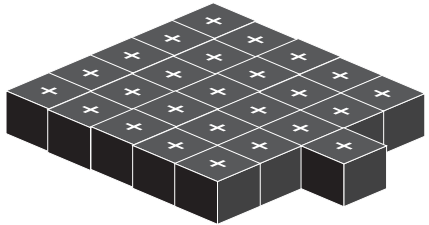
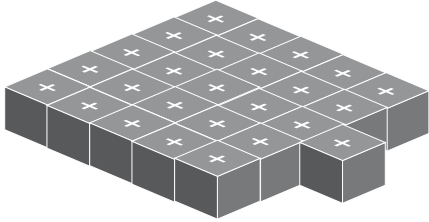
Gd 160
 Proton: 64
 Neutron: 96
 Spin:0
 Stable



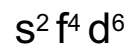
Terbium Nucleus



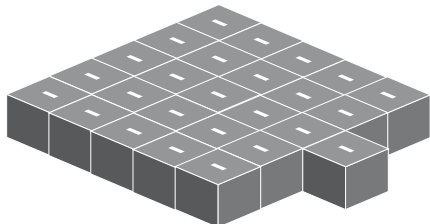
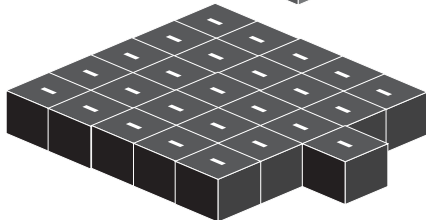
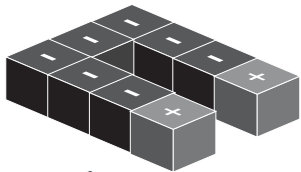
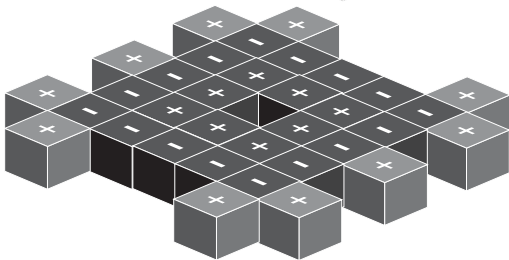
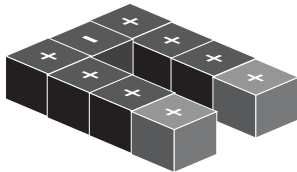
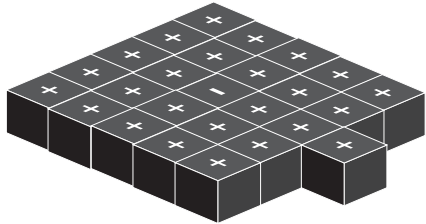
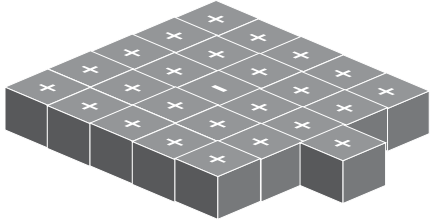
Tb 159
Proton: 65
Neutron: 94
Spin: 3/2
Stable



Dysprosium Nucleus



Dy 156
Proton: 66
Neutron: 90
Spin:0
Stable

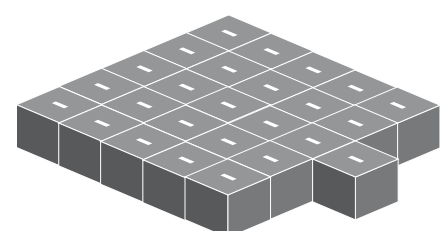
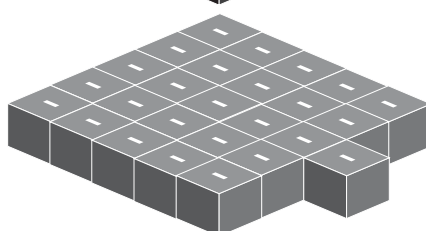
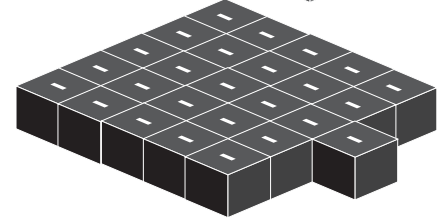
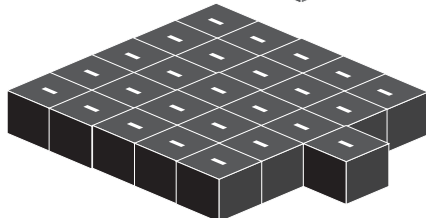
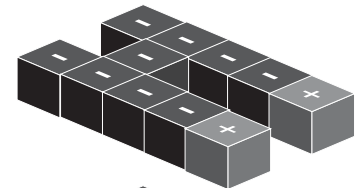
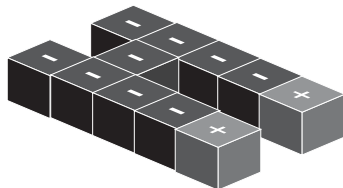
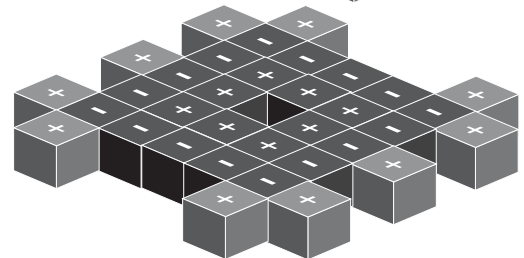
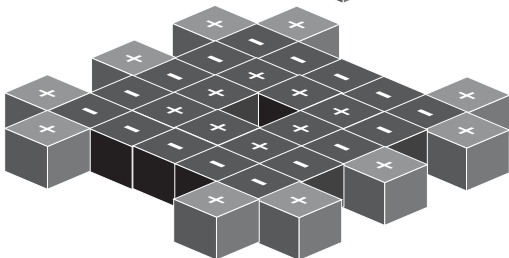
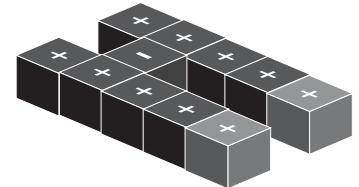
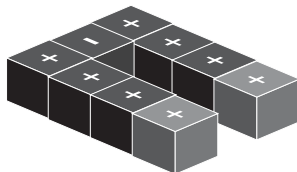
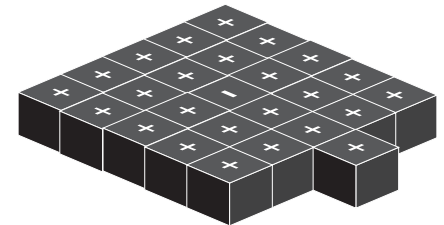
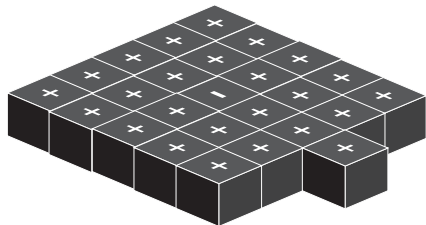
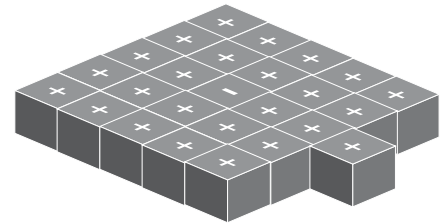
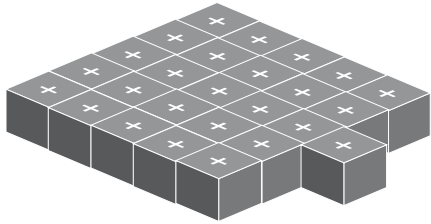


Dysprosium Nucleus

$$s^2 f^4 d^6$$

Dy 158
Proton: 66
Neutron: 92
Spin:0
Stable

Dy 160
Proton: 66
Neutron: 94
Spin:0
Stable

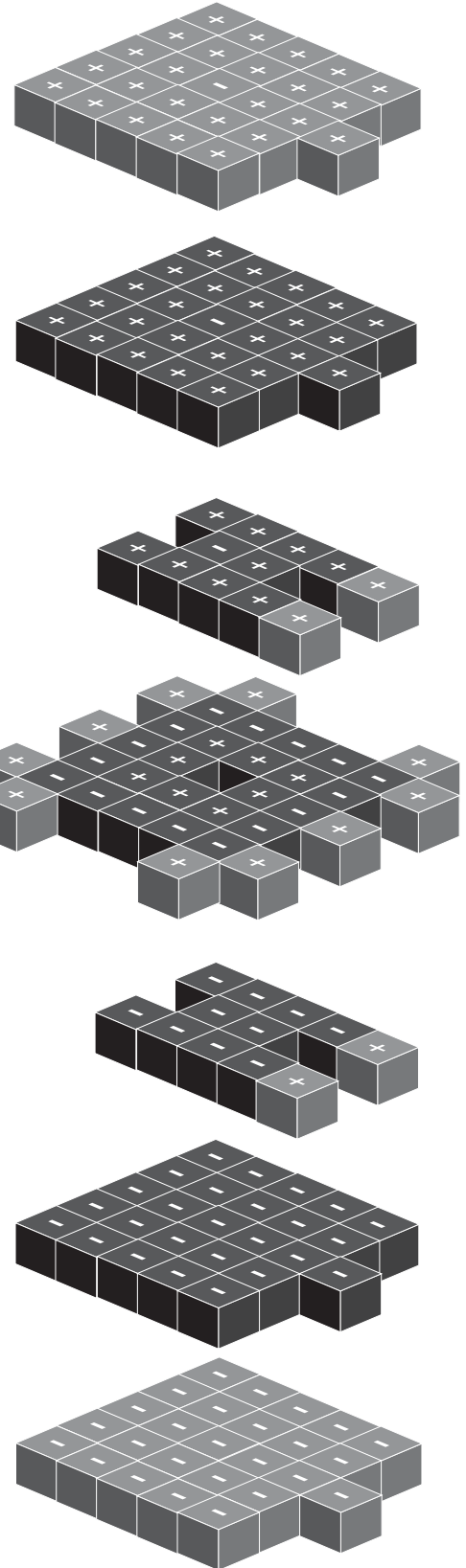
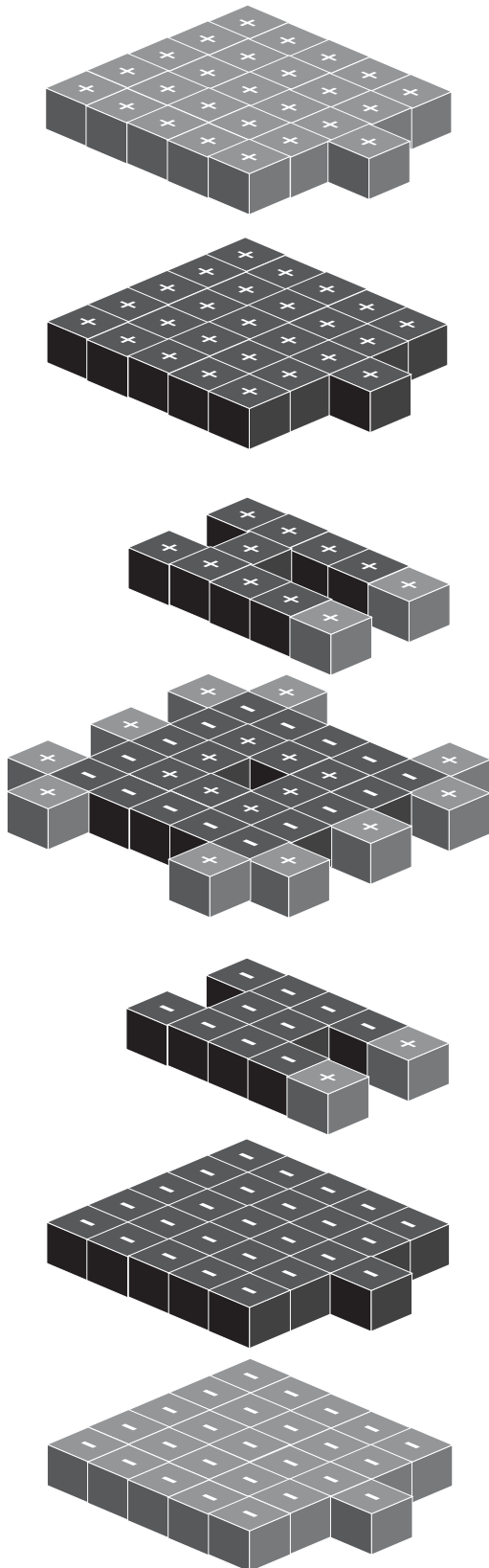


Dysprosium Nucleus

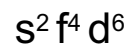
$$s^2 f^4 d^6$$

Dy 161
 Proton: 66
 Neutron: 95
 Spin: 5/2
 Stable

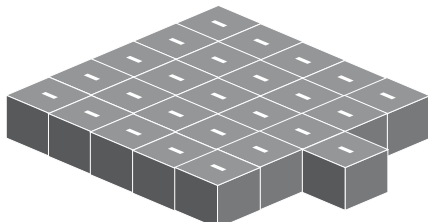
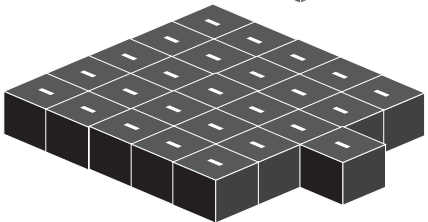
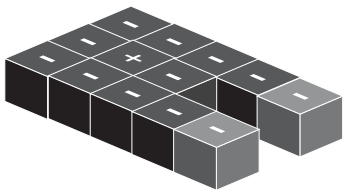
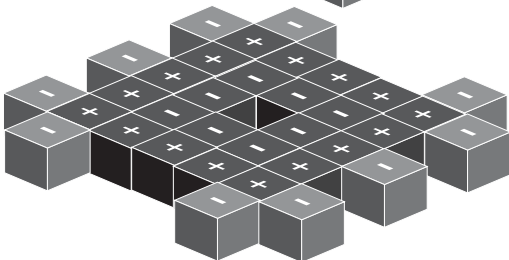
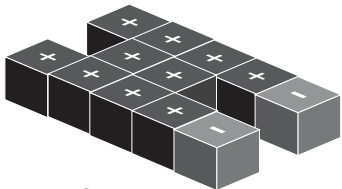
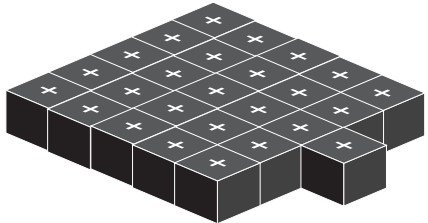
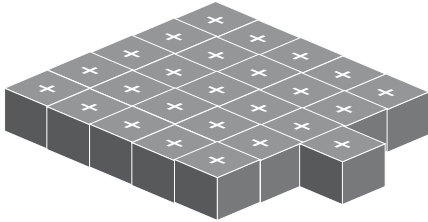
Dy 162
 Proton: 66
 Neutron: 96
 Spin: 0
 Stable



Dysprosium Nucleus



Dy 163
Proton: 66
Neutron: 97
Spin: -5/2
Stable

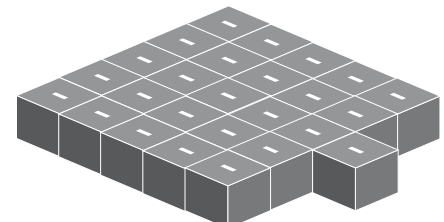
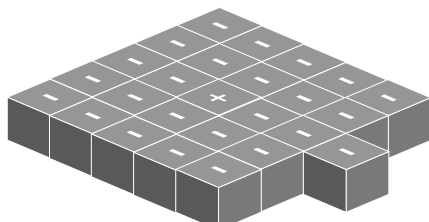
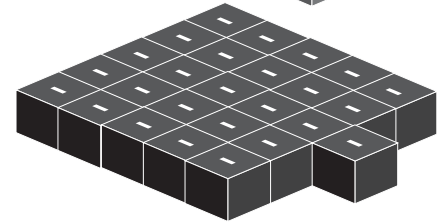
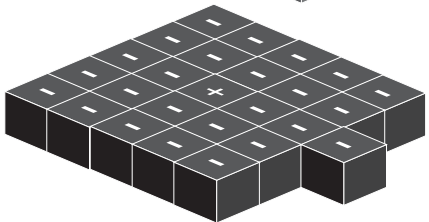
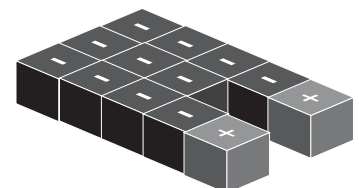
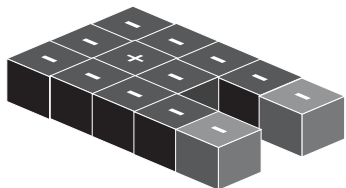
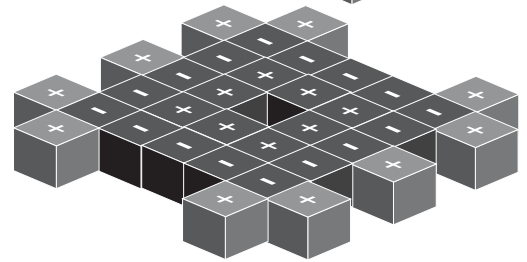
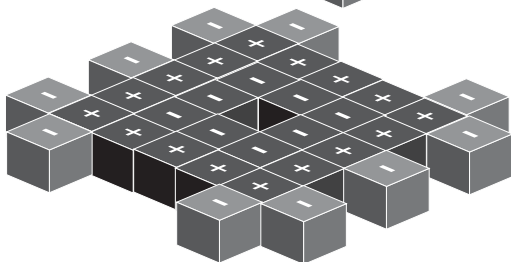
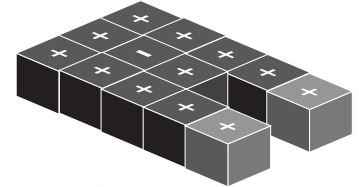
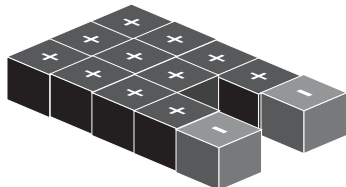
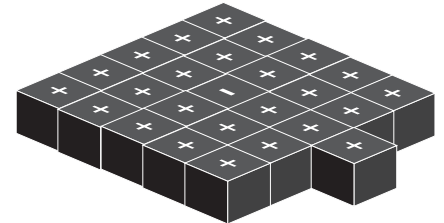
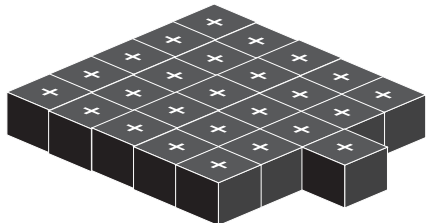
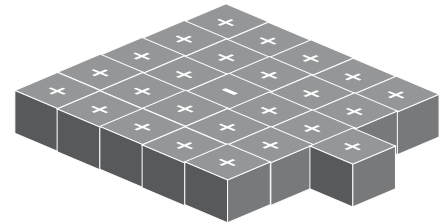
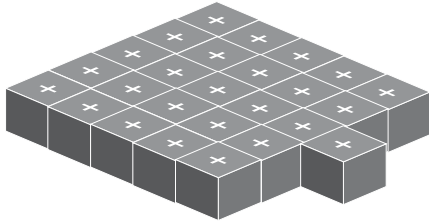


Dysprosium Nucleus

$$s^2 f^4 d^6$$

Dy 164
Proton: 66
Neutron: 98
Spin:0
Stable

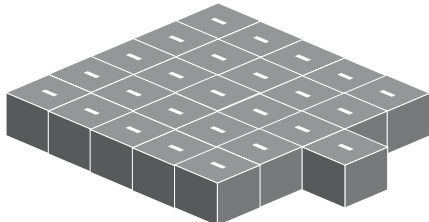
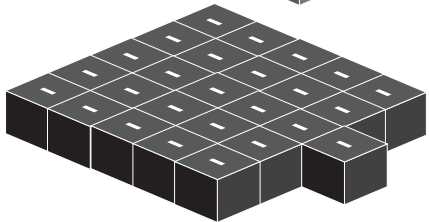
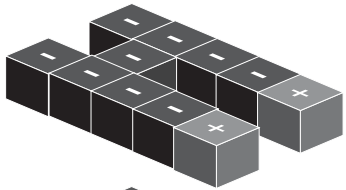
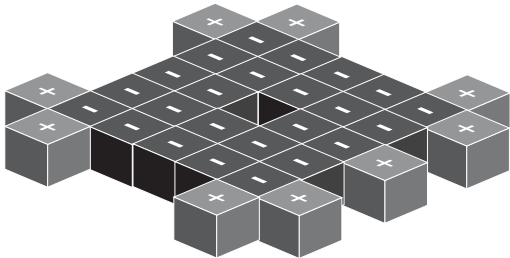
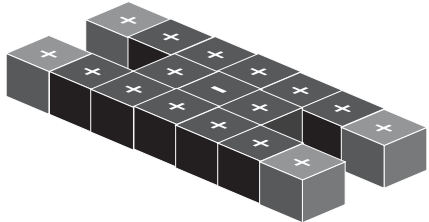
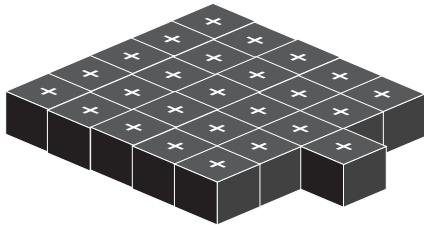
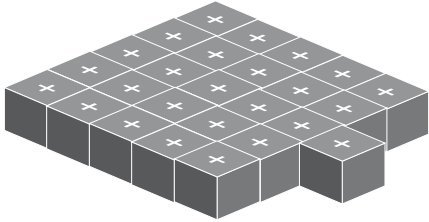
Dy 164
Proton: 66
Neutron: 98
Spin:0
Stable



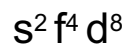
Holmium Nucleus

$s^2 f^4 d^7$

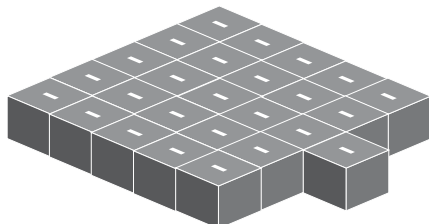
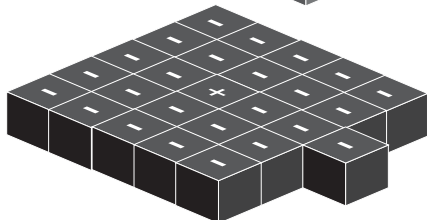
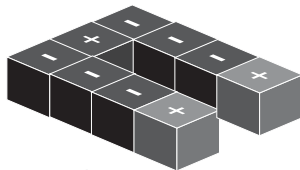
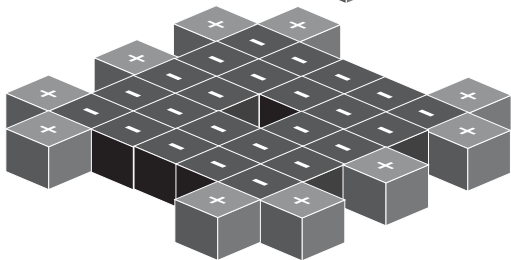
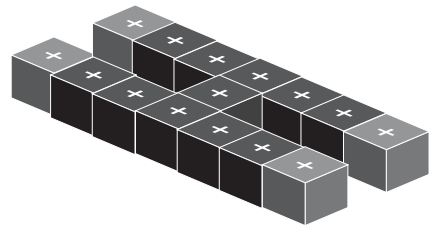
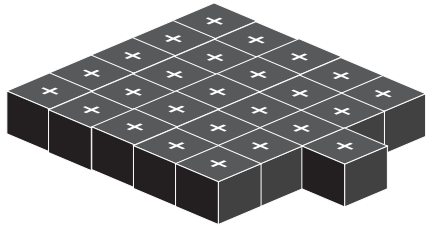
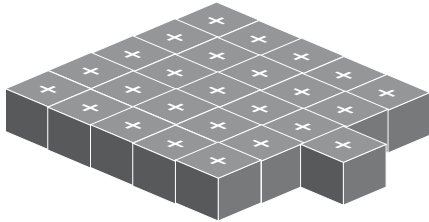
Ho 165
Proton: 67
Neutron: 98
Spin: -7/2
Stable



Erbium Nucleus



Er 162
Proton: 68
Neutron: 94
Spin:0
Stable

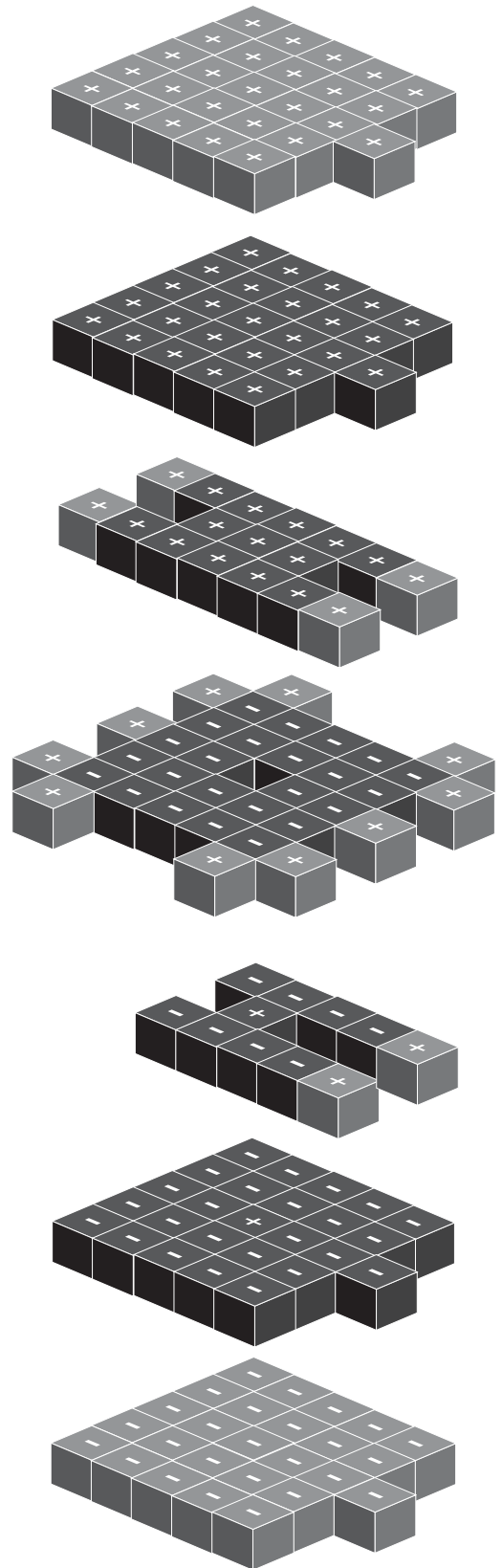
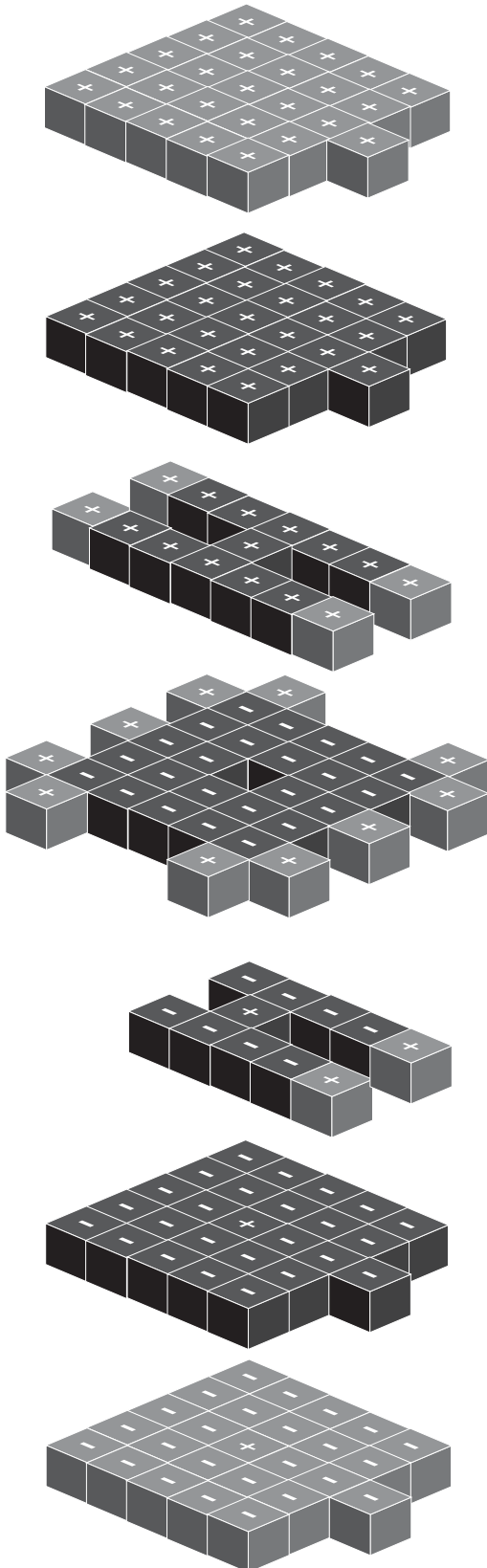


Erbium Nucleus

$$s^2 f^4 d^8$$

Er 164
 Proton: 68
 Neutron: 96
 Spin:0
 Stable

Er 166
 Proton: 68
 Neutron: 98
 Spin:0
 Stable

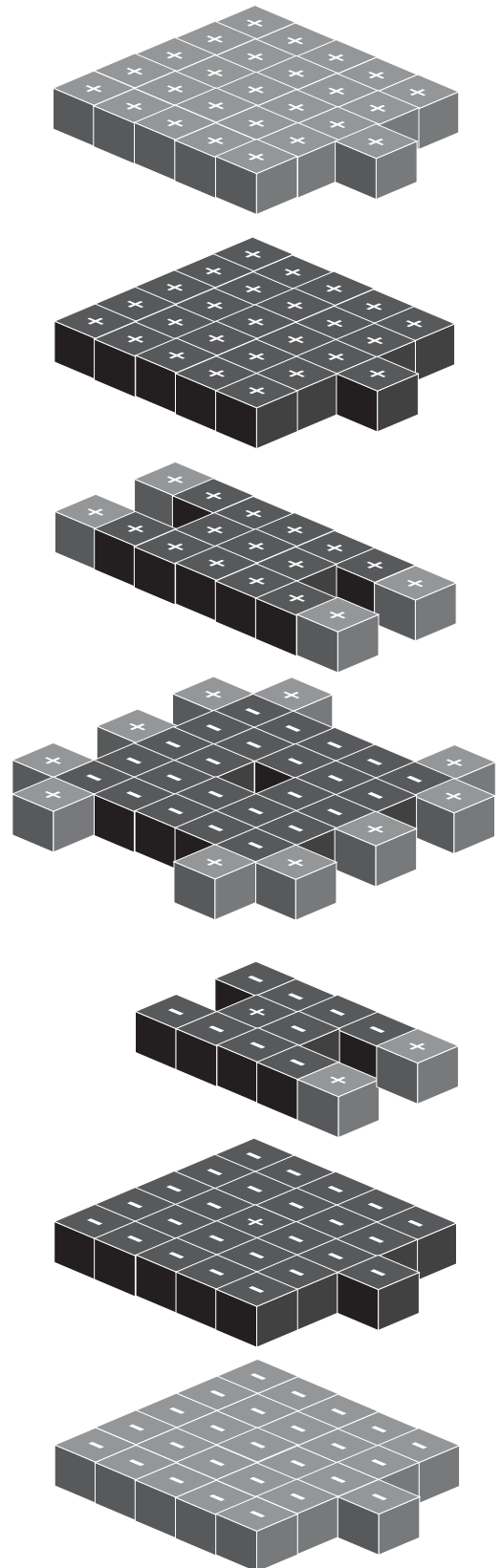
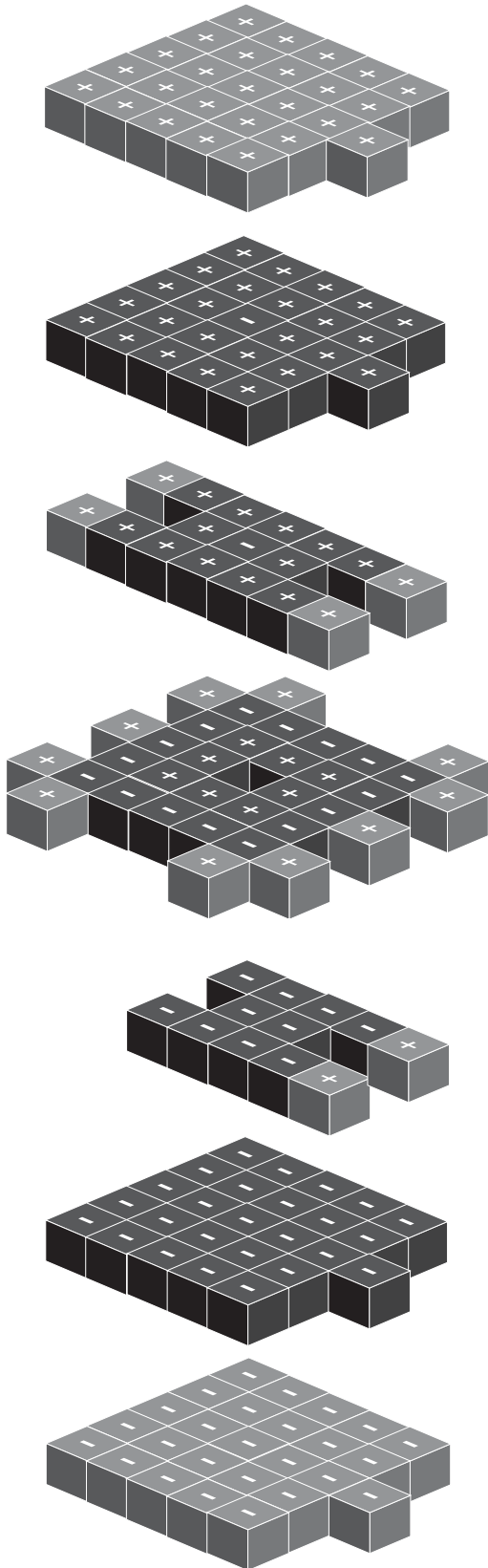


Erbium Nucleus

$$s^2 f^4 d^8$$

Er 167
 Proton: 68
 Neutron: 99
 Spin: 7/2
 Stable

Er 167m
 Proton: 68
 Neutron: 99
 Spin: -1/2

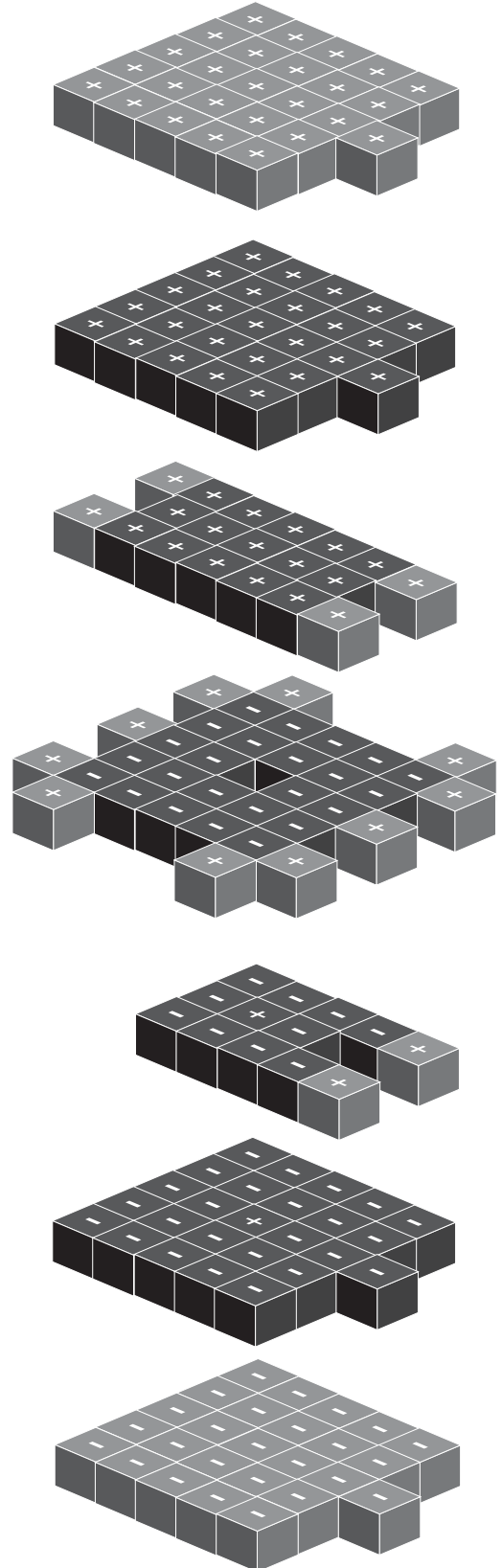
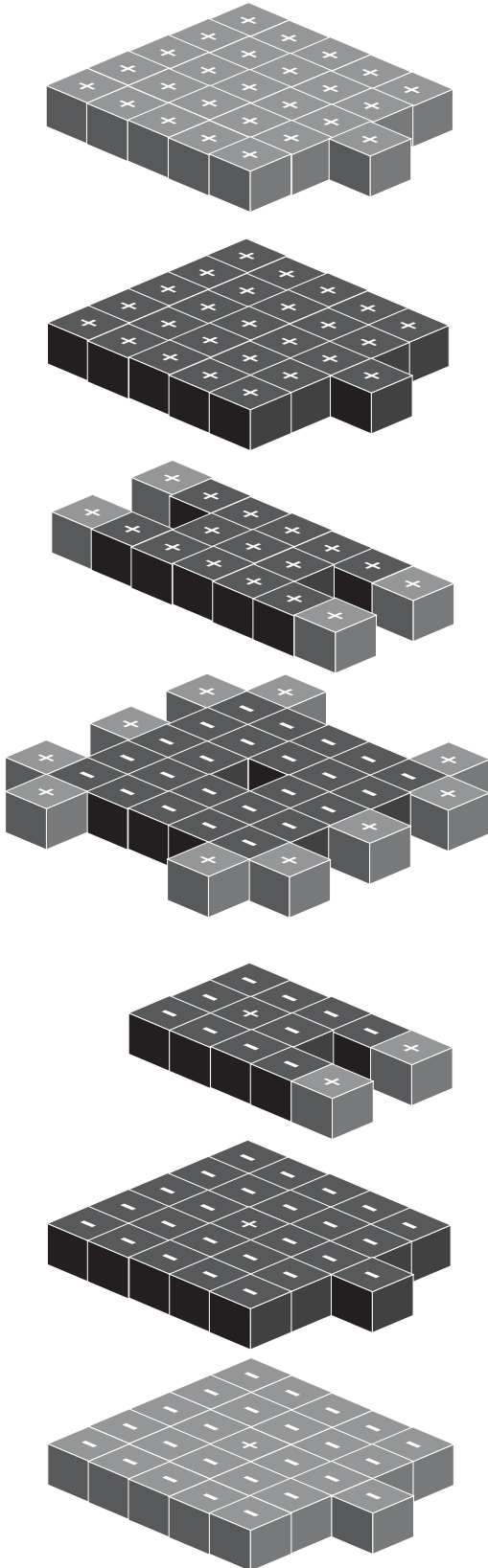


Erbium Nucleus

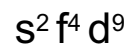
$$s^2 f^4 d^8$$

Er 168
 Proton: 68
 Neutron: 100
 Spin:0
 Stable

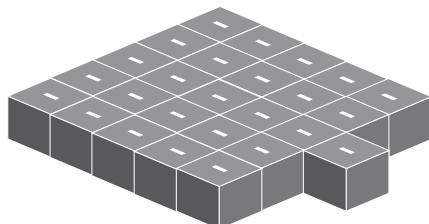
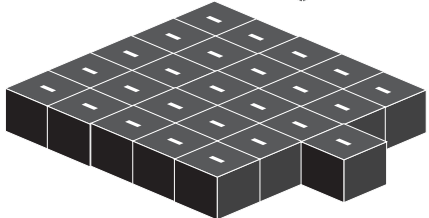
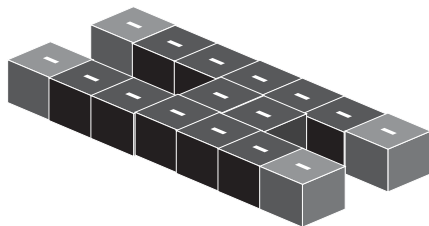
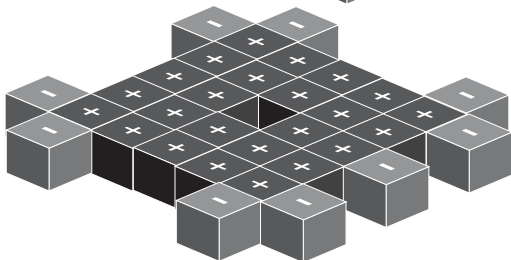
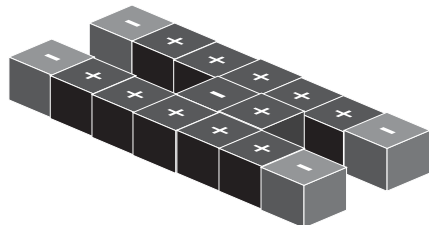
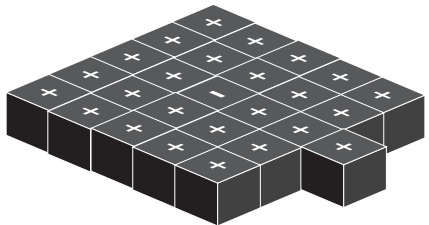
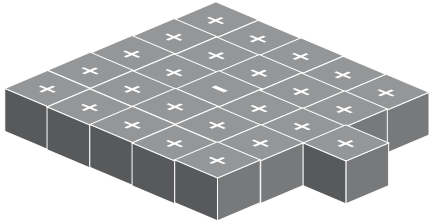
Er 170
 Proton: 68
 Neutron: 102
 Spin:0
 Stable



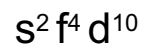
Thulium Nucleus



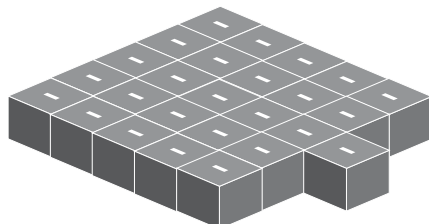
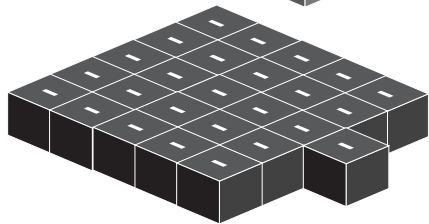
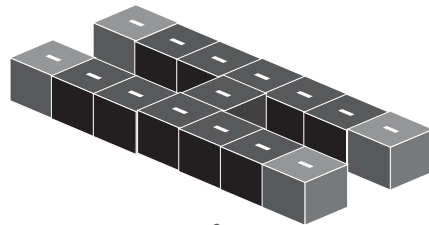
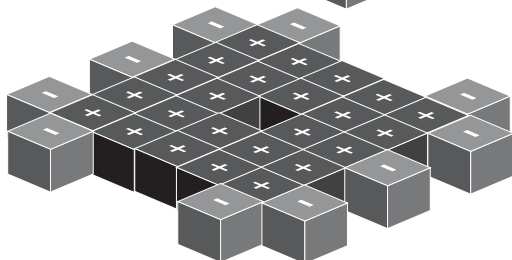
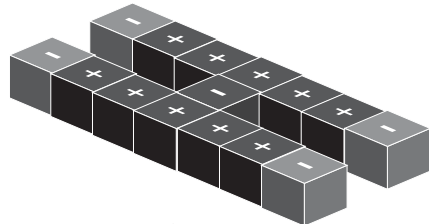
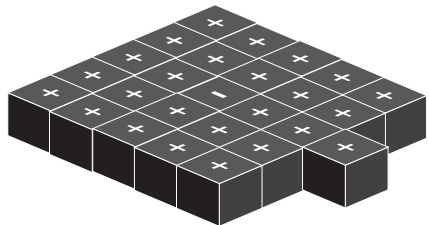
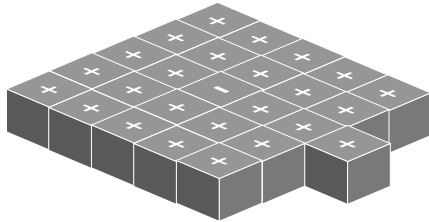
Tm 169
Proton: 69
Neutron: 100
Spin: 1/2
Stable



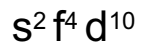
Ytterbium Nucleus



Yb 168
Proton: 70
Neutron: 98
Spin:0
Stable

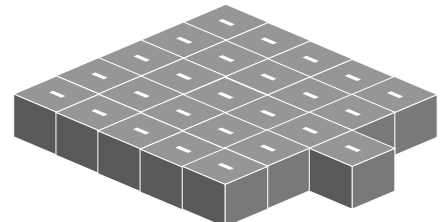
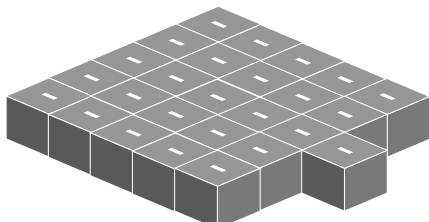
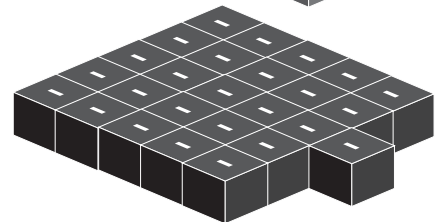
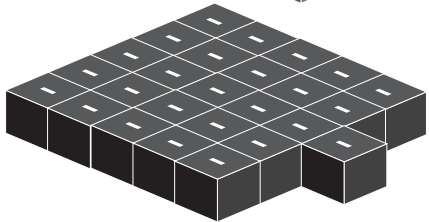
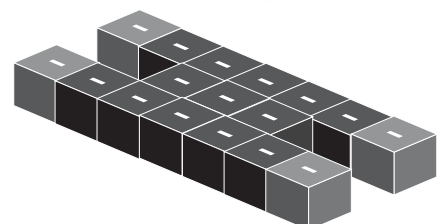
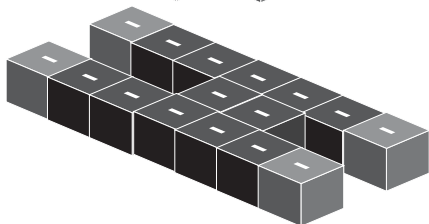
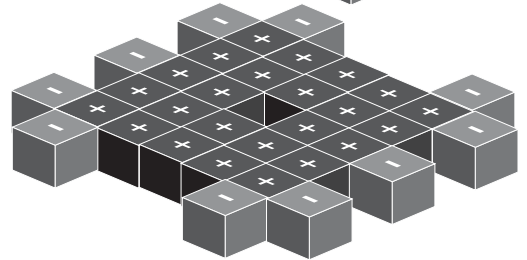
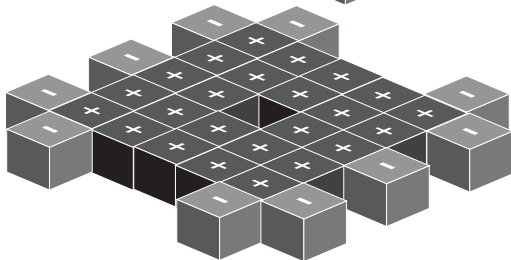
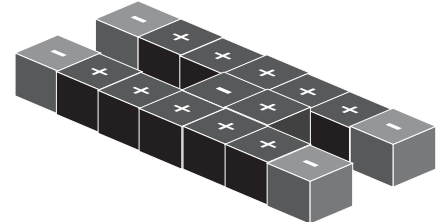
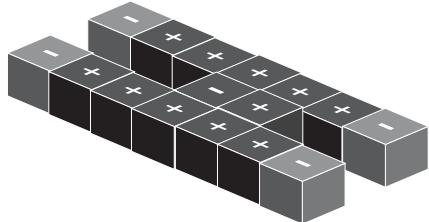
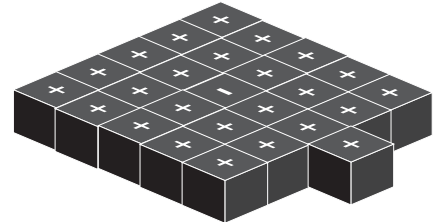
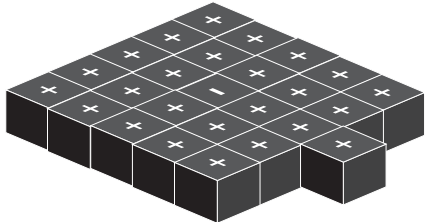
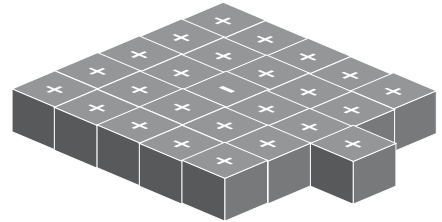
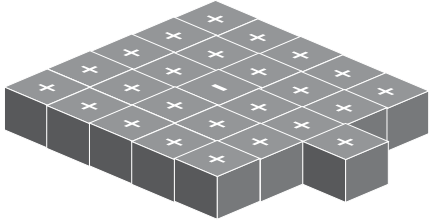


Ytterbium Nucleus



Yb 170
Proton: 70
Neutron: 100
Spin: 0
Stable

Yb 171
Proton: 70
Neutron: 101
Spin: -1/2
Stable

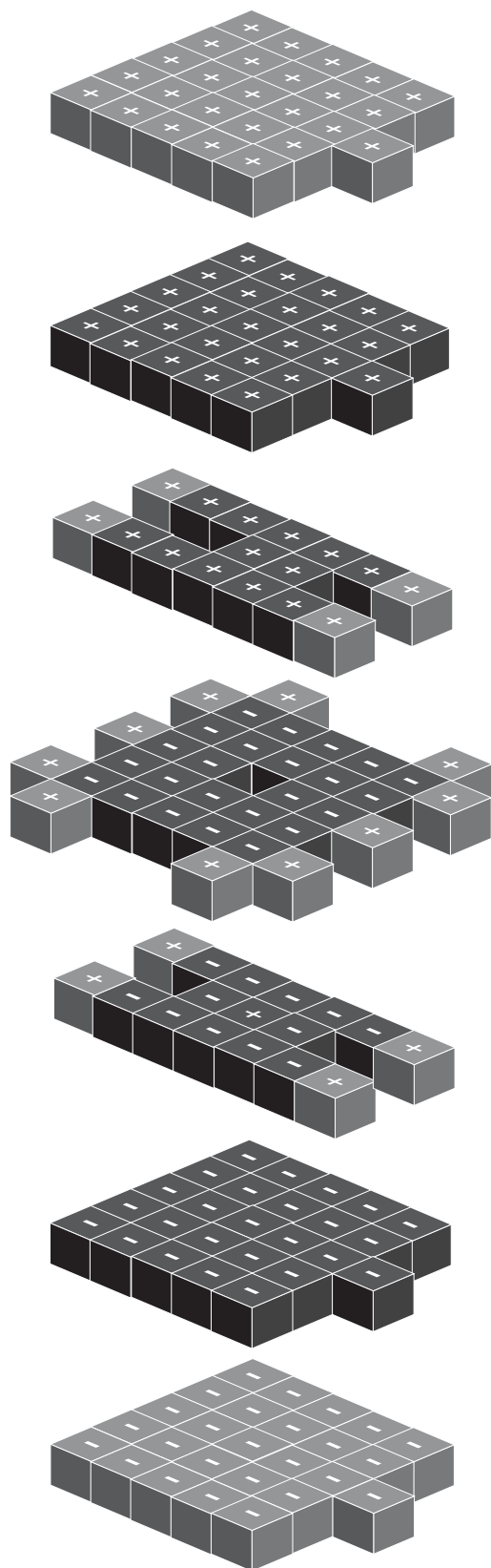
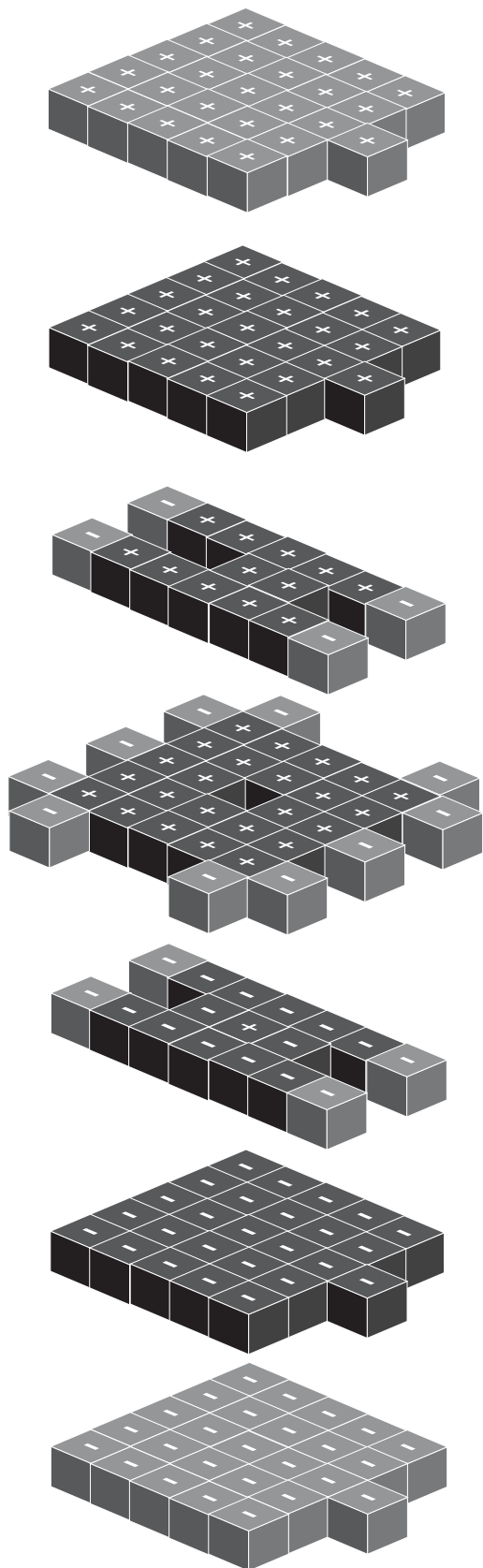


Ytterbium Nucleus

$$s^2 f^4 d^{10}$$

Yb 171m1
 Proton: 70
 Neutron: 101
 Spin: 7/2

Yb 171m2
 Proton: 70
 Neutron: 101
 Spin: -5/2

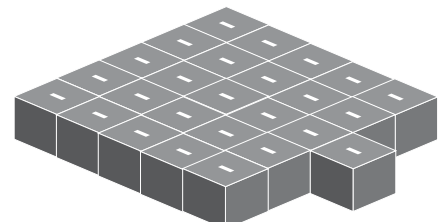
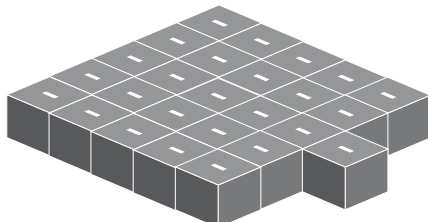
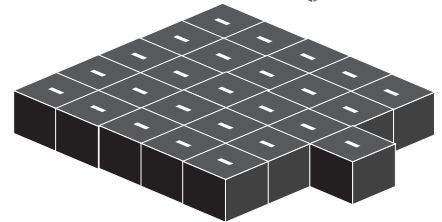
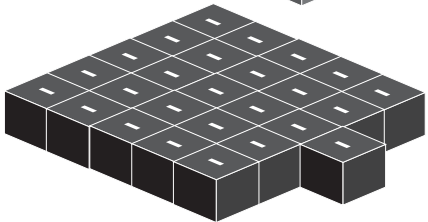
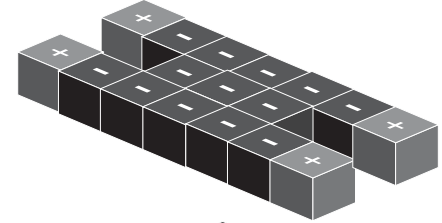
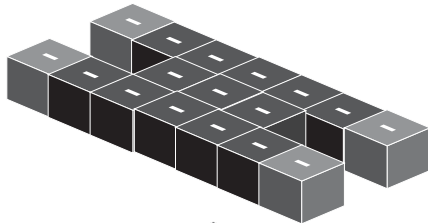
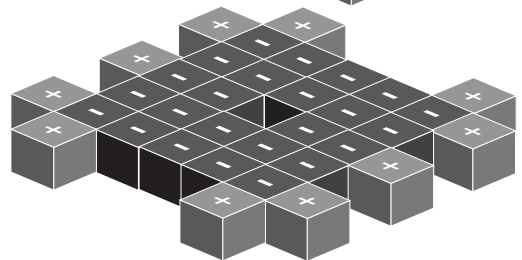
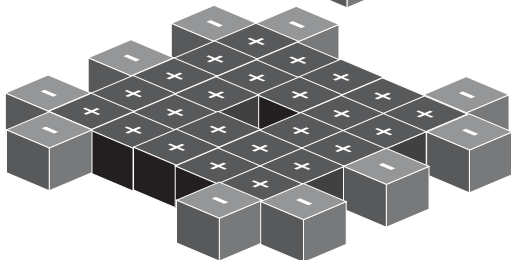
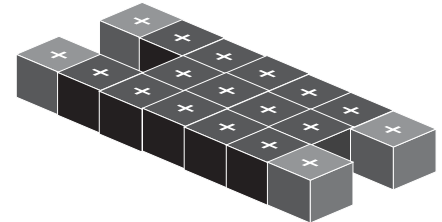
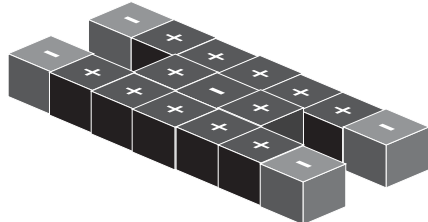
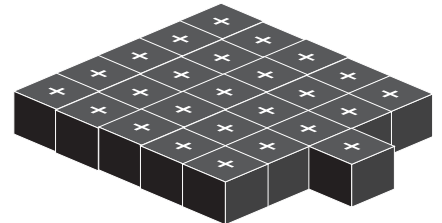
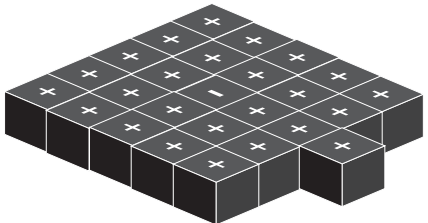
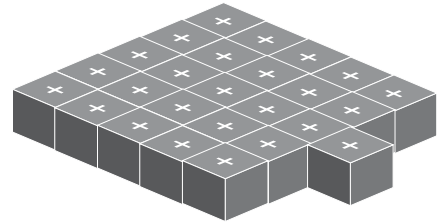
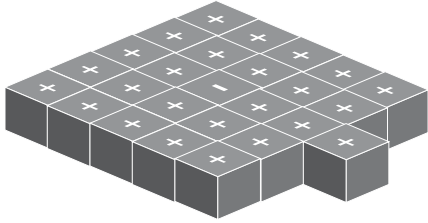


Ytterbium Nucleus

$$s^2 f^4 d^{10}$$

Yb 172
Proton: 70
Neutron: 102
Spin: 0
Stable

Yb 173
Proton: 70
Neutron: 103
Spin: -5/2
Stable

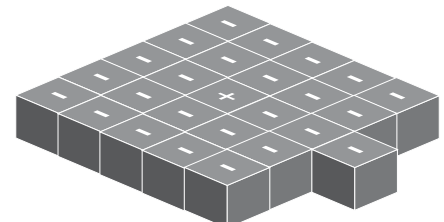
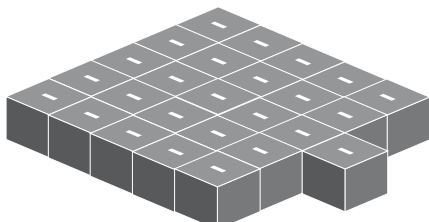
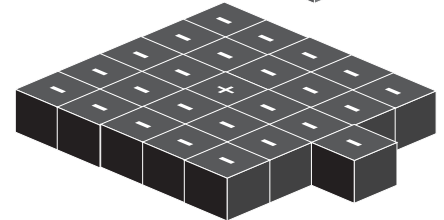
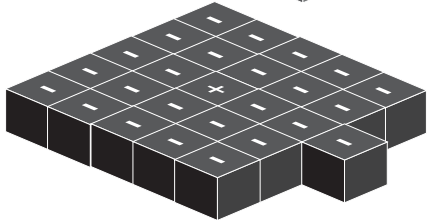
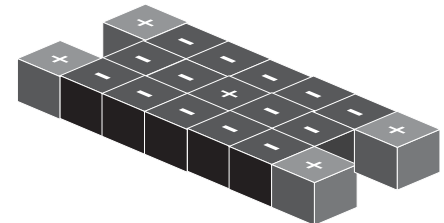
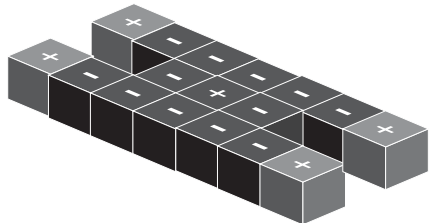
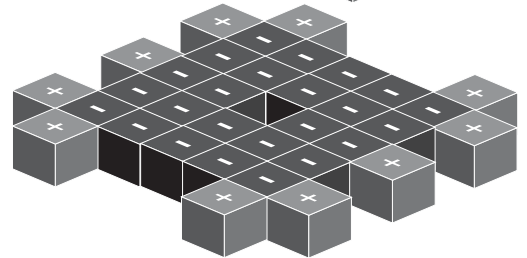
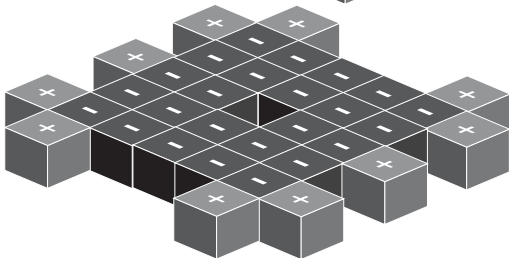
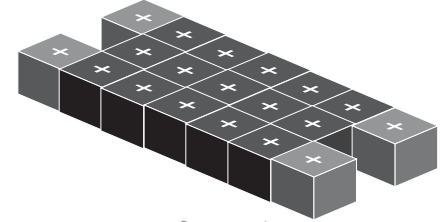
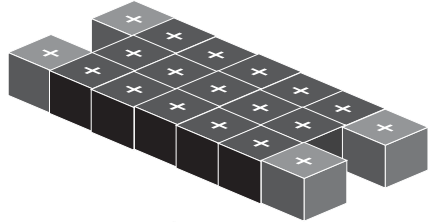
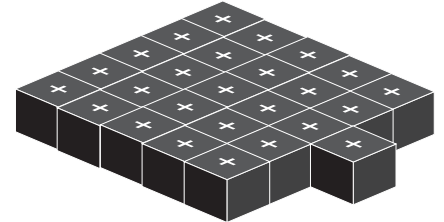
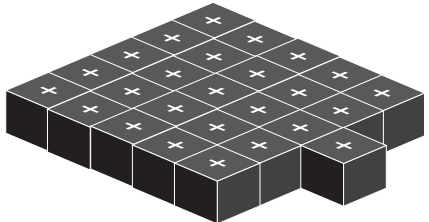
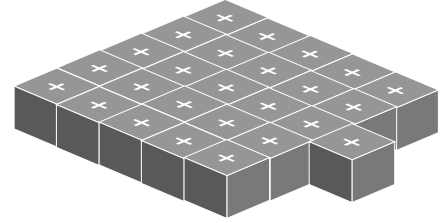
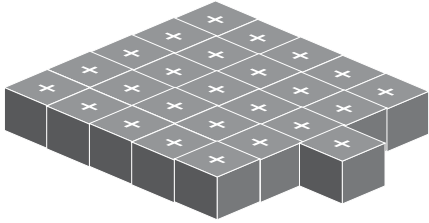


Ytterbium Nucleus

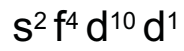
$$s^2 f^4 d^{10}$$

Yb 174
Proton: 70
Neutron: 104
Spin:0
Stable

Yb 176
Proton: 70
Neutron: 106
Spin:0
Stable

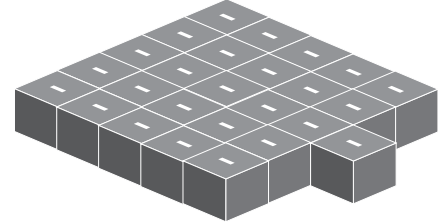
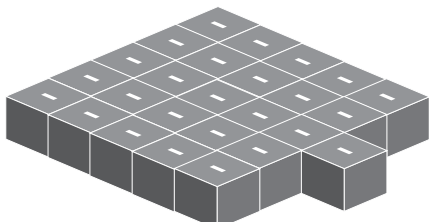
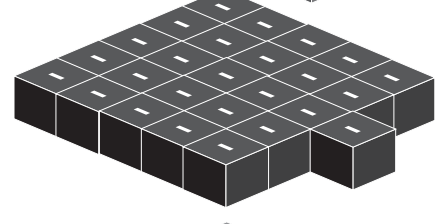
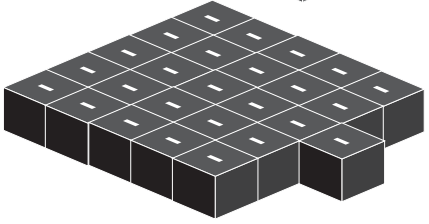
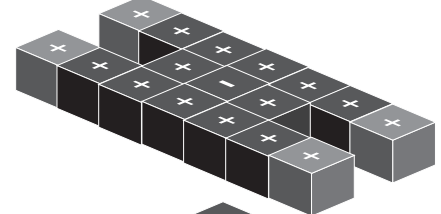
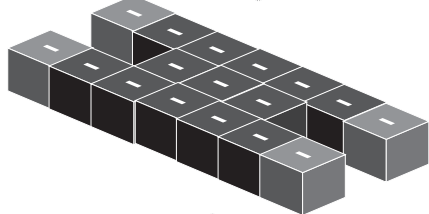
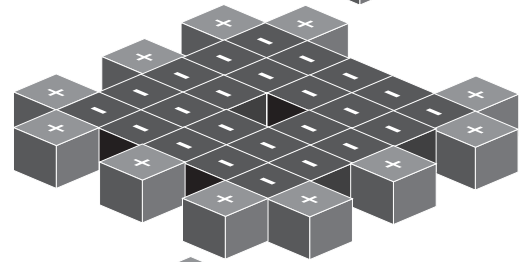
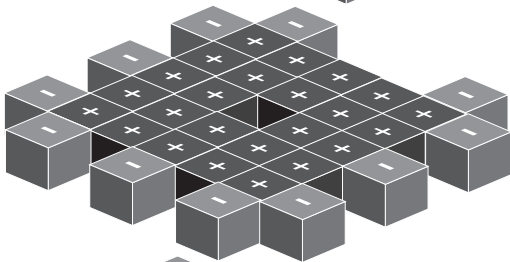
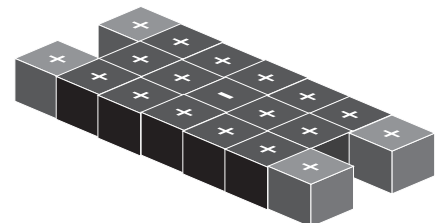
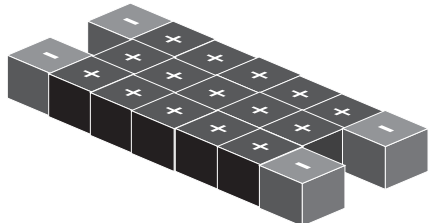
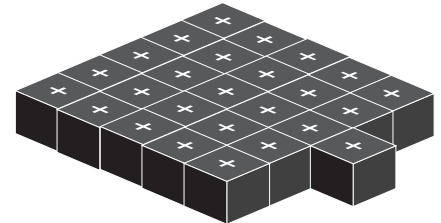
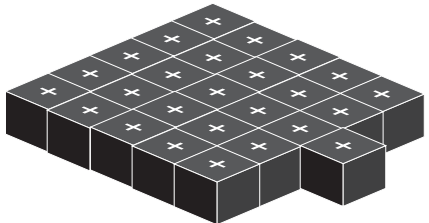
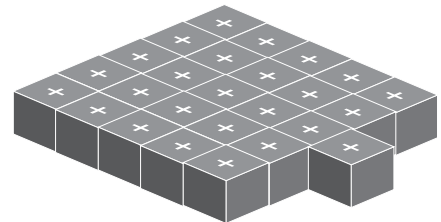
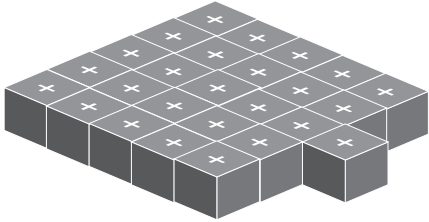


Lutetium Nucleus



Lu 175
Proton: 71
Neutron: 104
Spin: 7/2
Stable

Lu 175m1
Proton: 71
Neutron: 104
Spin: 19/2

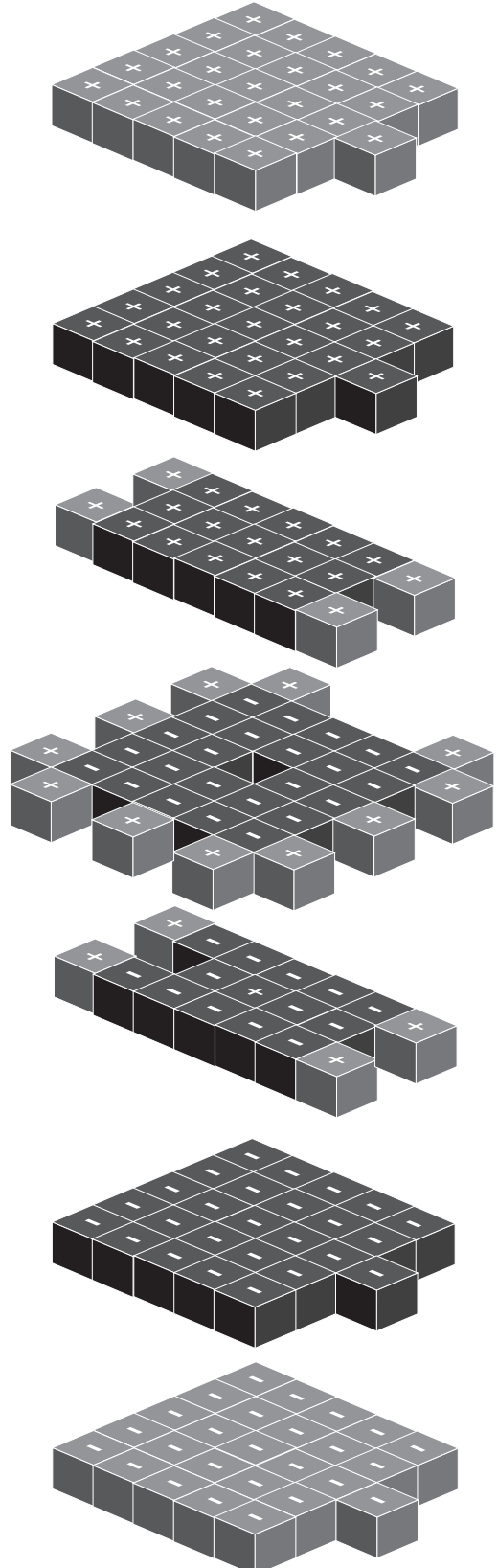
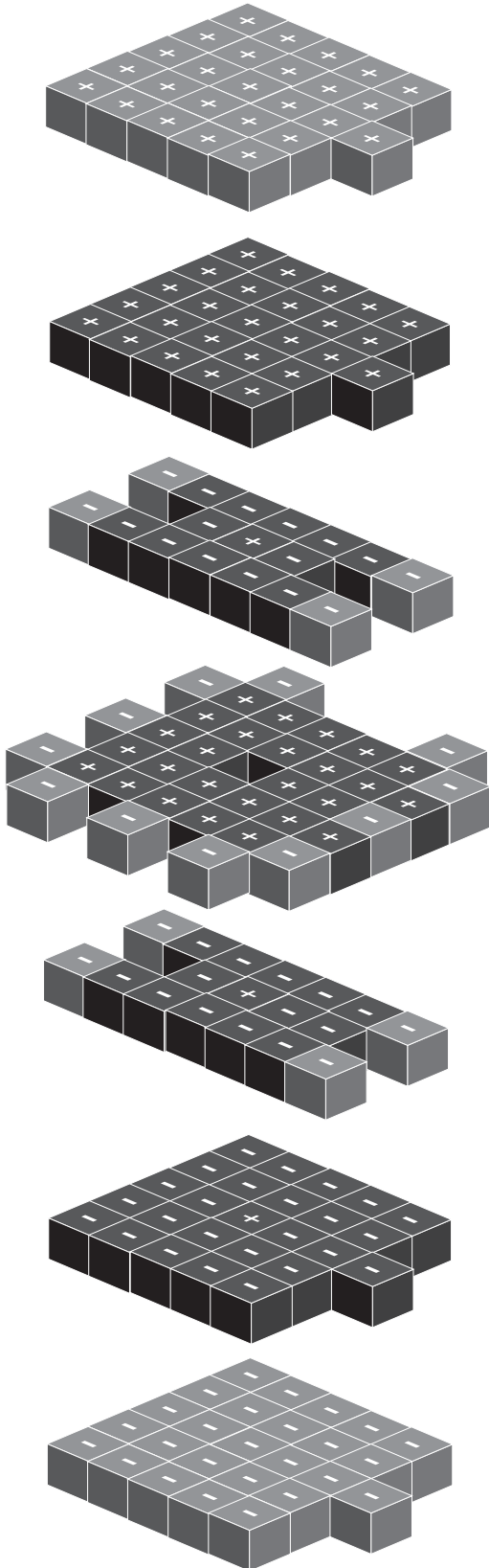


Lutetium Nucleus

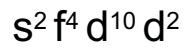
$$s^2 f^4 d^{10} d^1$$

Lu 176
 Proton: 71
 Neutron: 105
 Spin:-7

Lu 176m
 Proton: 71
 Neutron: 105
 Spin:-1

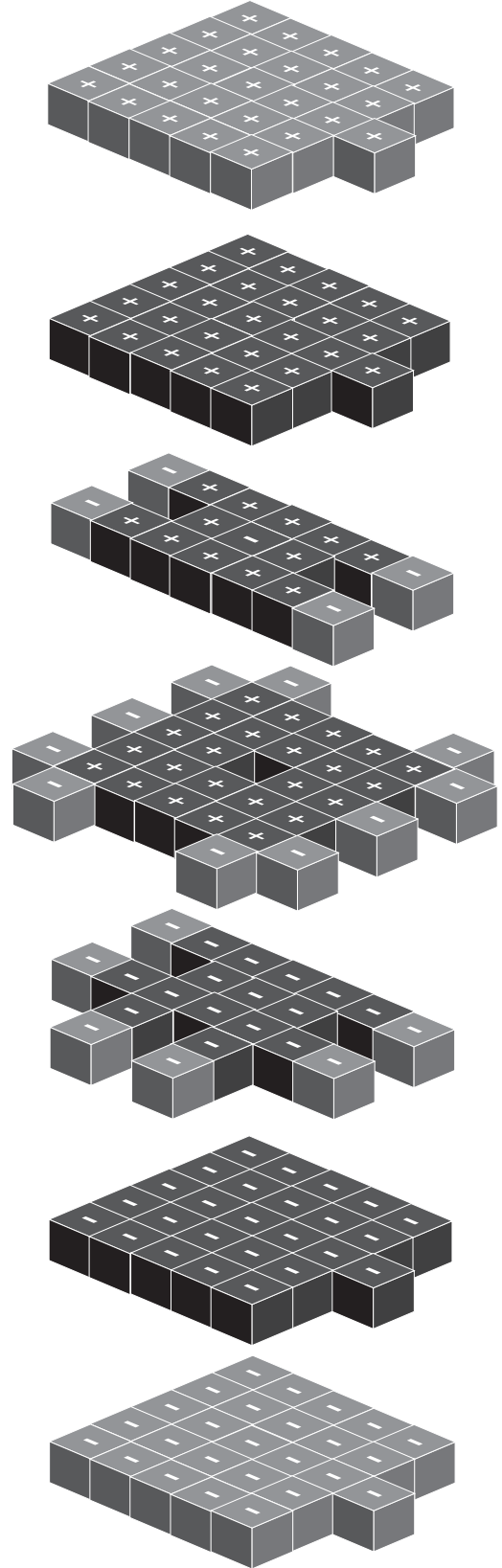
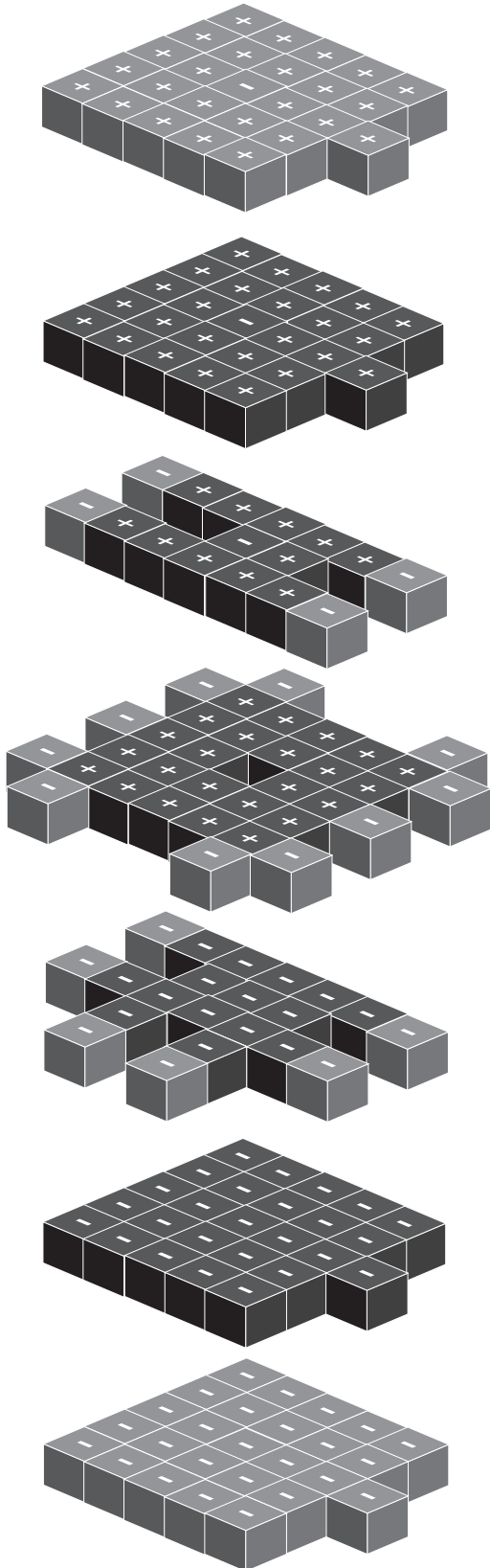


Hafnium Nucleus

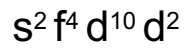


Hf 175
Proton: 72
Neutron: 103
Spin: -5/2

Hf 176
Proton: 72
Neutron: 104
Spin: 0
Stable

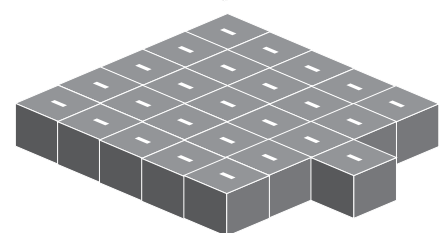
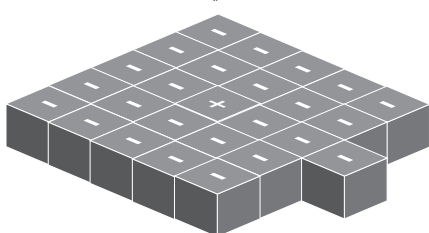
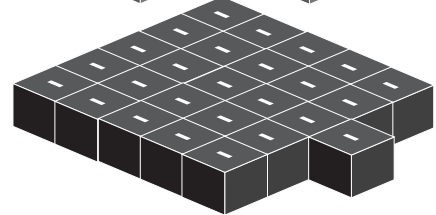
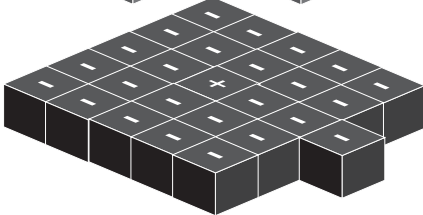
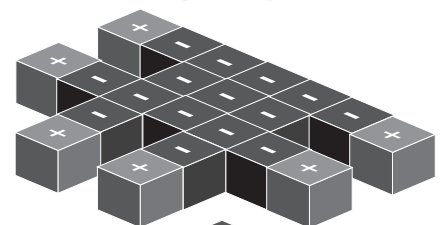
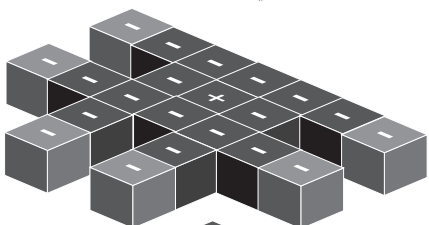
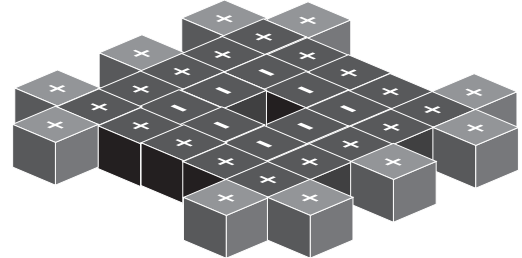
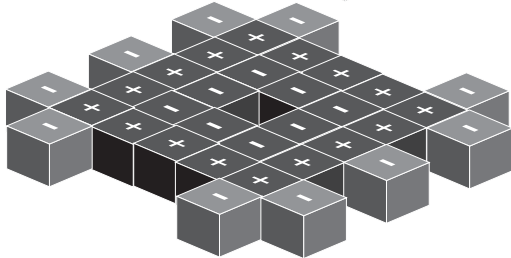
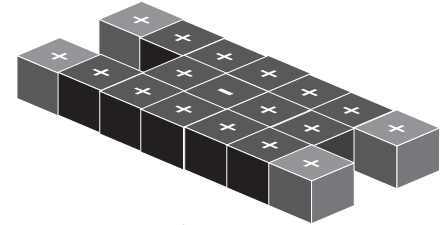
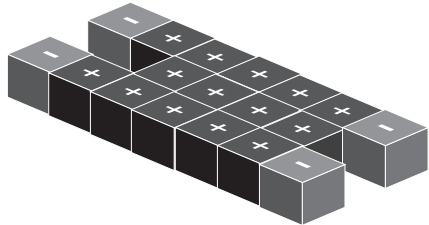
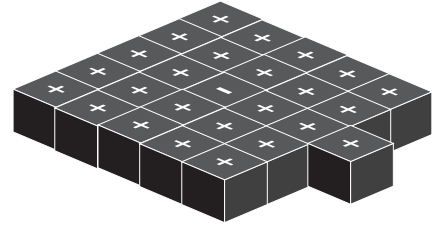
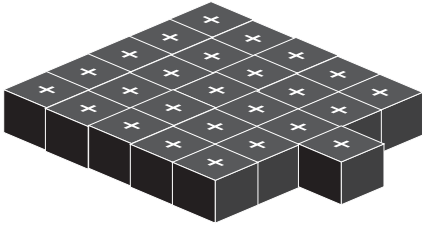
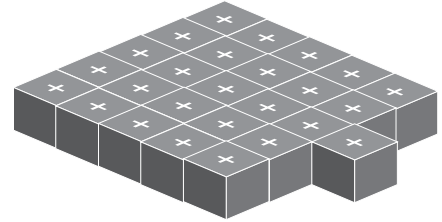
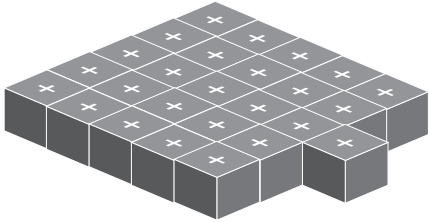


Hafnium Nucleus



Hf 177
Proton: 72
Neutron: 105
Spin: -7/2
Stable

Hf 177m1
Proton: 72
Neutron: 105
Spin: 23/2
Half life: 1.09 sec

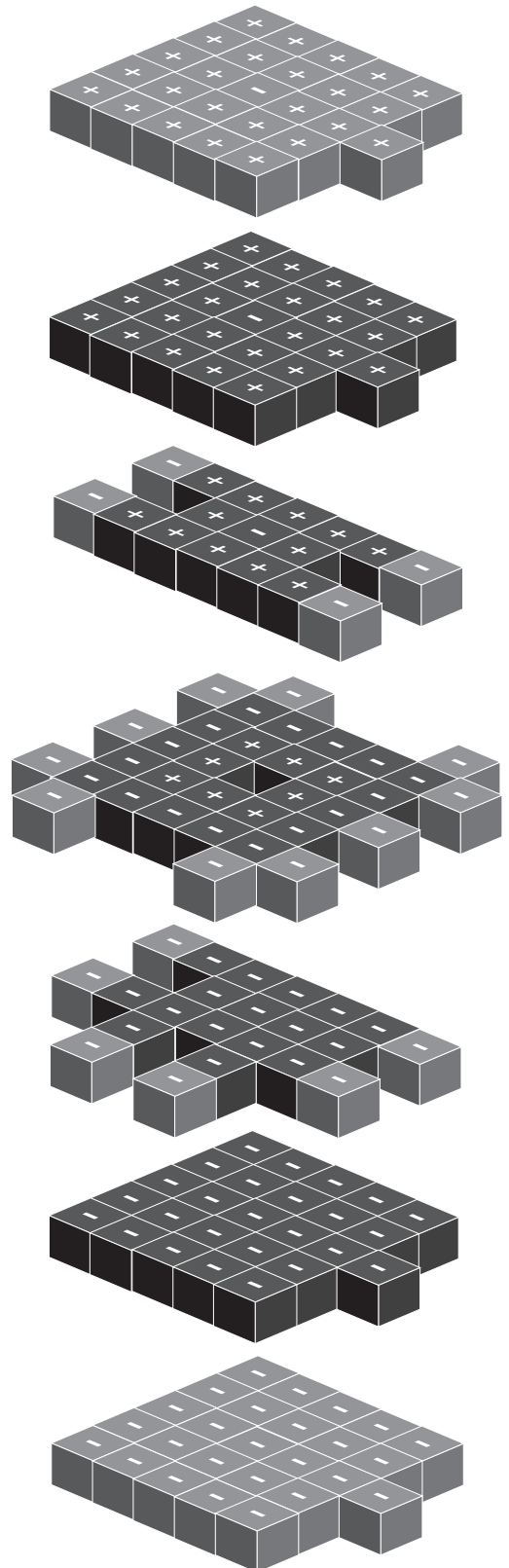
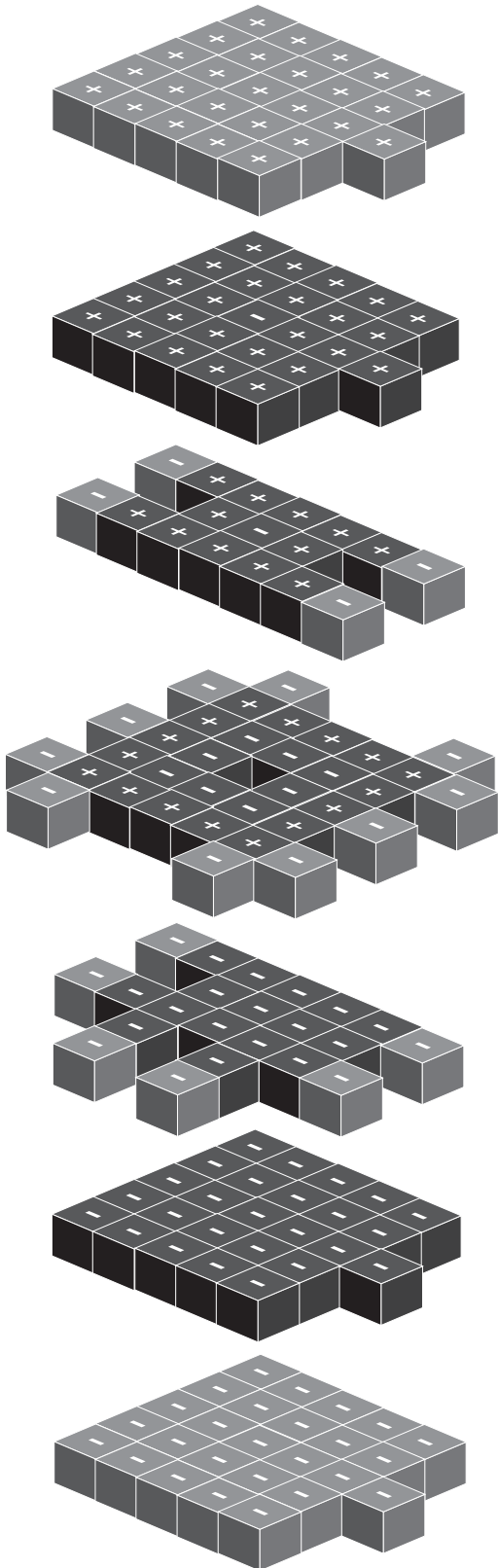


Hafnium Nucleus

$$s^2 f^4 d^{10} d^2$$

Hf 177m2
 Proton: 72
 Neutron: 105
 Spin: -19/2
 Half life: 55.9 μ s

Hf 177m3
 Proton: 72
 Neutron: 105
 Spin: -37/2
 Half life: 51.4 min

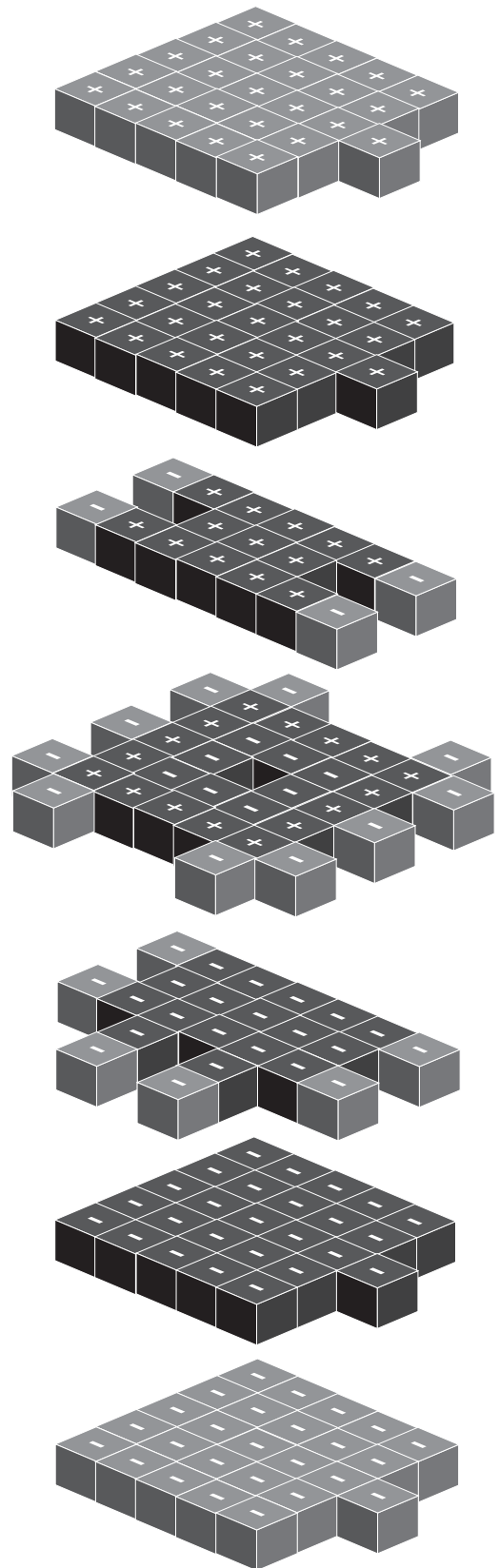
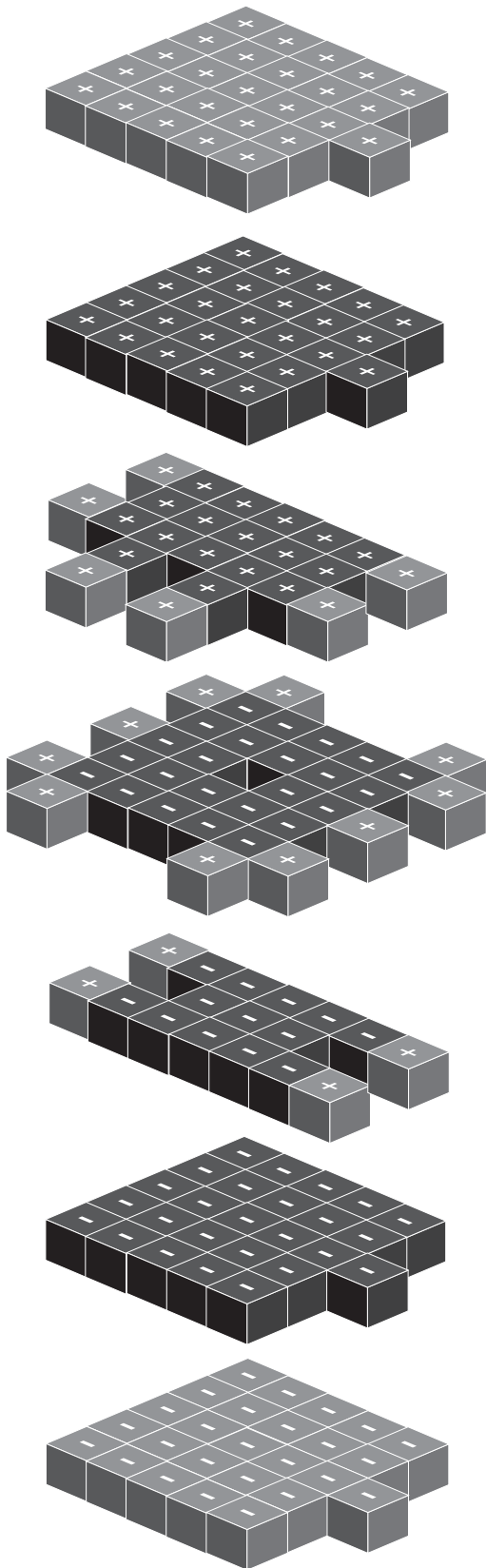


Hafnium Nucleus

$$s^2 f^4 d^{10} d^2$$

Hf 178
 Proton: 72
 Neutron: 106
 Spin: 0
 Stable

Hf 178m1
 Proton: 72
 Neutron: 106
 Spin: -8

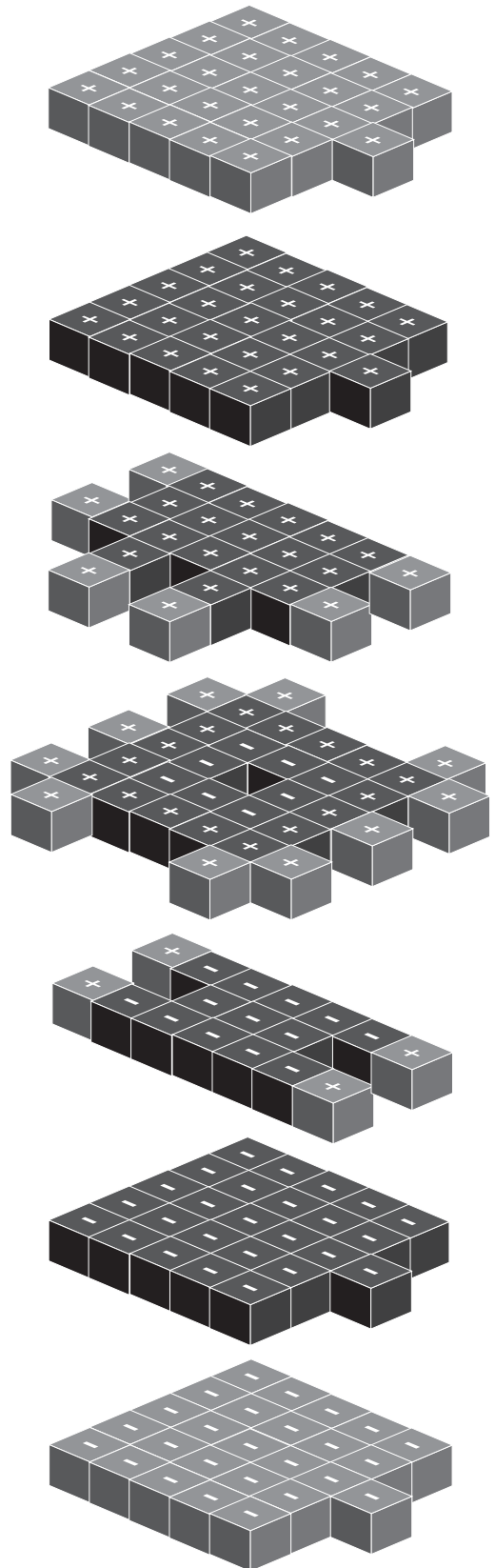
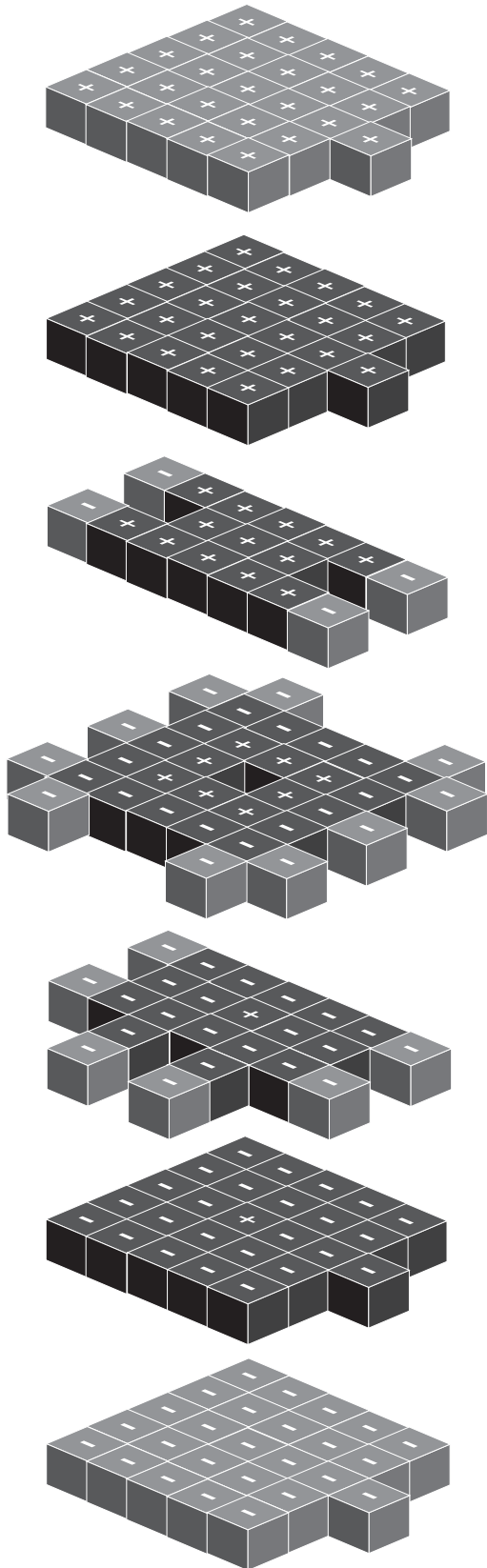


Hafnium Nucleus

$$s^2 f^4 d^{10} d^2$$

Hf 178m2
 Proton: 72
 Neutron: 106
 Spin:-14

Hf 178m3
 Proton: 72
 Neutron: 106
 Spin:16

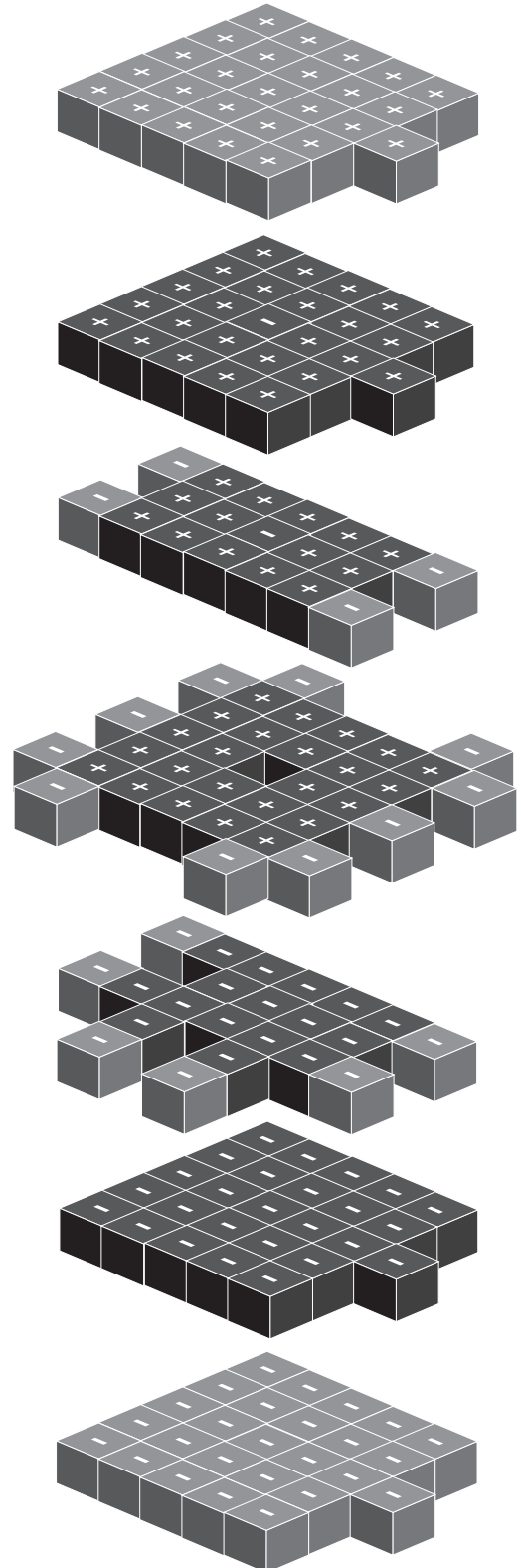
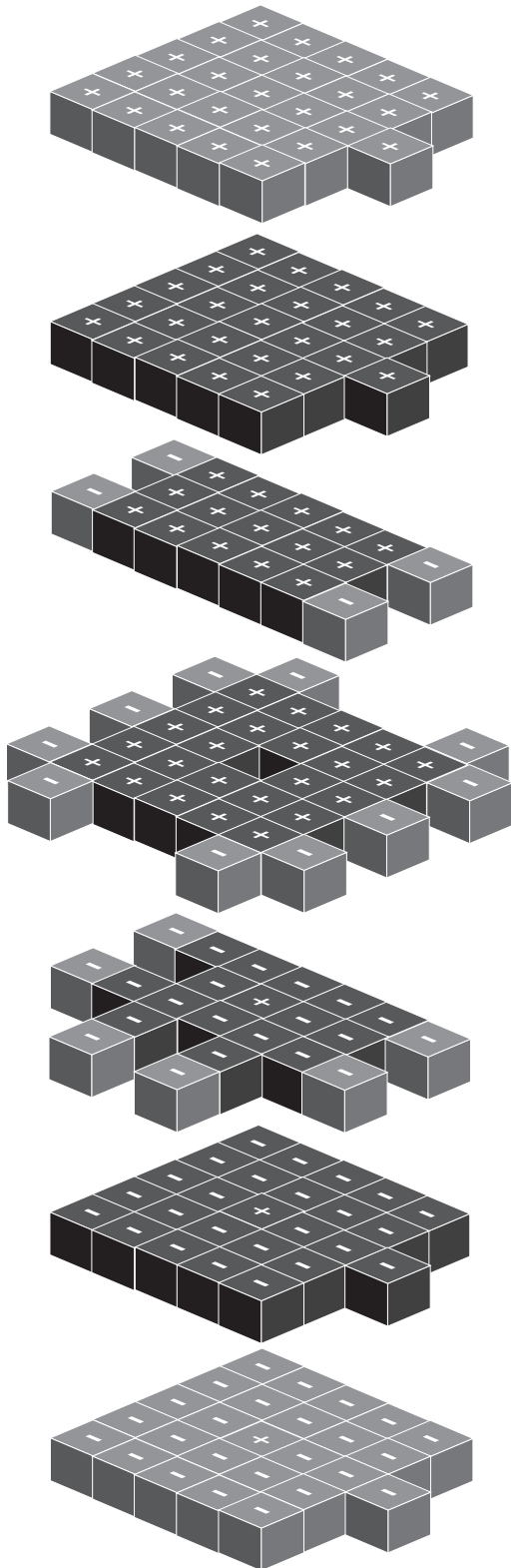


Hafnium Nucleus

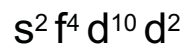
$s^2 f^4 d^{10} d^2$

Hf 179
Proton: 72
Neutron: 107
Spin: 9/2
Stable

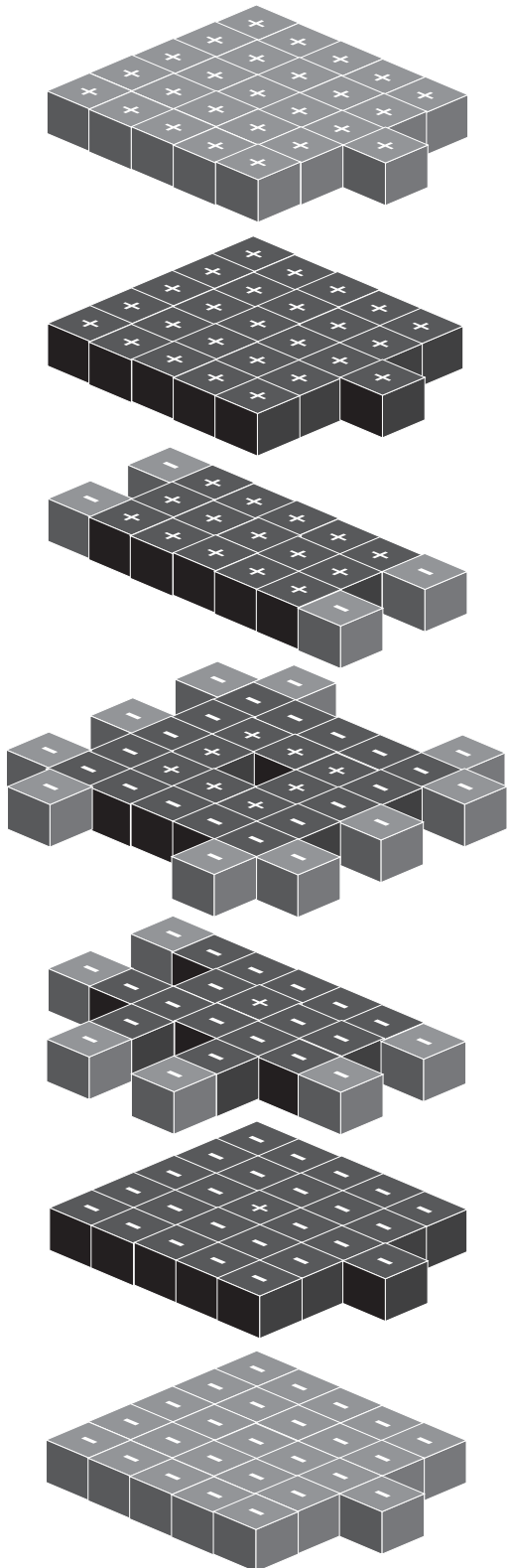
Hf 179m1
Proton: 72
Neutron: 107
Spin: -1/2



Hafnium Nucleus



Hf 179m2
Proton: 72
Neutron: 107
Spin: -25/2

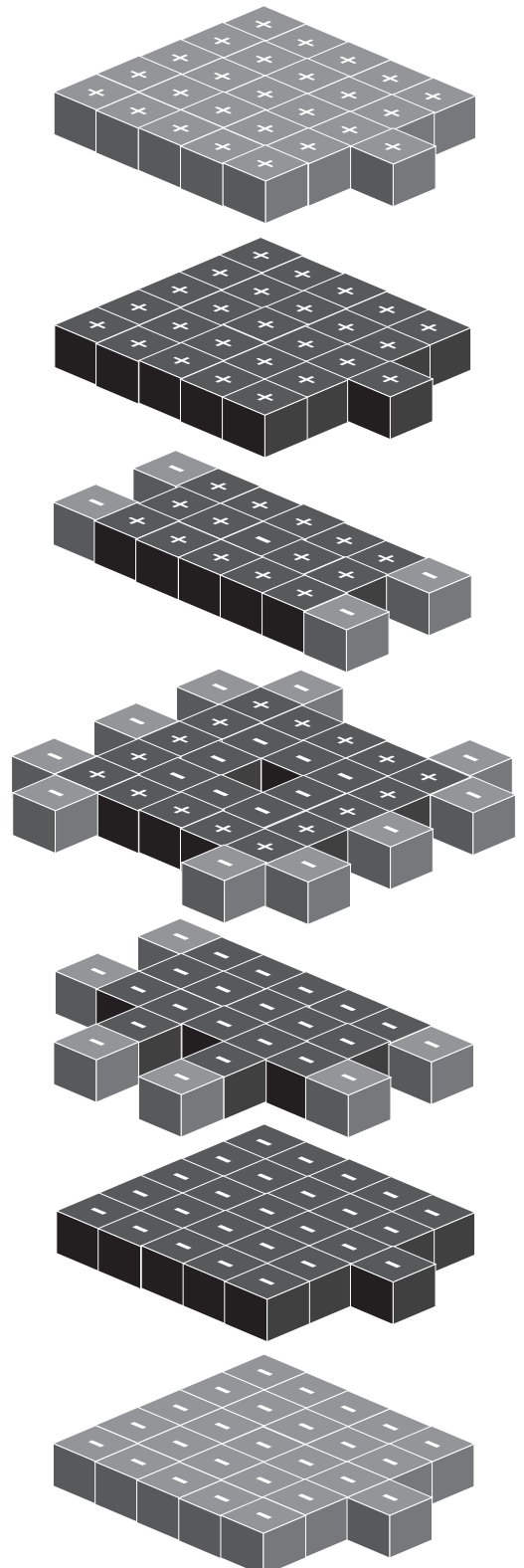
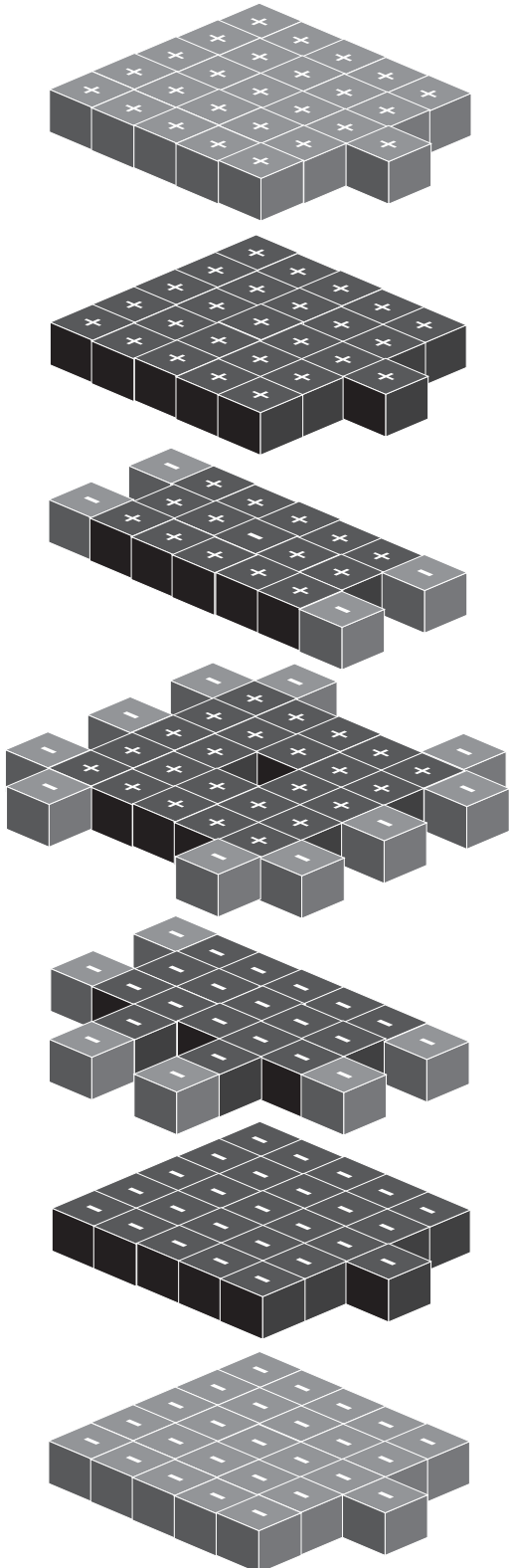


Hafnium Nucleus

$$s^2 f^4 d^{10} d^2$$

Hf 180
 Proton: 72
 Neutron: 108
 Spin:0
 Stable

Hf 180m1
 Proton: 72
 Neutron: 108
 Spin:-8

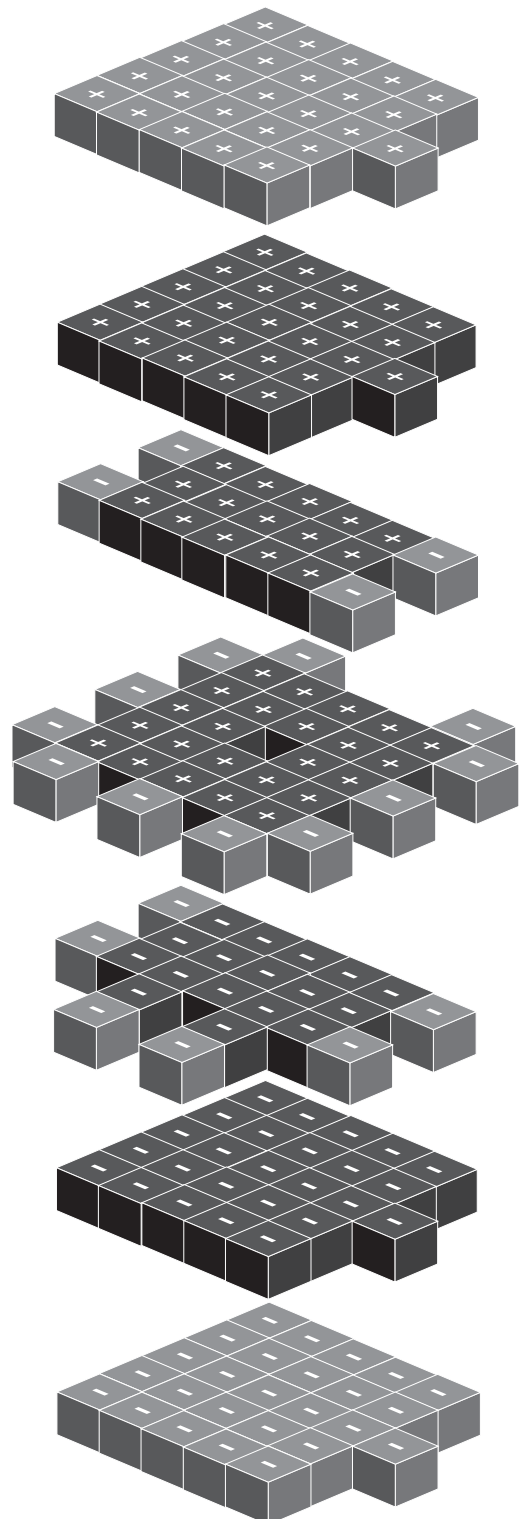
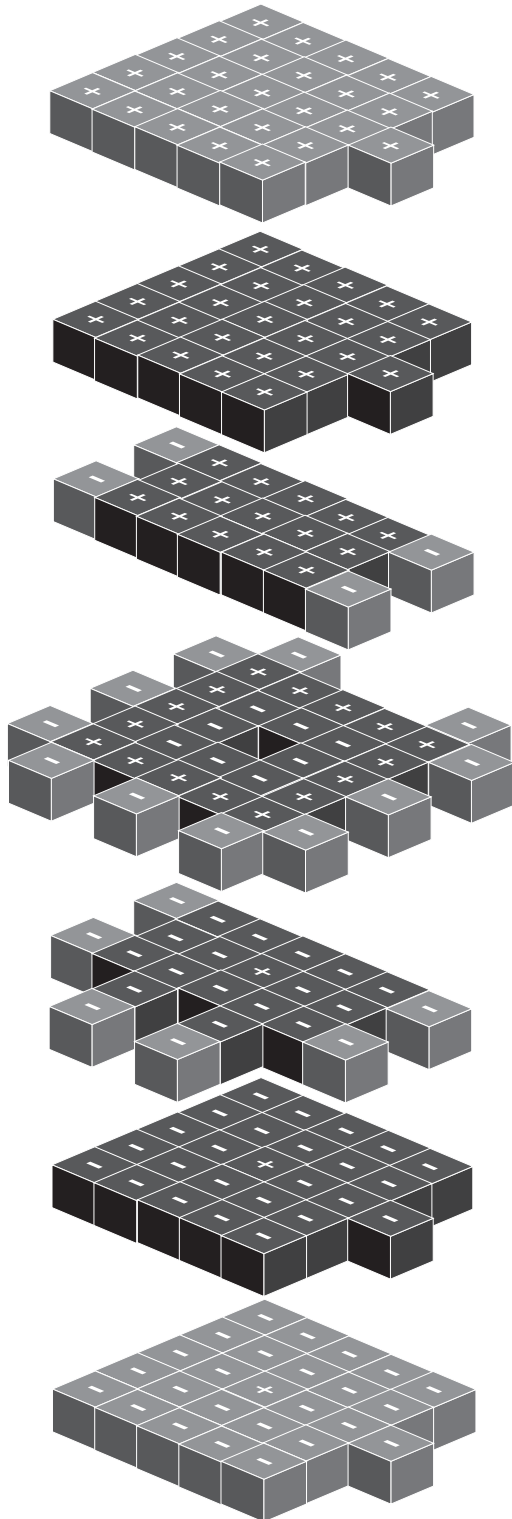


Tantalum Nucleus

$$s^2 f^4 d^{10} d^3$$

Ta 181m1
Proton: 73
Neutron: 108
Spin:-9/2

Ta 181m2
Proton: 73
Neutron: 108
Spin:1/2

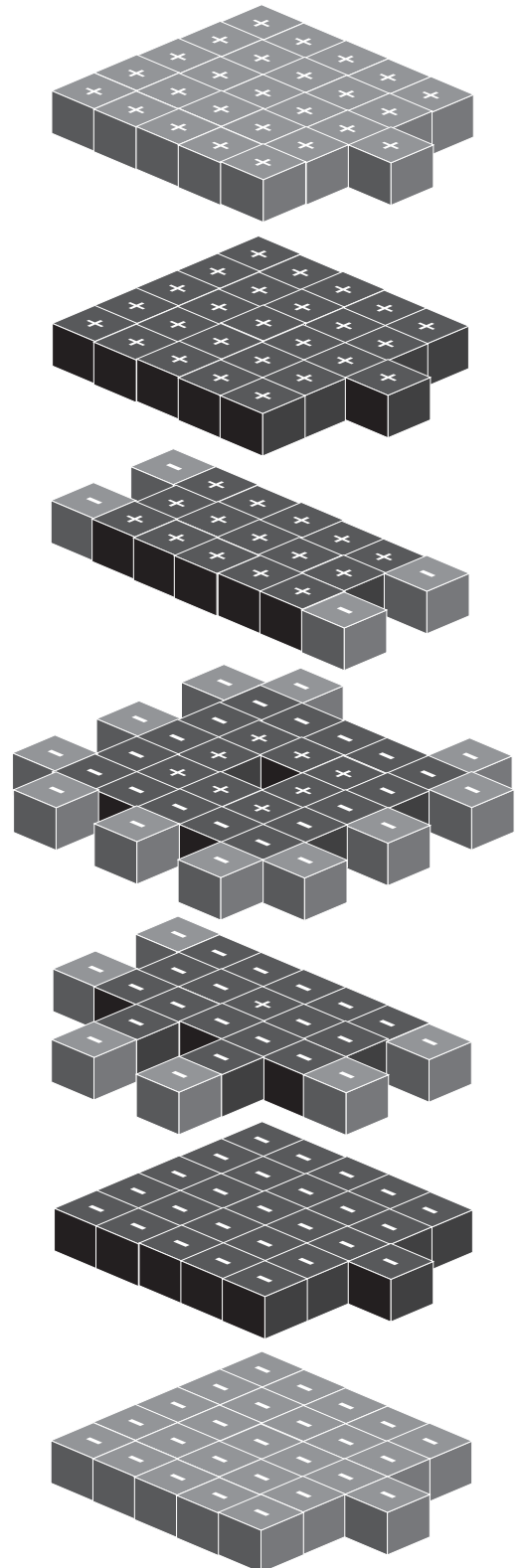
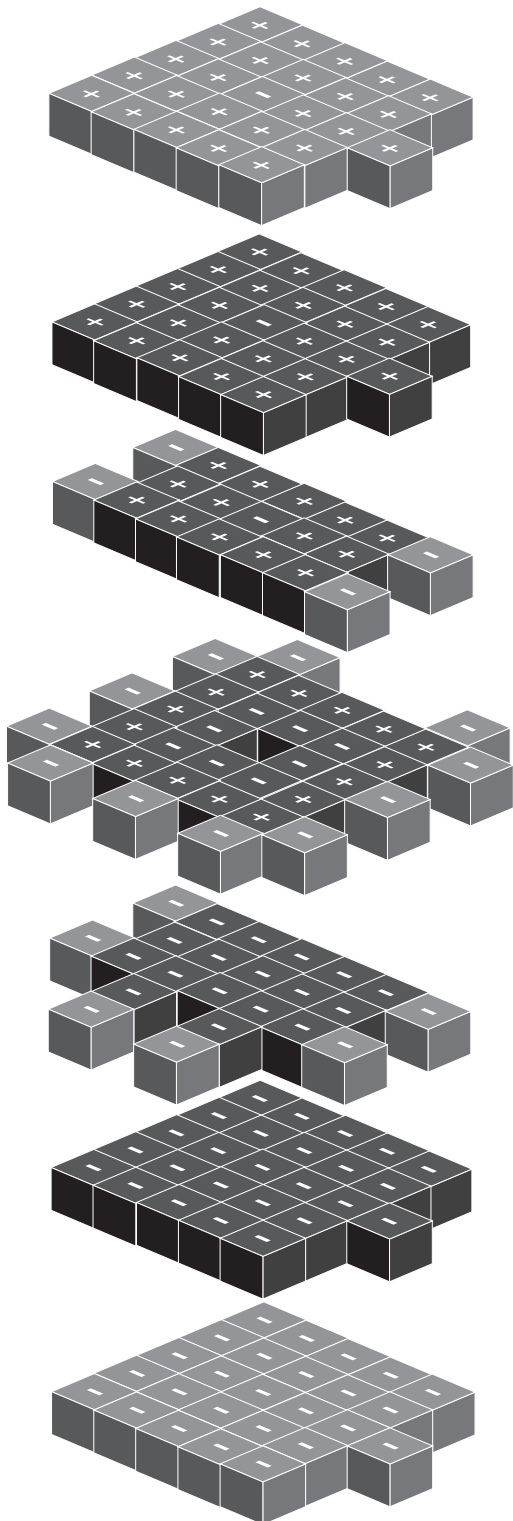


Tantalum Nucleus

$$s^2 f^4 d^{10} d^3$$

Ta 181m3
Proton: 73
Neutron: 108
Spin: -21/2

Ta 181m4
Proton: 73
Neutron: 108
Spin: -29/2

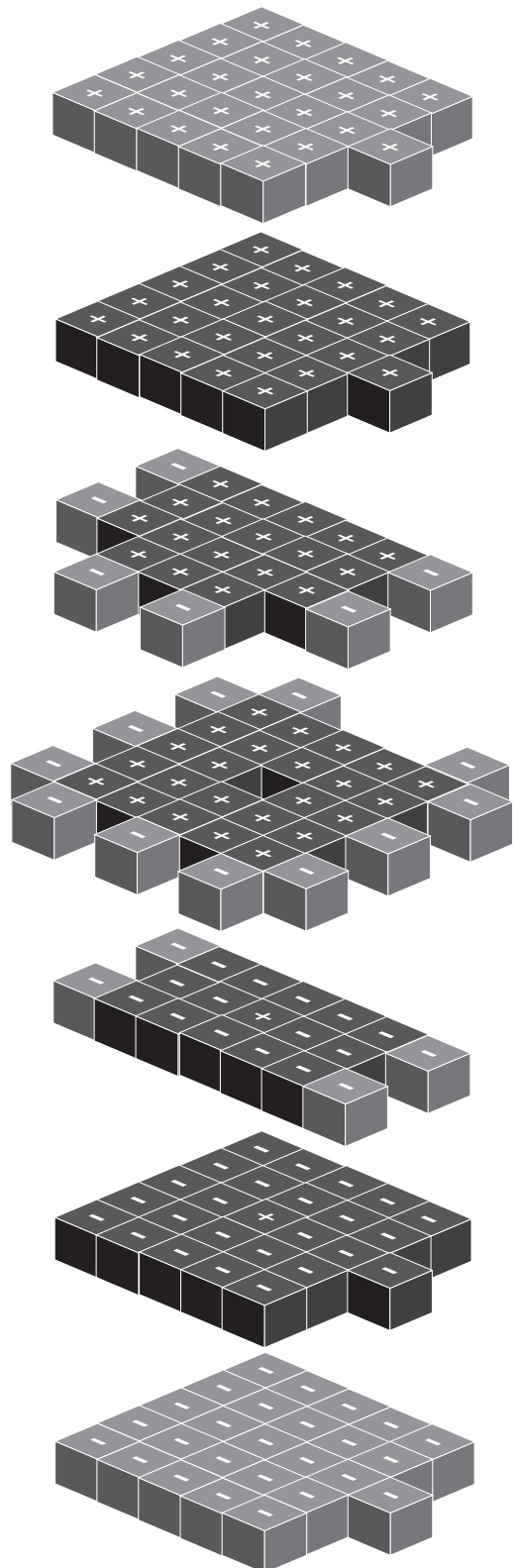
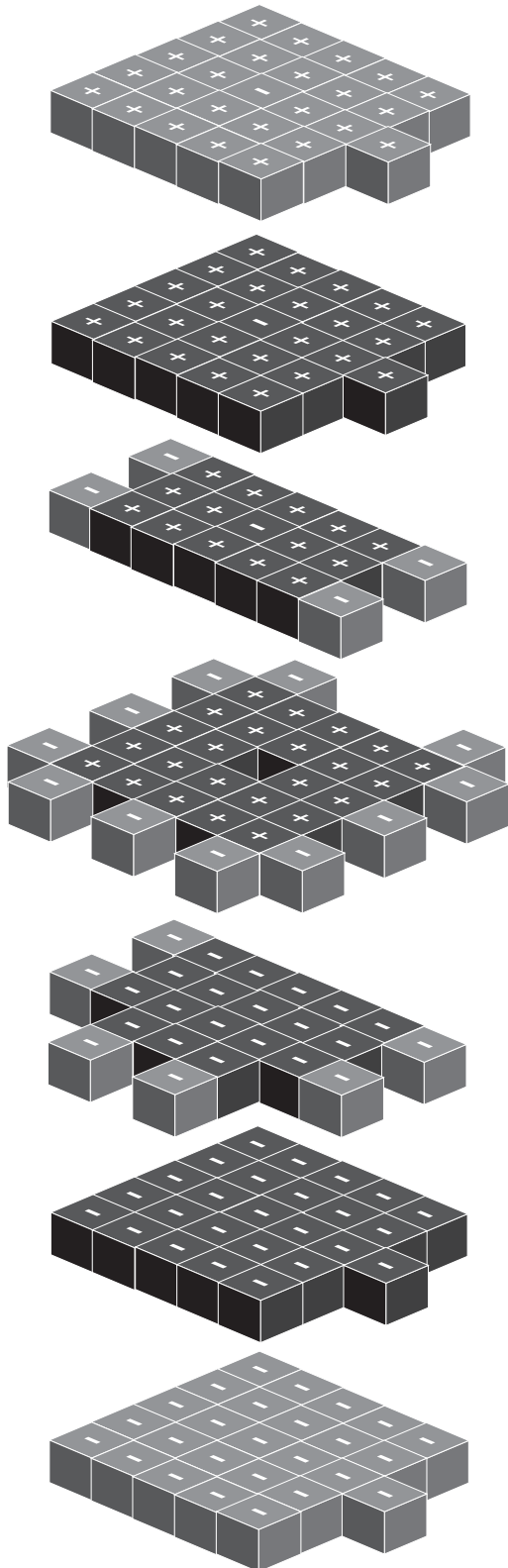


Tantalum Nucleus

$$s^2 f^4 d^{10} d^3$$

Ta 182
 Proton: 73
 Neutron: 109
 Spin:-3

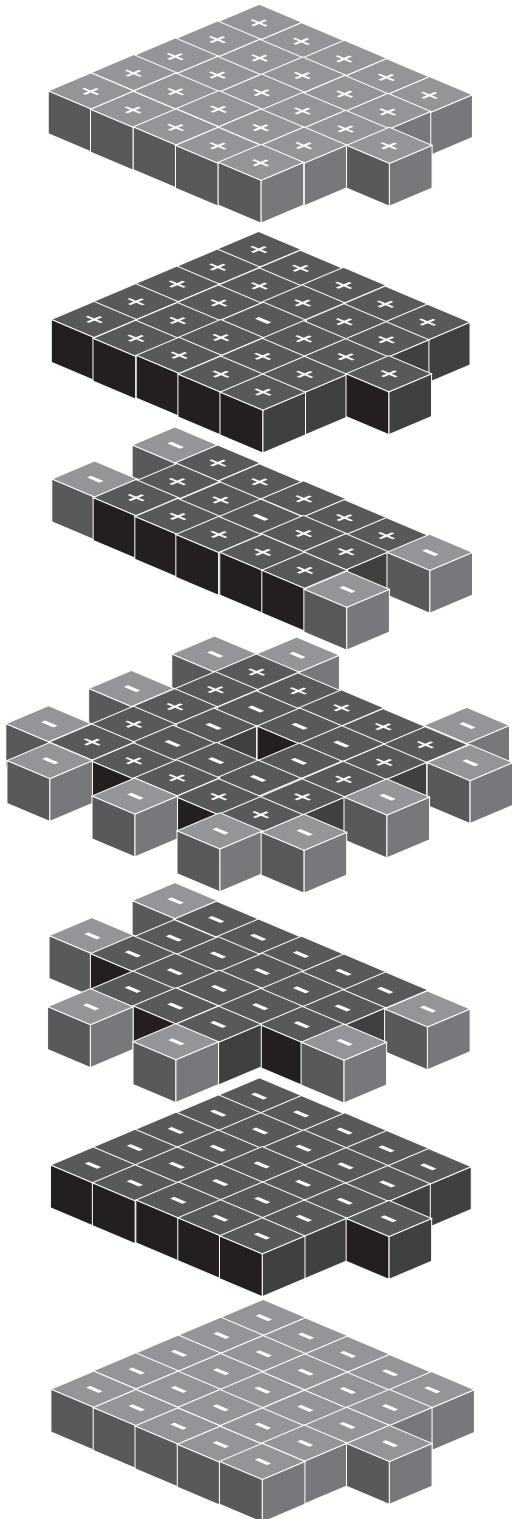
Ta 182m1
 Proton: 73
 Neutron: 109
 Spin:5



Tantalum Nucleus

$s^2 f^4 d^{10} d^3$

Ta 182m2
Proton: 73
Neutron: 109
Spin: -10

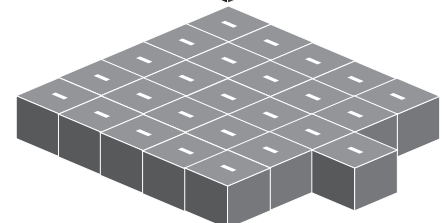
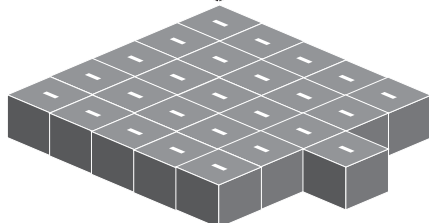
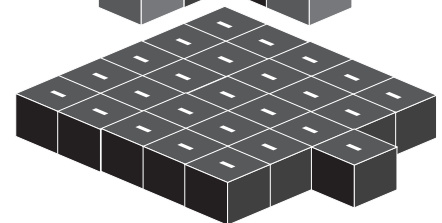
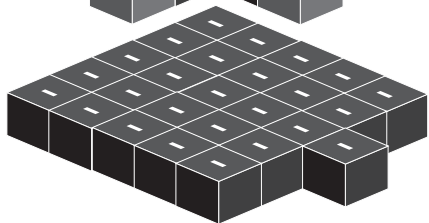
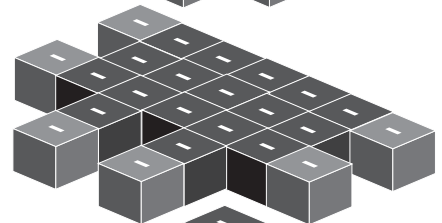
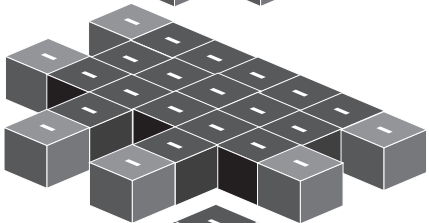
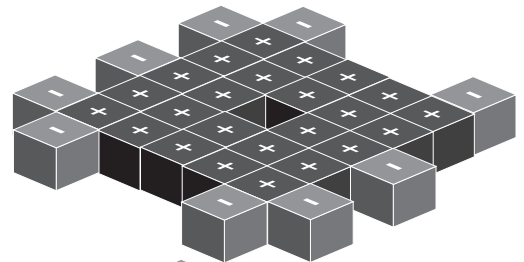
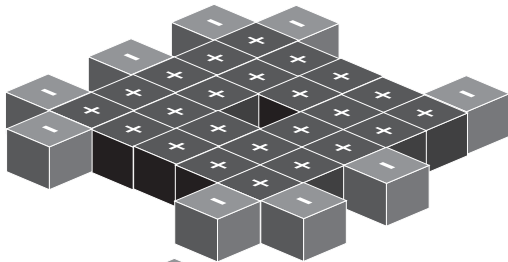
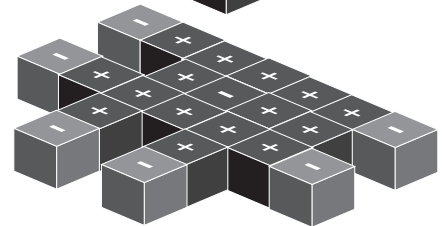
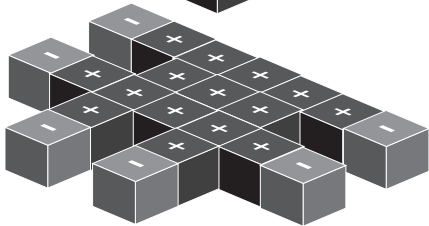
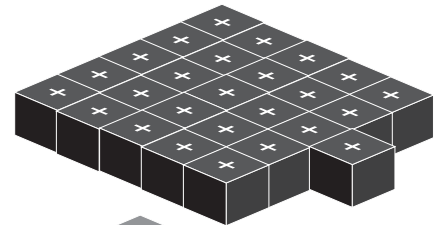
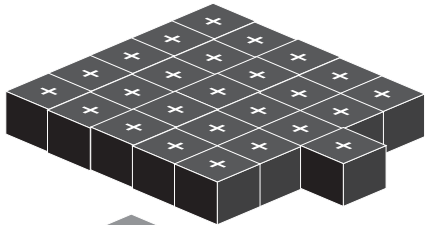
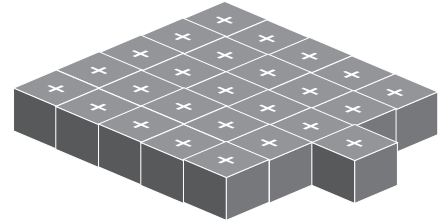
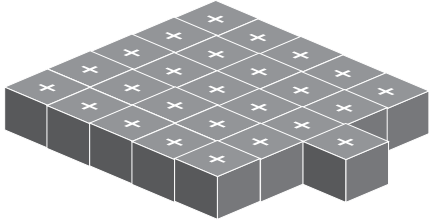


Tungsten Nucleus

$$s^2 f^4 d^{10} d^4$$

W 182
Proton: 74
Neutron: 108
Spin: 0
Stable

W 183
Proton: 74
Neutron: 109
Spin: -1/2
Stable

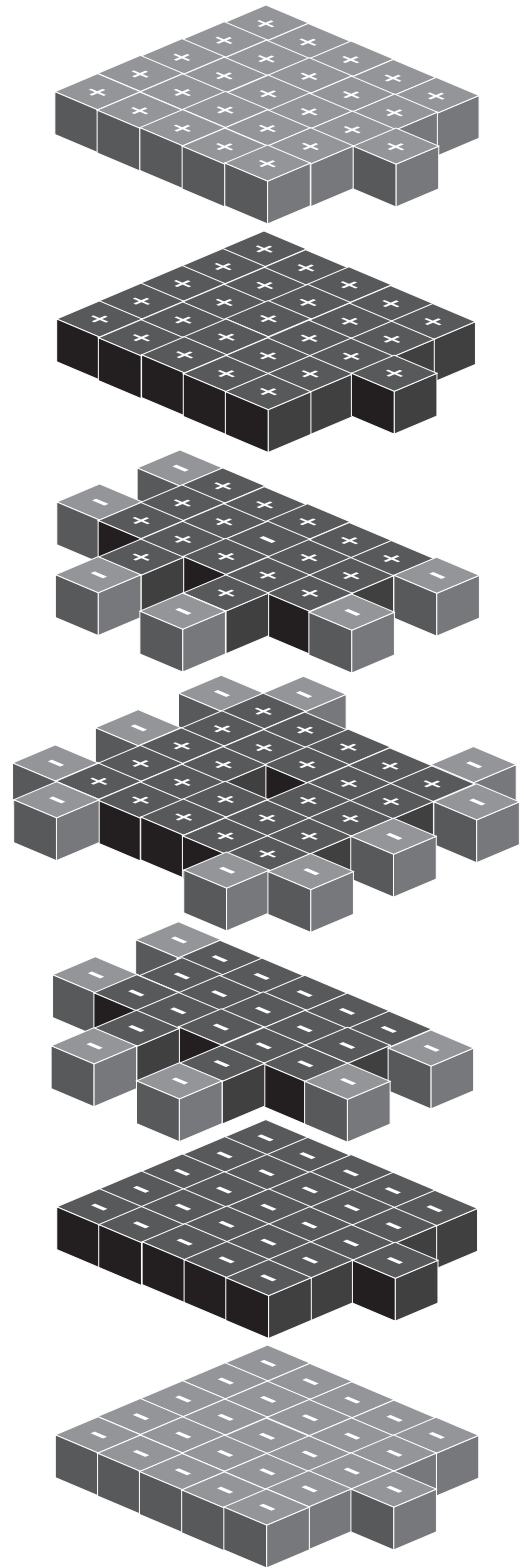
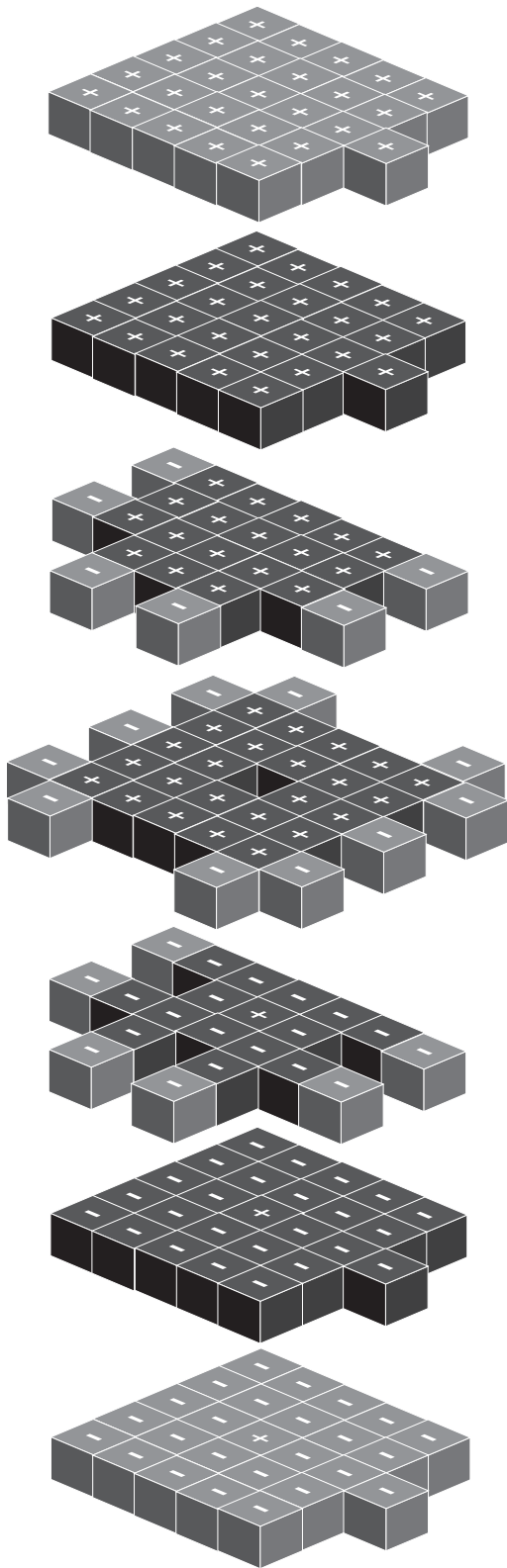


Tungsten Nucleus

$$s^2 f^4 d^{10} d^4$$

W 183m
Proton: 74
Neutron: 109
Spin: 11/2

W 184
Proton: 74
Neutron: 110
Spin: 0
Stable

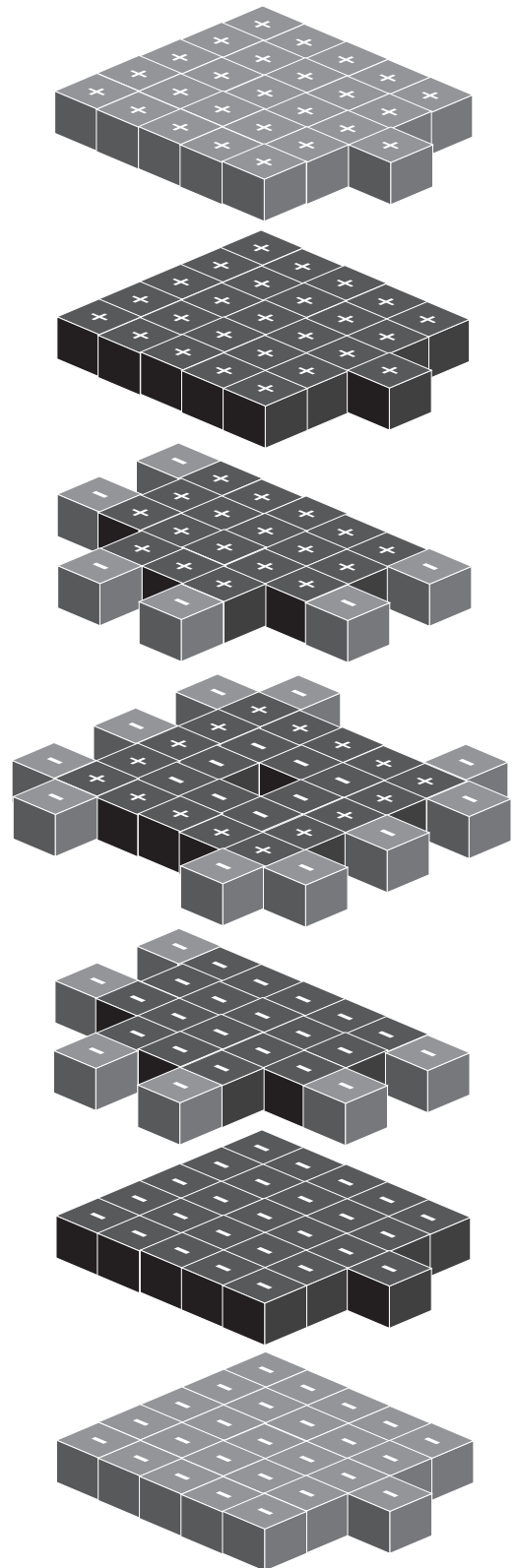
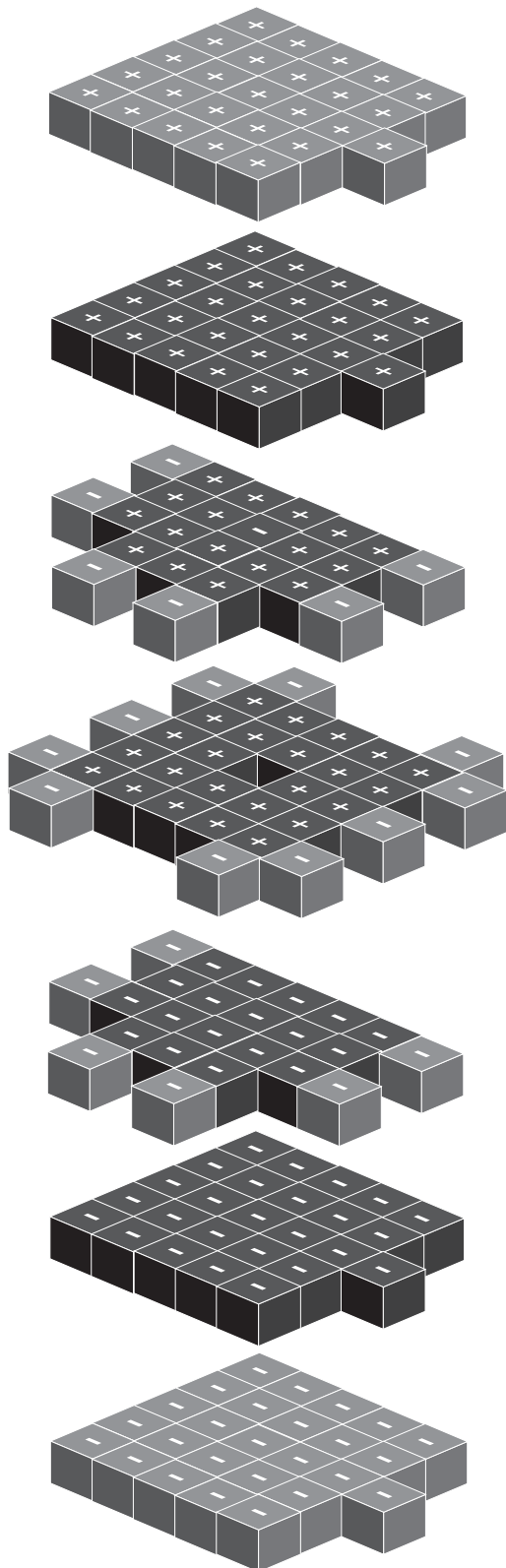


Tungsten Nucleus

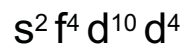
$$s^2 f^4 d^{10} d^4$$

W 186
 Proton: 74
 Neutron: 112
 Spin:0
 Stable

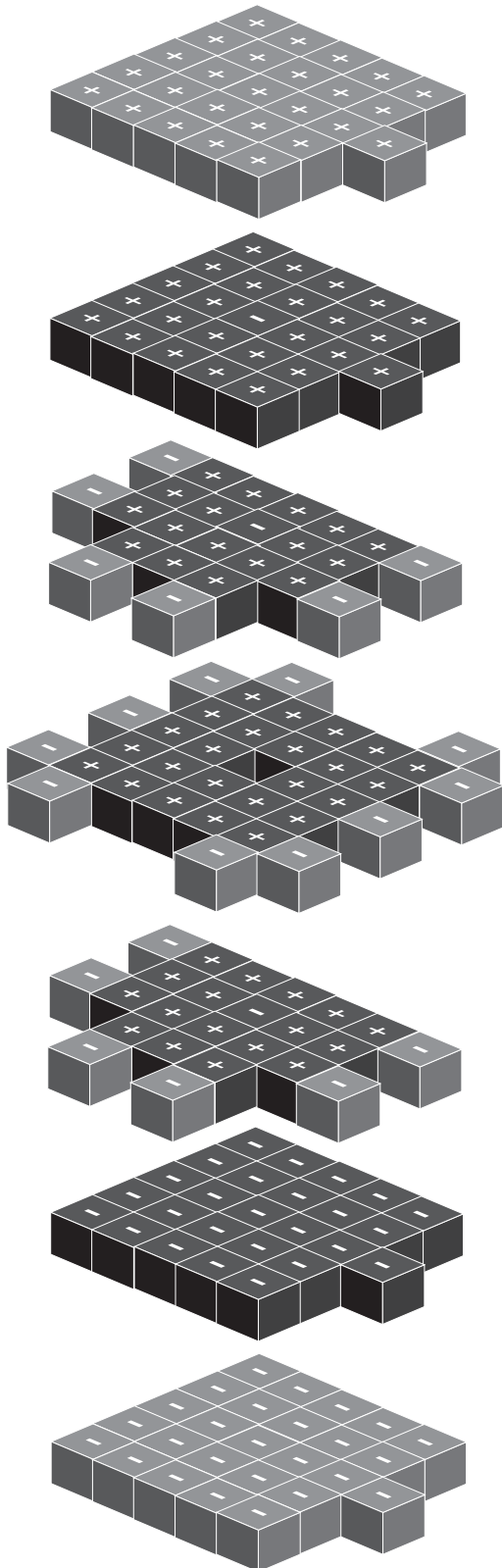
W 186m1
 Proton: 74
 Neutron: 112
 Spin:-7



Tungsten Nucleus



W 186m2
Proton: 74
Neutron: 112
Spin:16

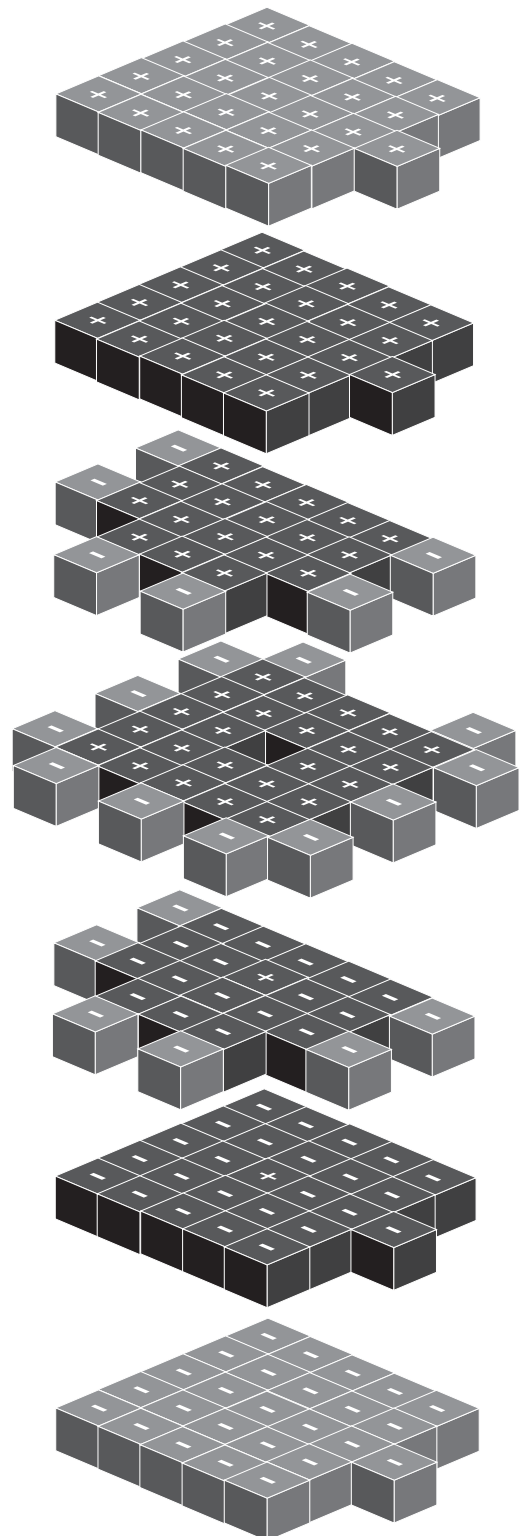
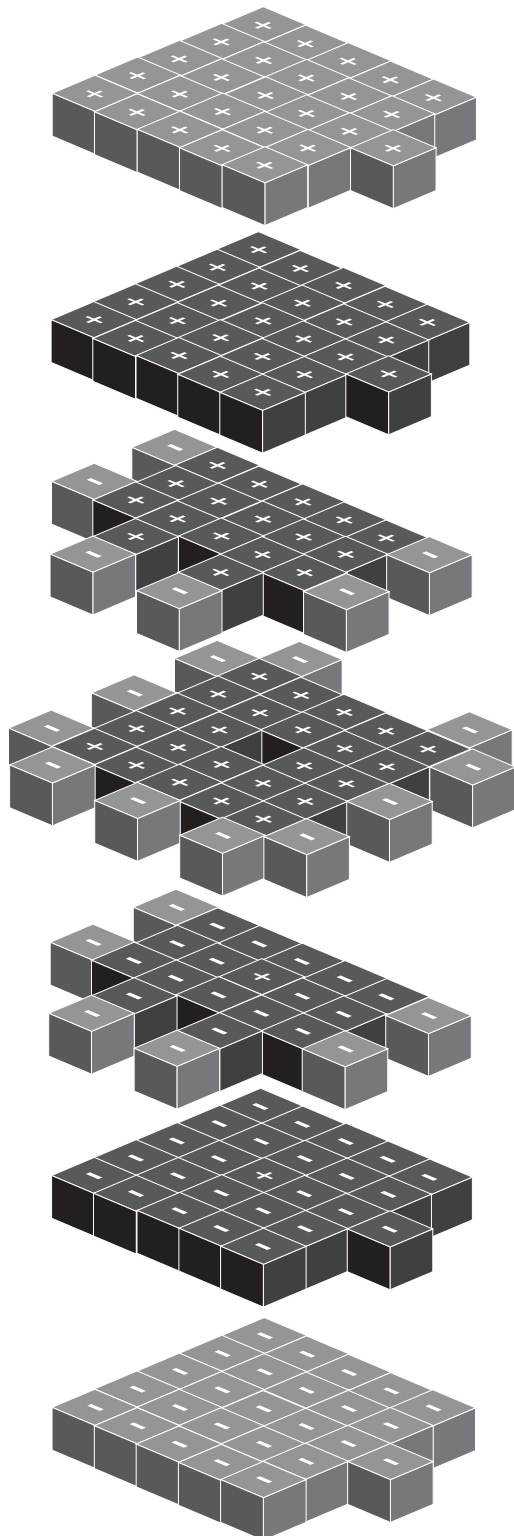


Rhenium Nucleus

$$s^2 f^4 d^{10} d^5$$

Re 185
Proton: 75
Neutron: 110
Spin: 5/2
Stable

Re 187
Proton: 75
Neutron: 112
Spin: 5/2

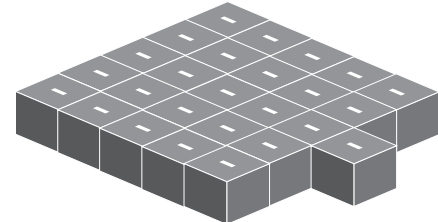
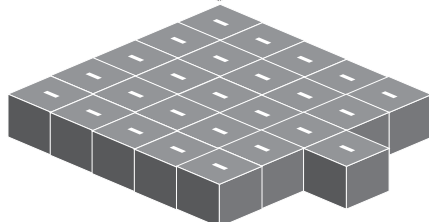
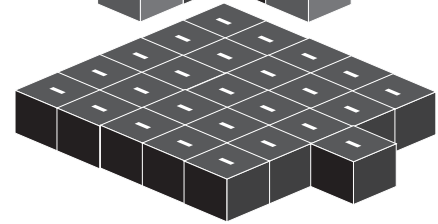
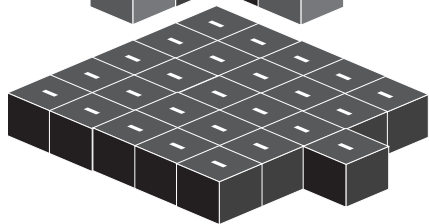
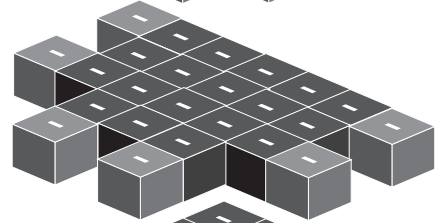
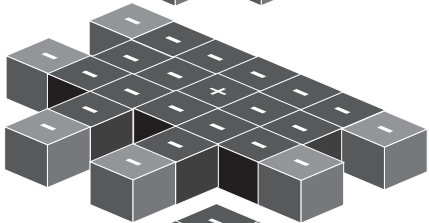
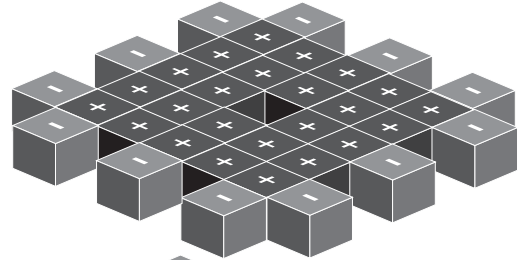
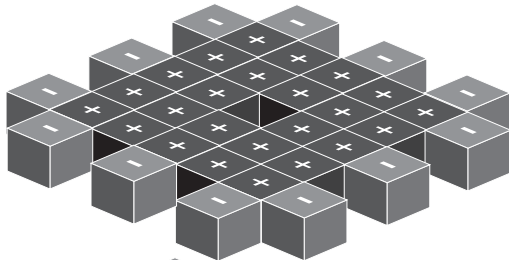
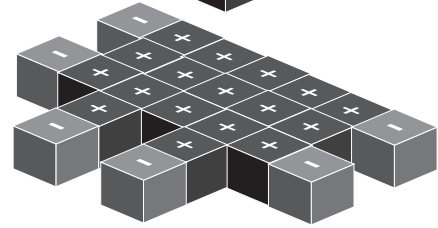
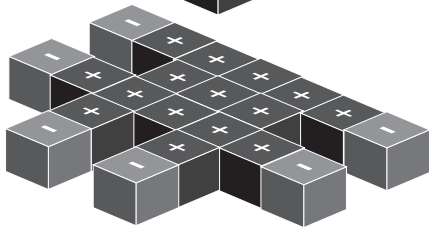
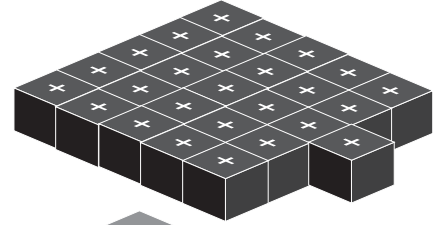
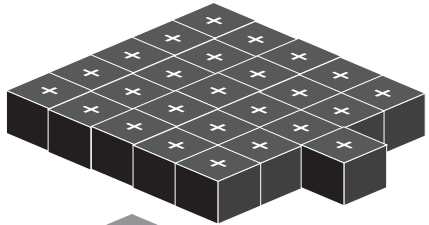
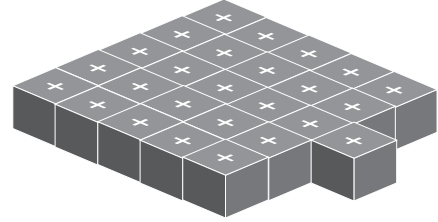
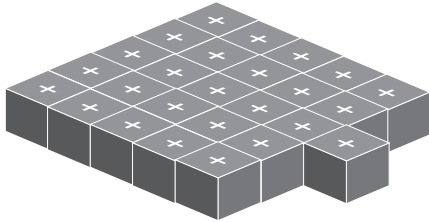


Osmium Nucleus

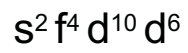
$$s^2 f^4 d^{10} d^6$$

Os 184
 Proton: 76
 Neutron: 108
 Spin:0
 Stable

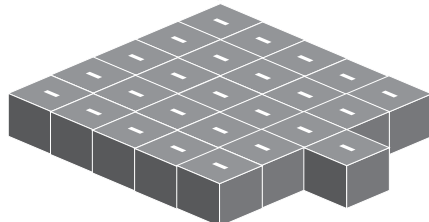
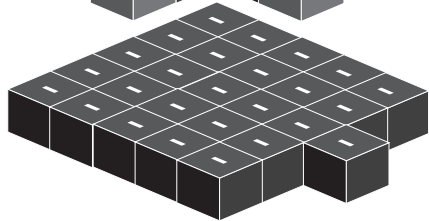
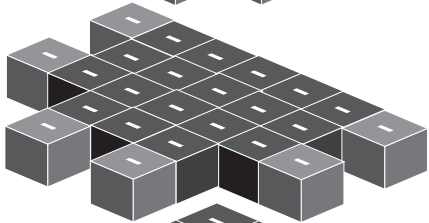
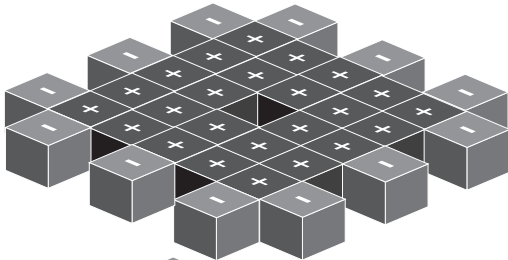
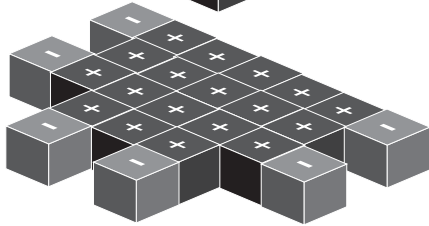
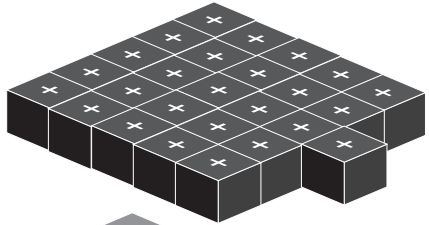
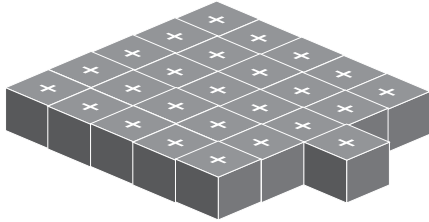
Os 187
 Proton: 76
 Neutron: 111
 Spin:-1/2
 Stable



Osmium Nucleus



Os 188
Proton: 76
Neutron: 112
Spin:0
Stable

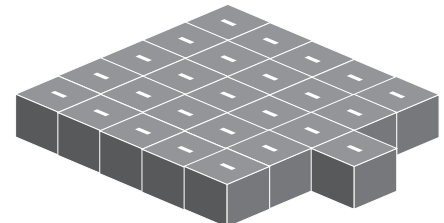
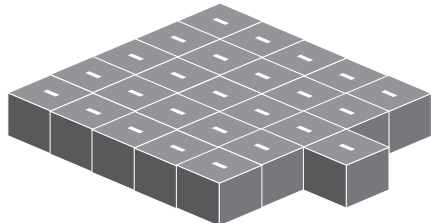
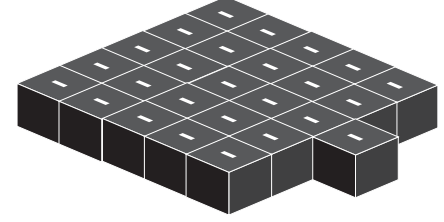
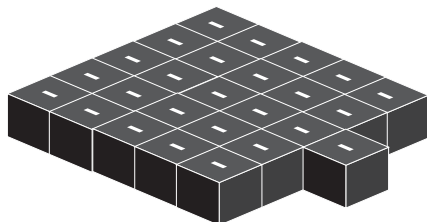
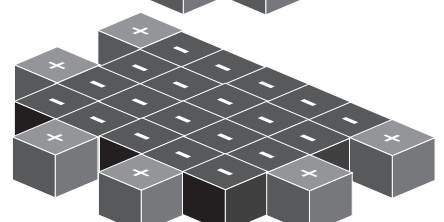
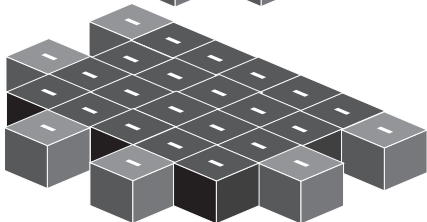
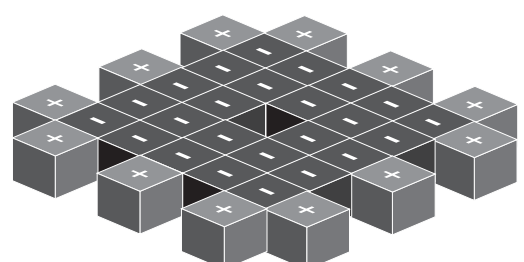
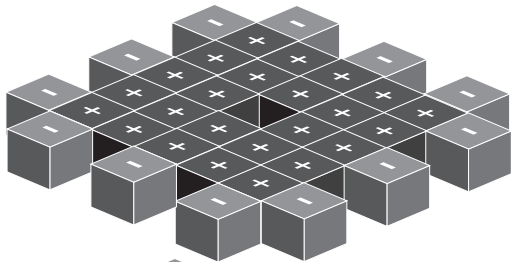
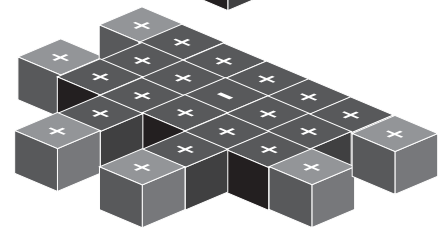
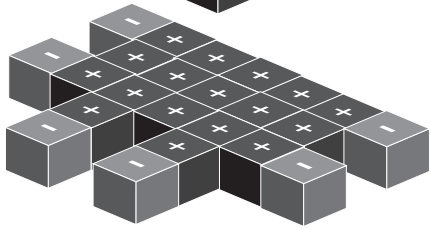
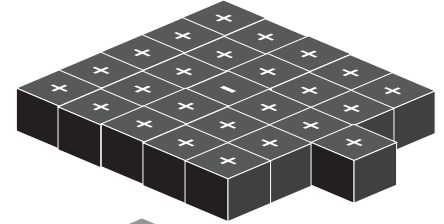
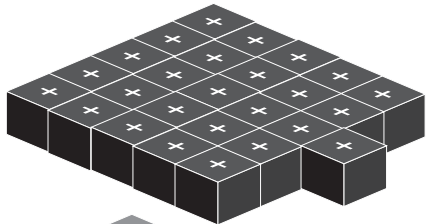
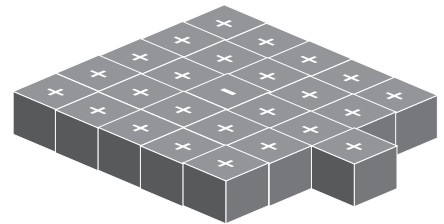
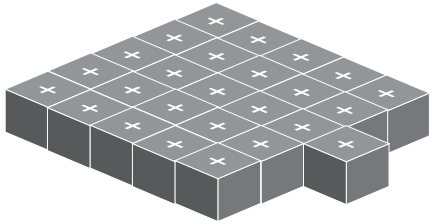


Osmium Nucleus

$$s^2 f^4 d^{10} d^6$$

Os 189
Proton: 76
Neutron: 113
Spin: -3/2
Stable

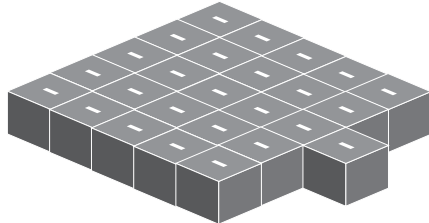
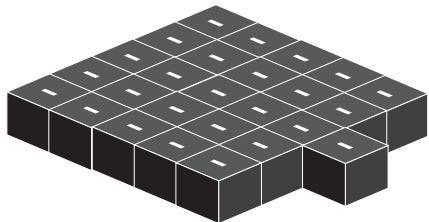
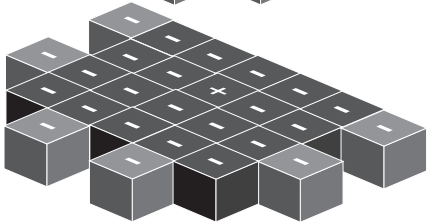
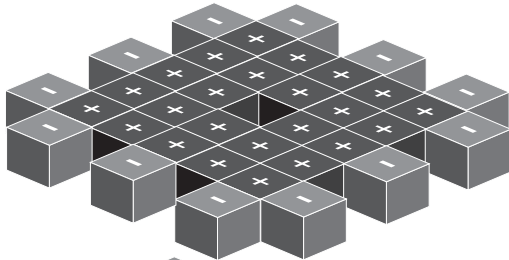
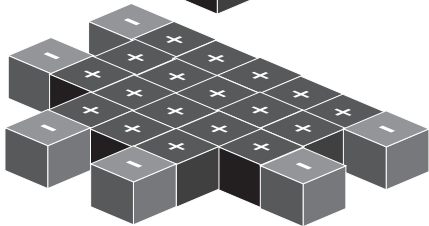
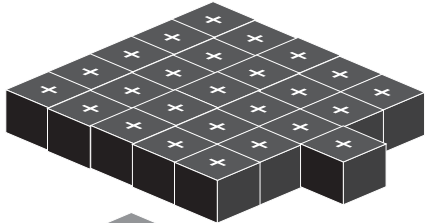
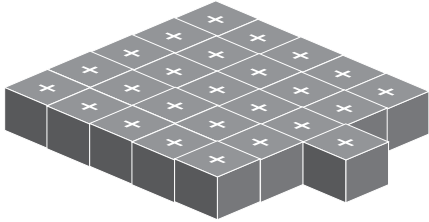
Os 189m
Proton: 76
Neutron: 113
Spin: -9/2



Osmium Nucleus

$s^2 f^4 d^{10} d^6$

Os 190
Proton: 76
Neutron: 114
Spin:0
Stable

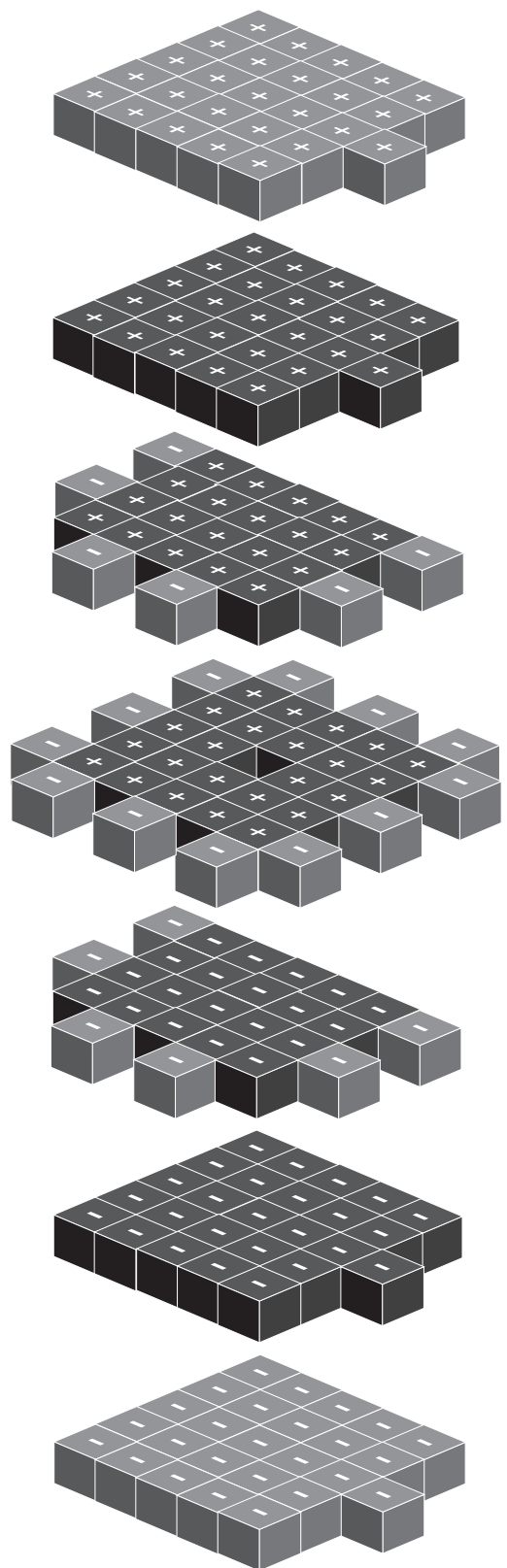
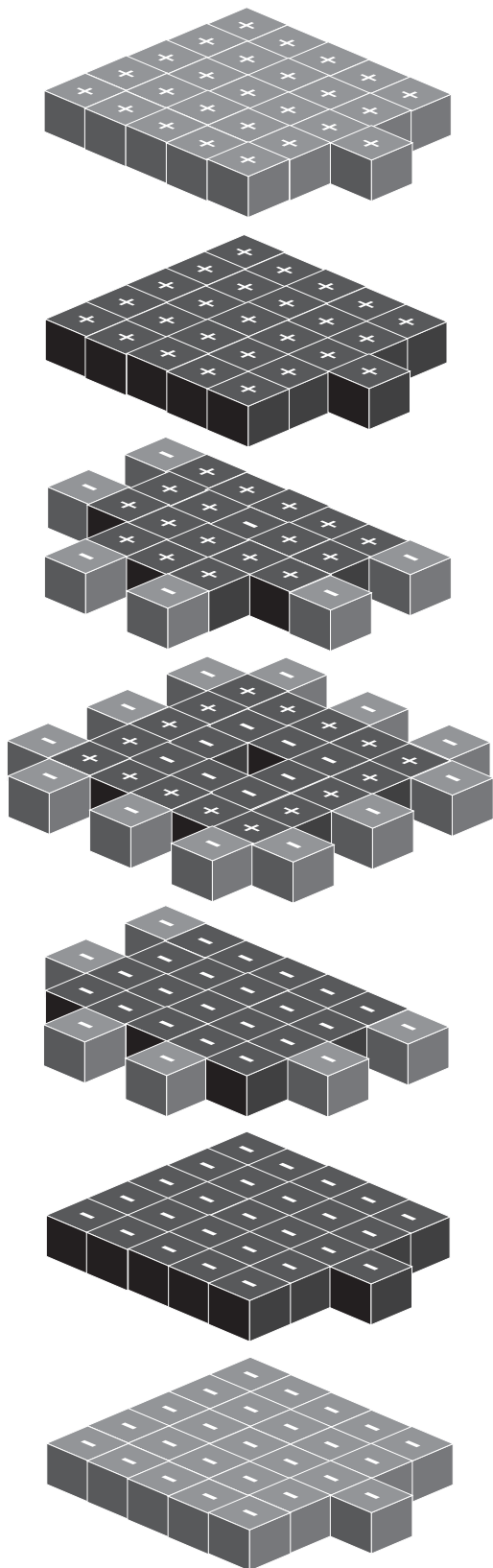


Osmium Nucleus

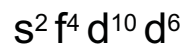
$$s^2 f^4 d^{10} d^6$$

Os 190m
 Proton: 76
 Neutron: 114
 Spin:-10

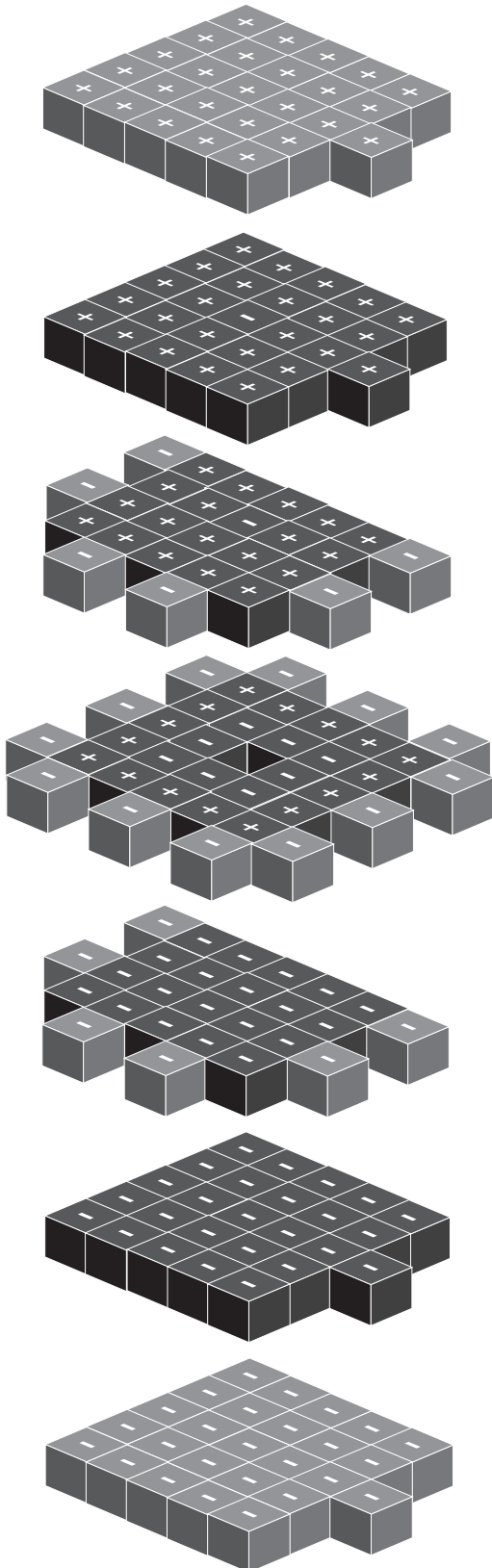
Os 192
 Proton: 76
 Neutron: 116
 Spin:0
 Stable



Osmium Nucleus



Os 192m
Proton: 76
Neutron: 116
Spin:-10

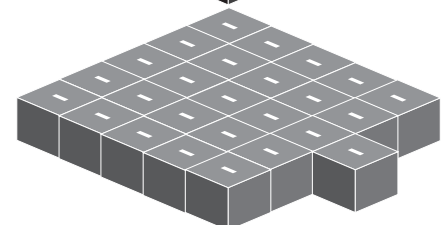
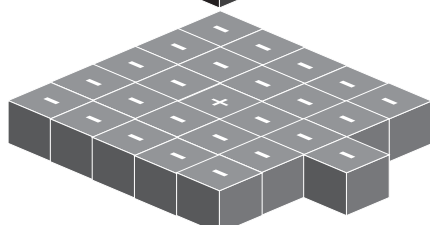
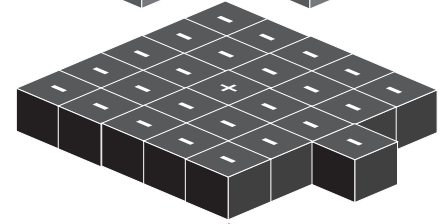
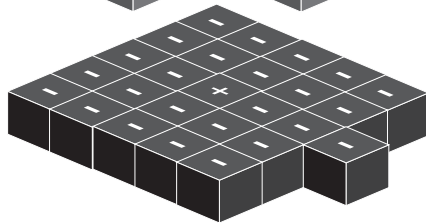
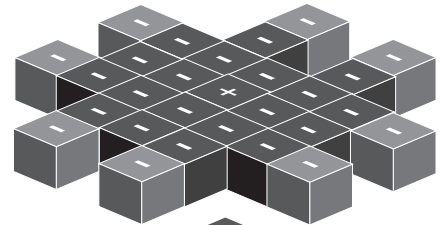
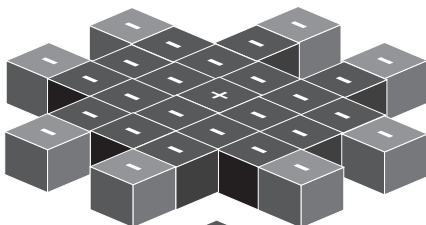
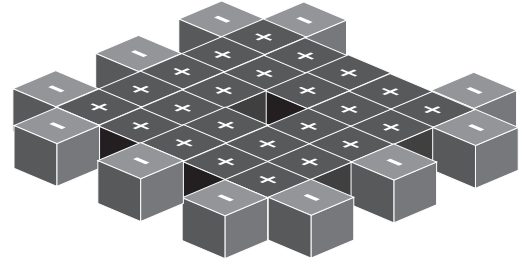
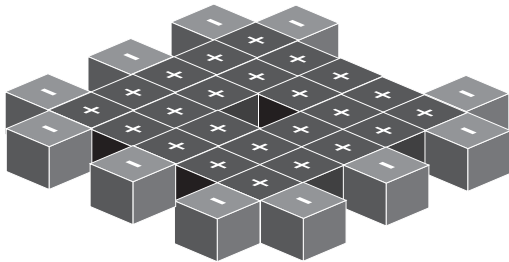
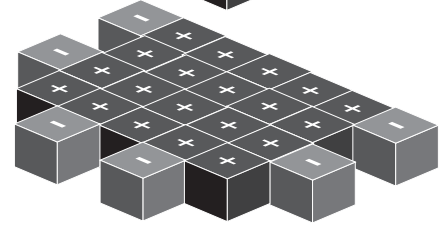
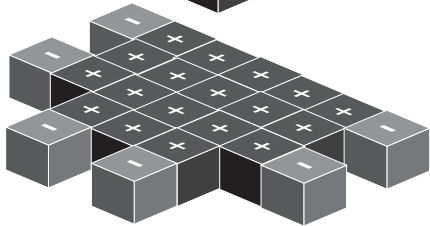
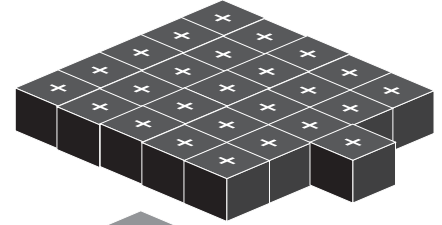
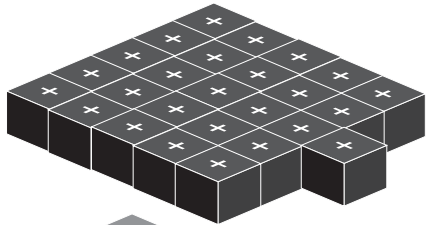
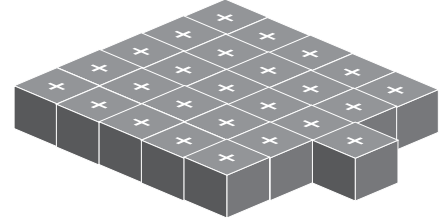
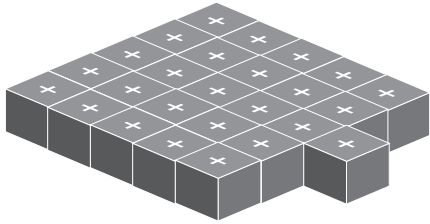


Iridium Nucleus

$$s^2 f^4 d^{10} d^7$$

Ir 191
Proton: 77
Neutron: 114
Spin: 3/2
Stable

Ir 193
Proton: 77
Neutron: 116
Spin: 3/2
Stable

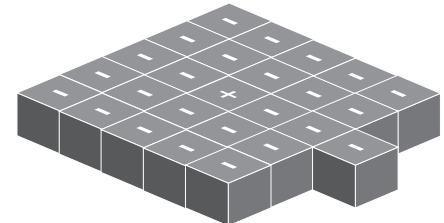
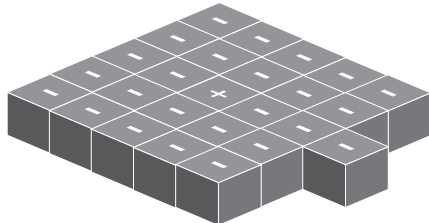
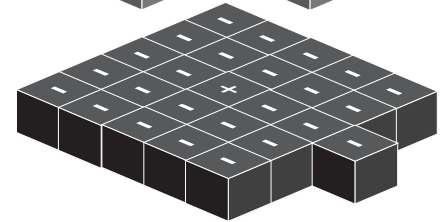
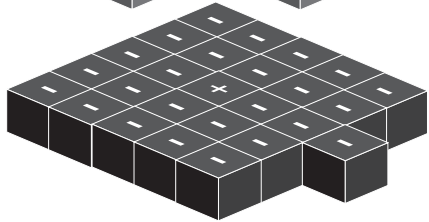
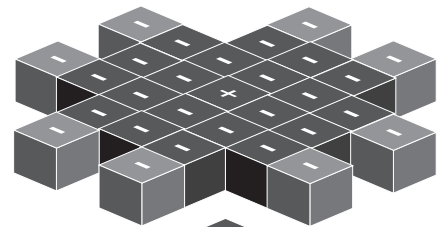
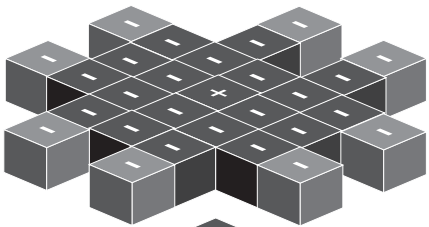
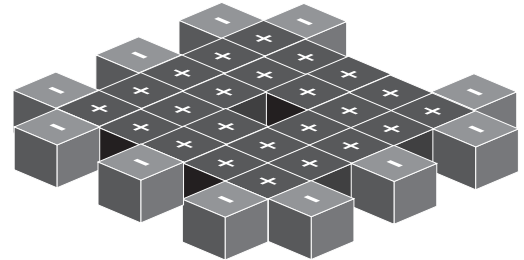
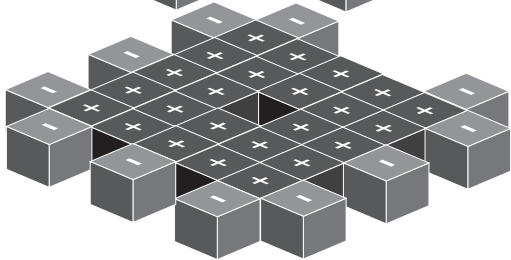
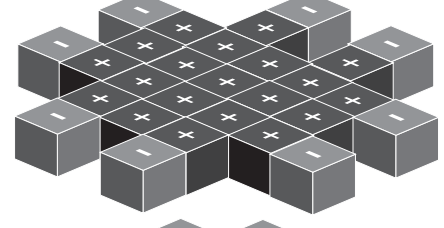
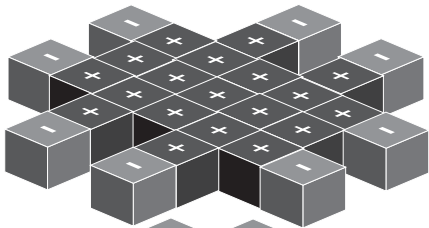
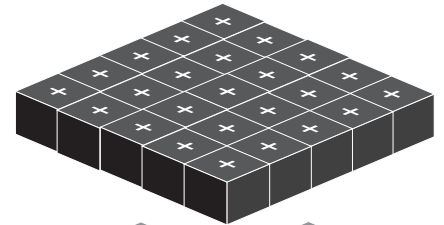
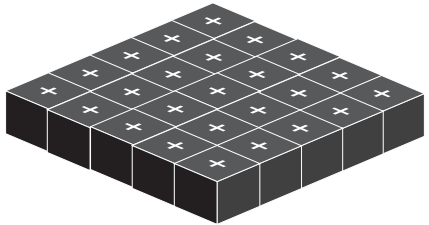
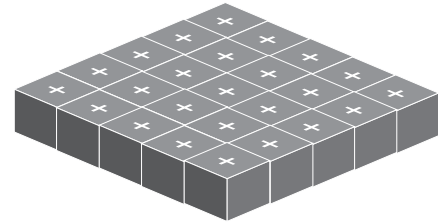
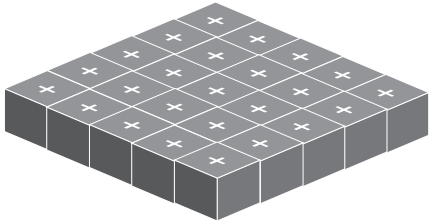


Platinum Nucleus

$s^1 f^4 d^{10} d^9$

Pt 192
 Proton: 78
 Neutron: 114
 Spin:0
 Stable

Pt 194
 Proton: 78
 Neutron: 116
 Spin:0
 Stable

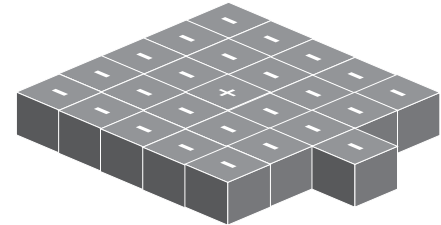
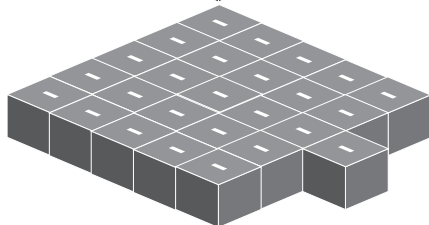
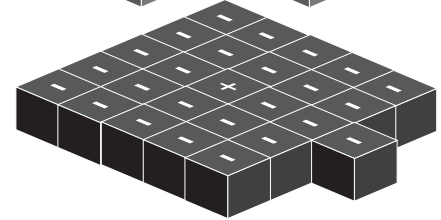
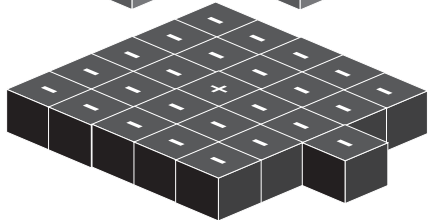
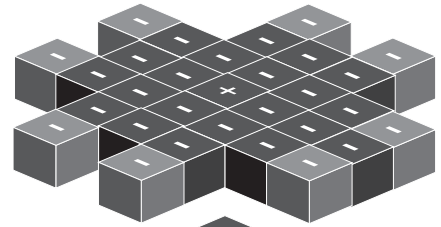
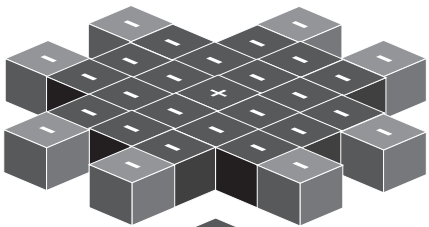
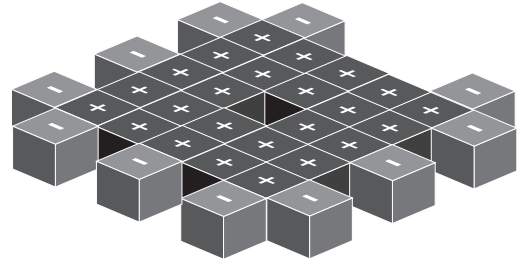
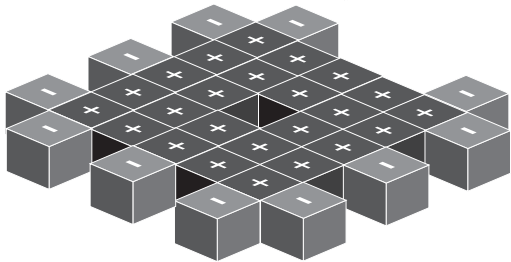
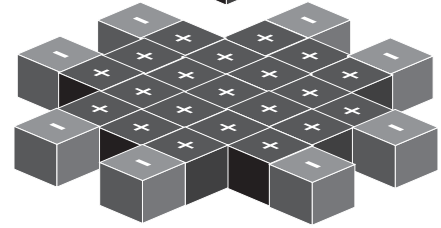
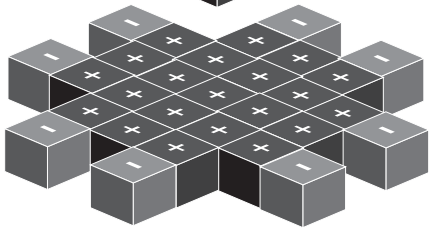
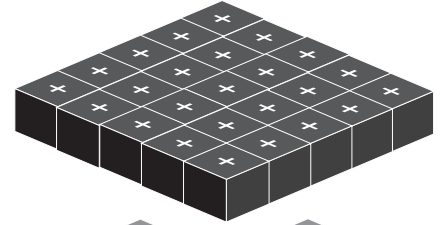
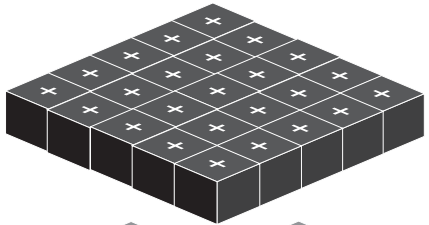
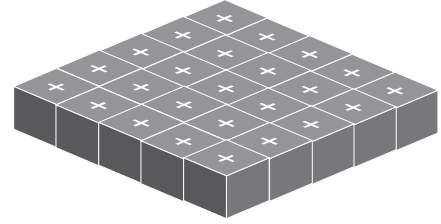
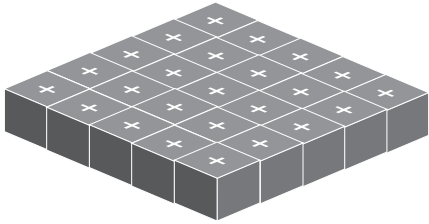


Platinum Nucleus

$s^1 f^4 d^{10} d^9$

Pt 195
 Proton: 78
 Neutron: 117
 Spin: -1/2
 Stable

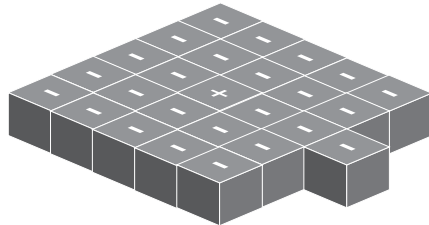
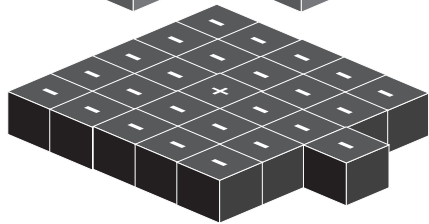
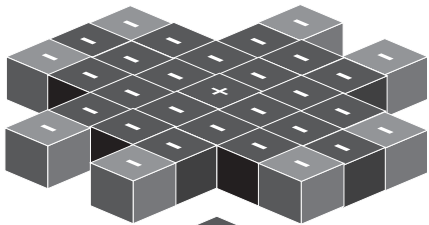
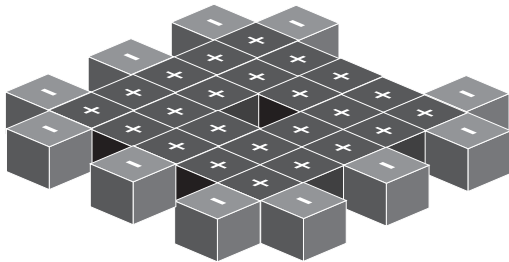
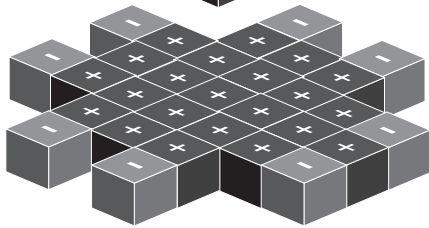
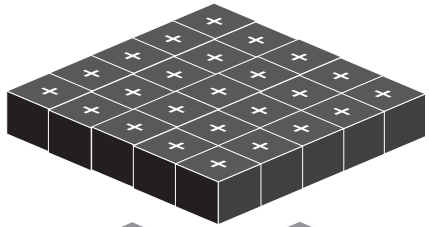
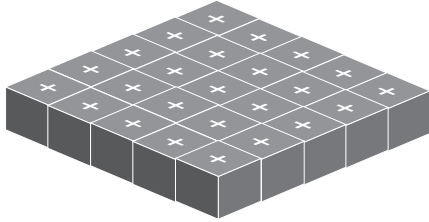
Pt 196
 Proton: 78
 Neutron: 118
 Spin: 0
 Stable



Platinum Nucleus

$s^1 f^4 d^{10} d^9$

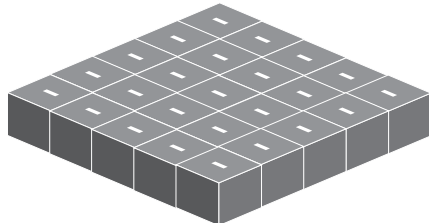
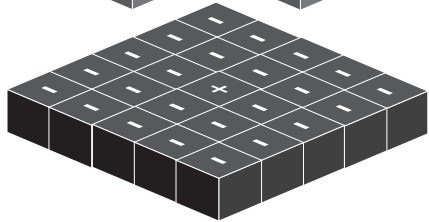
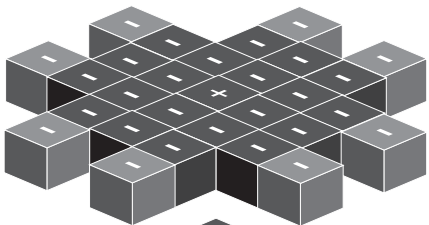
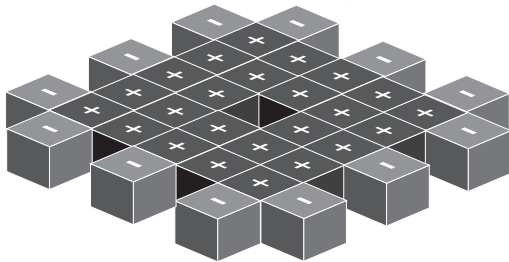
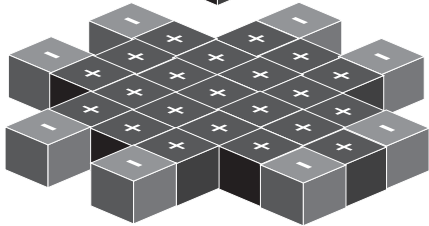
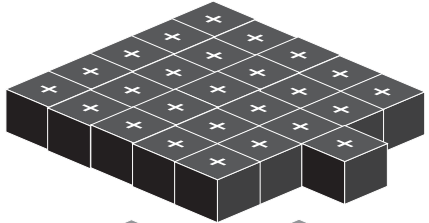
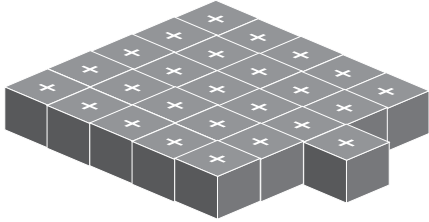
Pt 198
Proton: 78
Neutron: 120
Spin:0
Stable



Gold Nucleus

$s^1 f^4 d^{10} d^{10}$

Au 197
Proton: 79
Neutron: 118
Spin: 3/2
Stable

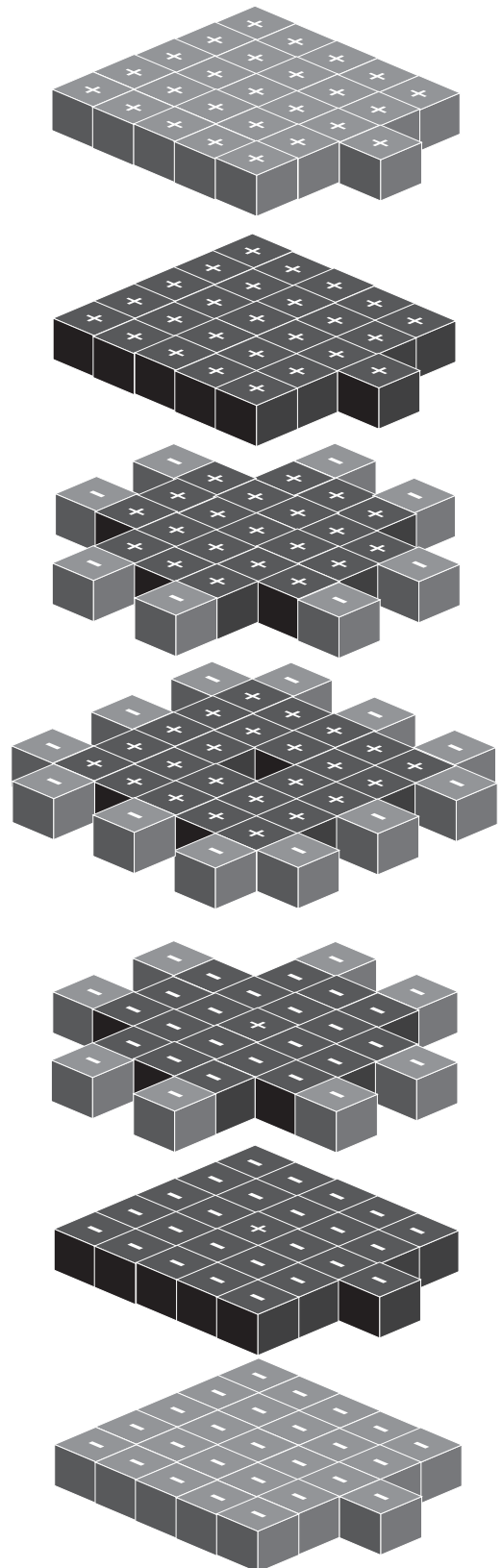
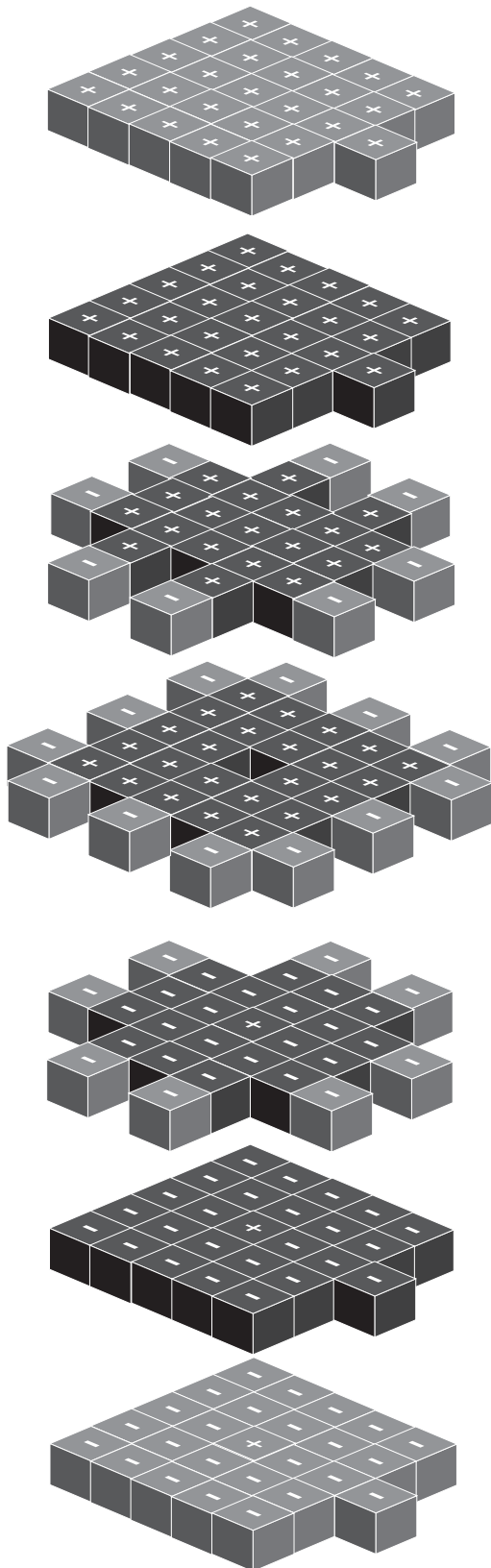


Mercury Nucleus

$$s^2 f^4 d^{10} d^{10}$$

Hg 196
 Proton: 80
 Neutron: 116
 Spin:0
 Stable

Hg 198
 Proton: 80
 Neutron: 118
 Spin:0
 Stable

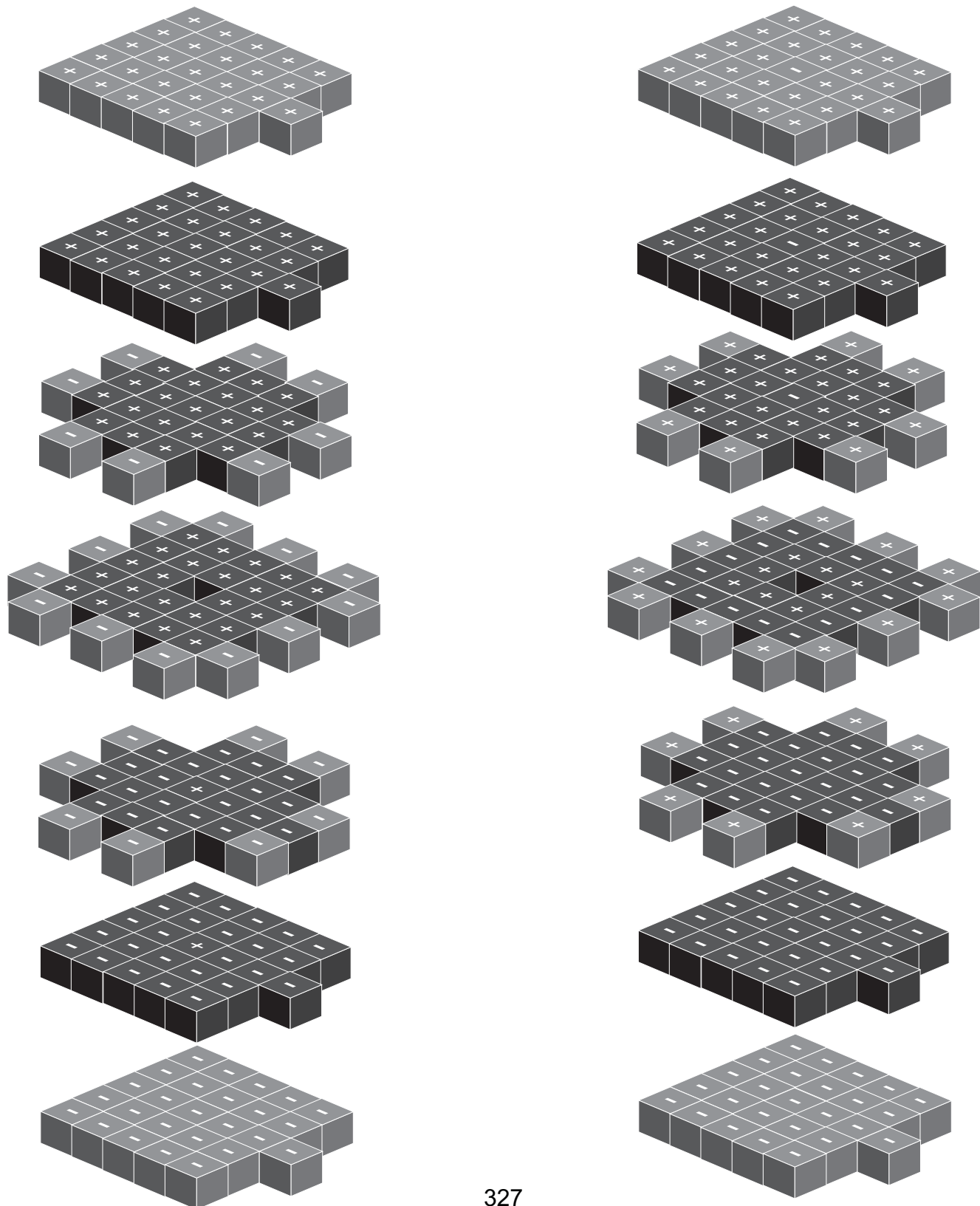


Mercury Nucleus

$$s^2 f^4 d^{10} d^{10}$$

Hg 199
 Proton: 80
 Neutron: 119
 Spin: -1/2
 Stable

Hg 199m
 Proton: 80
 Neutron: 119
 Spin: 13/2

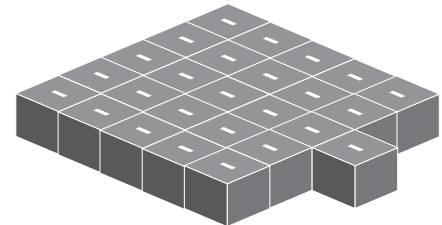
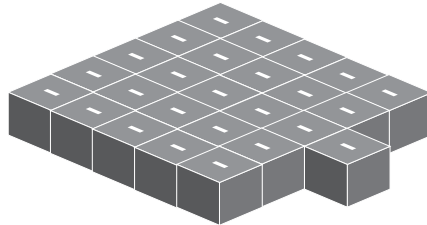
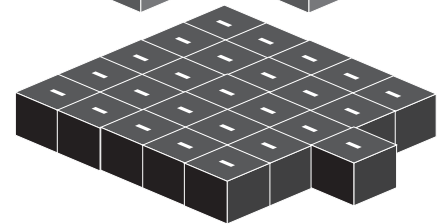
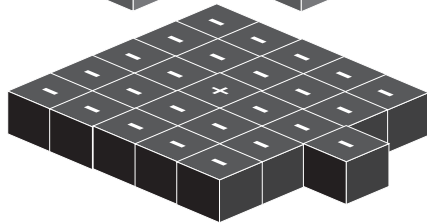
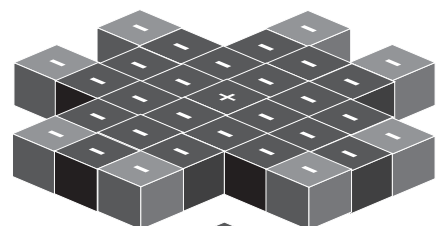
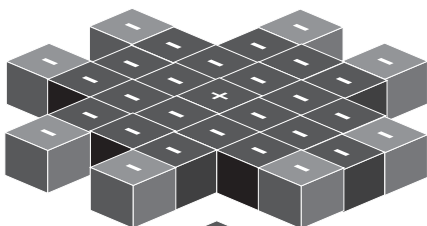
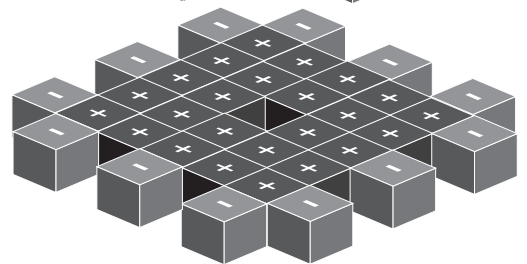
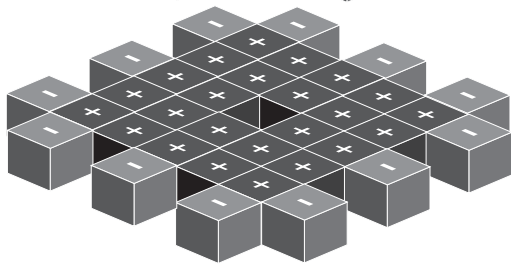
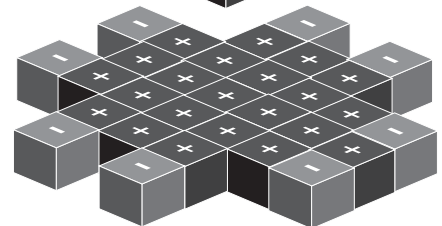
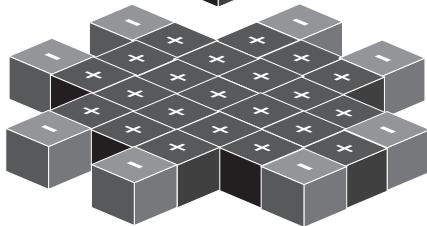
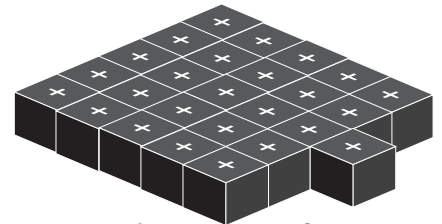
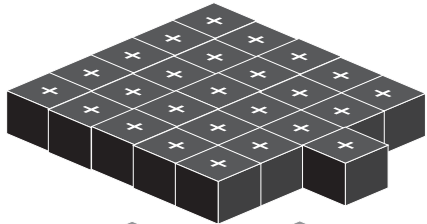
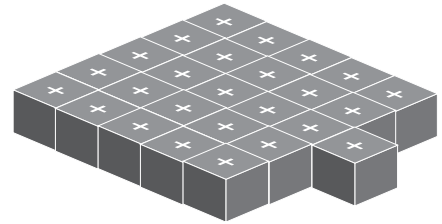
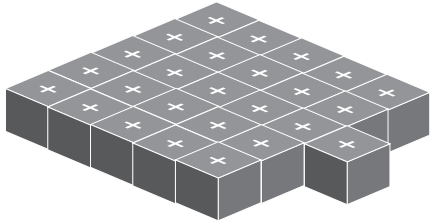


Mercury Nucleus

$s^2 f^4 d^{10} d^{10}$

Hg 200
Proton: 80
Neutron: 120
Spin:0
Stable

Hg 201
Proton: 80
Neutron: 121
Spin:-3/2
Stable

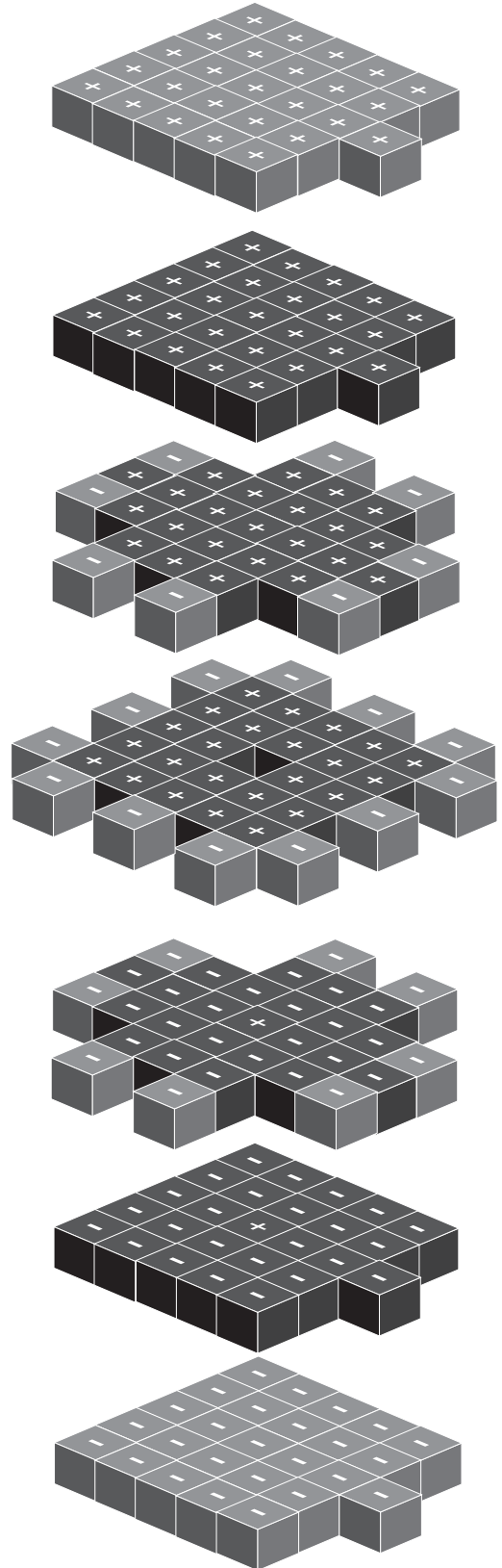
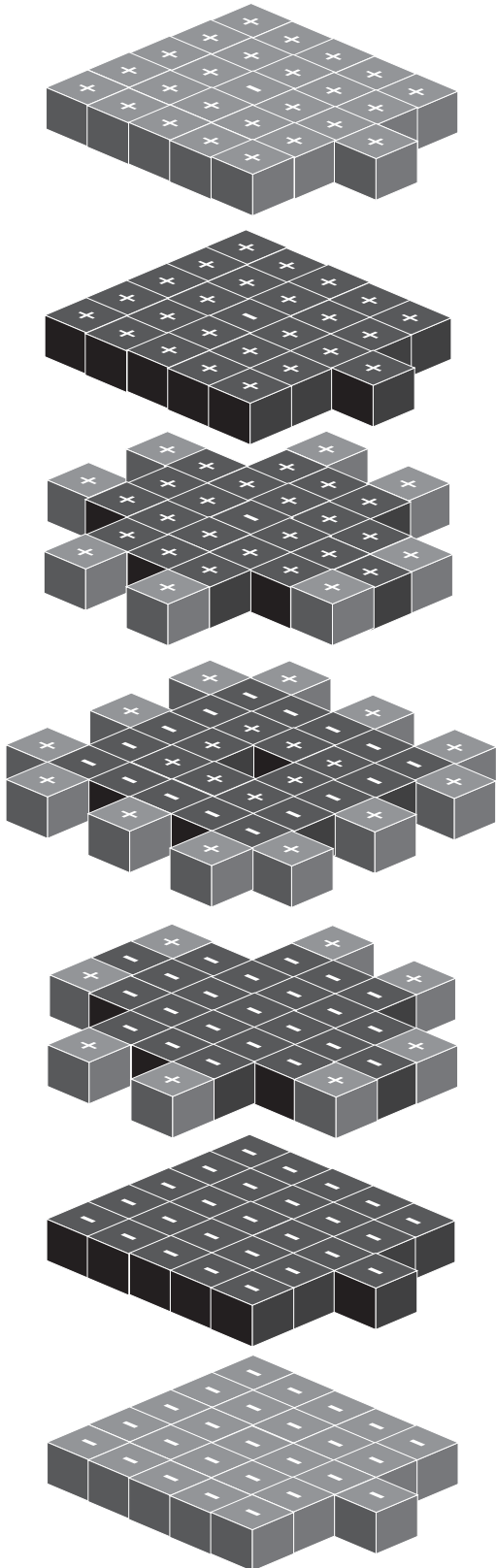


Mercury Nucleus

$$s^2 f^4 d^{10} d^{10}$$

Hg 201m
Proton: 80
Neutron: 121
Spin: 13/2

Hg 202
Proton: 80
Neutron: 122
Spin: 0
Stable

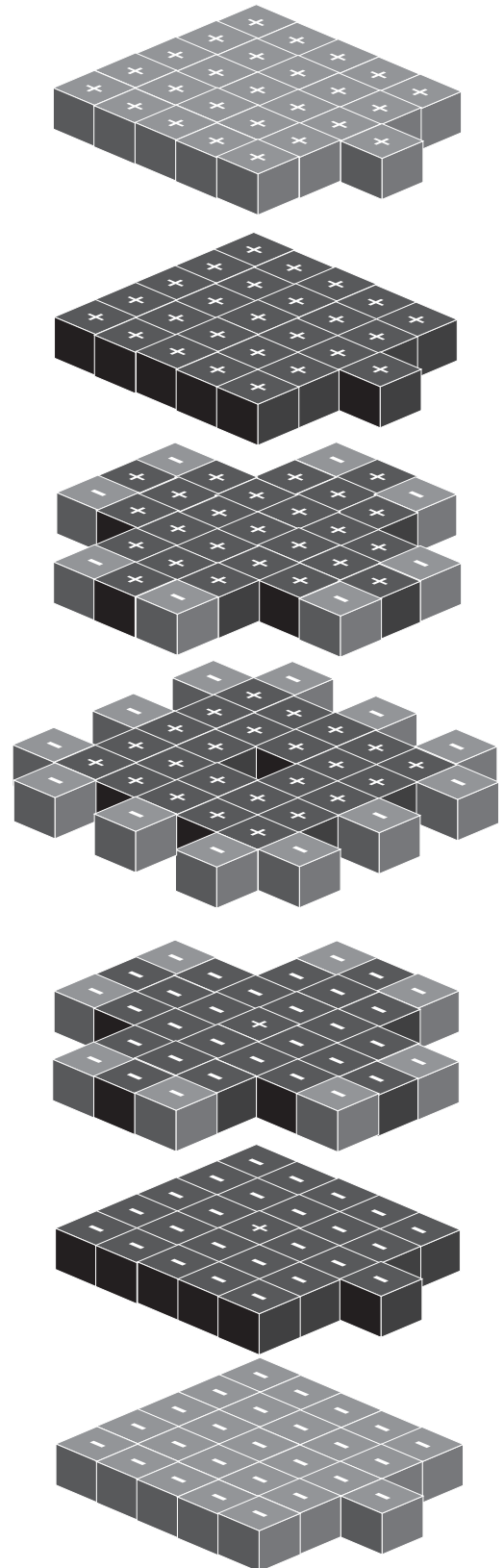
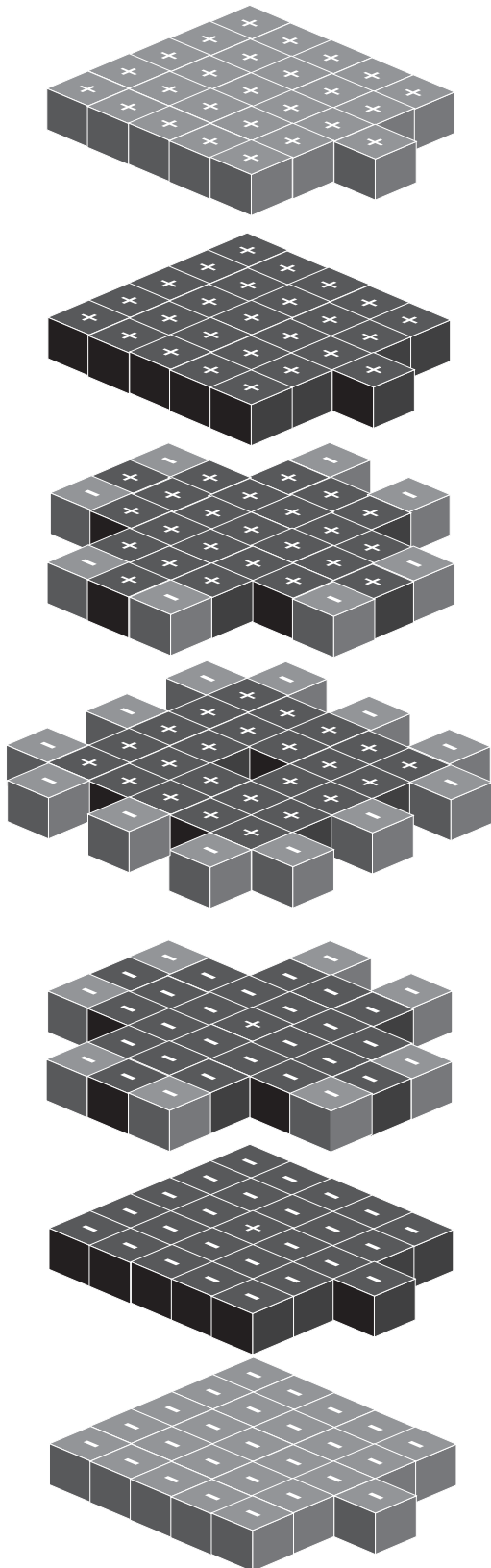


Mercury Nucleus

$$s^2 f^4 d^{10} d^{10}$$

Hg 204
 Proton: 80
 Neutron: 124
 Spin:0
 Stable

Hg 206
 Proton: 80
 Neutron: 126
 Spin:0

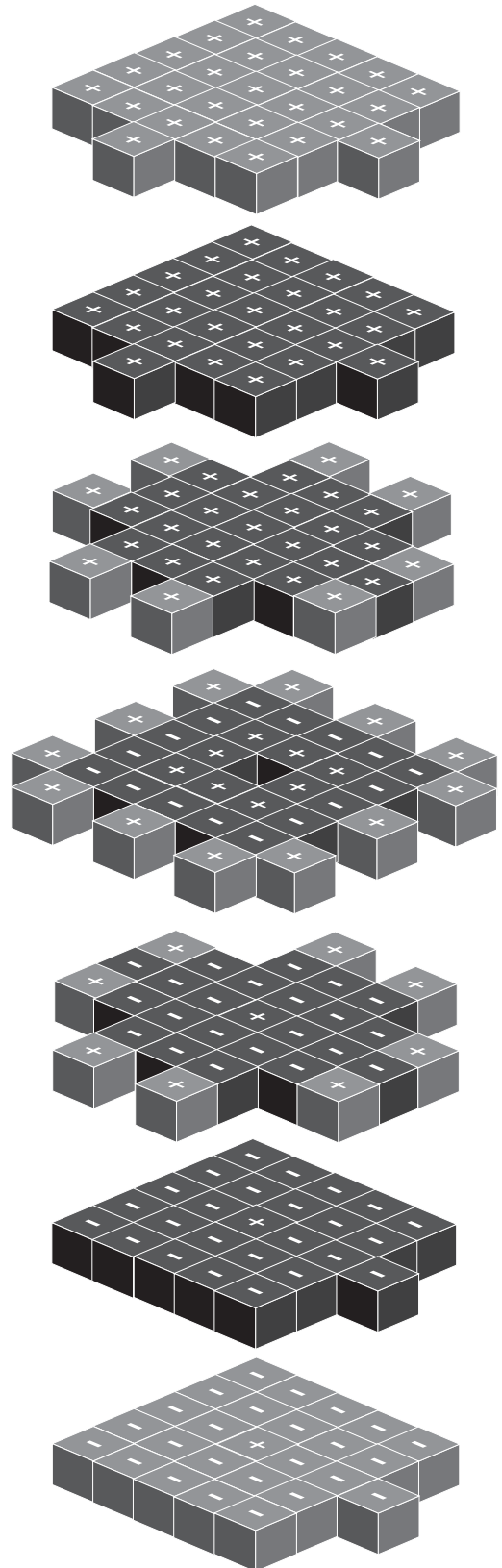
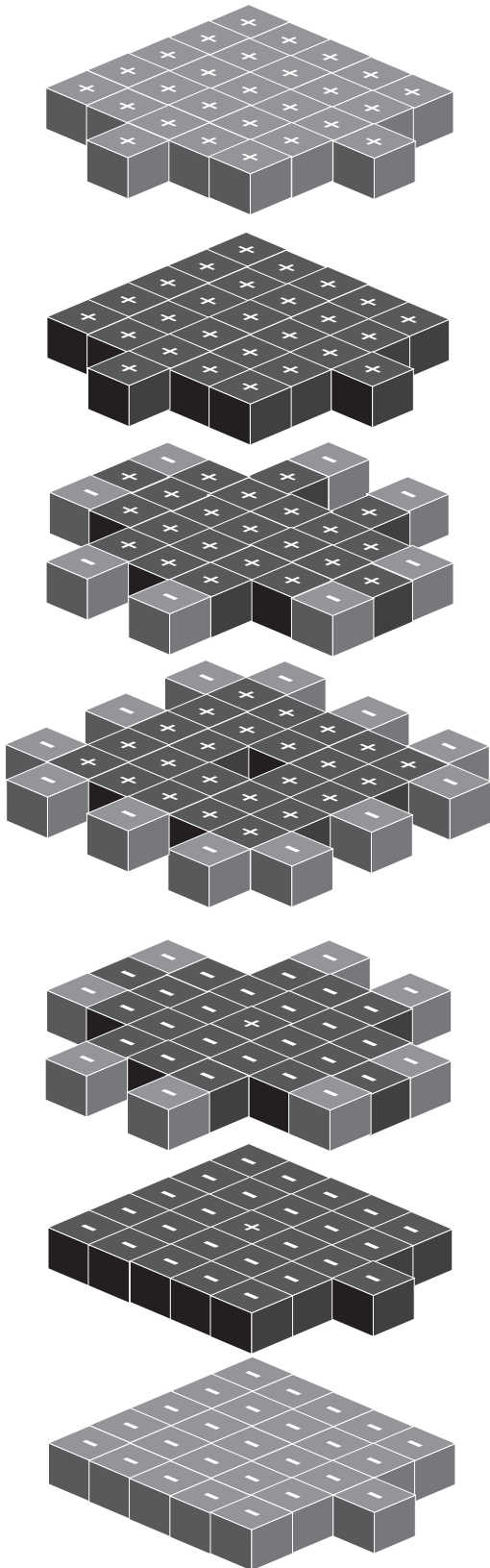


Thallium Nucleus

$s^2 f^4 d^{10} d^{10} p^1$

Ti 203
 Proton: 81
 Neutron: 122
 Spin: 1/2
 Stable

Ti 203m
 Proton: 81
 Neutron: 122
 Spin: 25/2

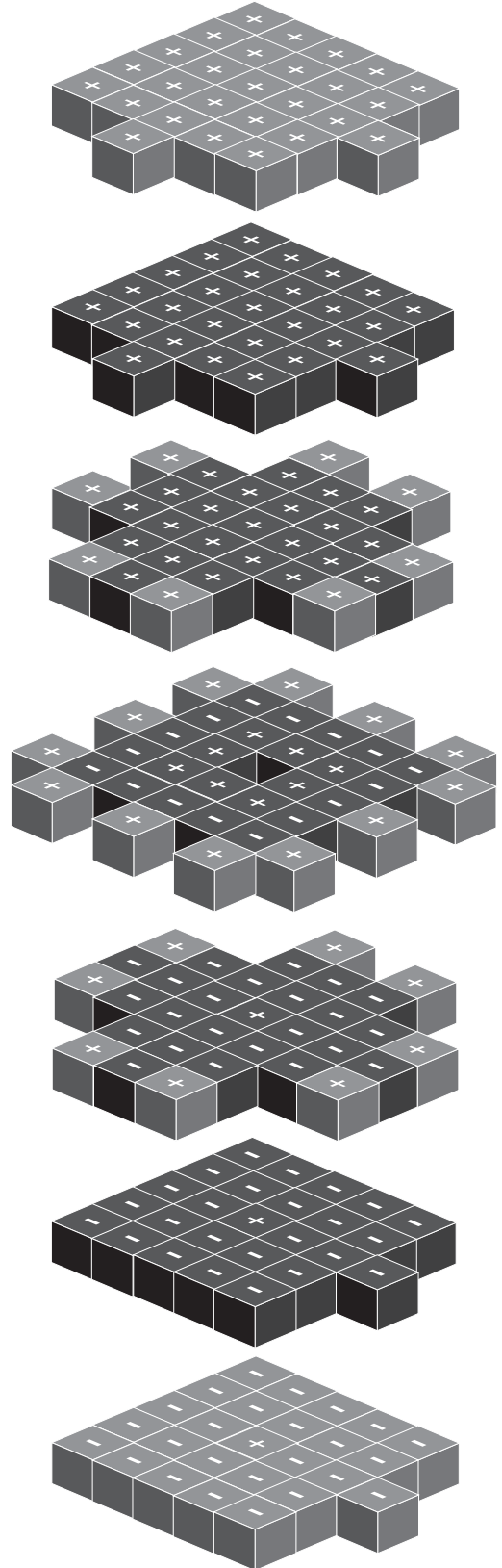
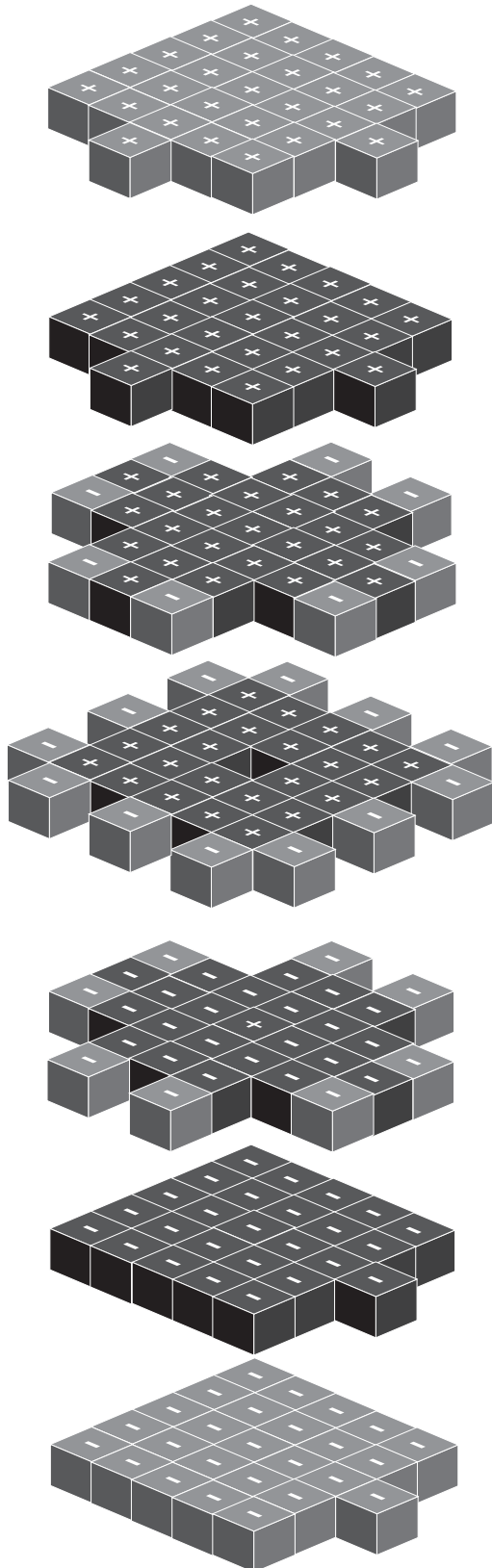


Thallium Nucleus

$s^2 f^4 d^{10} d^{10} p^1$

Ti 205
 Proton: 81
 Neutron: 124
 Spin: 1/2
 Stable

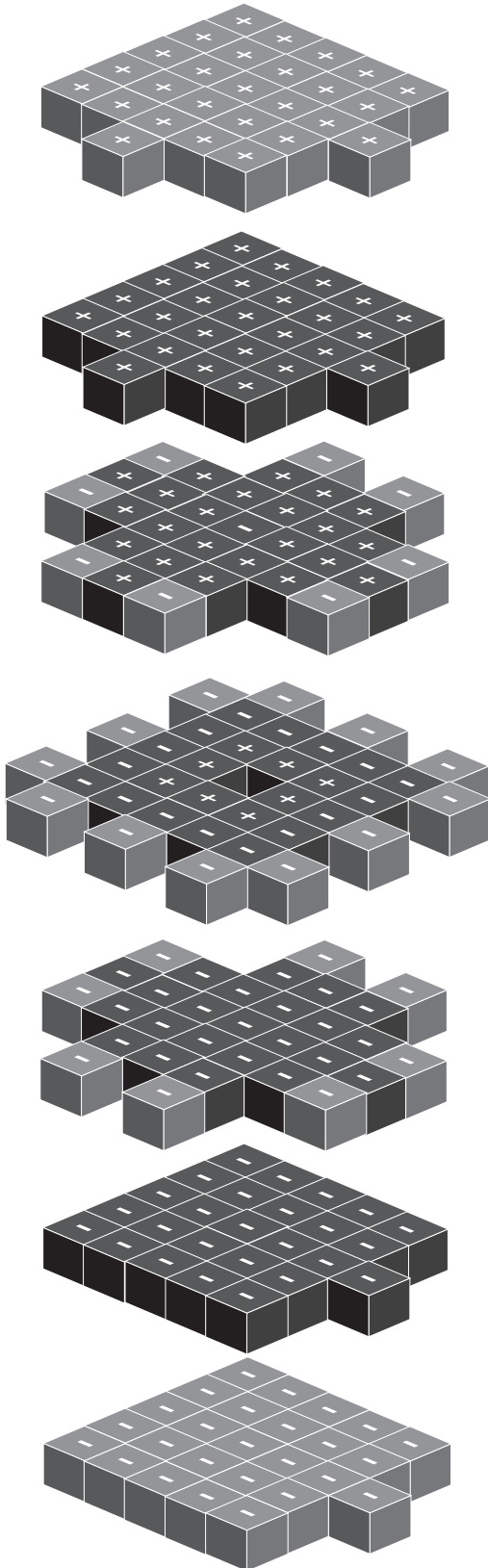
Ti 205-m1
 Proton: 81
 Neutron: 124
 Spin: 25/2



Thallium Nucleus

$s^2 f^4 d^{10} d^{10} p^1$

Ti 205-m2
Proton: 81
Neutron: 124
Spin: -35/2

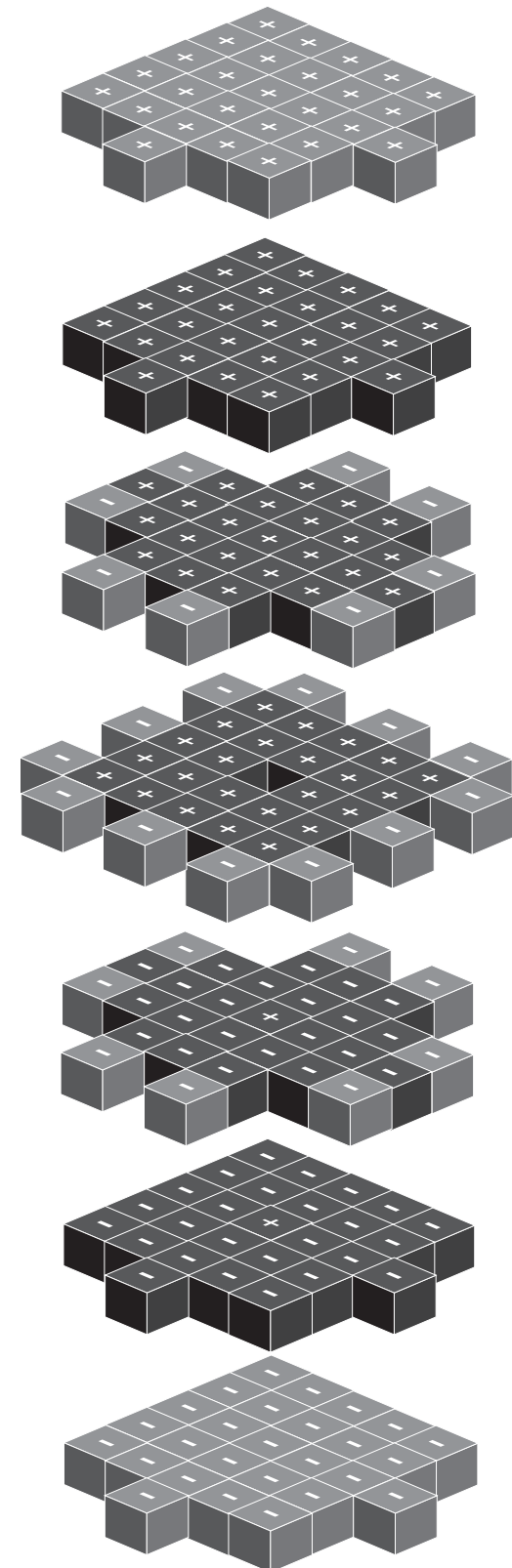
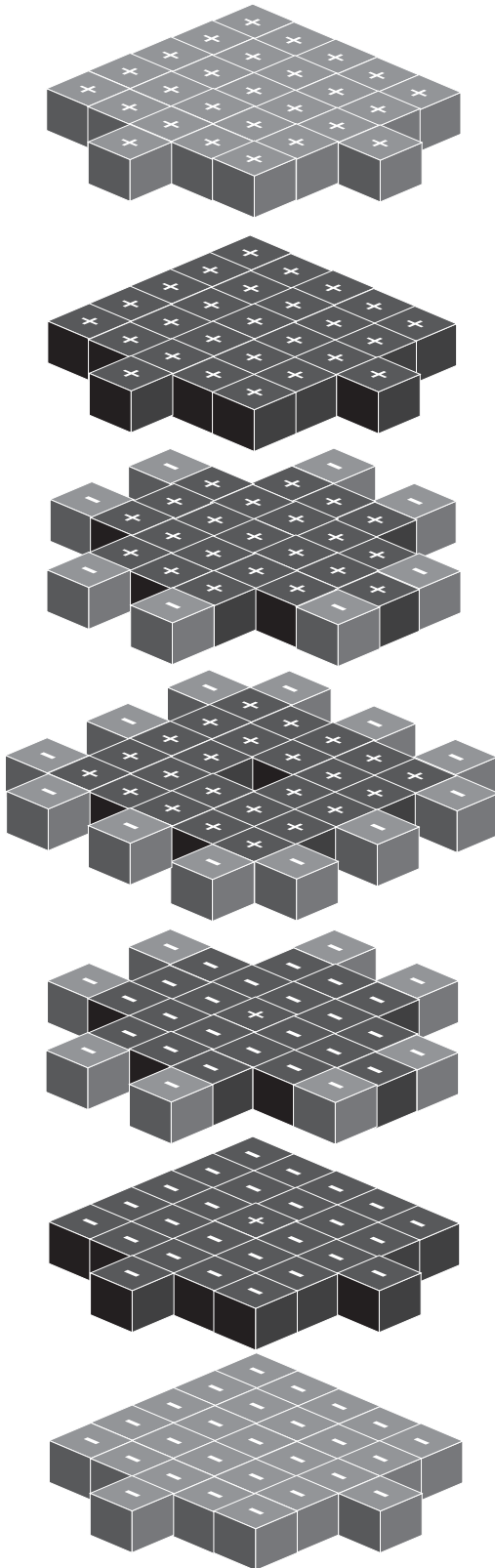


Lead Nucleus

$s^2 f^4 d^{10} d^{10} p^2$

Pb 204
 Proton: 82
 Neutron: 122
 Spin:0
 Stable

Pb 206
 Proton: 82
 Neutron: 124
 Spin:0
 Stable

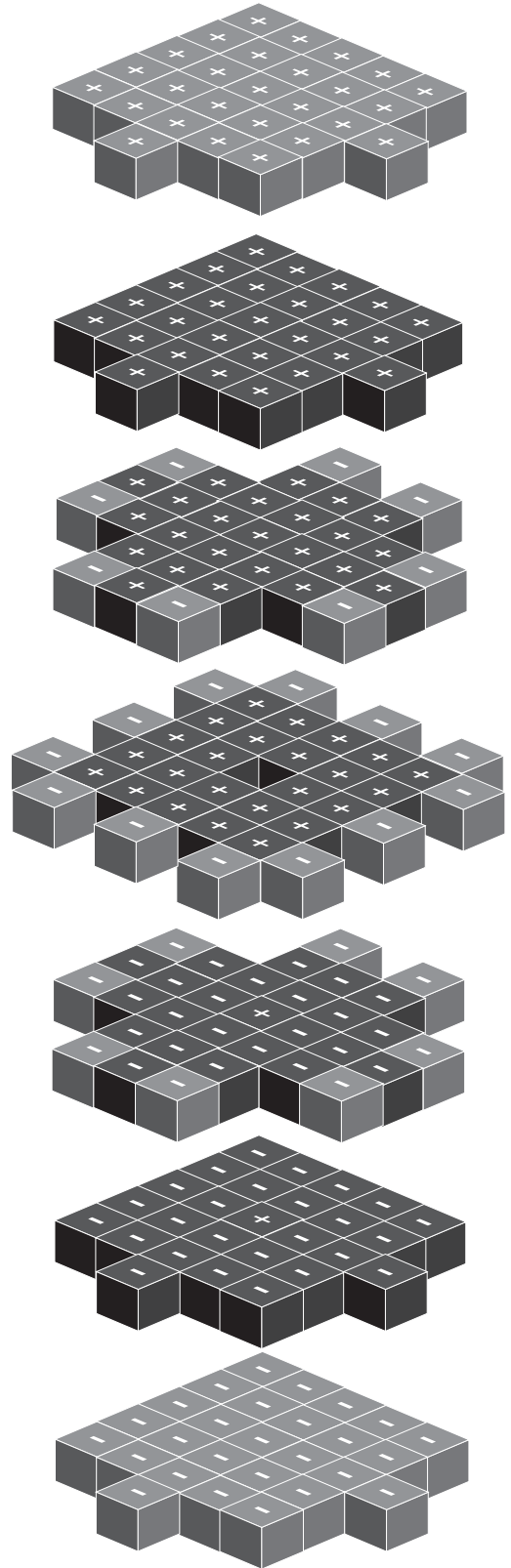
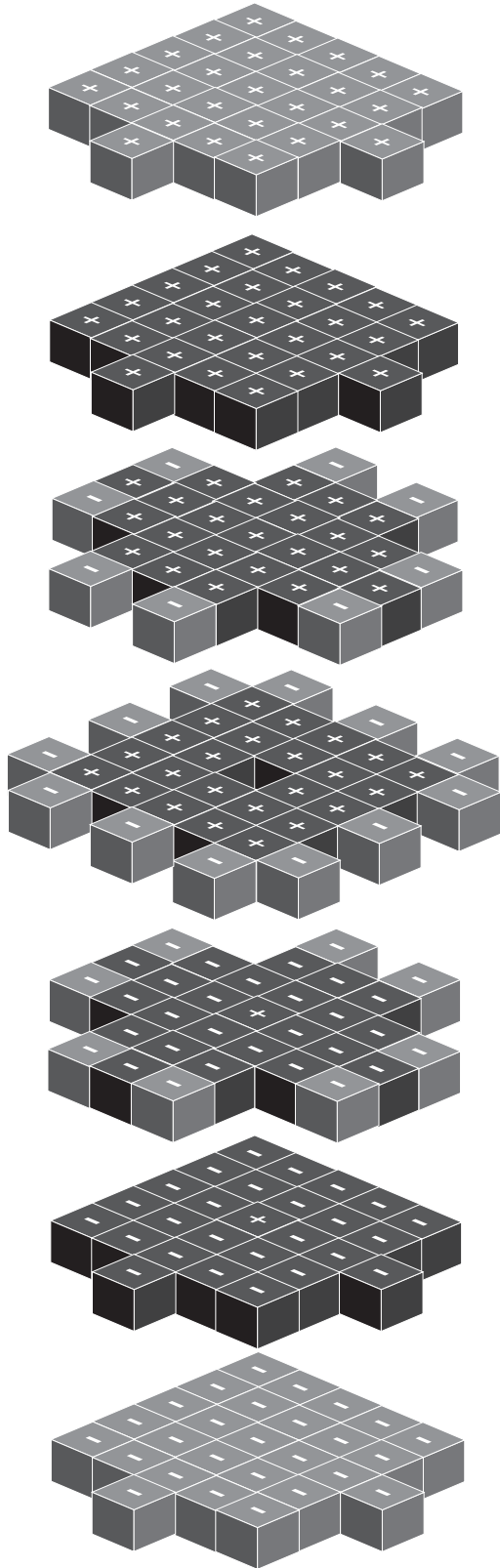


Lead Nucleus

$s^2 f^4 d^{10} d^{10} p^2$

Pb 207
 Proton: 82
 Neutron: 125
 Spin: -1/2
 Stable

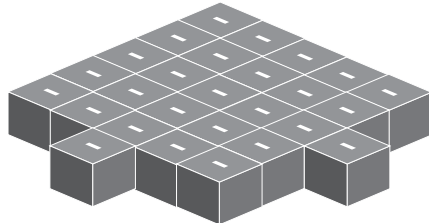
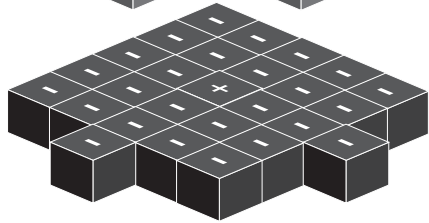
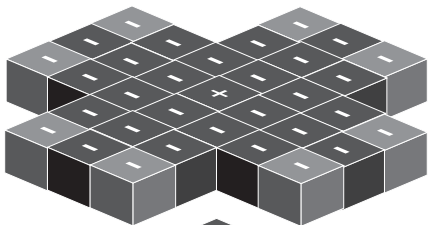
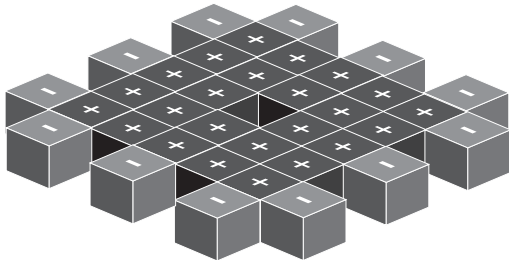
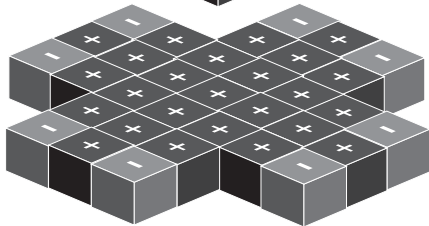
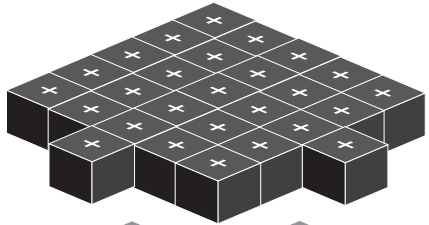
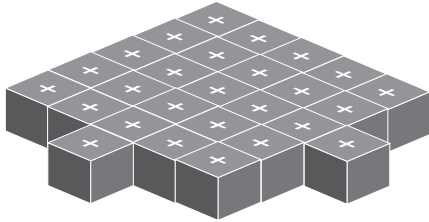
Pb 208
 Proton: 82
 Neutron: 126
 Spin: 0
 Stable



Lead Nucleus

$s^2 f^4 d^{10} d^{10} p^2$

Pb 210
Proton: 82
Neutron: 128
Spin:0

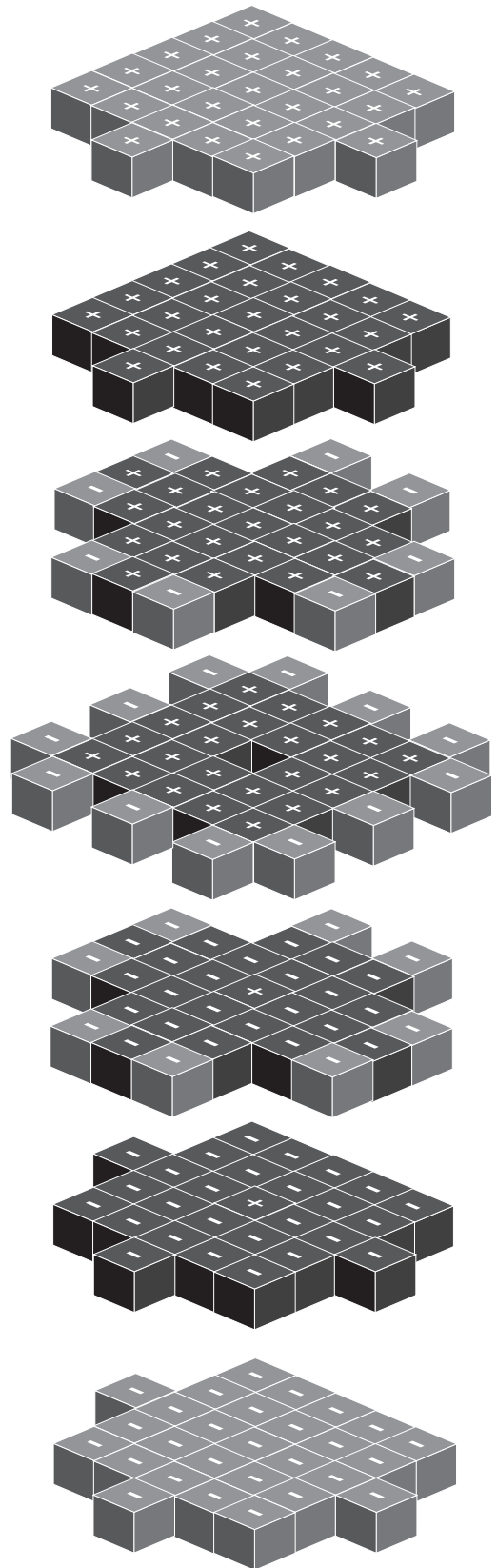
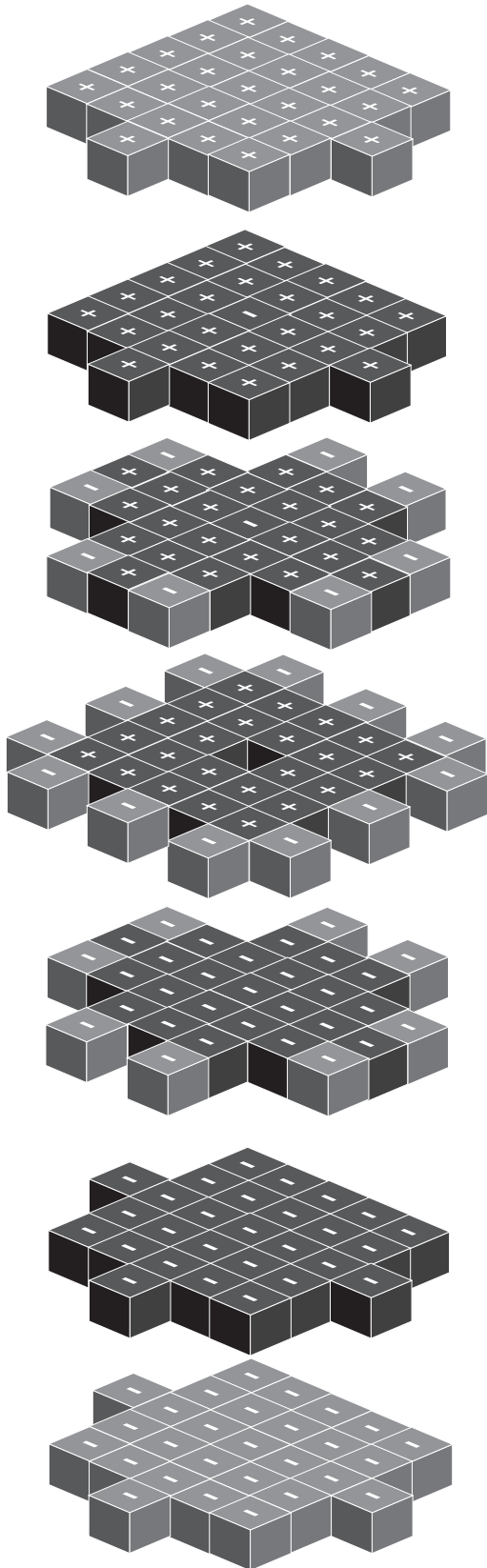


Bismuth Nucleus

$$s^2 f^4 d^{10} d^{10} p^3$$

Bi 209
 Proton: 83
 Neutron: 126
 Spin: -9/2

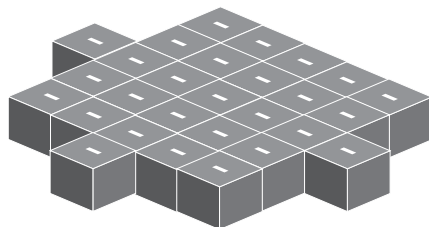
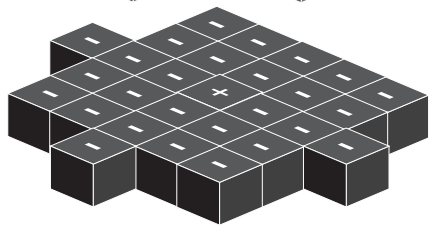
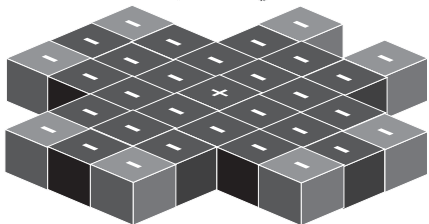
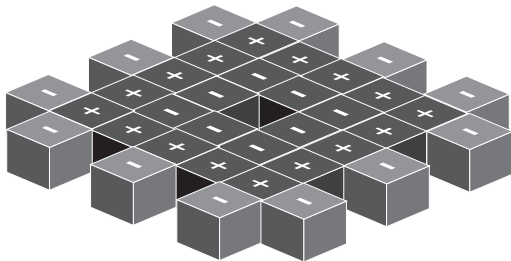
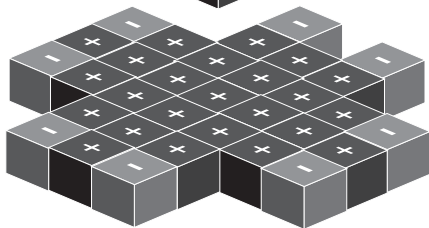
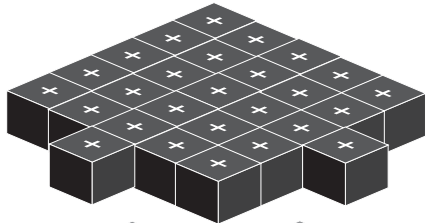
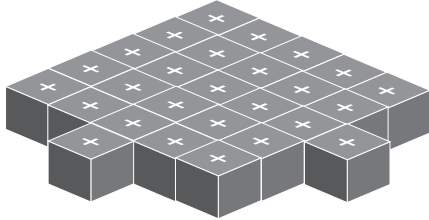
Bi 210
 Proton: 83
 Neutron: 127
 Spin: -1



Bismuth Nucleus

$s^2 f^4 d^{10} d^{10} p^3$

Bi 210m
Proton: 83
Neutron: 127
Spin:-9

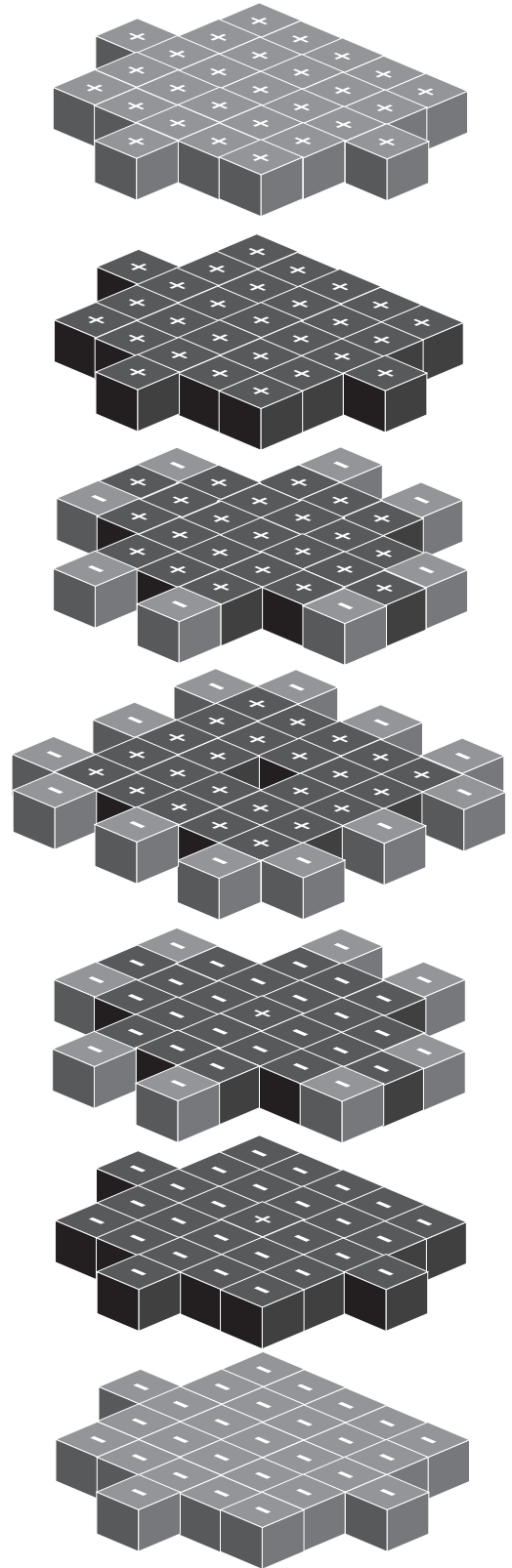
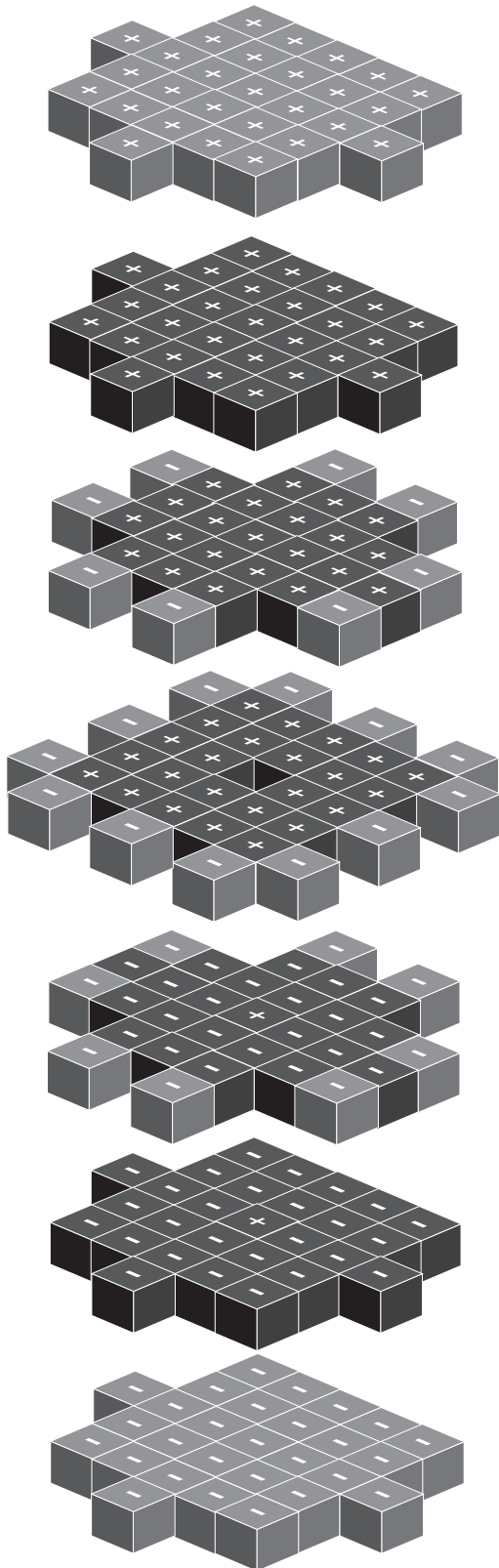


Polonium Nucleus

$$s^2 f^4 d^{10} d^{10} p^4$$

Po 209
 Proton: 84
 Neutron: 125
 Spin: -1/2

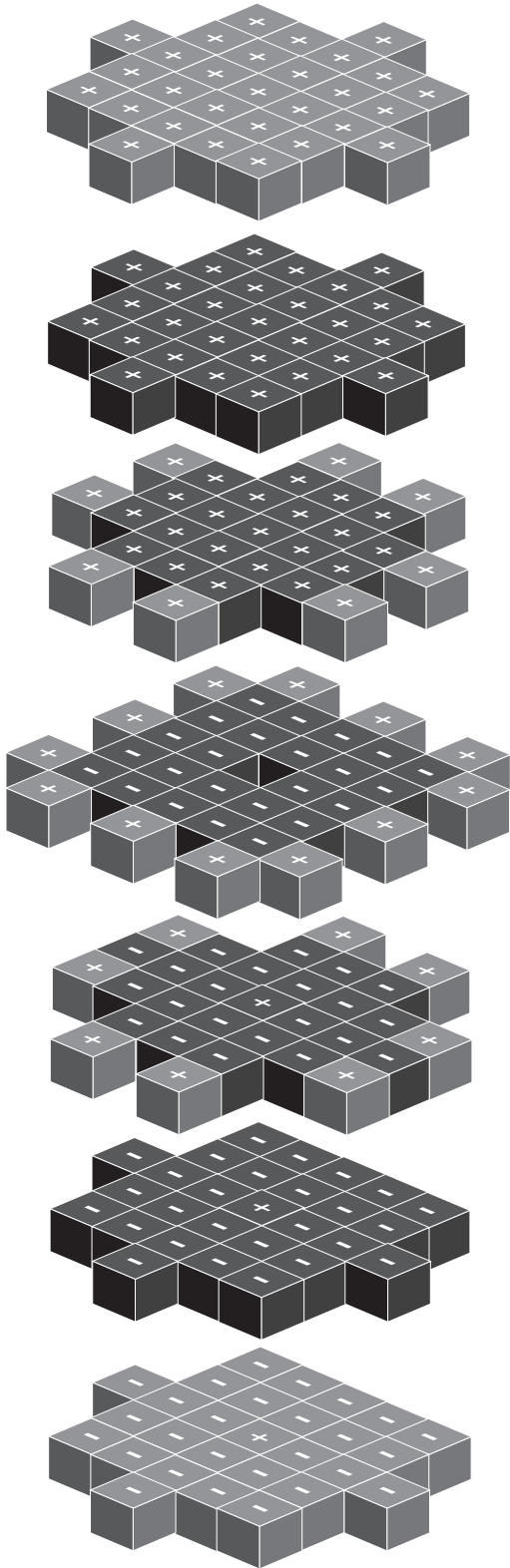
Po 210
 Proton: 84
 Neutron: 126
 Spin: 0



Astatine Nucleus

$s^2 f^4 d^{10} d^{10} p^5$

At 210
Proton: 85
Neutron: 125
Spin:5

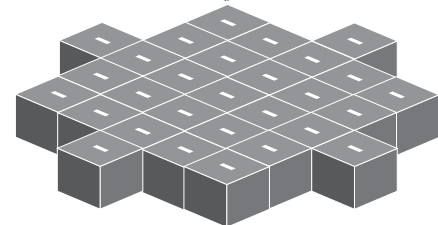
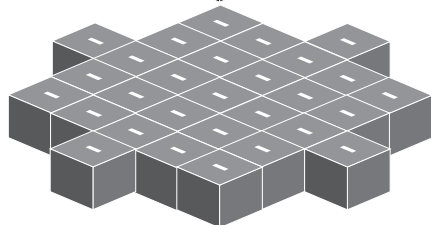
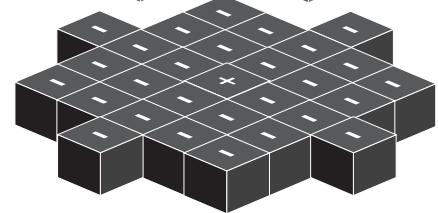
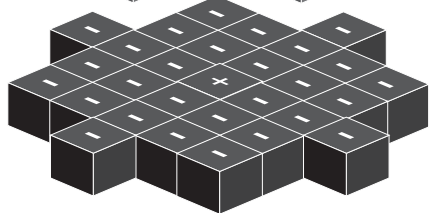
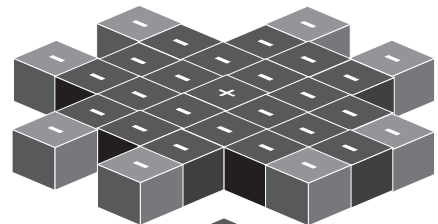
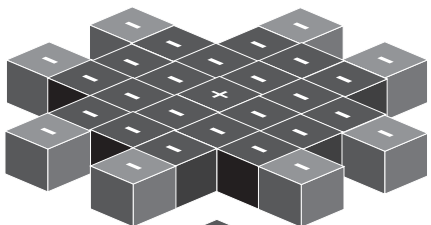
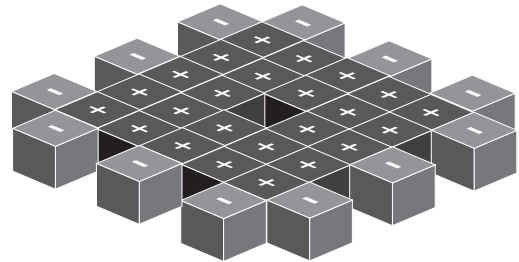
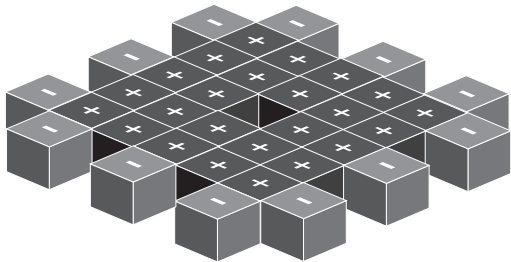
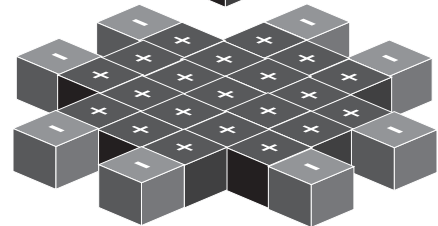
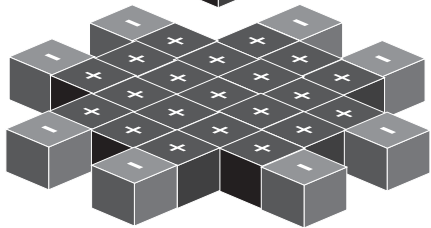
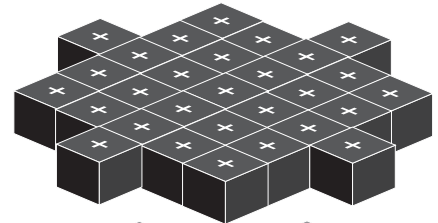
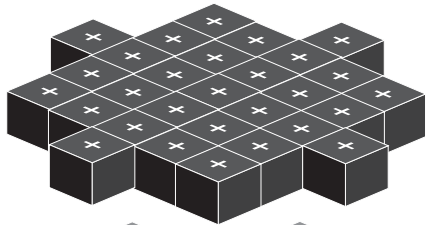
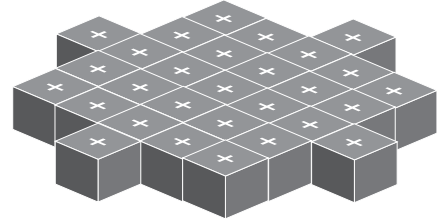
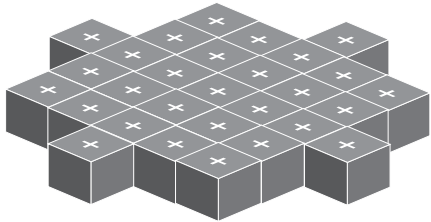


Radon Nucleus

$s^2 f^4 d^{10} d^{10} p^6$

Rn 210
Proton: 86
Neutron: 124
Spin:0

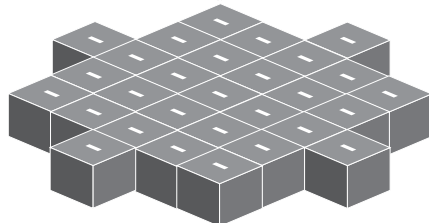
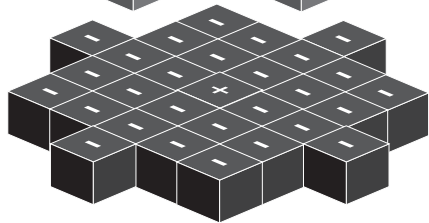
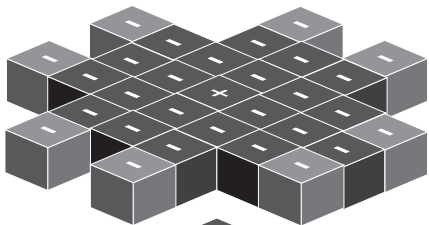
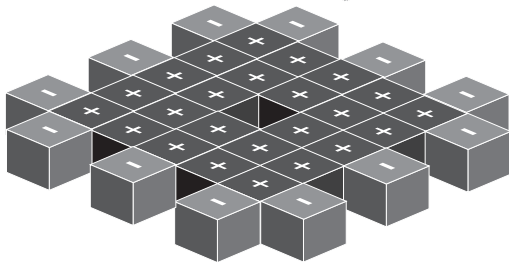
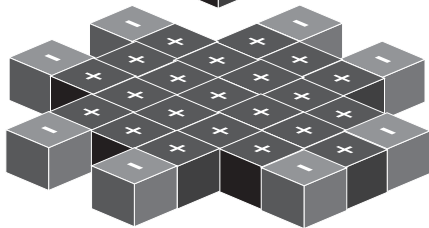
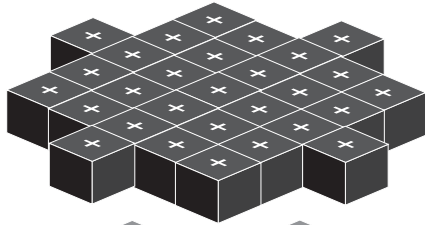
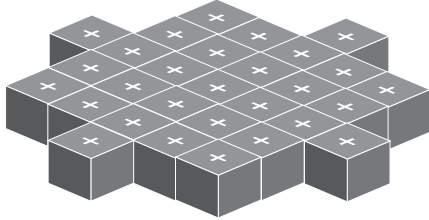
Rn 211
Proton: 86
Neutron: 125
Spin:-1/2



Radon Nucleus

$s^2 f^4 d^{10} d^{10} p^6$

Rn 212
Proton: 86
Neutron: 126
Spin:0

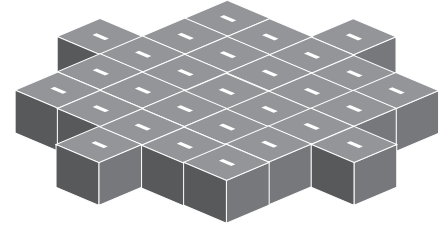
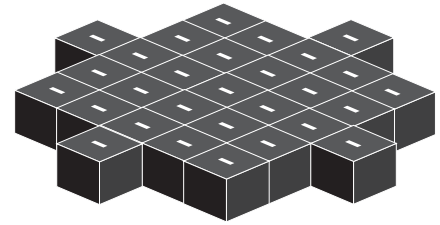
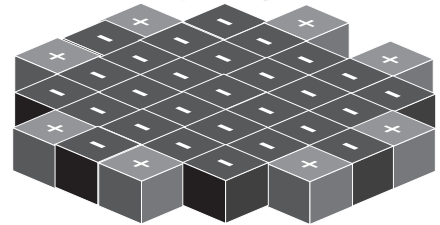
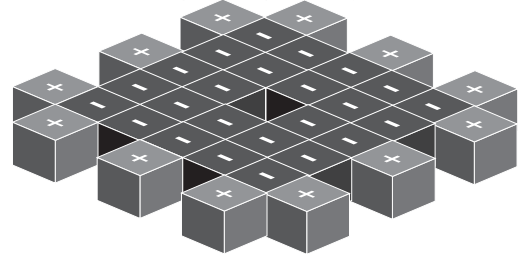
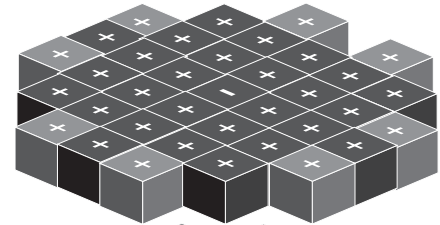
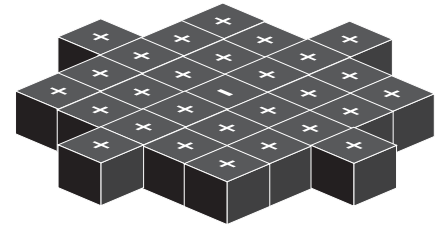
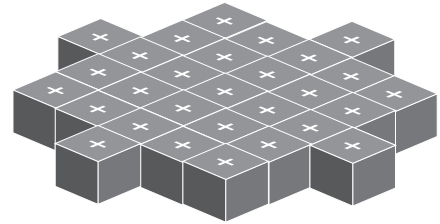
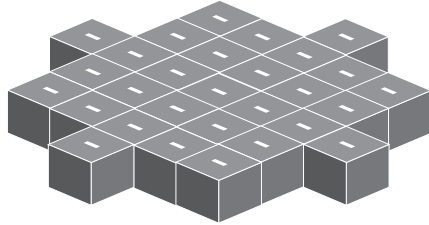
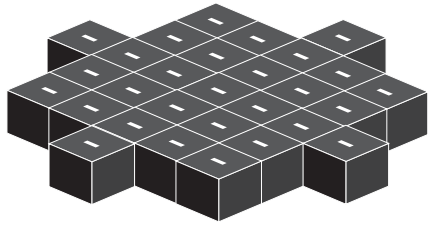
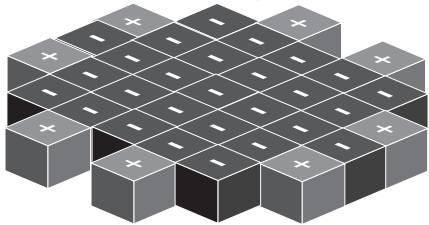
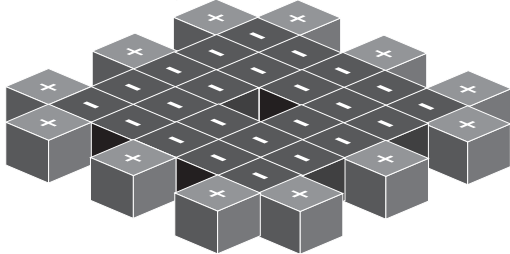
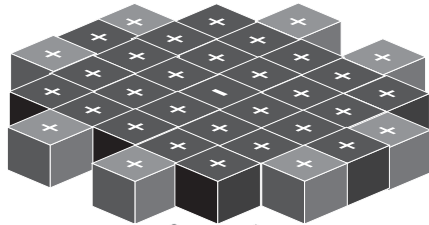
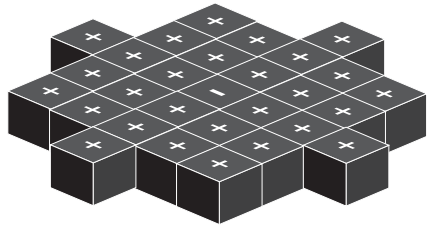
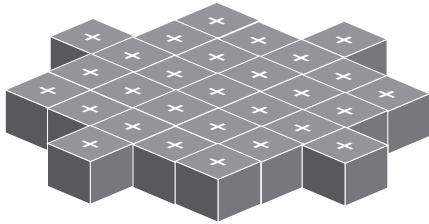


Radon Nucleus

$s^2 f^4 d^{10} d^{10} p^6$

Rn 222
Proton: 86
Neutron: 136
Spin:0

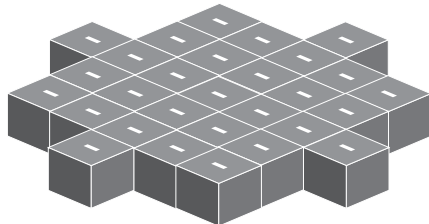
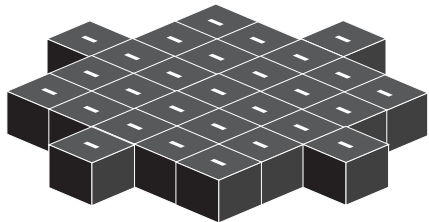
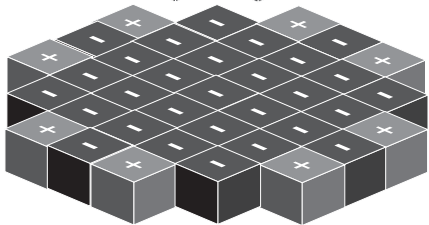
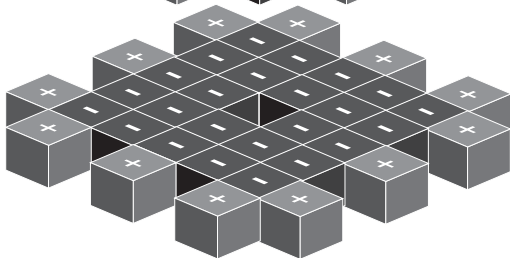
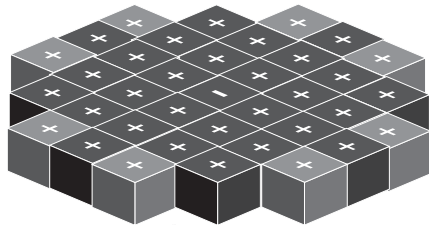
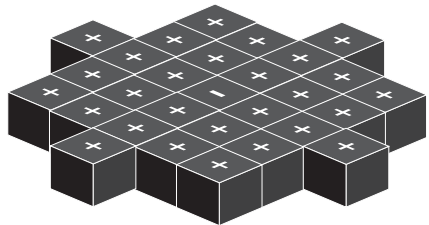
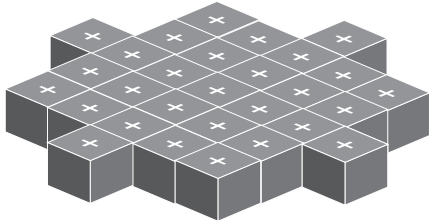
Rn 224
Proton: 86
Neutron: 138
Spin:0



Radon Nucleus

$s^2 f^4 d^{10} d^{10} p^6$

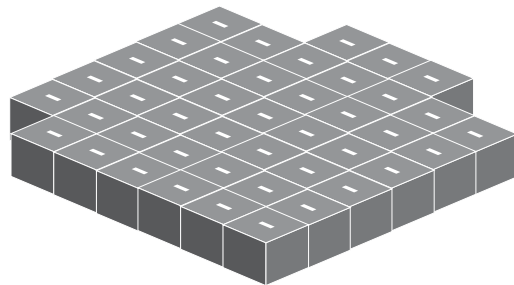
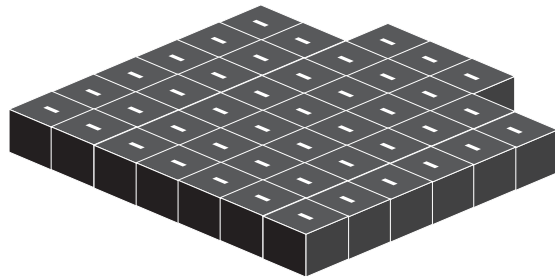
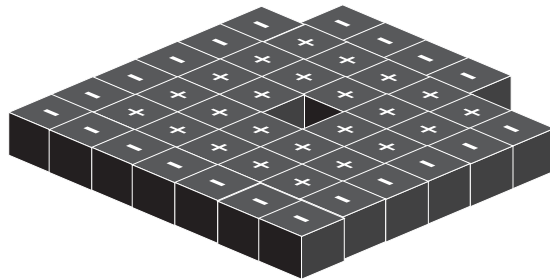
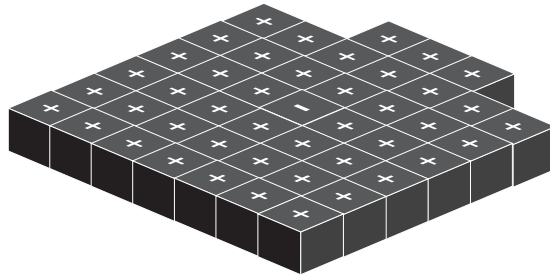
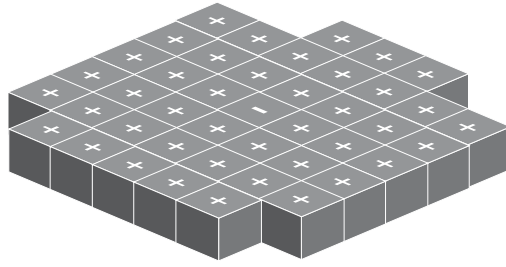
Rn 226
Proton: 86
Neutron: 140
Spin:0



Francium Nucleus

s^1

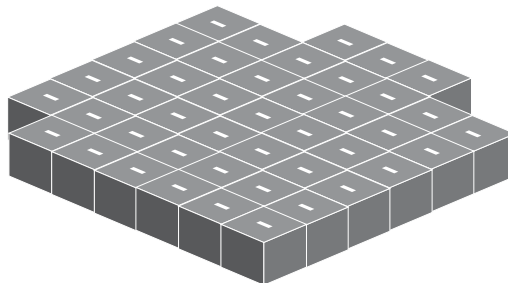
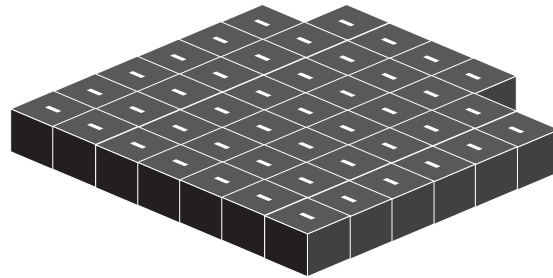
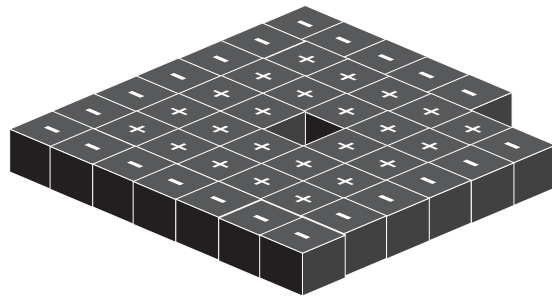
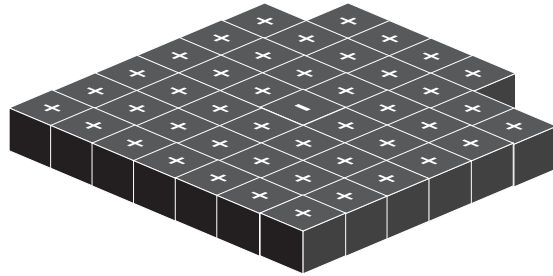
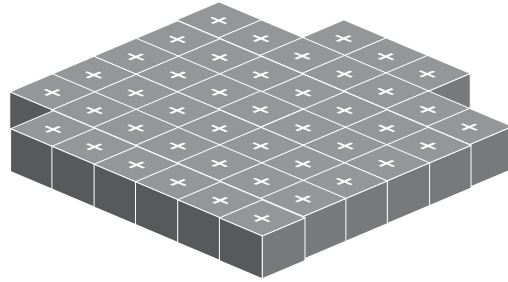
Fr 223
Proton: 87
Neutron: 136
Spin: $-3/2$



Radium Nucleus

s^2

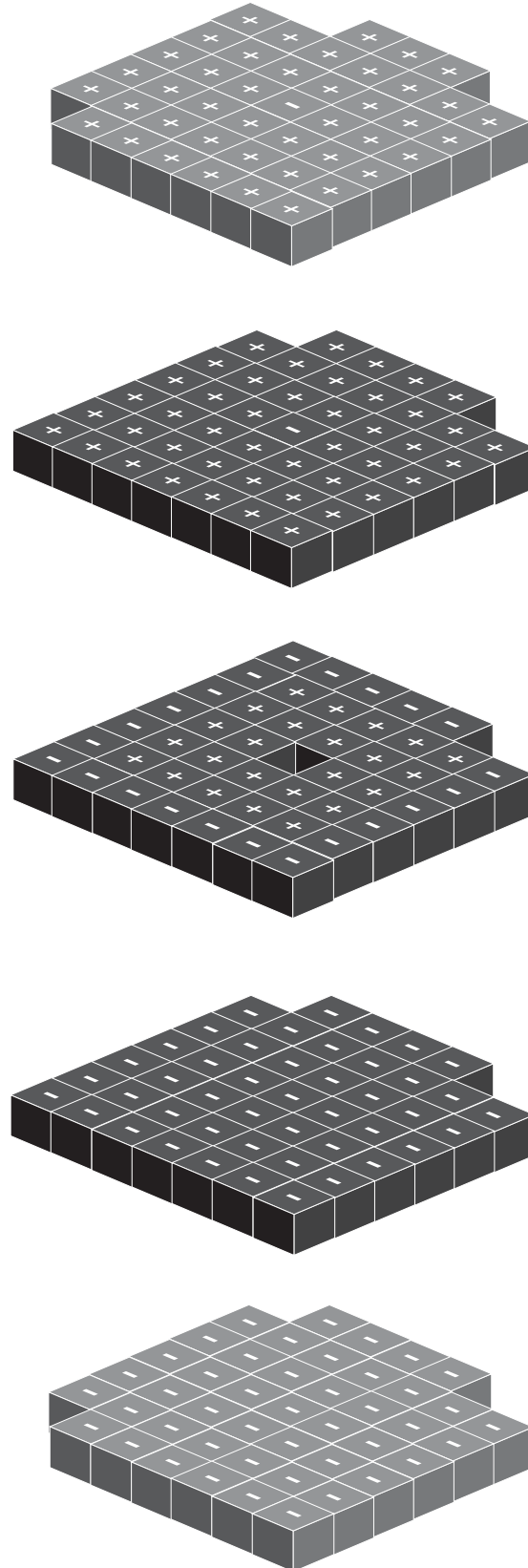
Ra 226
Proton: 88
Neutron: 138
Spin:0



Actinium Nucleus

$s^2 f^1$

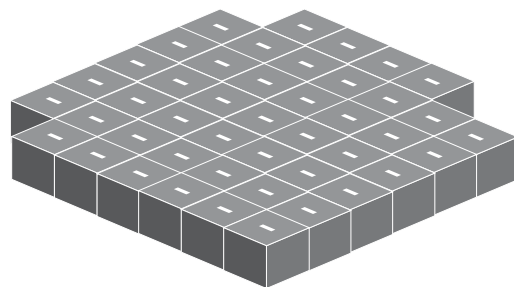
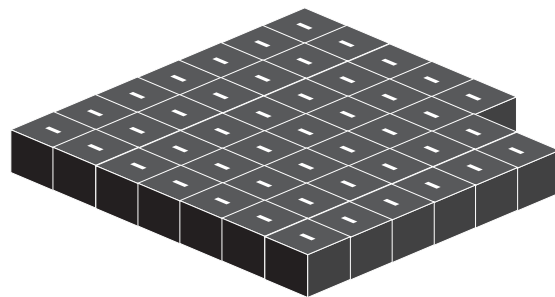
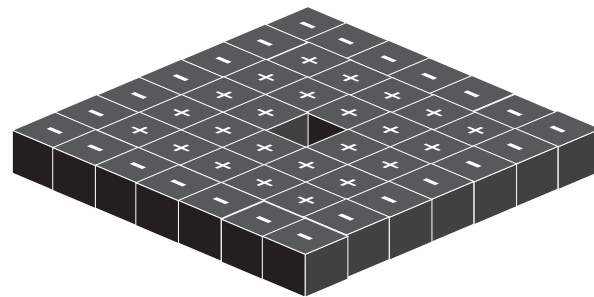
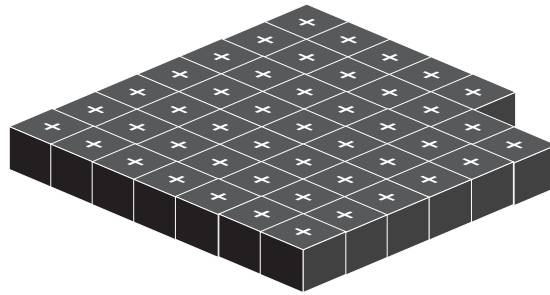
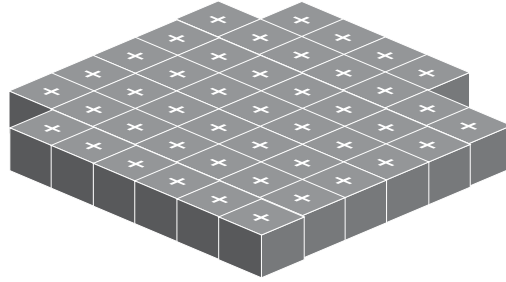
Ac 227
Proton: 89
Neutron: 138
Spin: $-3/2$



Thorium Nucleus

$s^2 f^2$

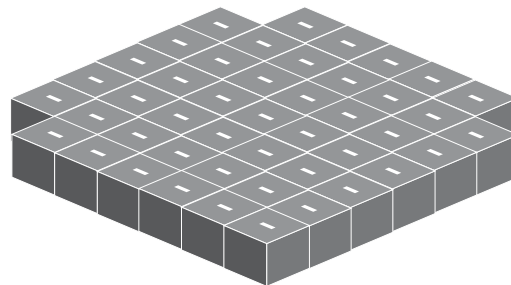
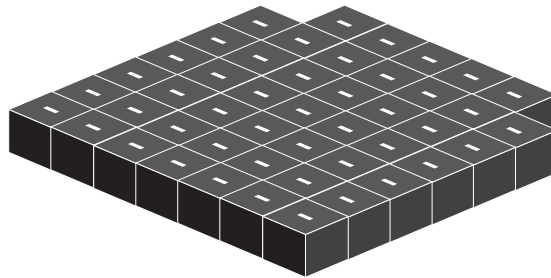
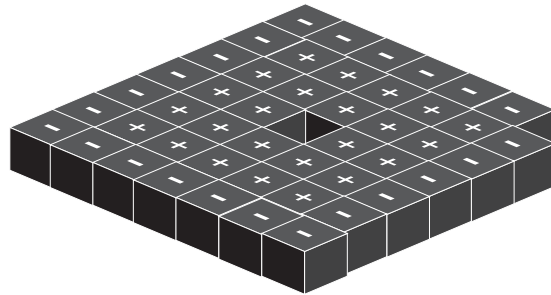
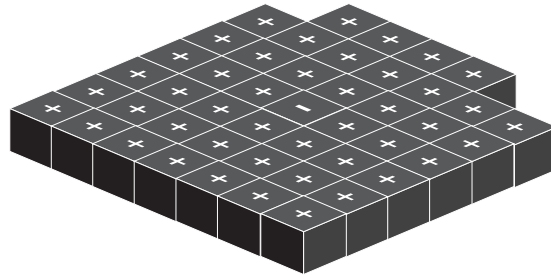
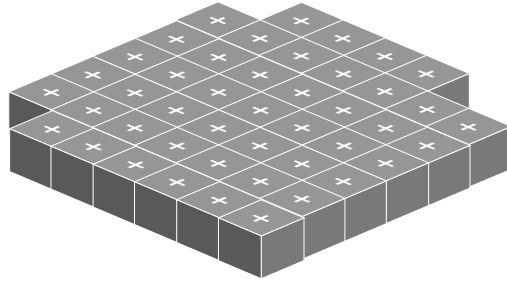
Th 232
Proton: 90
Neutron: 142
Spin:0



Protactinium Nucleus

$$s^2 f^3$$

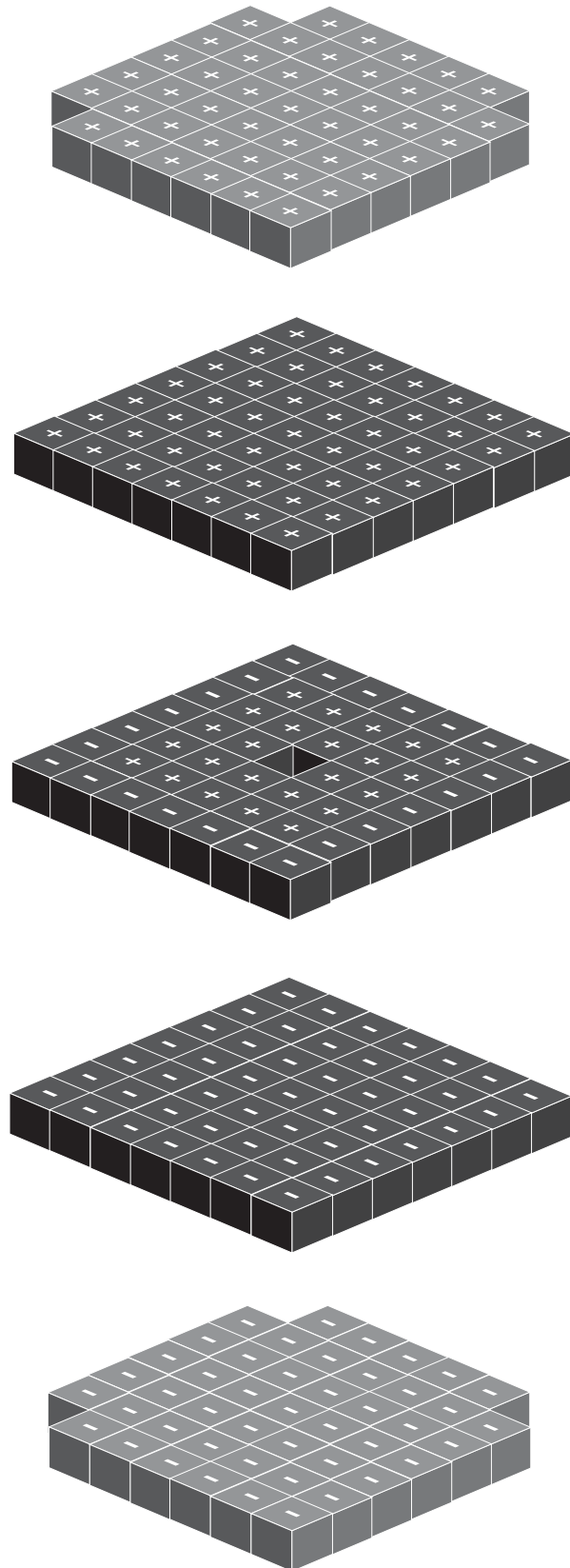
Pa 231
Proton: 91
Neutron: 140
Spin: -3/2



Uranium Nucleus

$$s^2 f^4$$

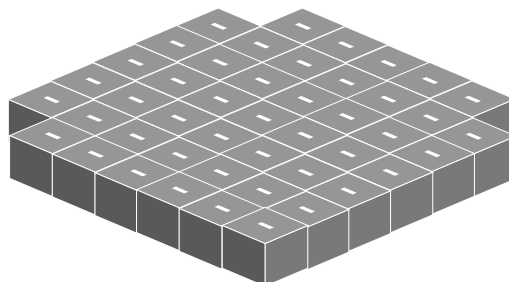
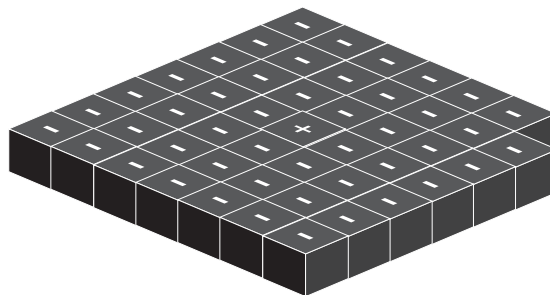
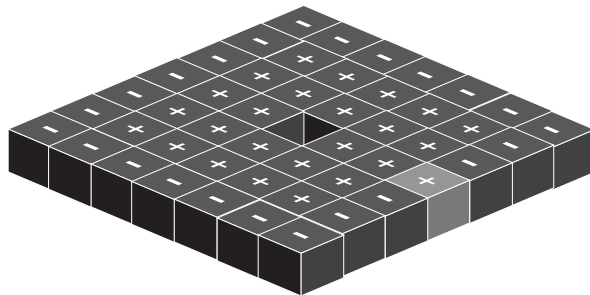
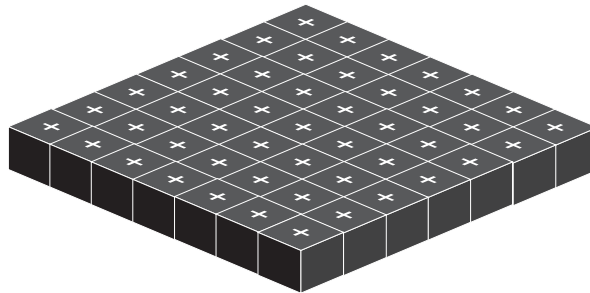
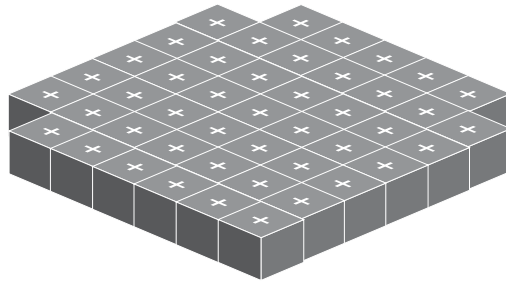
U 238
Proton: 92
Neutron: 146
Spin:0



Neptunium Nucleus

$$s^2 f^4 d^1$$

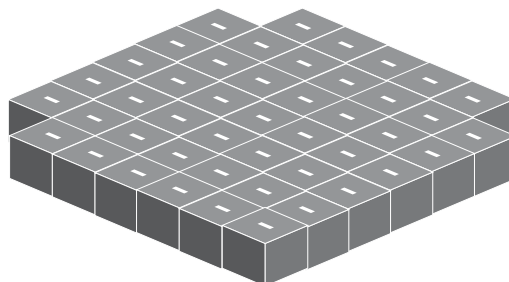
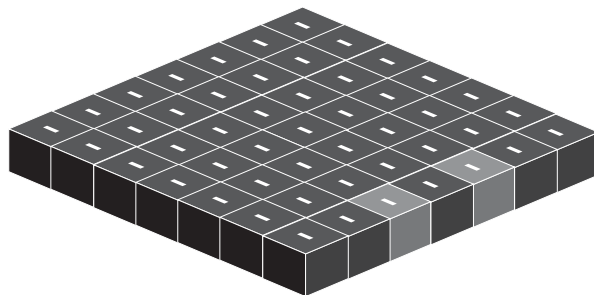
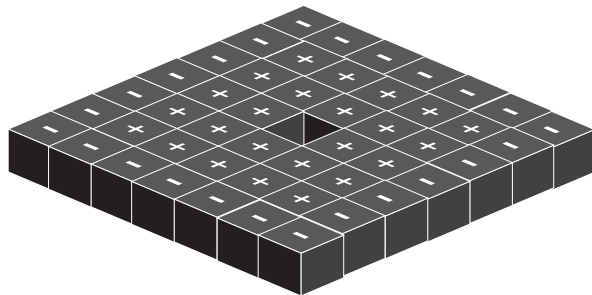
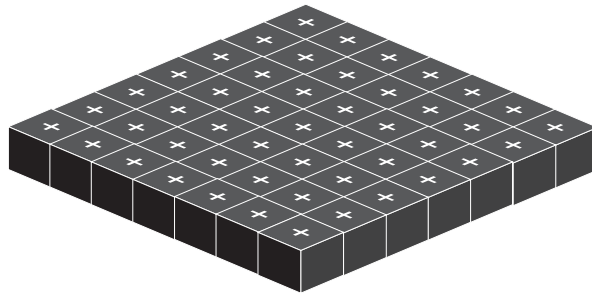
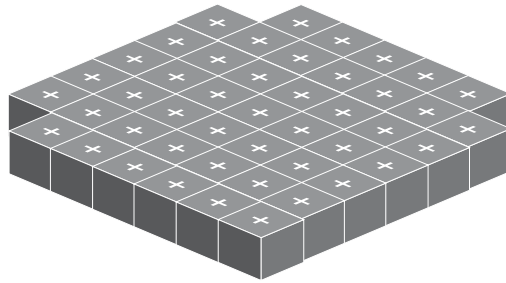
Np 237
Proton: 93
Neutron: 144
Spin: 5/2



Plutonium Nucleus

$$s^2 f^4 d^2$$

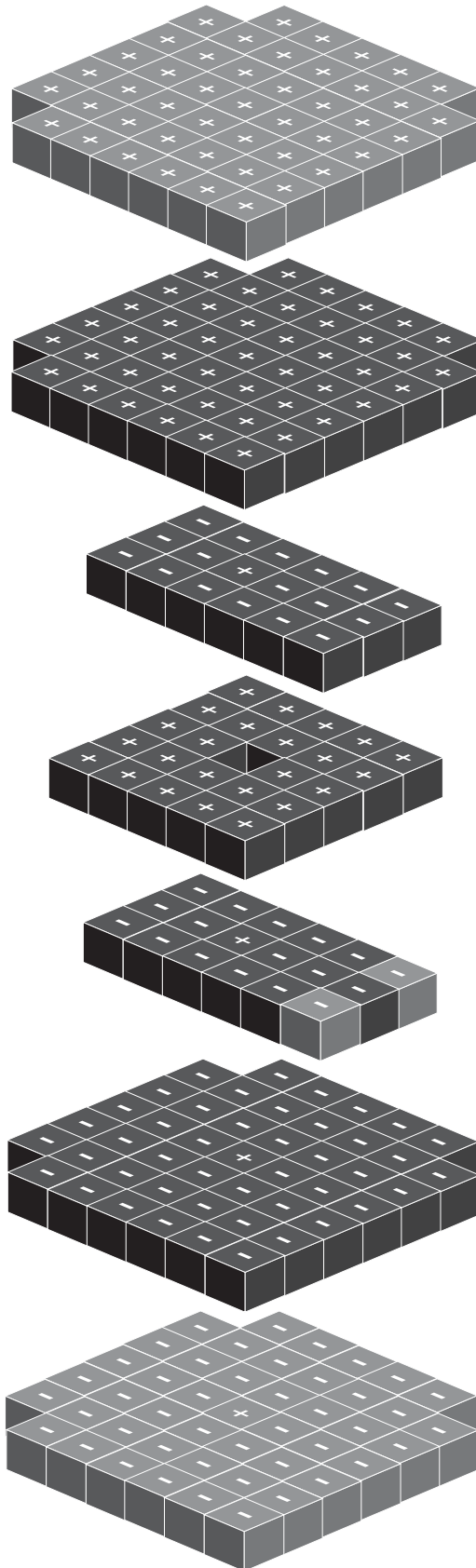
Pu 238
Proton: 94
Neutron: 144
Spin:0



Plutonium Nucleus

$$s^2 f^4 d^2$$

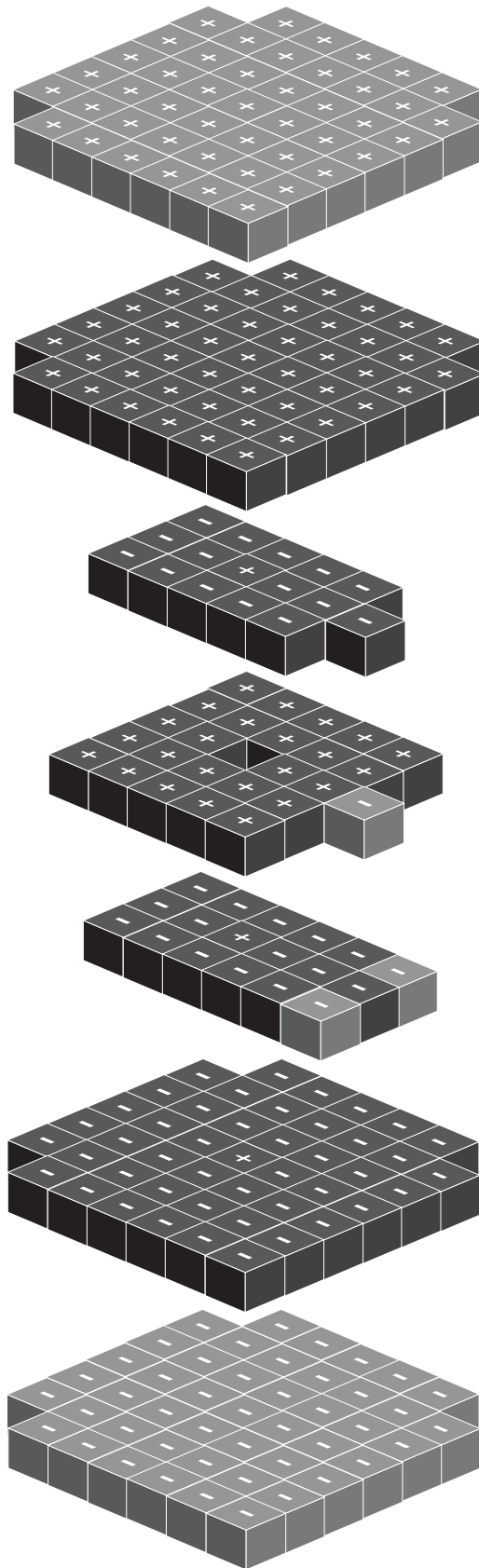
Pu 244
Proton:94
Neutron:150
Spin:0



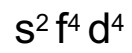
Americium Nucleus

$$s^2 f^4 d^3$$

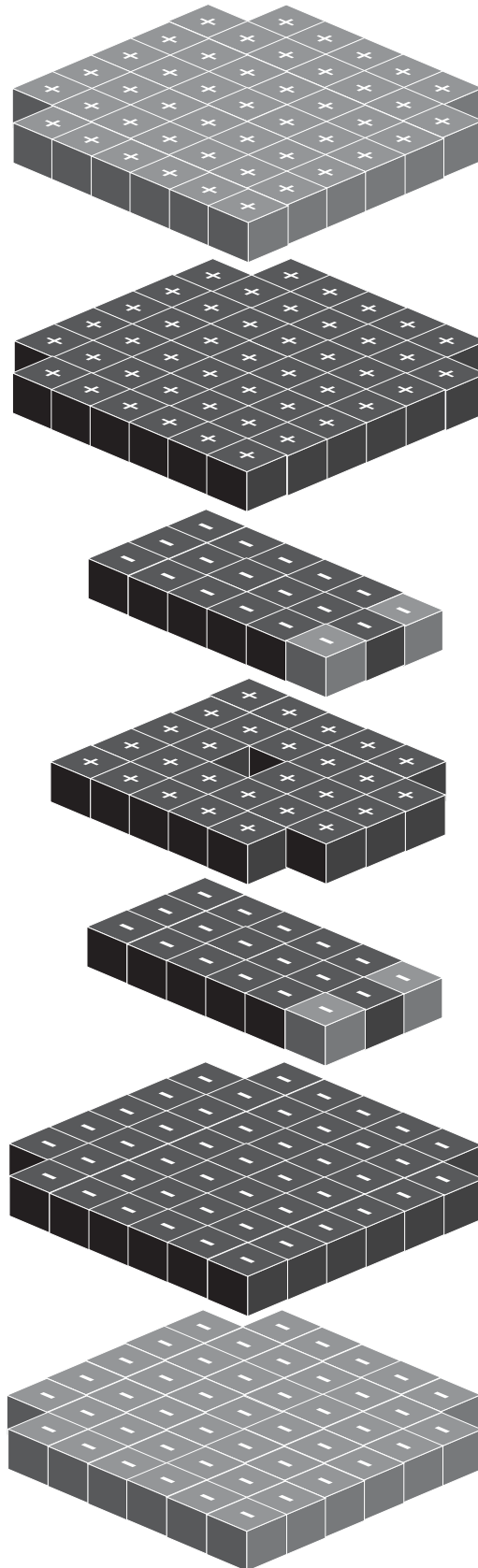
Am 243
Proton:95
Neutron:148
Spin:-5/2



Curium Nucleus



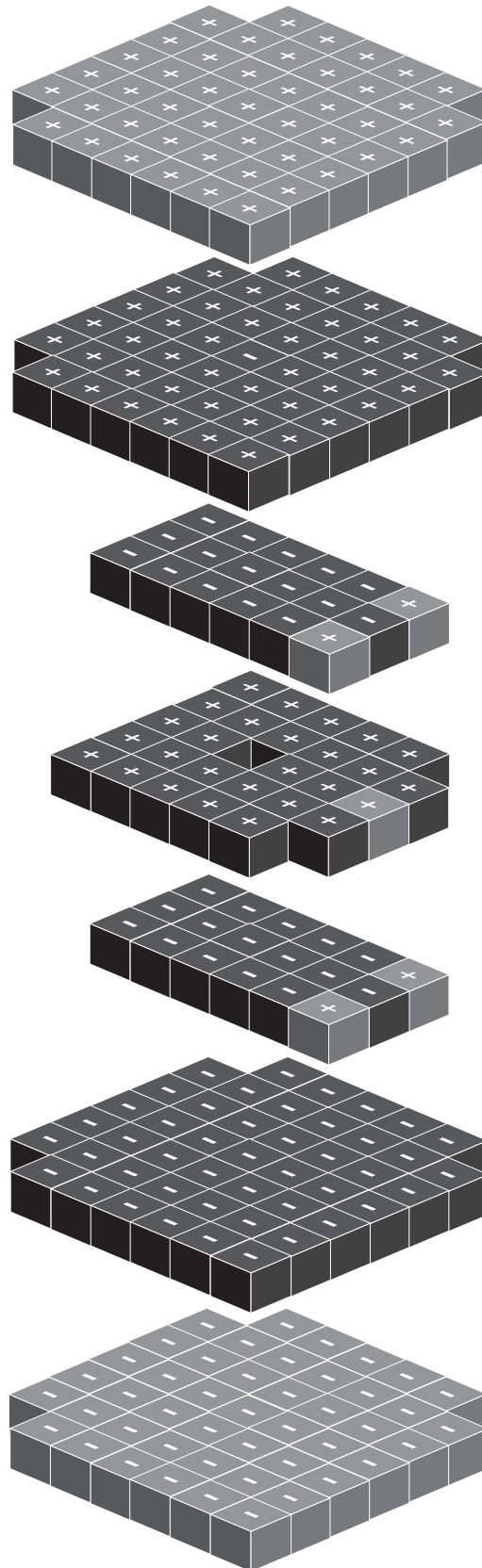
Cm 247
Proton:96
Neutron:151
Spin:-9/2



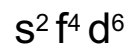
Berkelium Nucleus

$$s^2 f^4 d^5$$

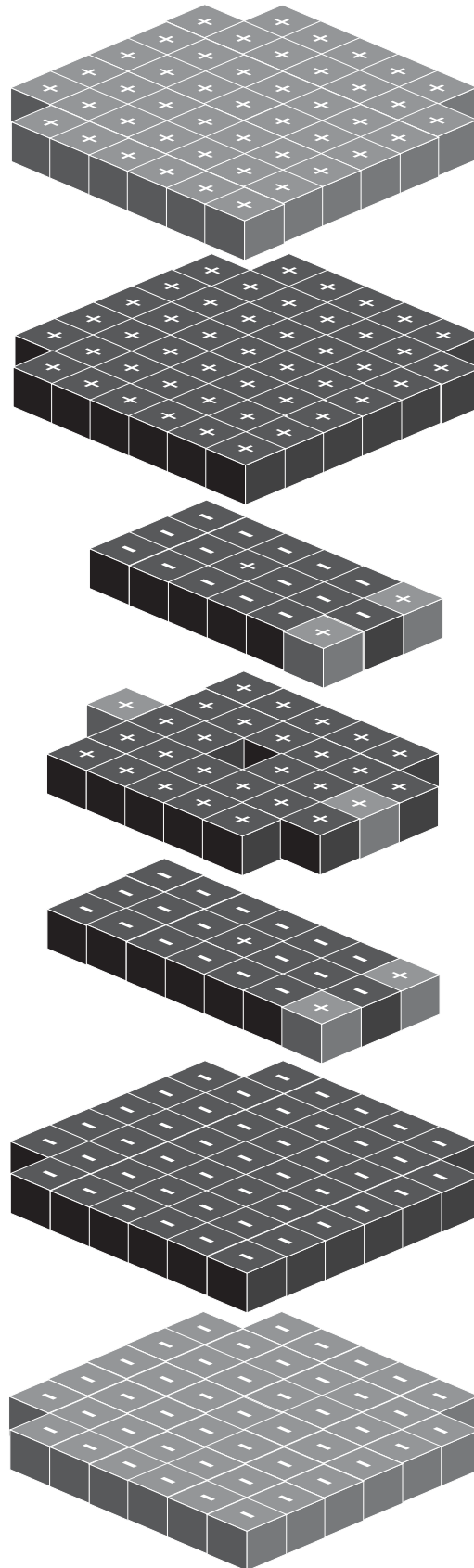
Bk 247
Proton:97
Neutron:150
Spin:-3/2



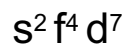
Californium Nucleus



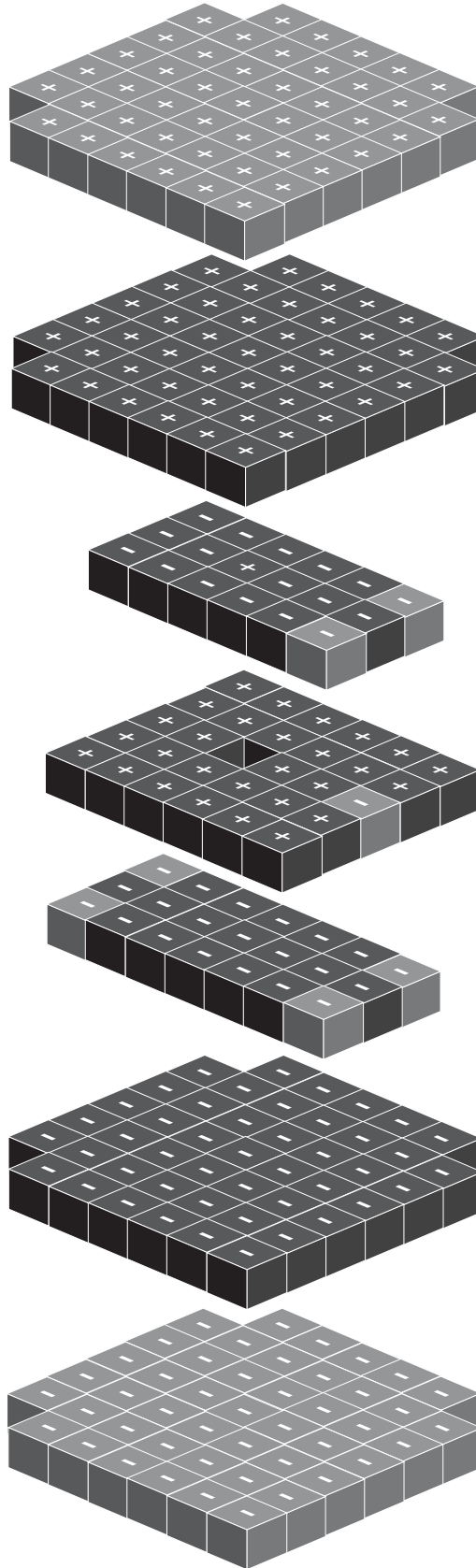
Cf 251
Proton:98
Neutron:153
Spin:1/2



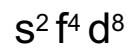
Einsteinium Nucleus



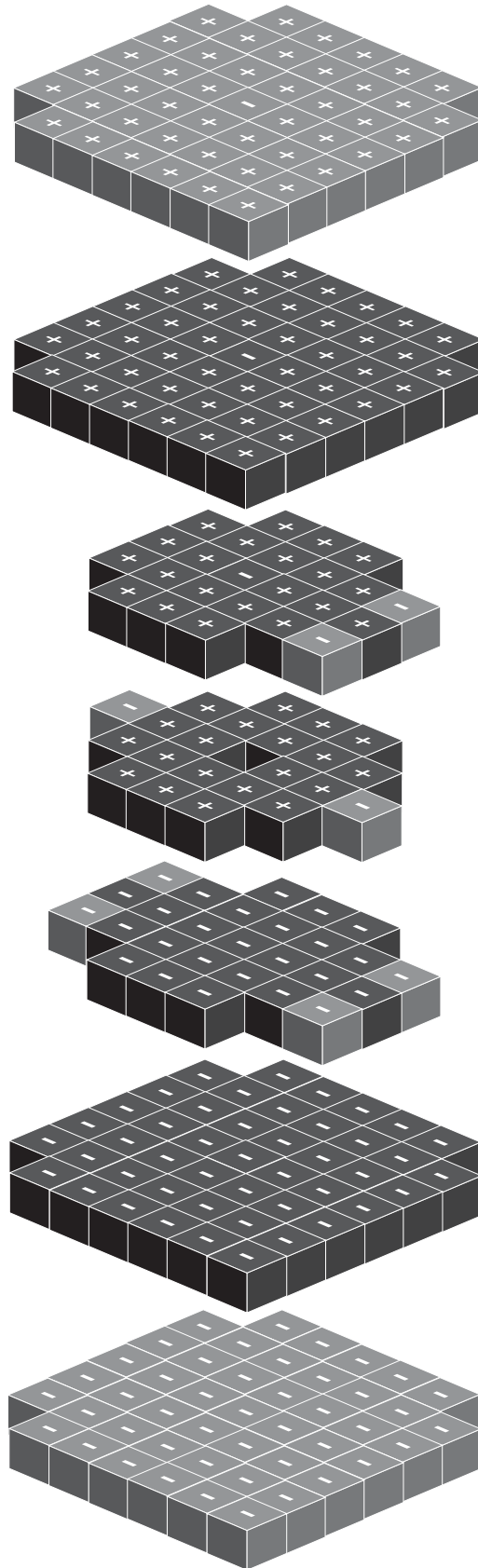
Es 252
Proton:99
Neutron:153
Spin:-5



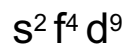
Fermium Nucleus



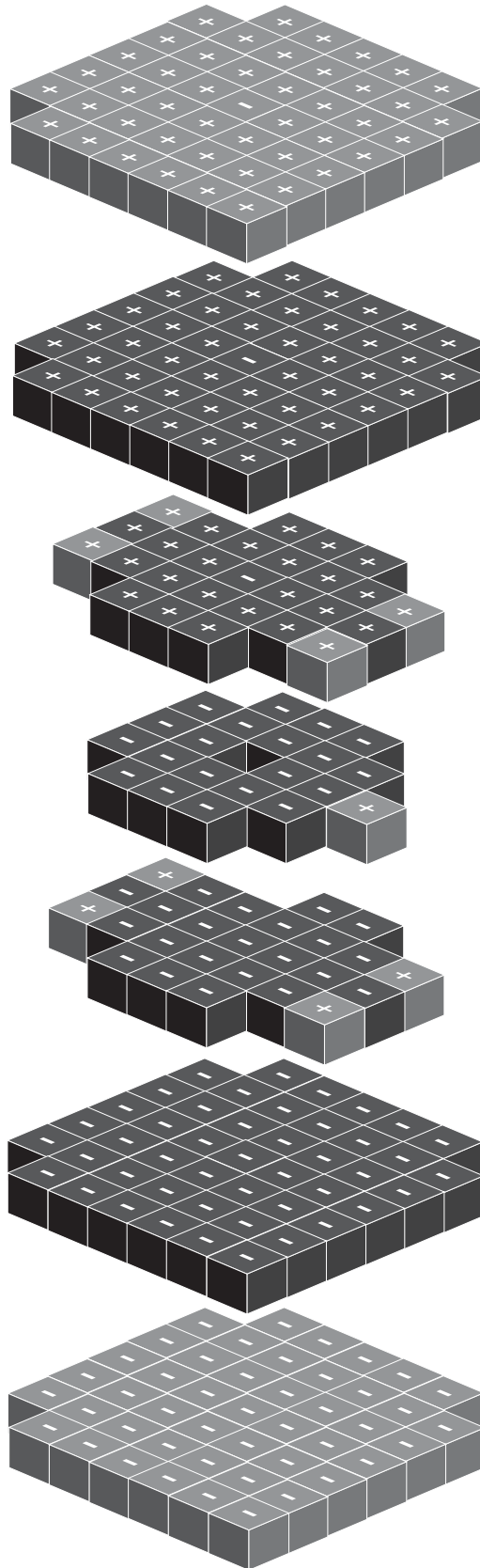
Fm 257
Proton:100
Neutron:157
Spin:9/2



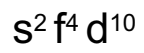
Mendelevium Nucleus



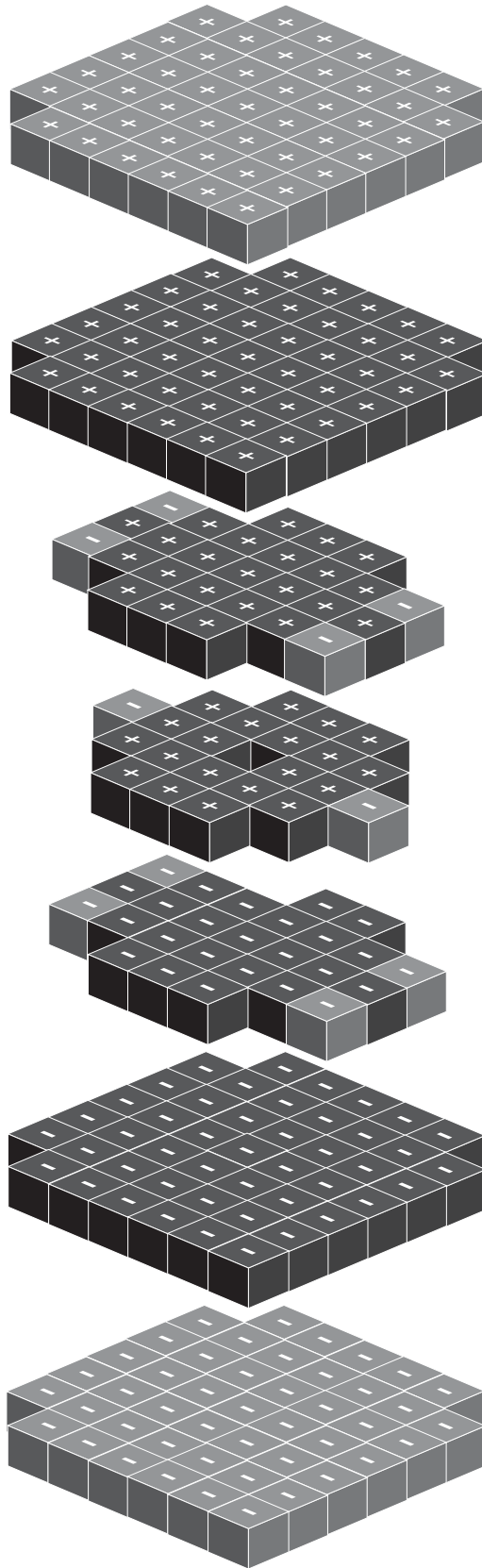
Md 258
Proton:101
Neutron:157
Spin:-8



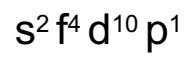
Nobelium Nucleus



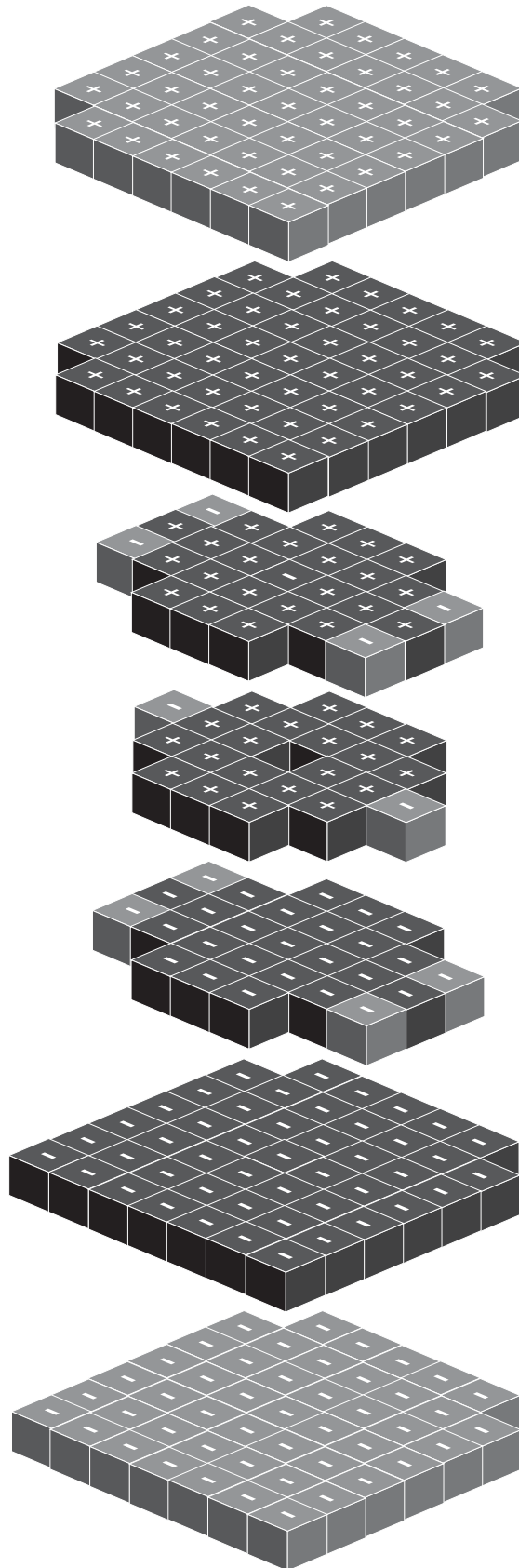
No 259
Proton:102
Neutron:157
Spin:9/2



Lawrencium Nucleus



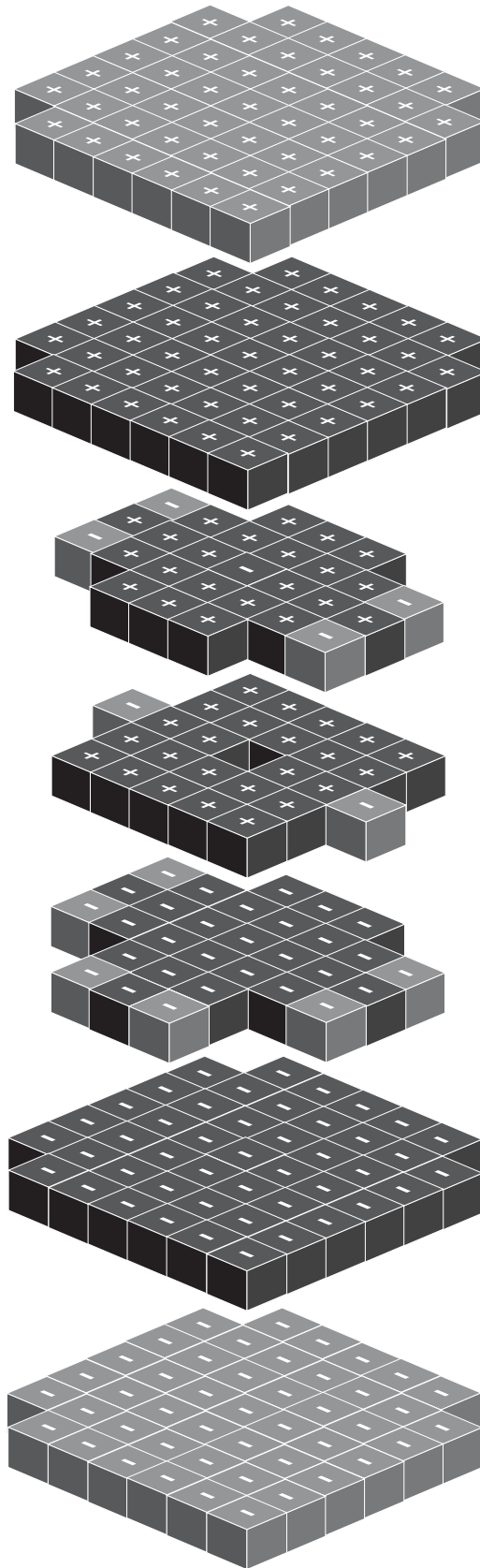
Lr 262
Proton:103
Neutron:159
Spin:2



Rutherfordium Nucleus

$s^2 f^4 d^{10} d^2$

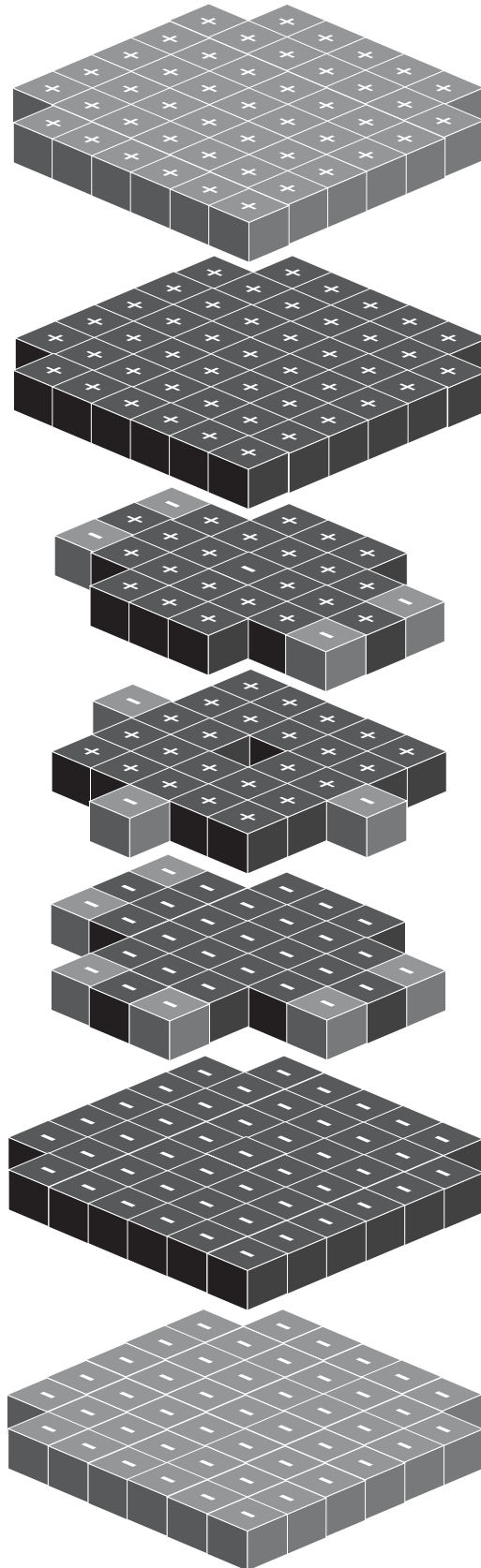
Rf 267
Proton:104
Neutron:163
Spin:9/2



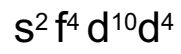
Dubnium Nucleus

$s^2 f^4 d^{10} d^3$

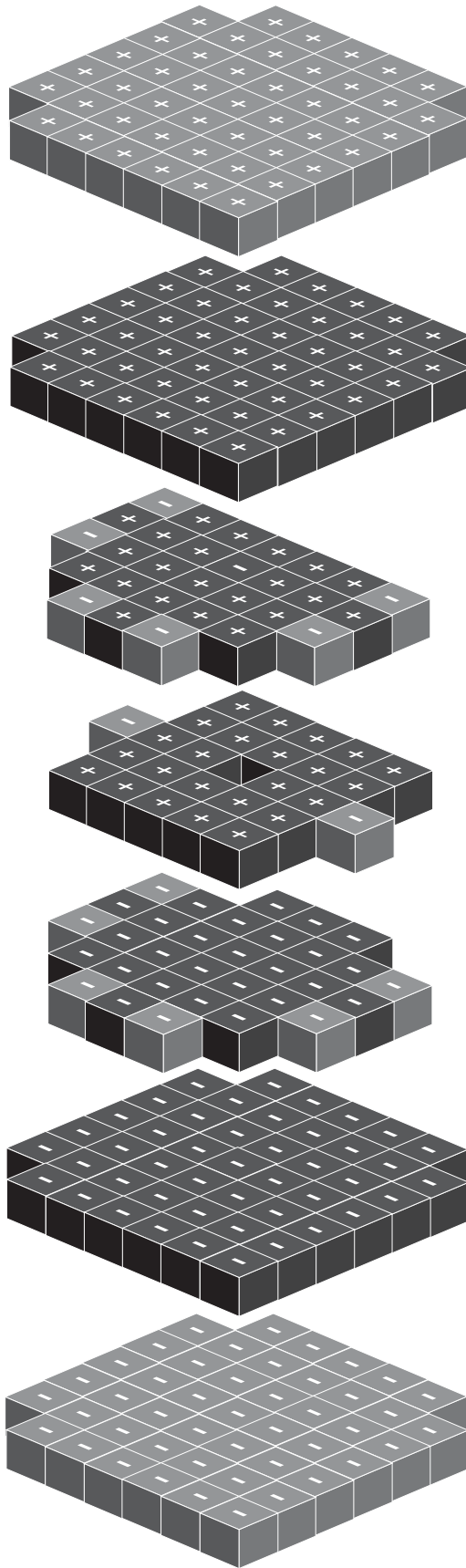
Db 268
Proton:105
Neutron:163
Spin:4



Seaborgium Nucleus



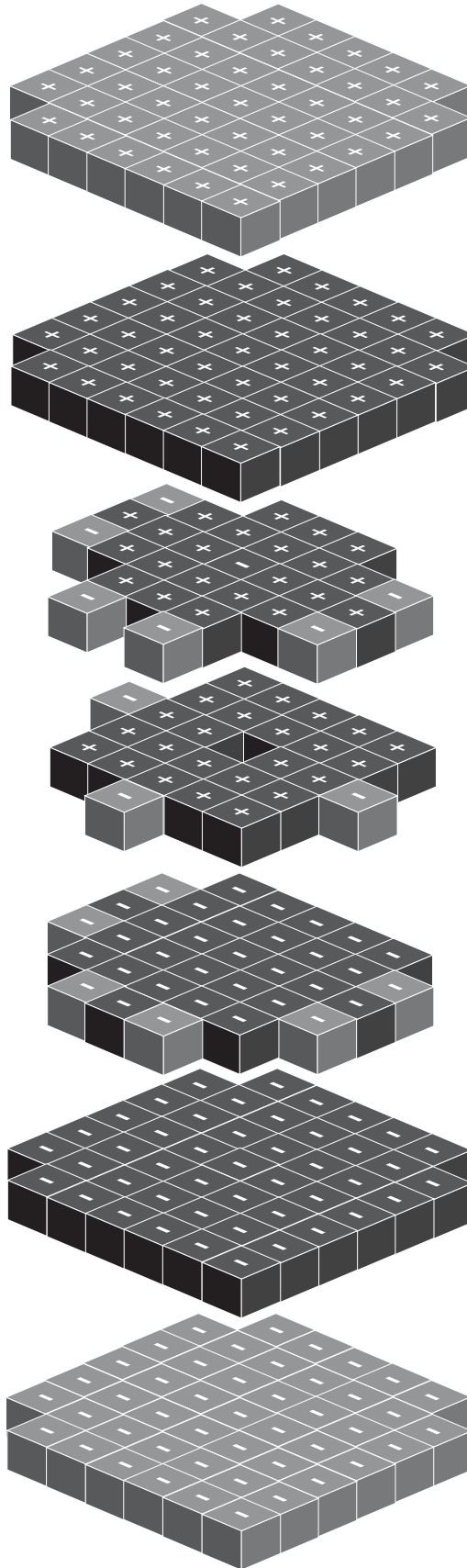
Sg 271
Proton:106
Neutron:165
Spin:5/2



Bohrium Nucleus

$s^2 f^4 d^{10} d^5$

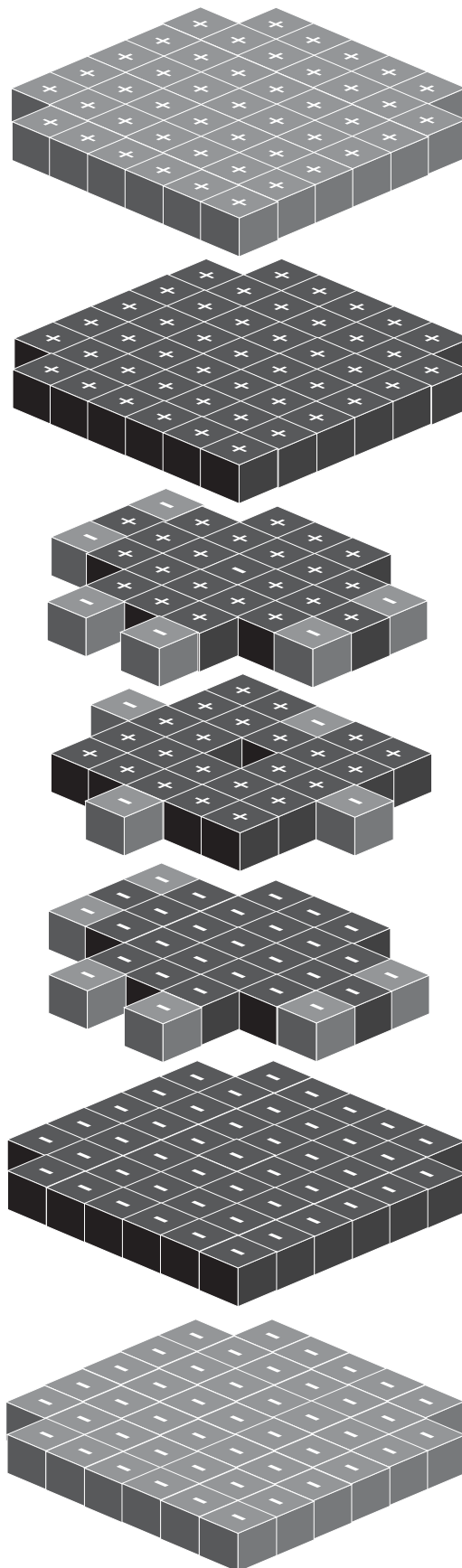
Bh 274
Proton:107
Neutron:167
Spin:1



Hassium Nucleus

$s^2 f^4 d^{10} d^6$

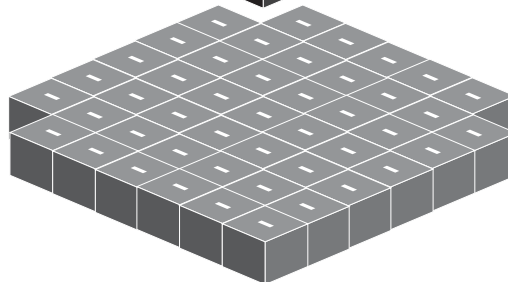
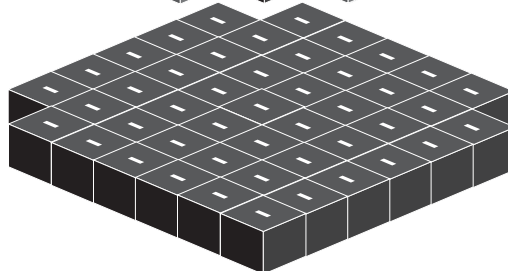
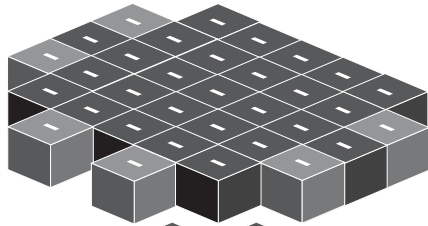
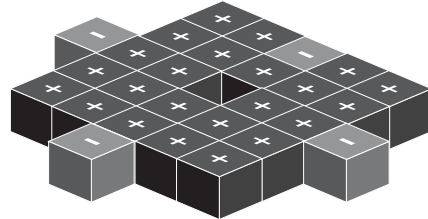
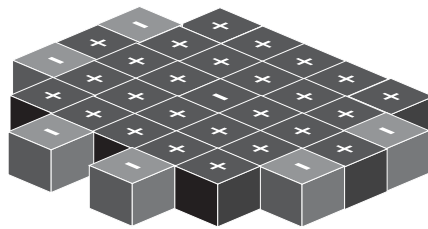
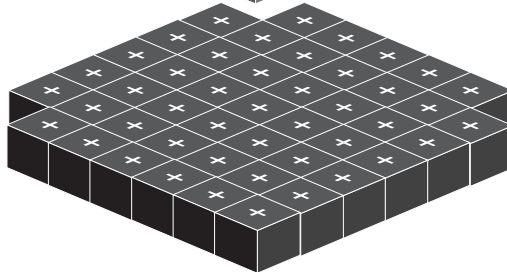
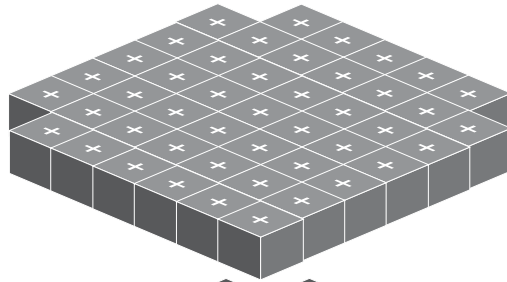
Hs 269
Proton:108
Neutron:161
Spin:5/2



Hassium Nucleus

$s^2 f^4 d^{10} d^6$

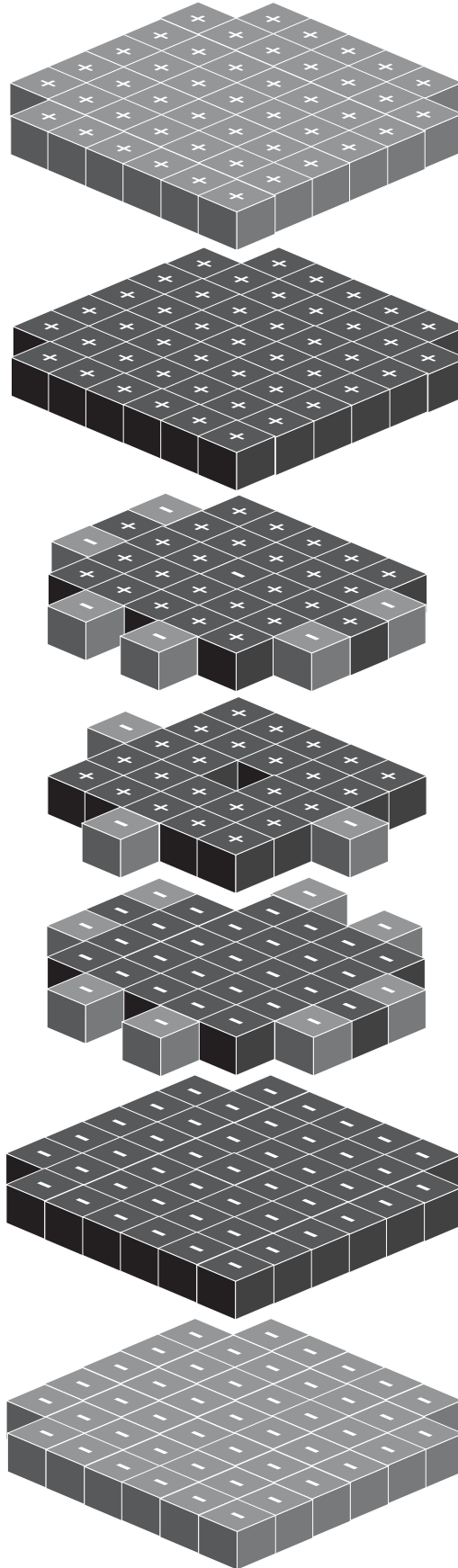
Hs 277
Proton:108
Neutron:169
Spin:5/2



Meitnerium Nucleus

$s^2 f^4 d^{10} d^7$

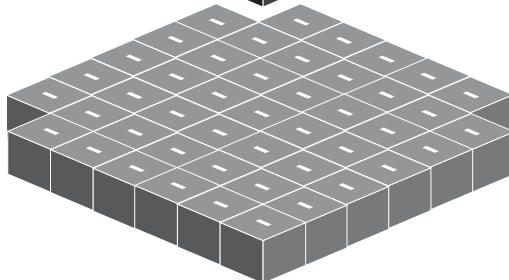
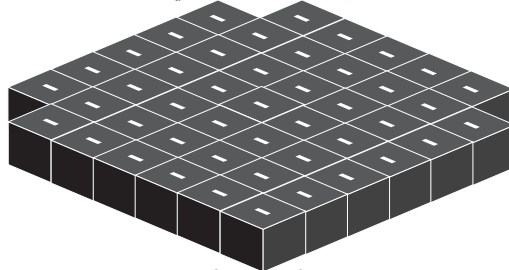
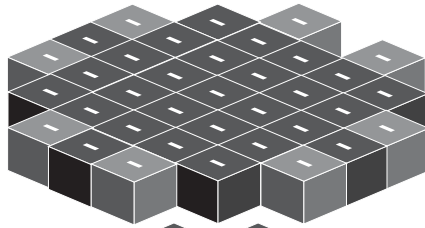
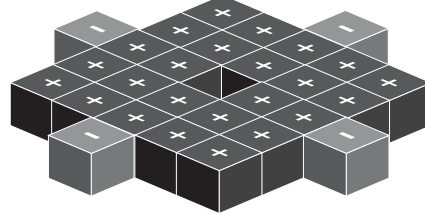
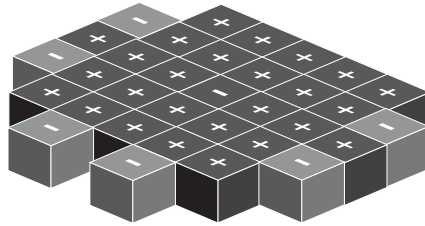
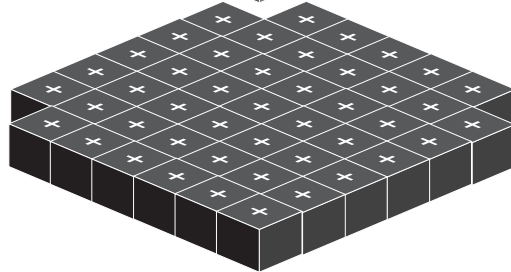
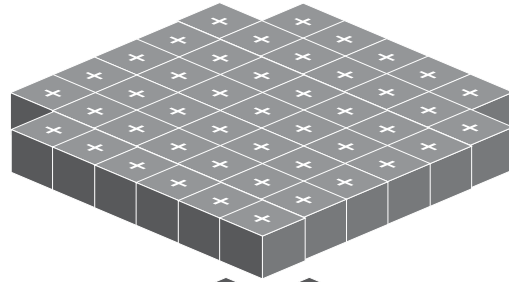
Mt 278
Proton:109
Neutron:169
Spin:3



Darmstadtium Nucleus

$s^2 f^4 d^{10} d^8$

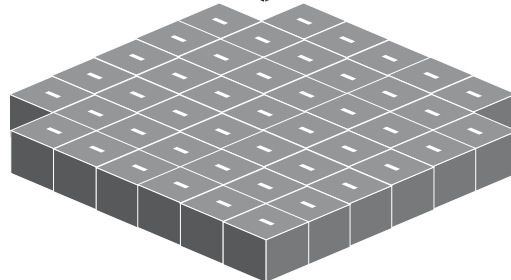
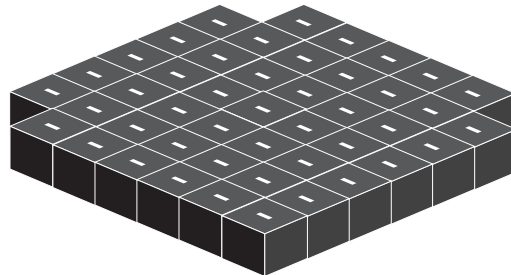
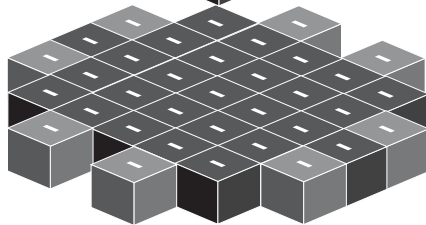
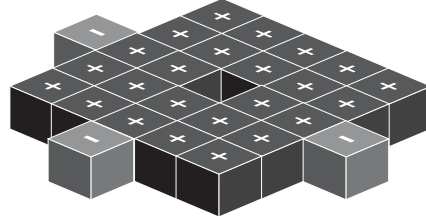
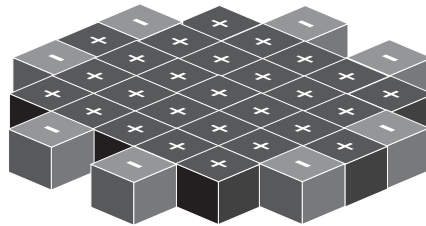
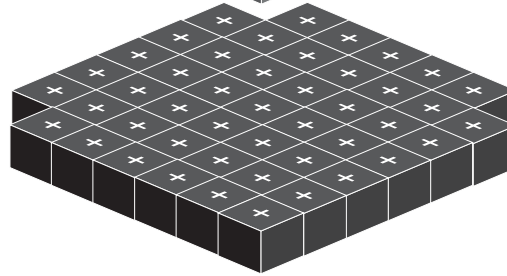
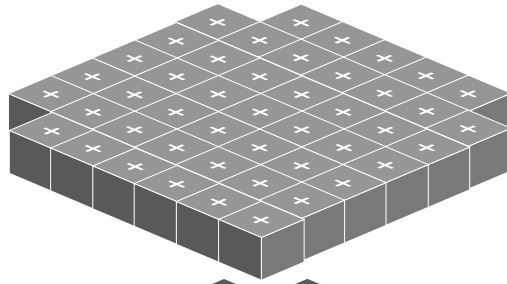
Ds 281
Proton:110
Neutron:171
Spin:3/2



Roentgenium Nucleus

$s^2 f^4 d^{10} d^9$

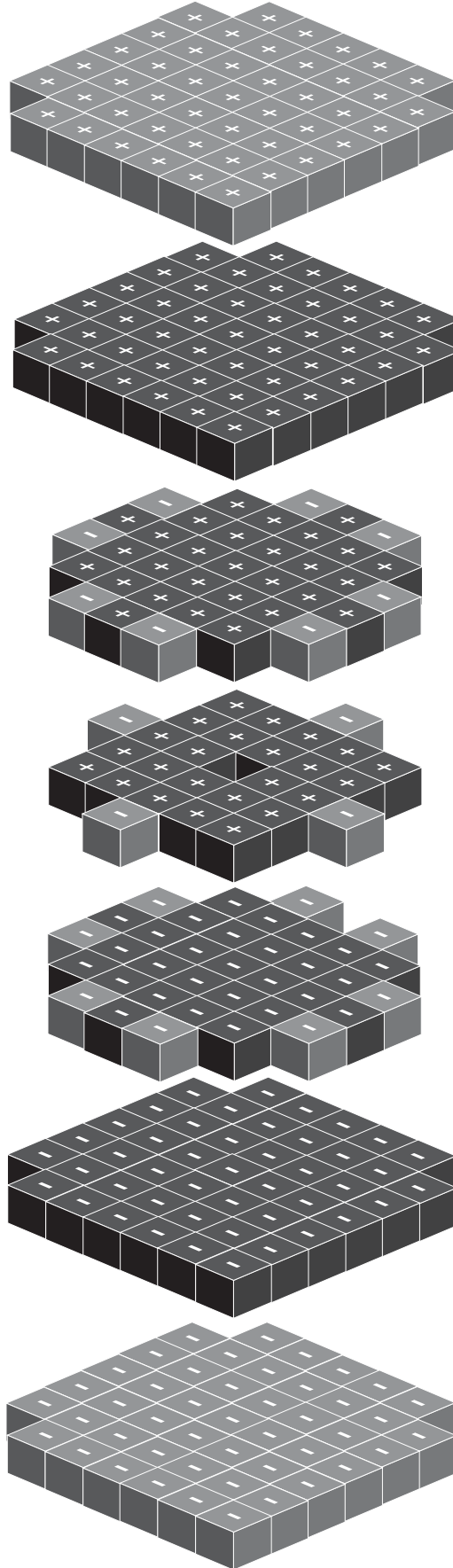
Rg 281
Proton:111
Neutron:170
Spin:5/2



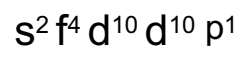
Copernicium Nucleus

$s^2 f^4 d^{10} d^{10}$

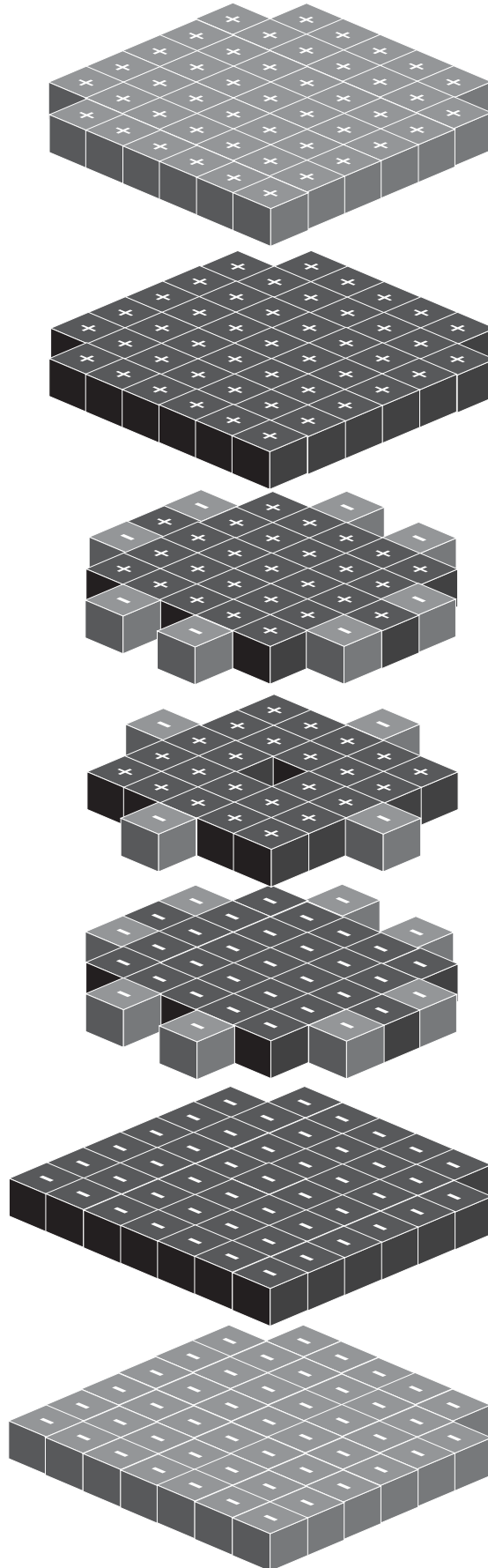
Cn 285
Proton:112
Neutron:173
Spin:5/2



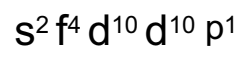
Ununtrium Nucleus



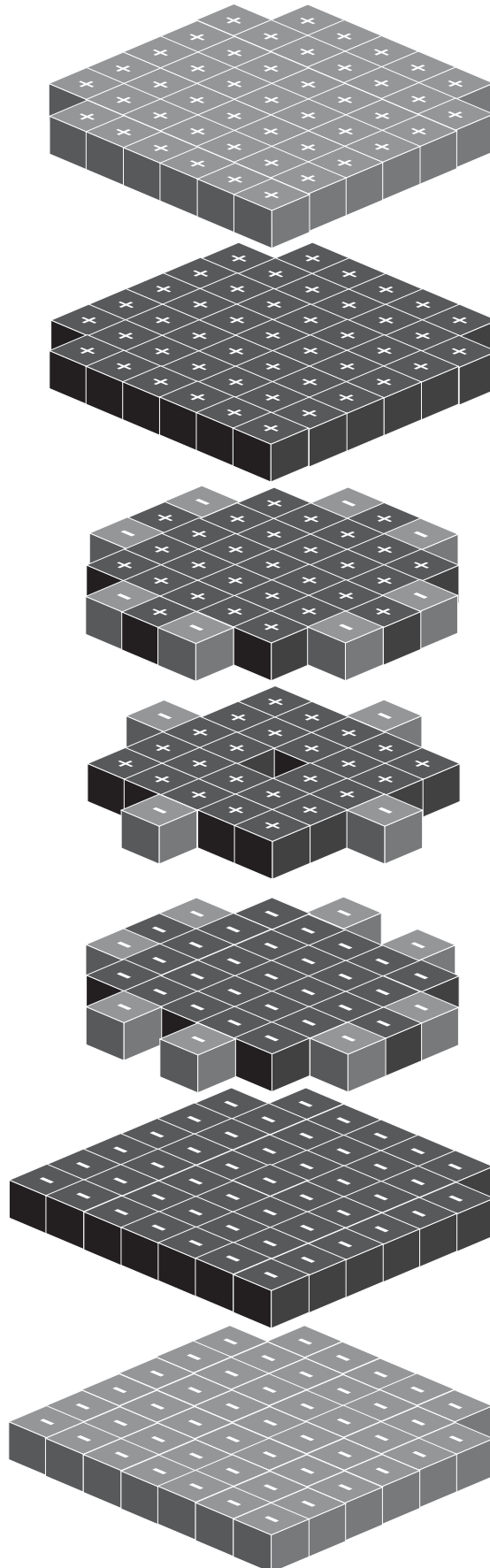
Uut 284
Proton:113
Neutron:171
Spin:1



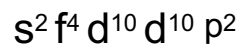
Ununtrium Nucleus



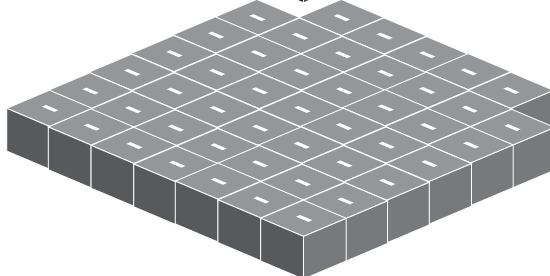
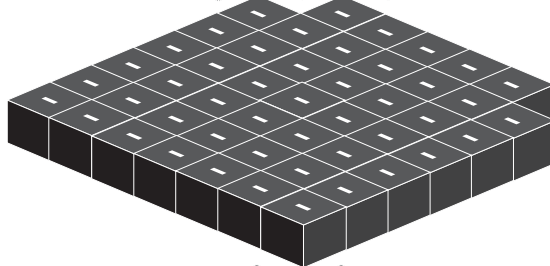
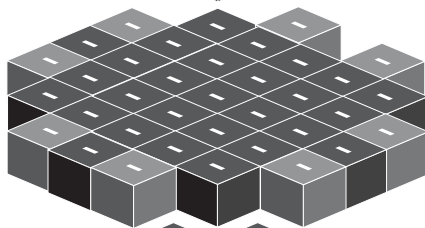
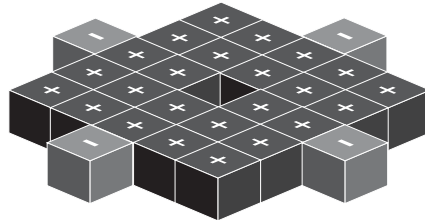
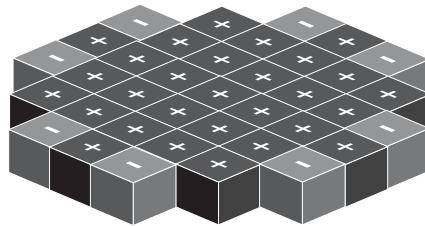
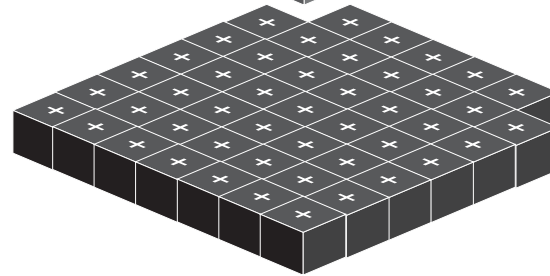
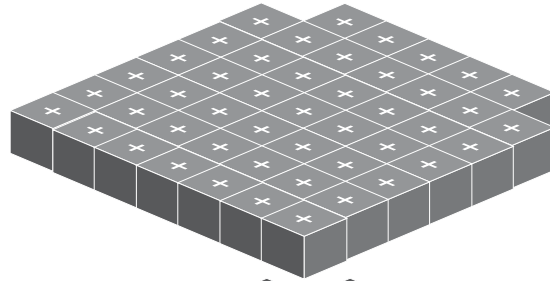
Uut 286
Proton:113
Neutron:173
Spin:2



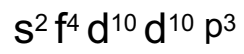
Ununquadium Nucleus



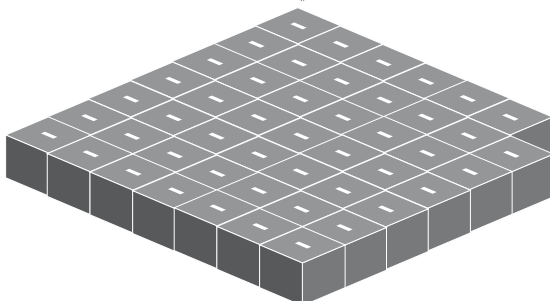
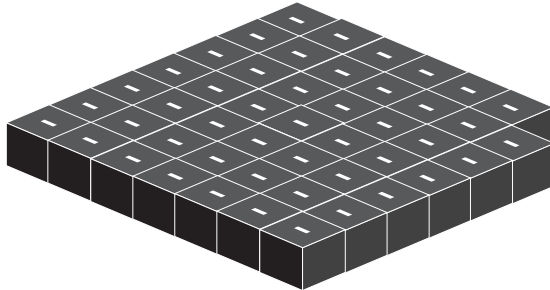
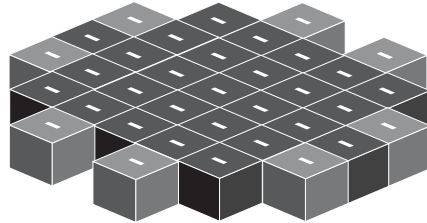
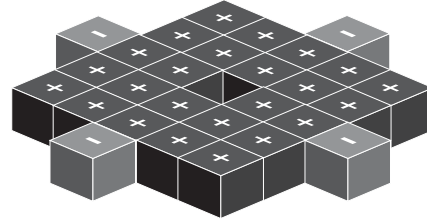
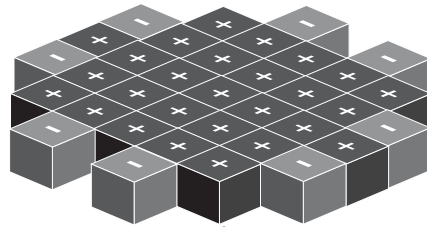
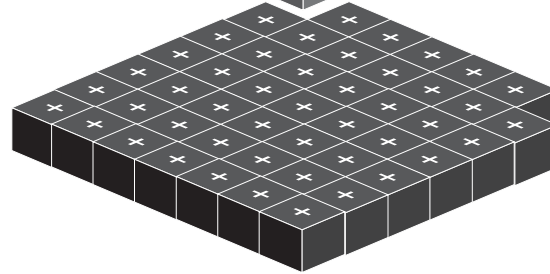
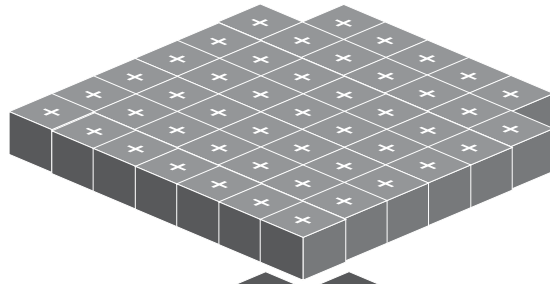
Uuq 289
Proton:114
Neutron:175
Spin:5/2



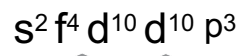
Ununpentium Nucleus



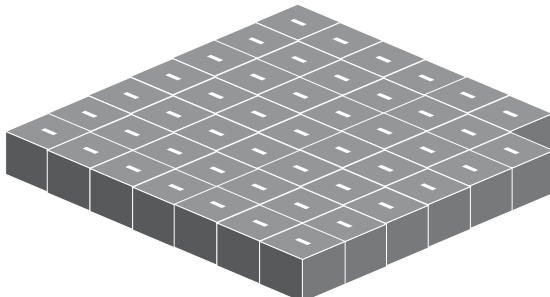
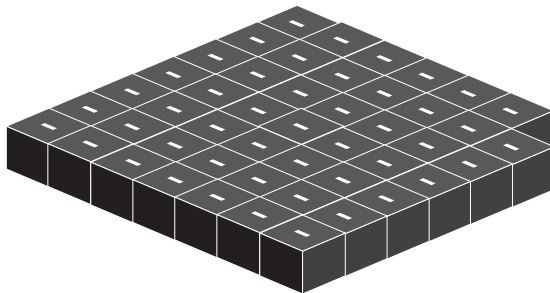
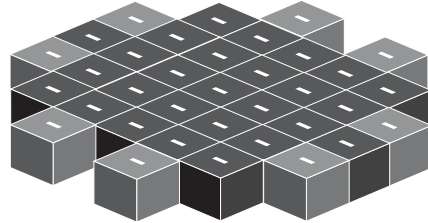
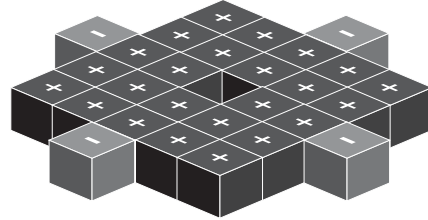
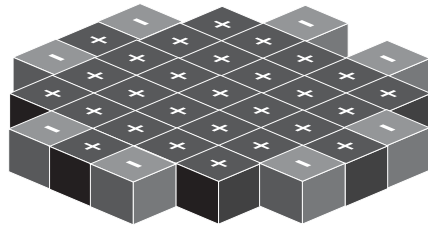
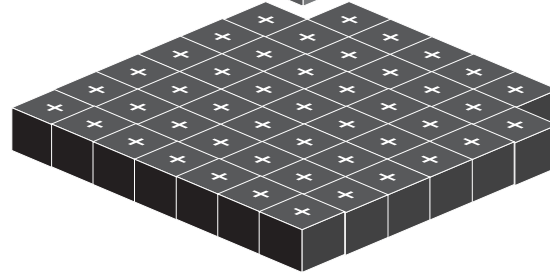
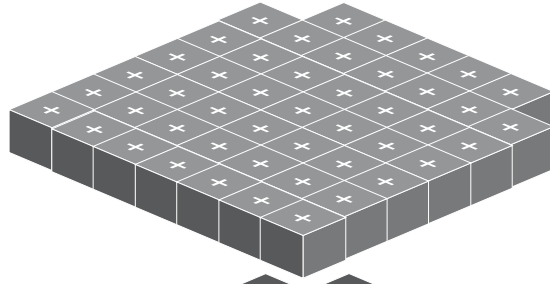
Uup 288
Proton:115
Neutron:173
Spin:1



Ununpentium Nucleus



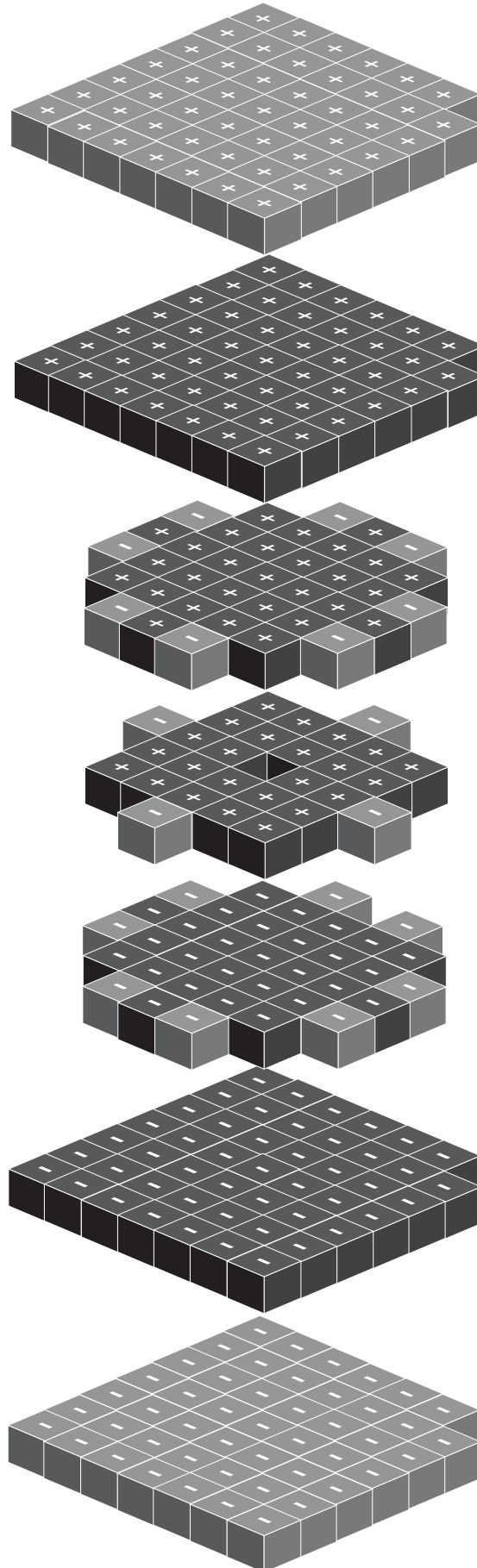
Uup 289
Proton:115
Neutron:174
Spin:3/2



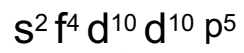
Ununhexium Nucleus

$s^2 f^4 d^{10} d^{10} p^4$

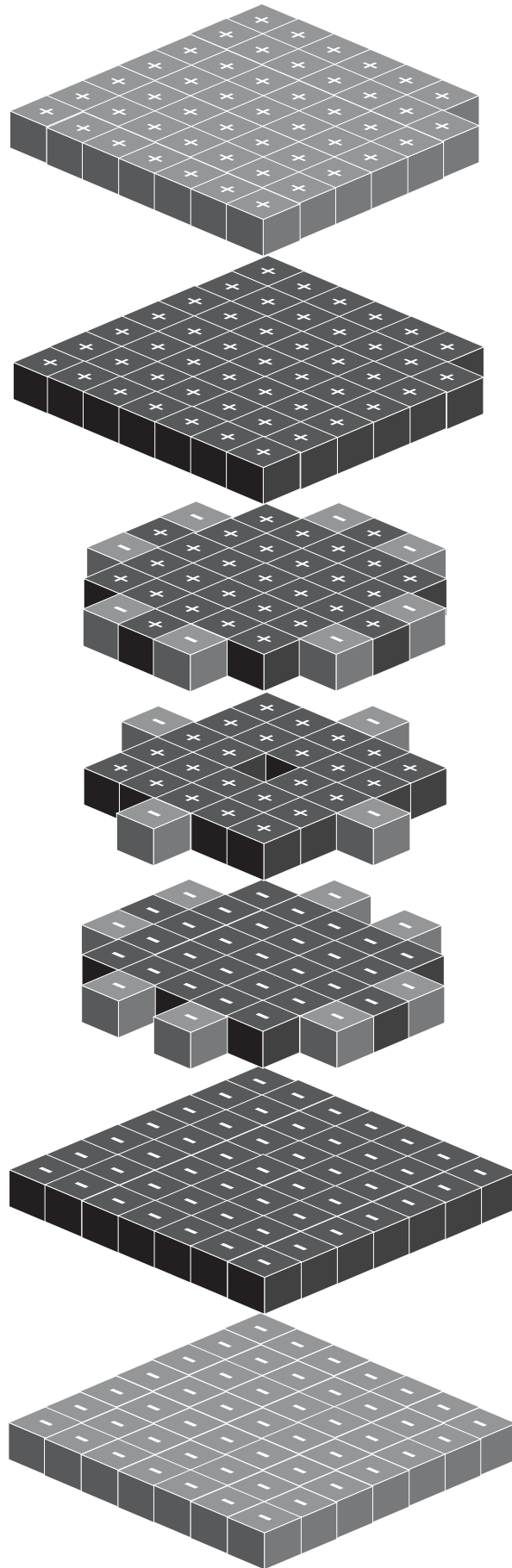
Uuh 293
Proton:116
Neutron:177
Spin:5/2



Ununseptium Nucleus



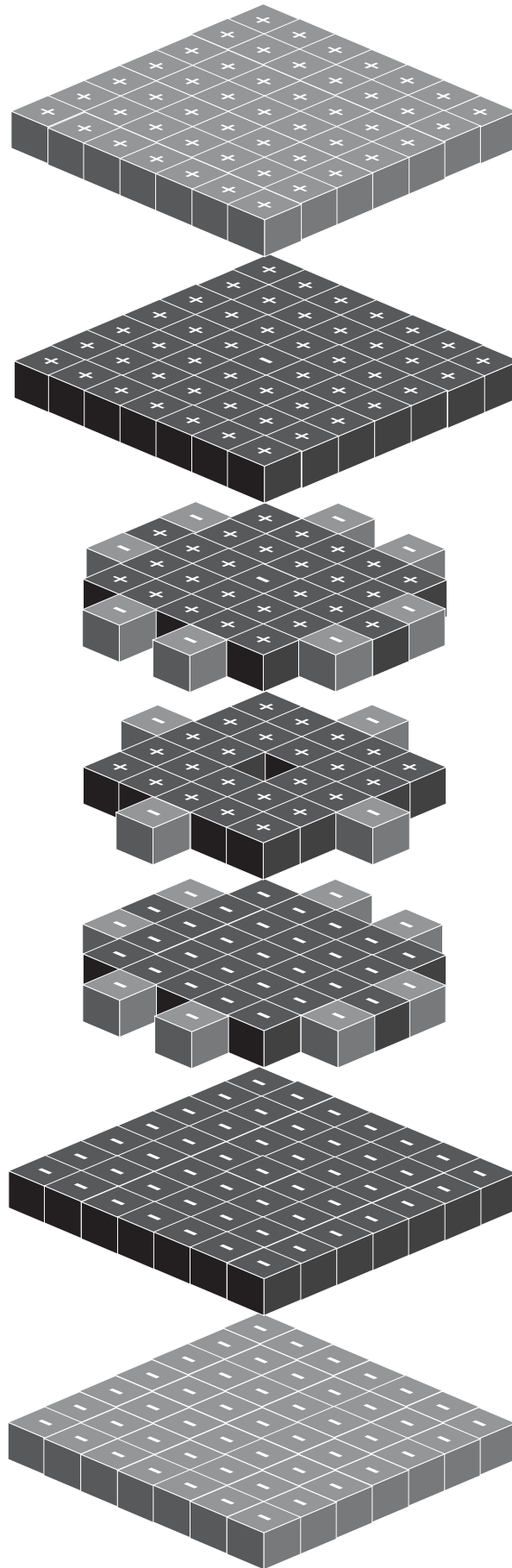
Uus 294
Proton:117
Neutron:177
Spin:2



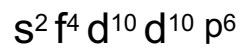
Ununoctium Nucleus

$$s^2 f^4 d^{10} d^{10} p^6$$

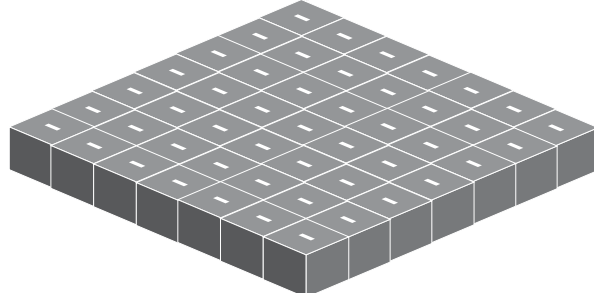
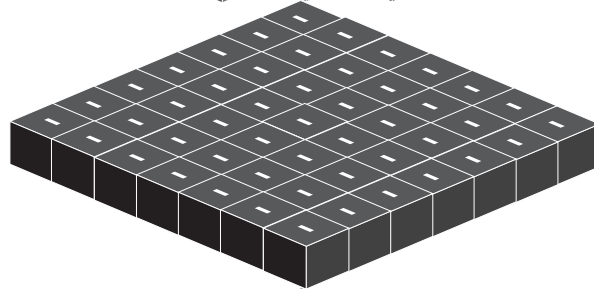
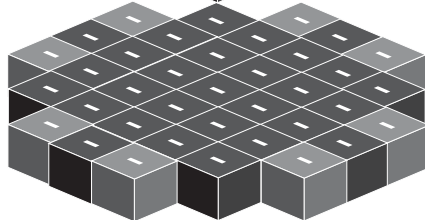
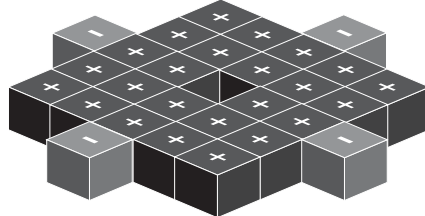
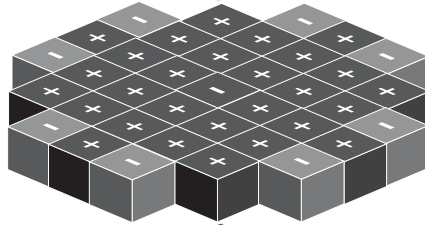
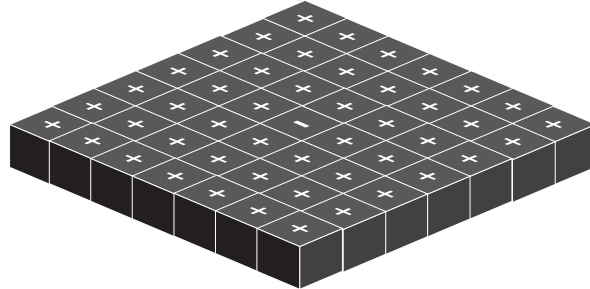
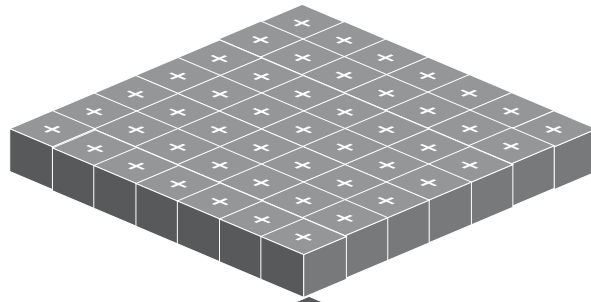
Uuo 294
Proton:118
Neutron:176
Spin:0



Ununoctium Nucleus



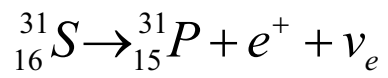
Uuo 298
Proton:118
Neutron:180
Spin:0



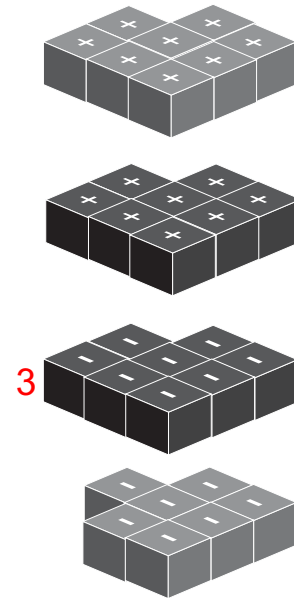
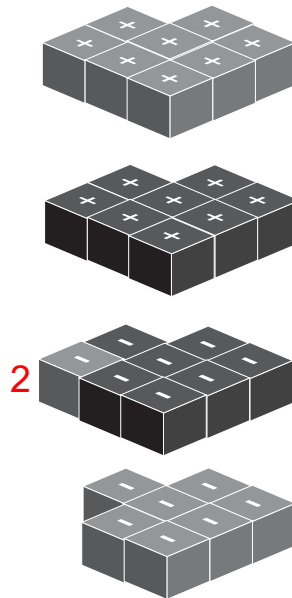
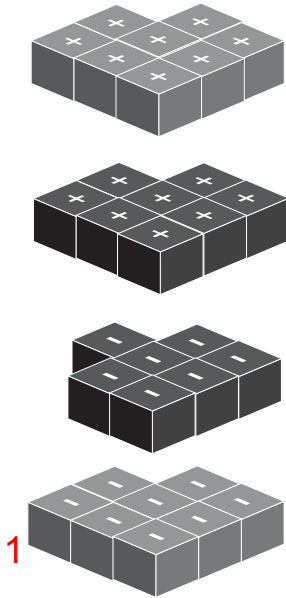
Nuclear Decay

$^{31}\text{S} \beta^+ \text{ decay } ^{31}\text{P}$

S 31
Proton: 16
Neutron: 15
Spin: 0

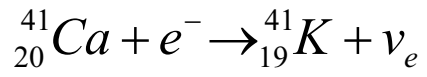


P 31
Proton: 15
Neutron: 16
Spin: 1/2
Stable

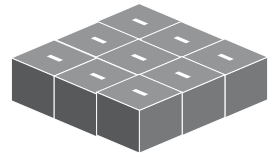
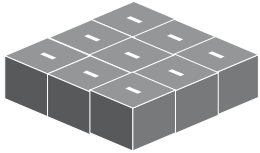
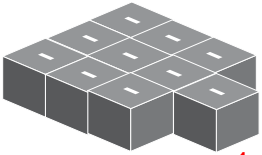
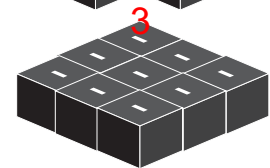
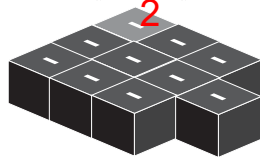
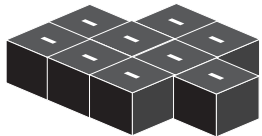
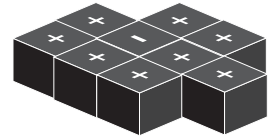
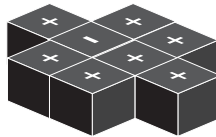
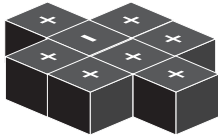
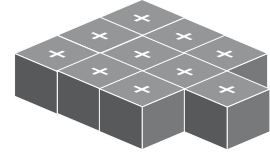
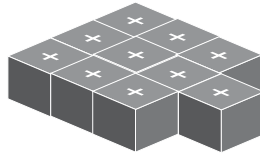
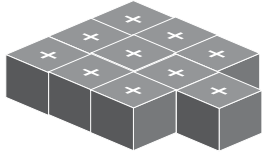


41Ca Electron Capture Decay 41K

Ca 41
 Proton: 20
 Neutron: 21
 Spin: -7/2

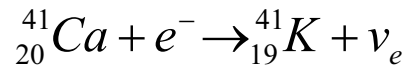


K 41
 Proton: 19
 Neutron: 22
 Spin: 3/2
 Stable

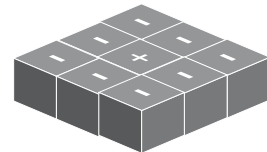
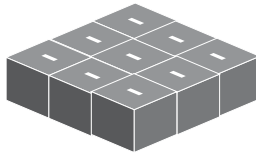
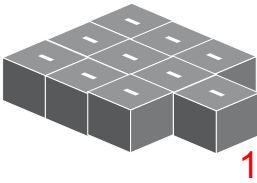
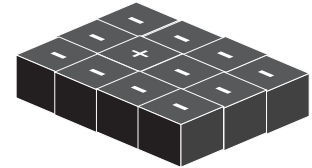
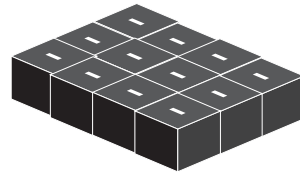
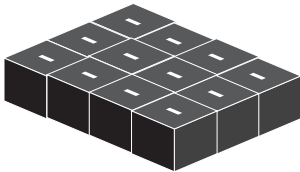
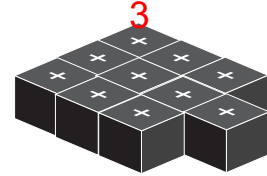
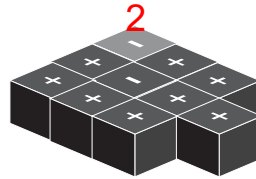
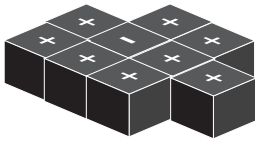
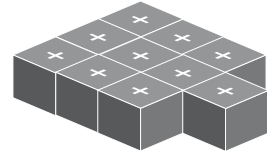
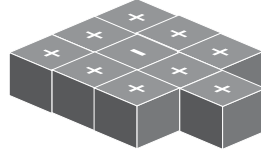
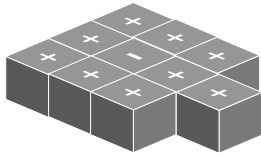


41Ca Electron Capture Decay 41K

Ca 41
 Proton: 20
 Neutron: 21
 Spin: -7/2

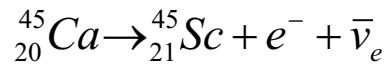


K 41
 Proton: 19
 Neutron: 22
 Spin: 3/2
 Stable

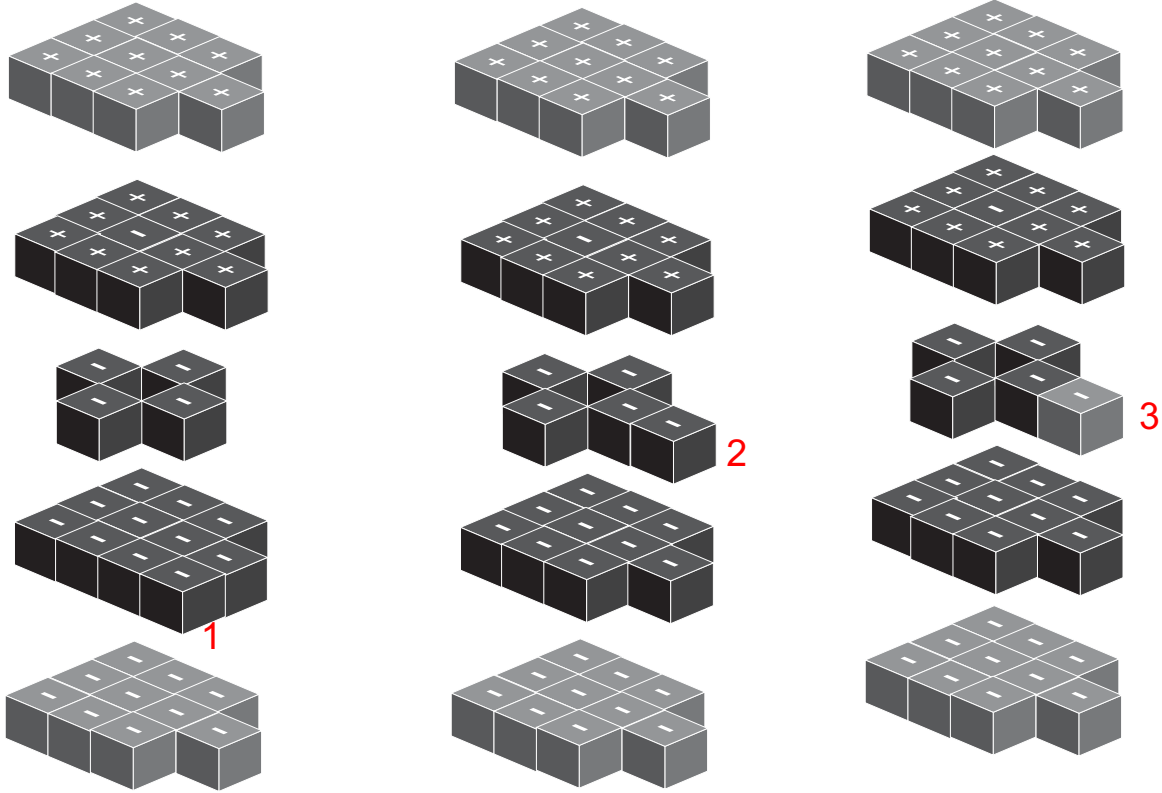


45Ca β^- decay 45 Sc

Ca 45
 Proton: 20
 Neutron: 25
 Spin: -7/2

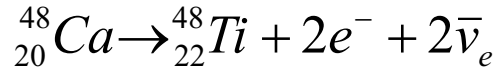


Sc 45
 Proton: 21
 Neutron: 24
 Spin: -7/2
 Stable

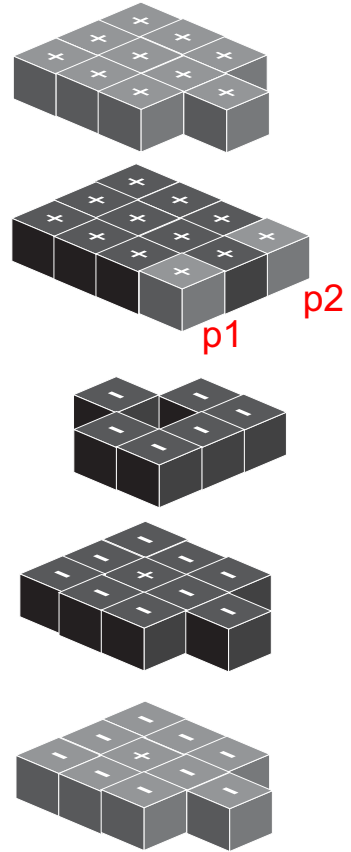
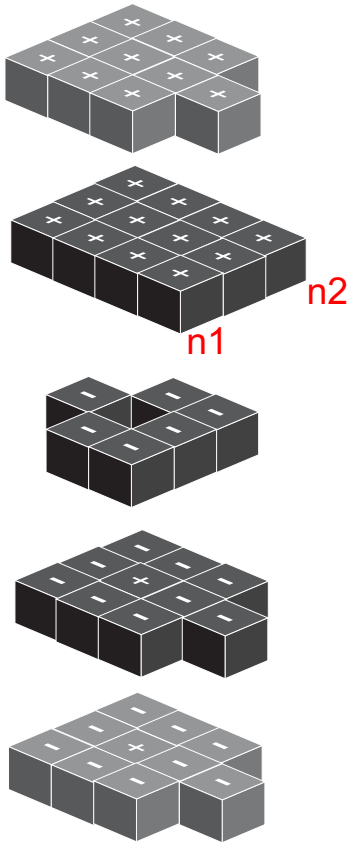


48Ca $\beta\text{-}\beta\text{-}$ decay 48Ti

Ca 48
 Proton: 20
 Neutron: 28
 Spin: 0
 Stable

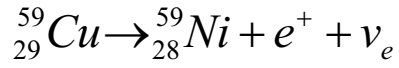


Ti 48
 Proton: 22
 Neutron: 26
 Spin: 0
 Stable

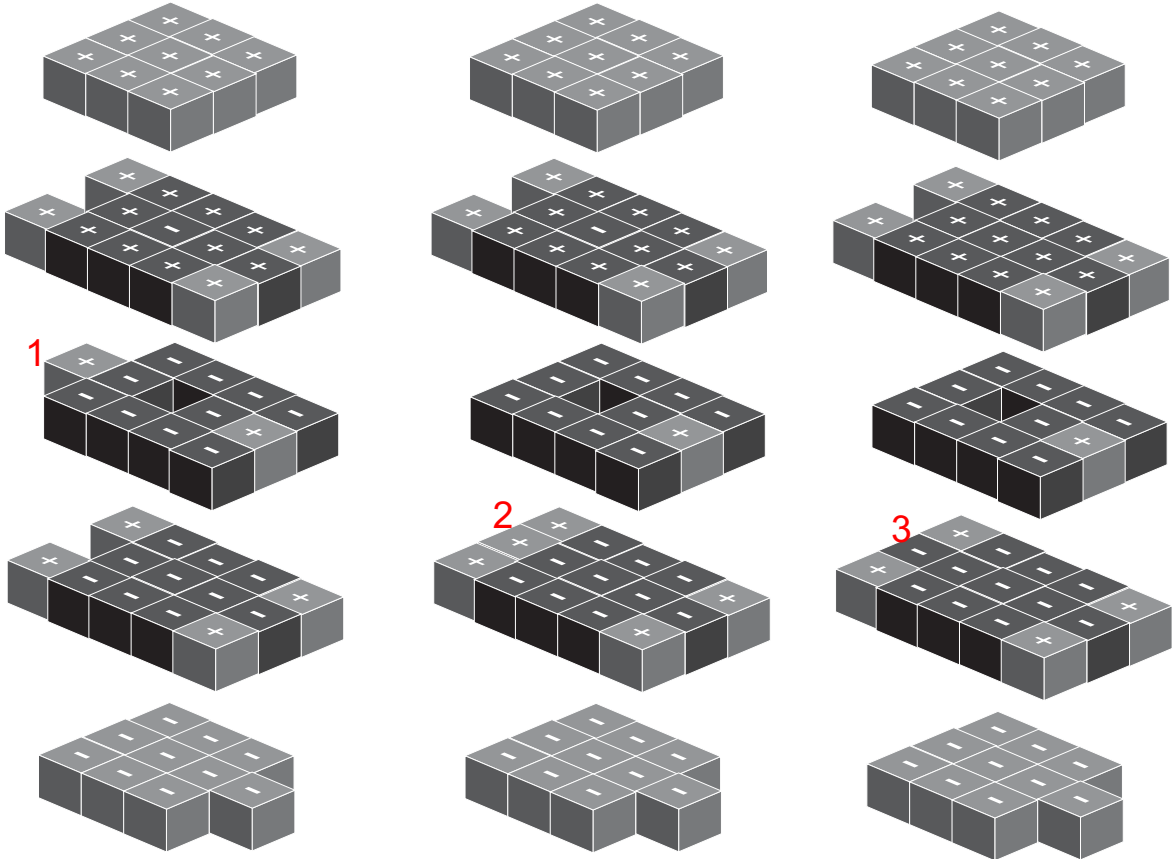


59Cu β+ decay 59Ni

Cu 59
 Proton 29
 Neutron 30
 Spin: -3/2
 Half life: 81.5s



Ni 59
 Proton 28
 Neutron 31
 Spin: -3/2

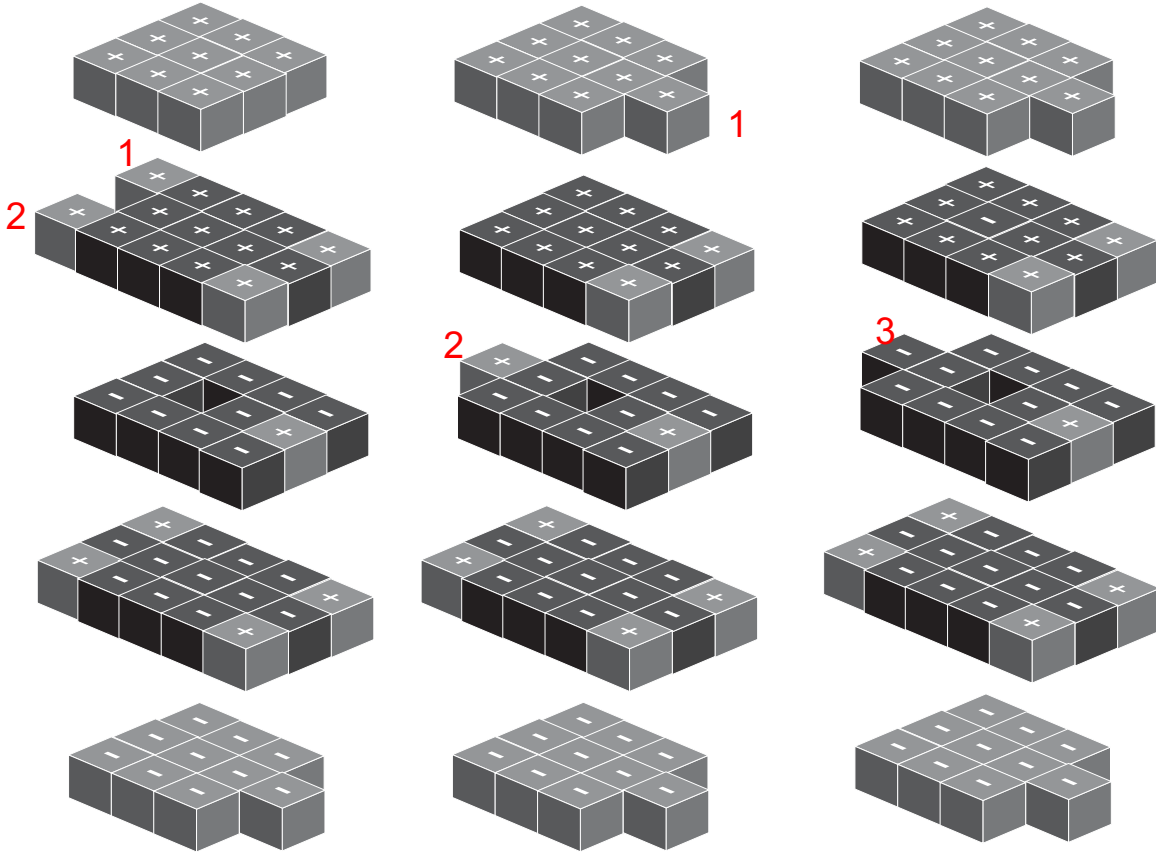


59Ni β+ decay 59Co

Ni 59
Proton 28
Neutron 31
Spin: -3/2

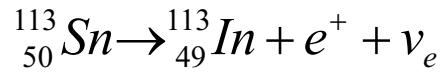


Co 59
Proton 27
Neutron 32
Spin: -7/2

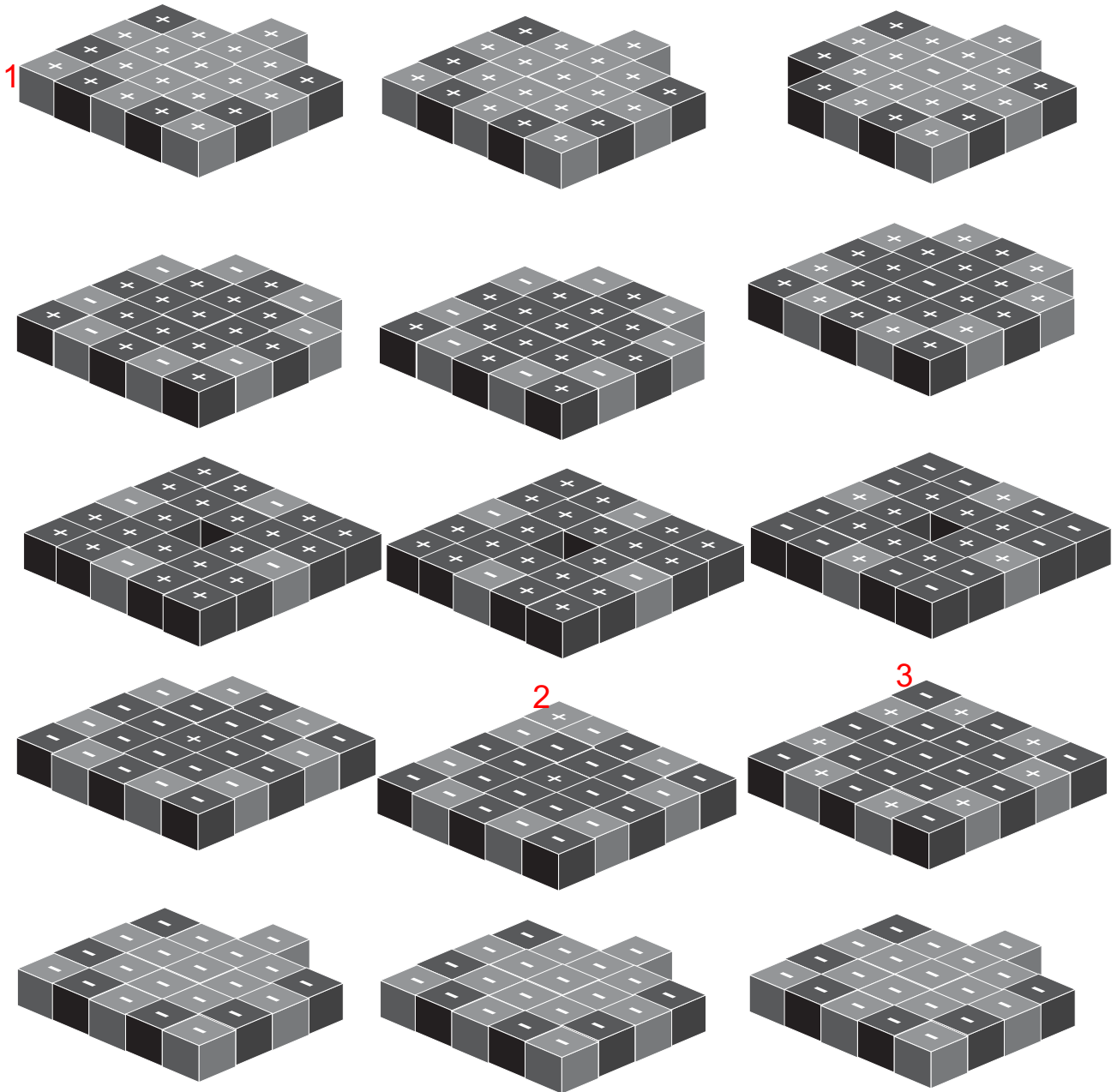


113Sn β^+ decay 113In

Sn 113
 Proton: 50
 Neutron: 63
 Spin: 1/2

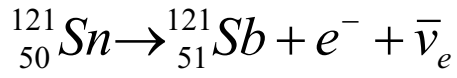


In 113
 Proton: 49
 Neutron: 64
 Spin: 9/2

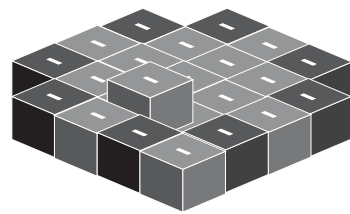
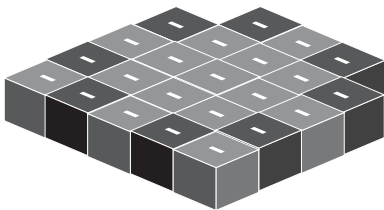
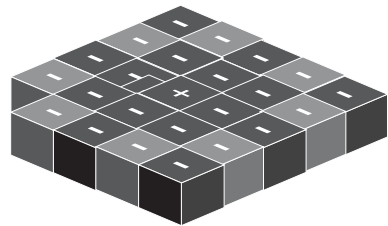
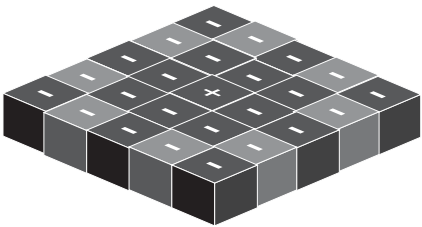
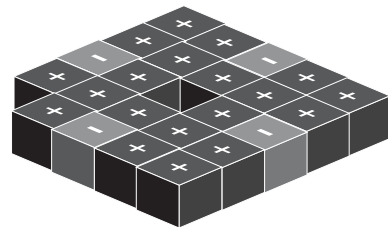
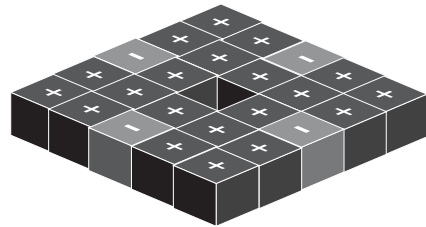
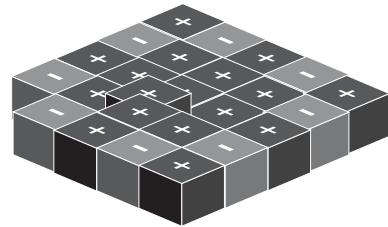
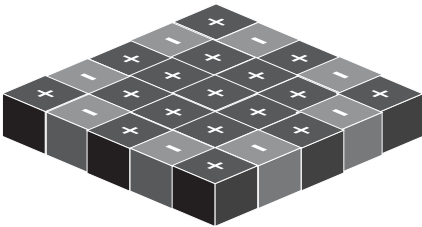
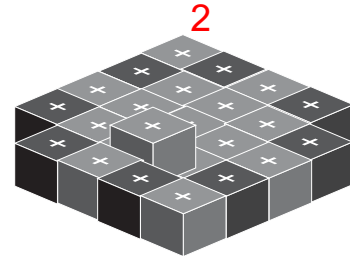
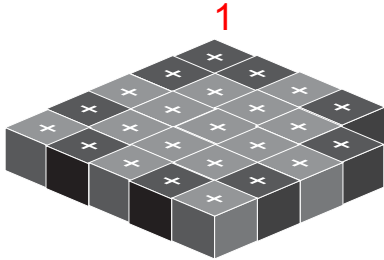


121Sn β - decay 121Sb

Sn 121
 Proton: 50
 Neutron: 71
 Spin: 3/2

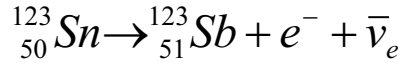


Sb 121
 Proton: 51
 Neutron: 70
 Spin: 5/2
 Stable

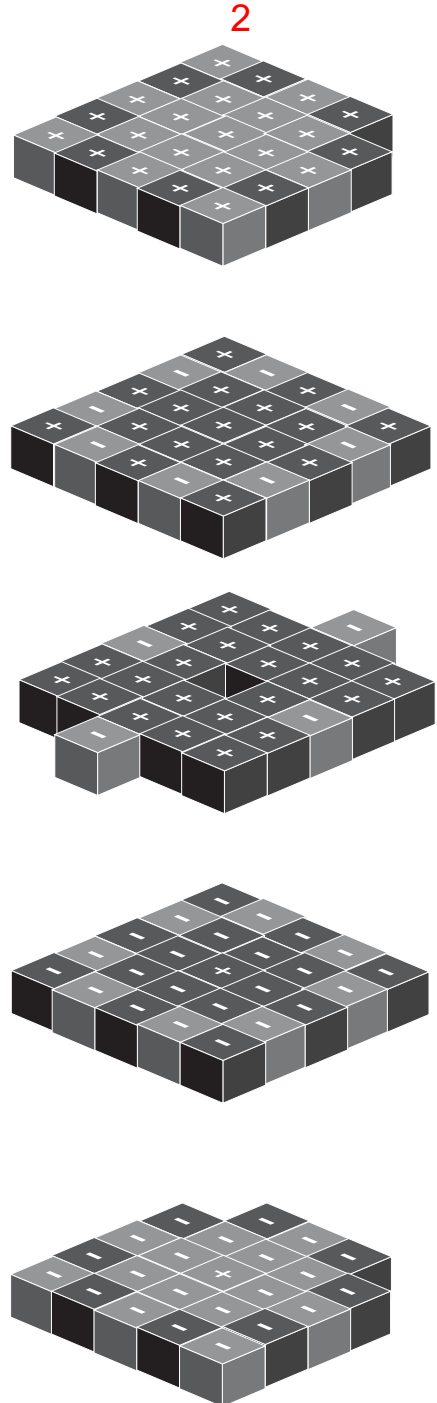
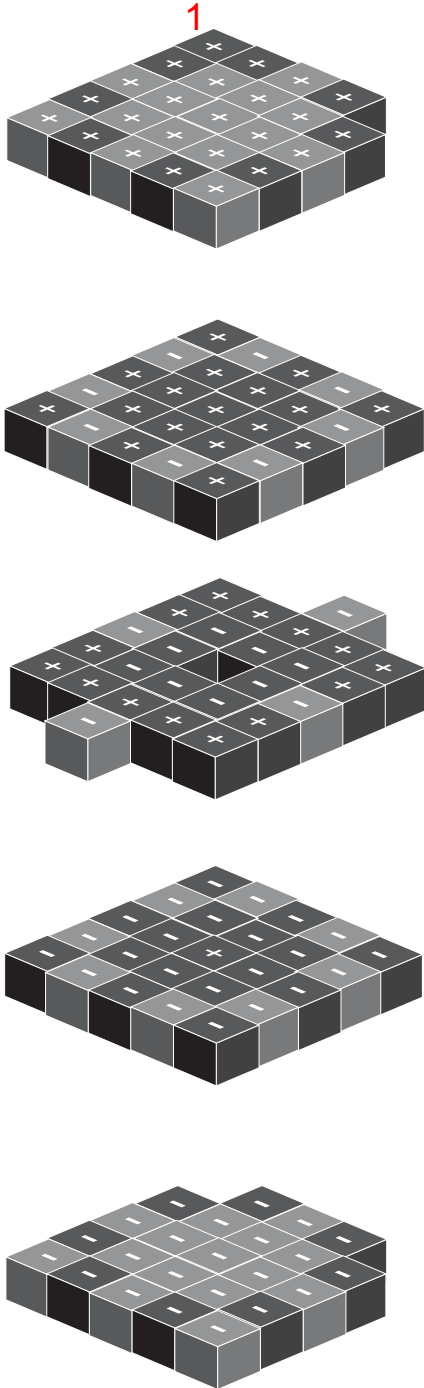


123Sn β - decay 123Sb

Sn 123
 Proton: 50
 Neutron: 73
 Spin: -11/2
 Stable



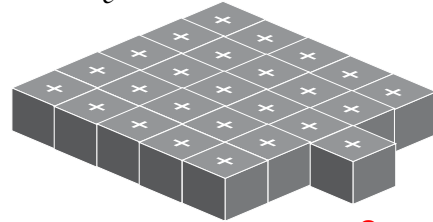
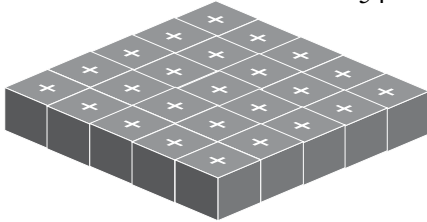
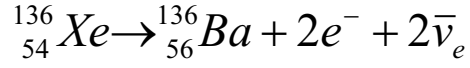
Sb 123
 Proton: 51
 Neutron: 72
 Spin: 7/2
 Stable



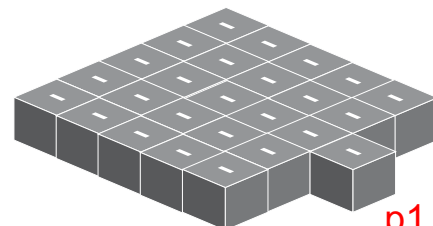
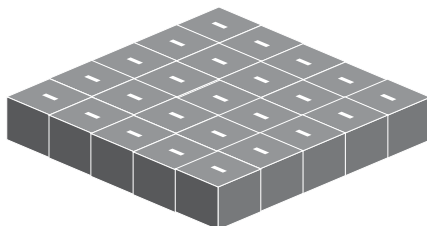
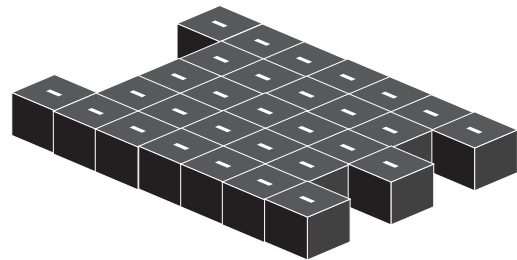
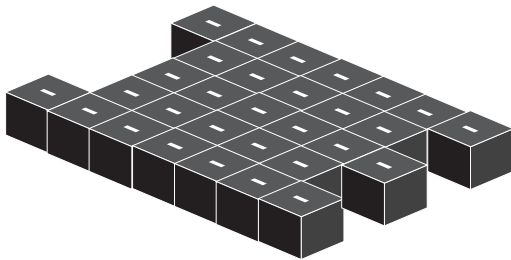
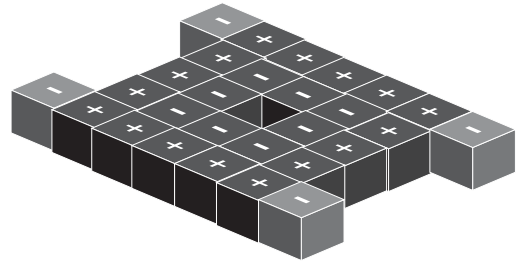
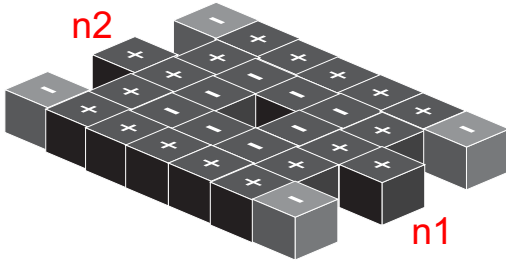
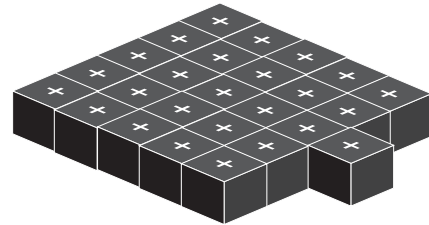
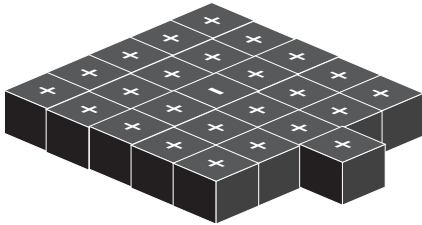
136Xe $\beta\text{-}\beta\text{-}$ decay 136Ba

Xe136
 Proton: 54
 Neutron: 82
 Spin:0
 Stable

Ba136
 Proton: 56
 Neutron: 80
 Spin:0
 Stable



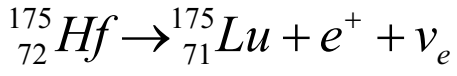
p2



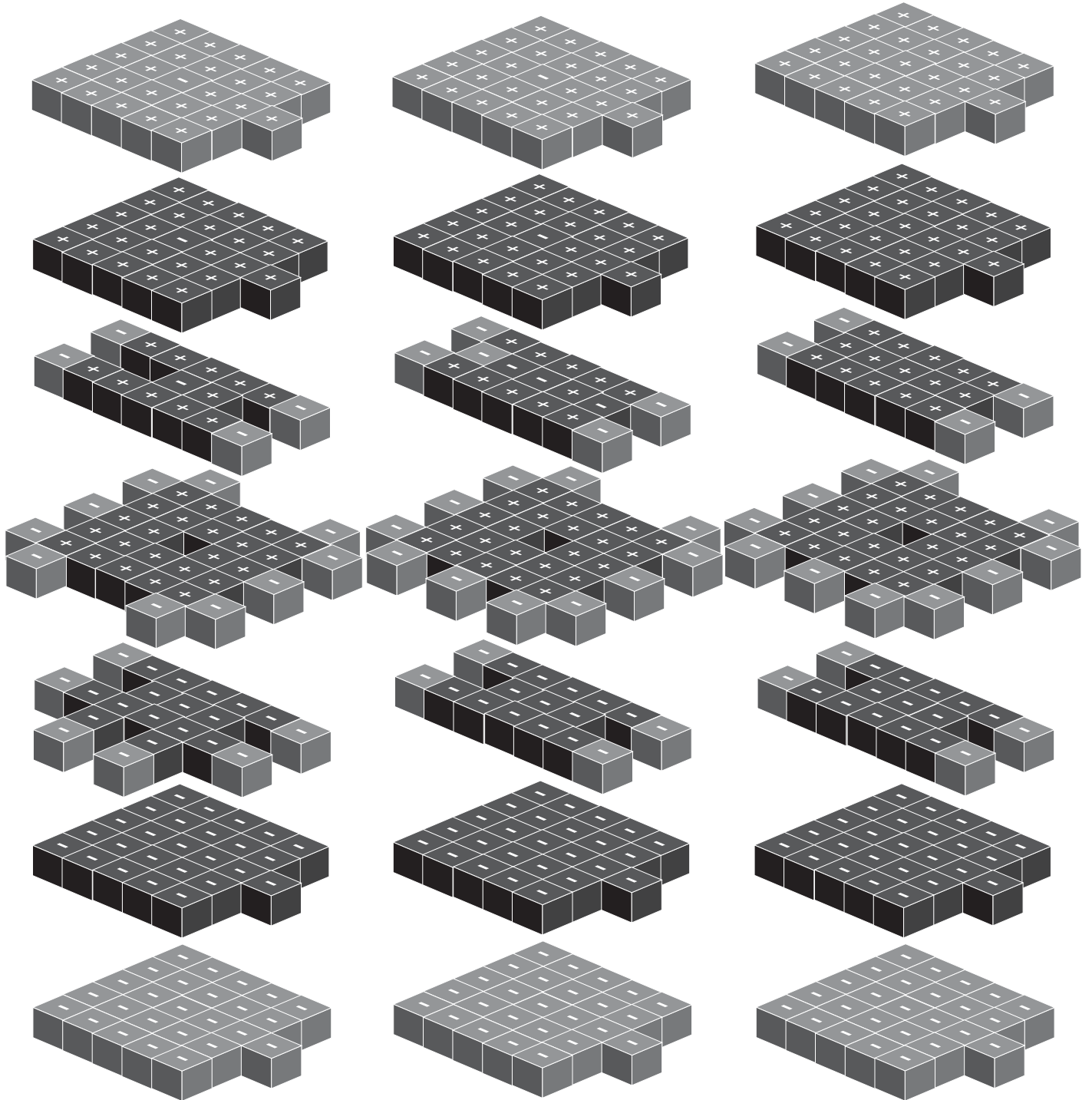
p1

175 Hf β^+ decay 175 Lu

Hf 175
 Proton: 72
 Neutron: 103
 Spin:-5/2

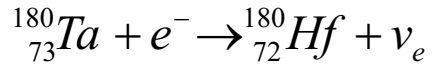


Lu 175
 Proton: 71
 Neutron: 104
 Spin:7/2
 Stable

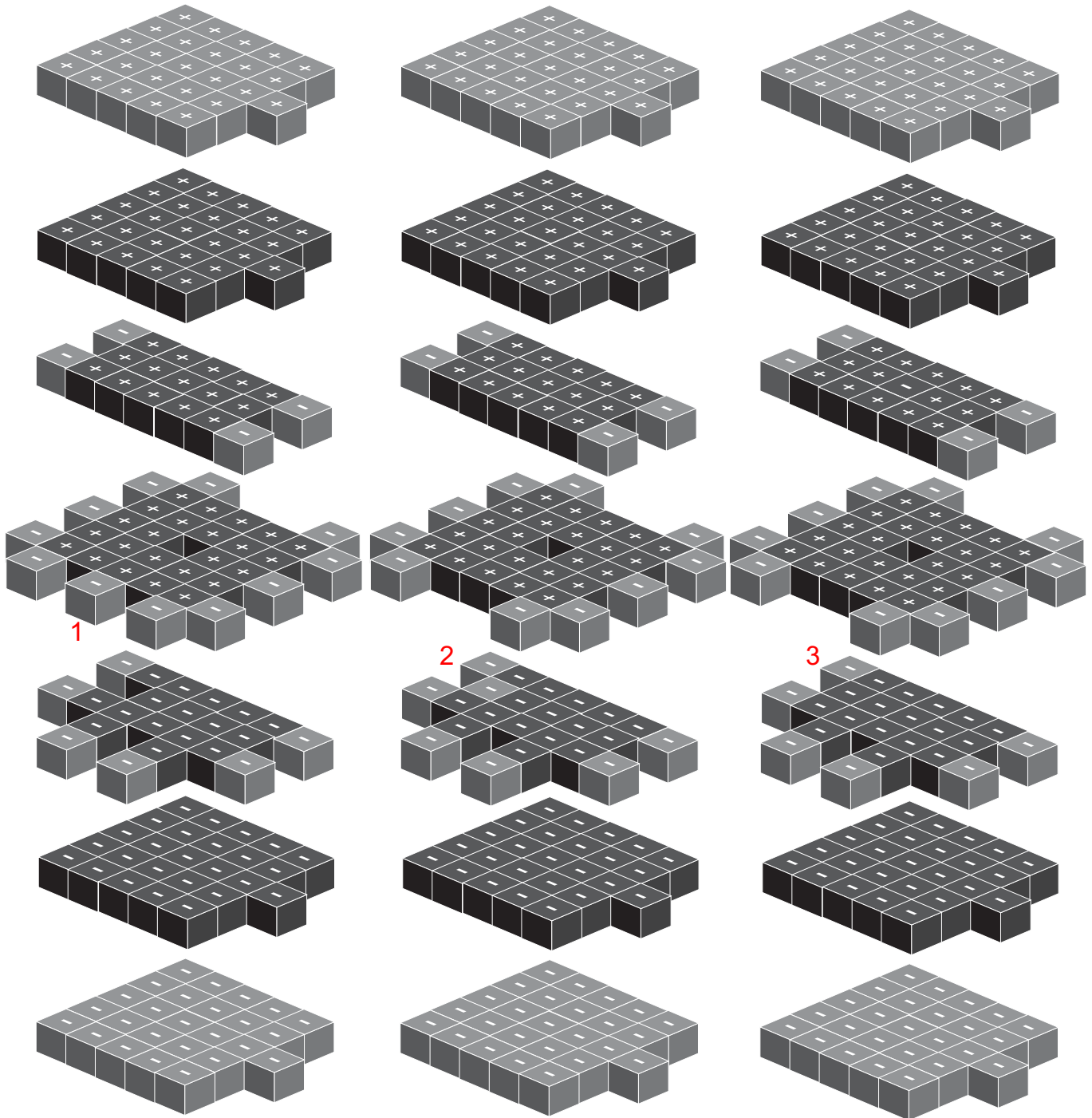


180Ta Electron Capture Decay 180Hf

Ta 180
 Proton: 73
 Neutron: 107
 Spin: 1
 Half life: 8.152h

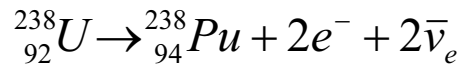


Hf 180
 Proton: 72
 Neutron: 108
 Spin: 0
 Stable

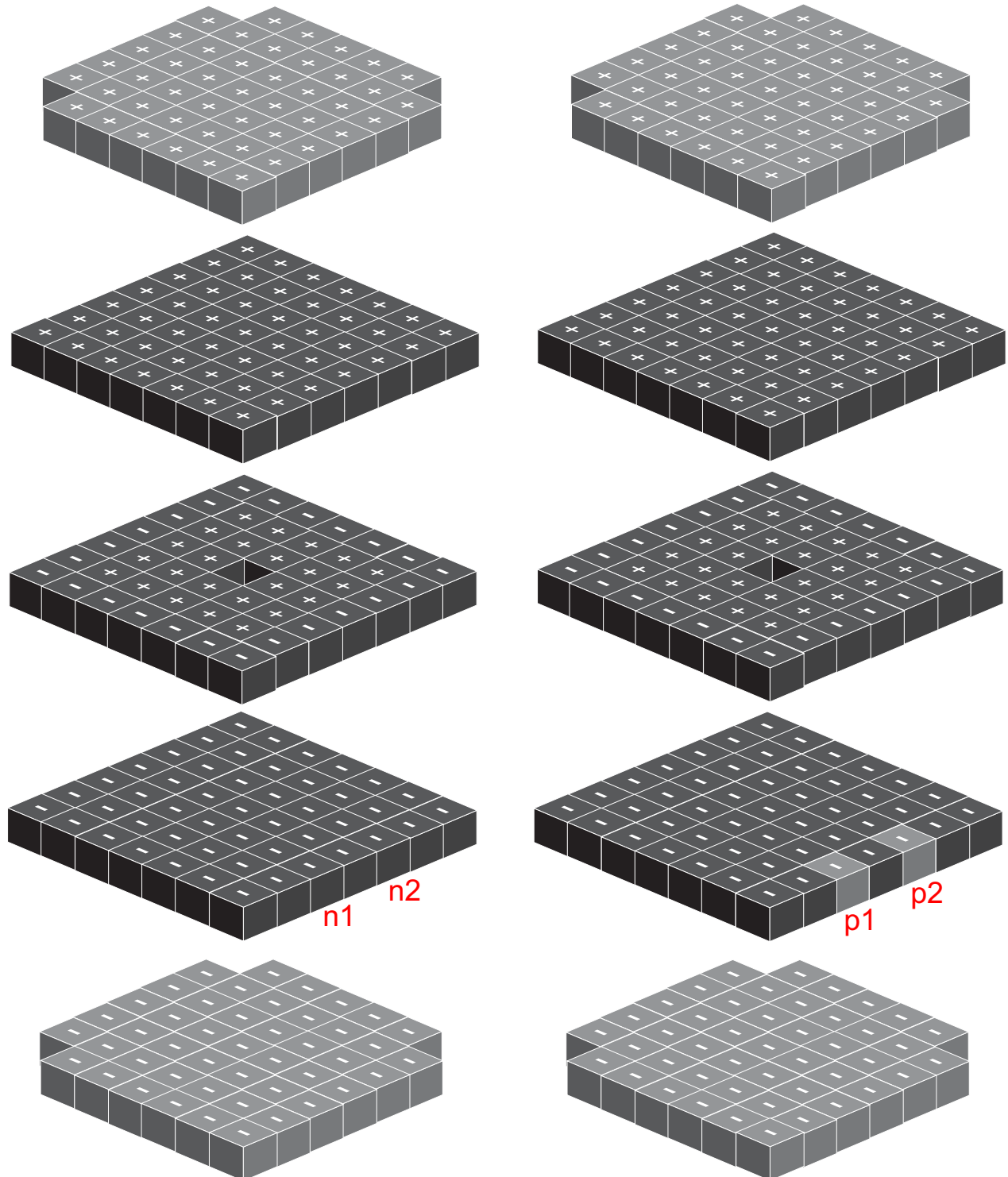


238U β-β- decay 238Pu

U 238
Proton: 92
Neutron: 146
Spin:0

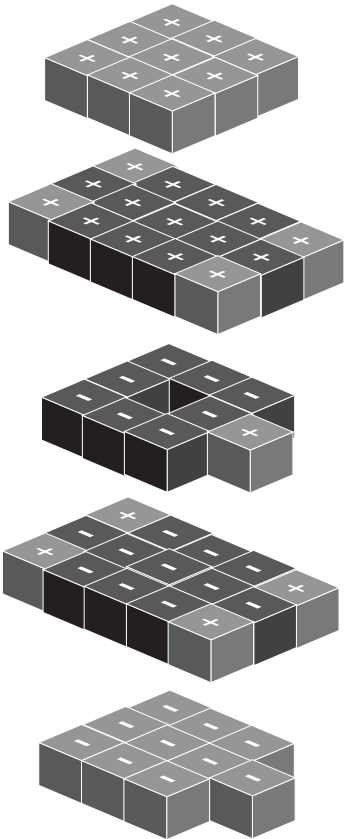


Pu 238
Proton: 94
Neutron: 144
Spin:0



Nickel-58 copper-63 nuclear transmutation

Ni 58
Proton: 28
Neutron: 30
Spin: 0
Stable



Step 1
 $p + \text{Ni}58 = \text{Cu}59$

$\text{Cu}59 \rightarrow \text{Ni}59$

Step 2
 $p + \text{Ni}59 = \text{Cu}60$
 $\text{Cu}60 \rightarrow \text{Ni}60$

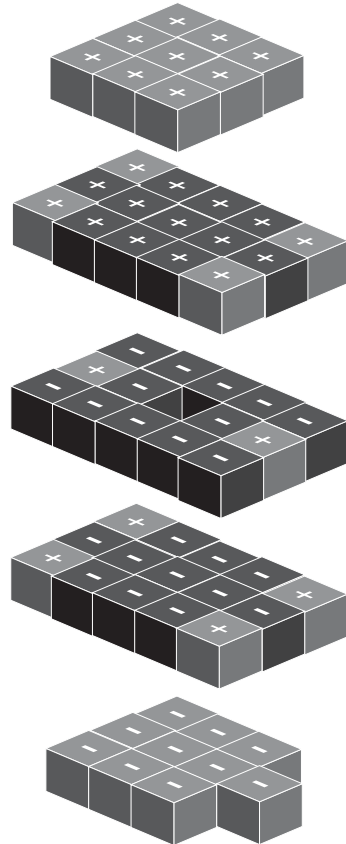
Step 3
 $p + \text{Ni}60 = \text{Cu}61$
 $\text{Cu}61 \rightarrow \text{Ni}61$

Step 4
 $p + \text{Ni}61 = \text{Cu}62$

$\text{Cu}62 \rightarrow \text{Ni}62$

Step 5
 $p + \text{Ni}62 = \text{Cu}63$

Cu 63
Proton 29
Neutron 34
Spin: -3/2
Stable

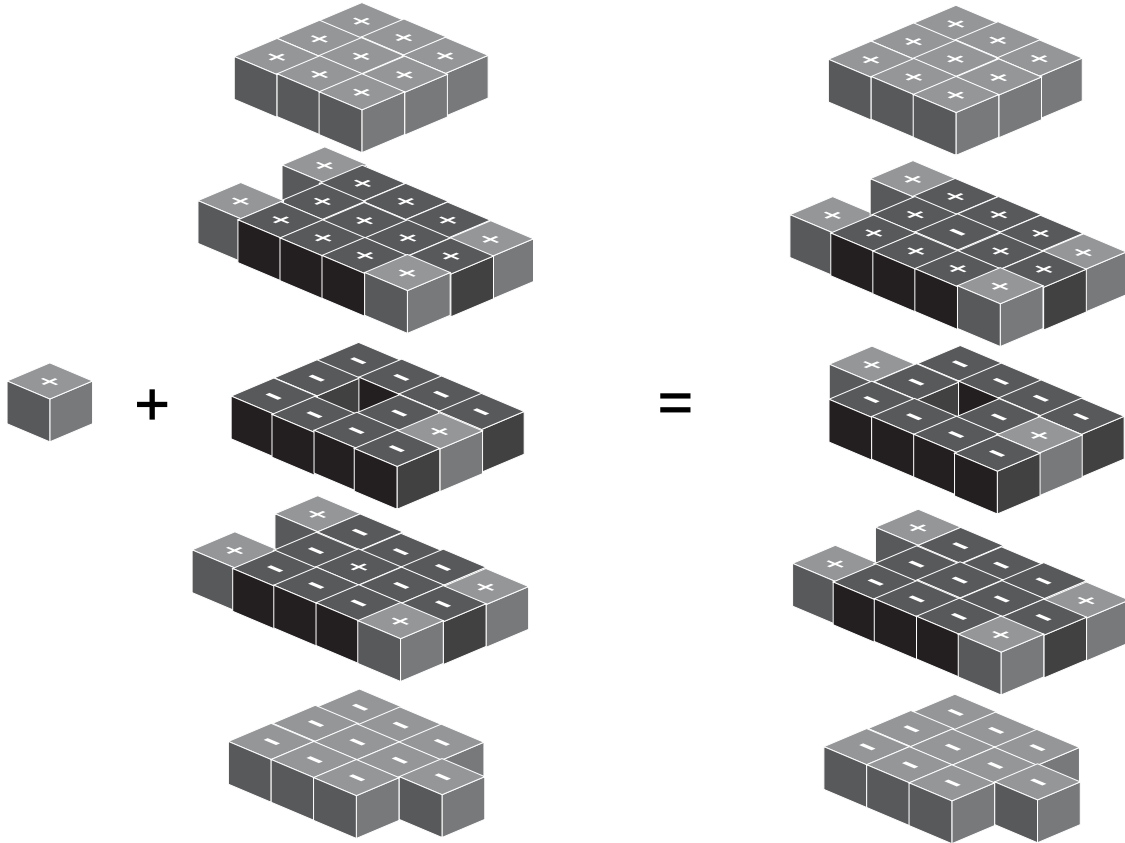


Nickel copper nuclear transmutation

Step 1.1 $p + \text{Ni}58 = \text{Cu}59$

Ni 58
Proton: 28
Neutron: 30
Spin: 0
Most Stable

Cu 59
Proton 29
Neutron 30
Spin: -3/2
Half life: 81.5s



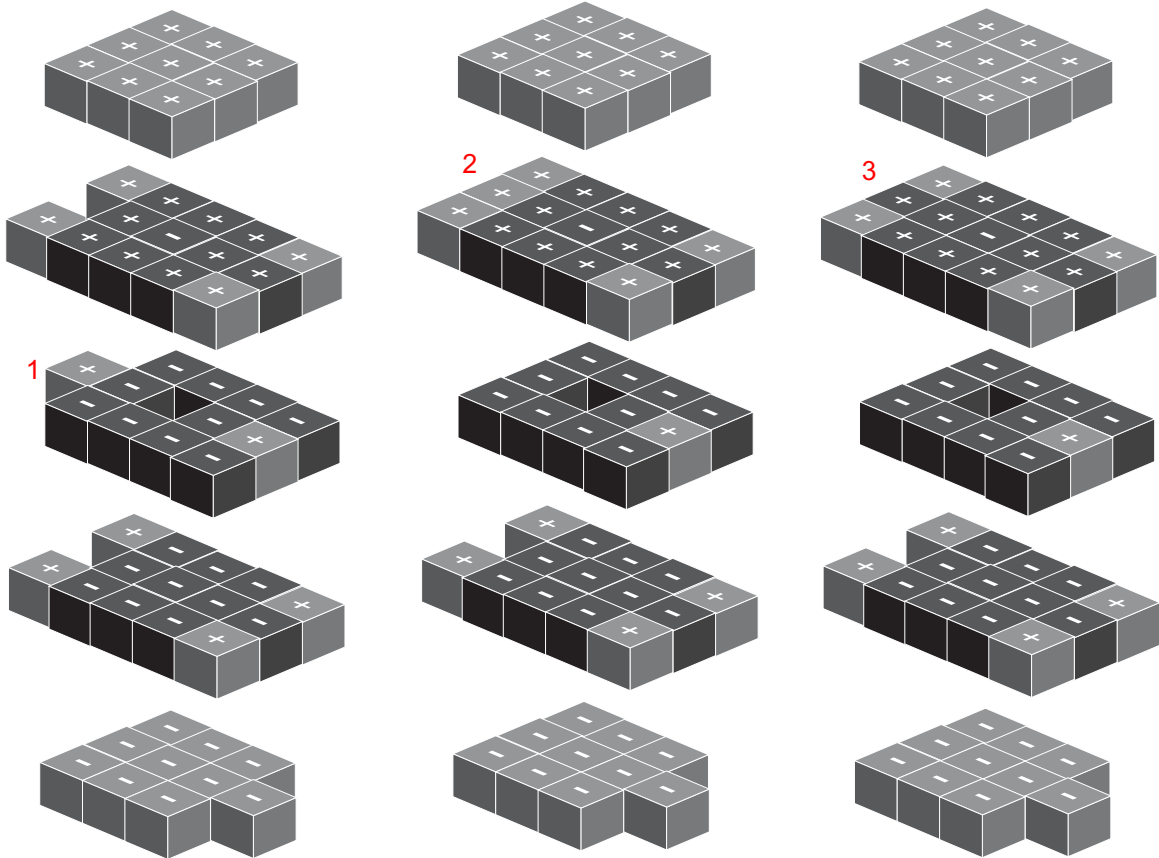
Nickel copper nuclear transmutation

Step 1.2

$^{59}\text{Cu} \beta^+ \text{ decay } ^{59}\text{Ni}$
 $\text{Cu}59 \rightarrow \text{Ni}59$

Cu 59
 Proton 29
 Neutron 30
 Spin: $-3/2$
 Half life: 81.5s

Ni 59
 Proton 28
 Neutron 31
 Spin: $-3/2$

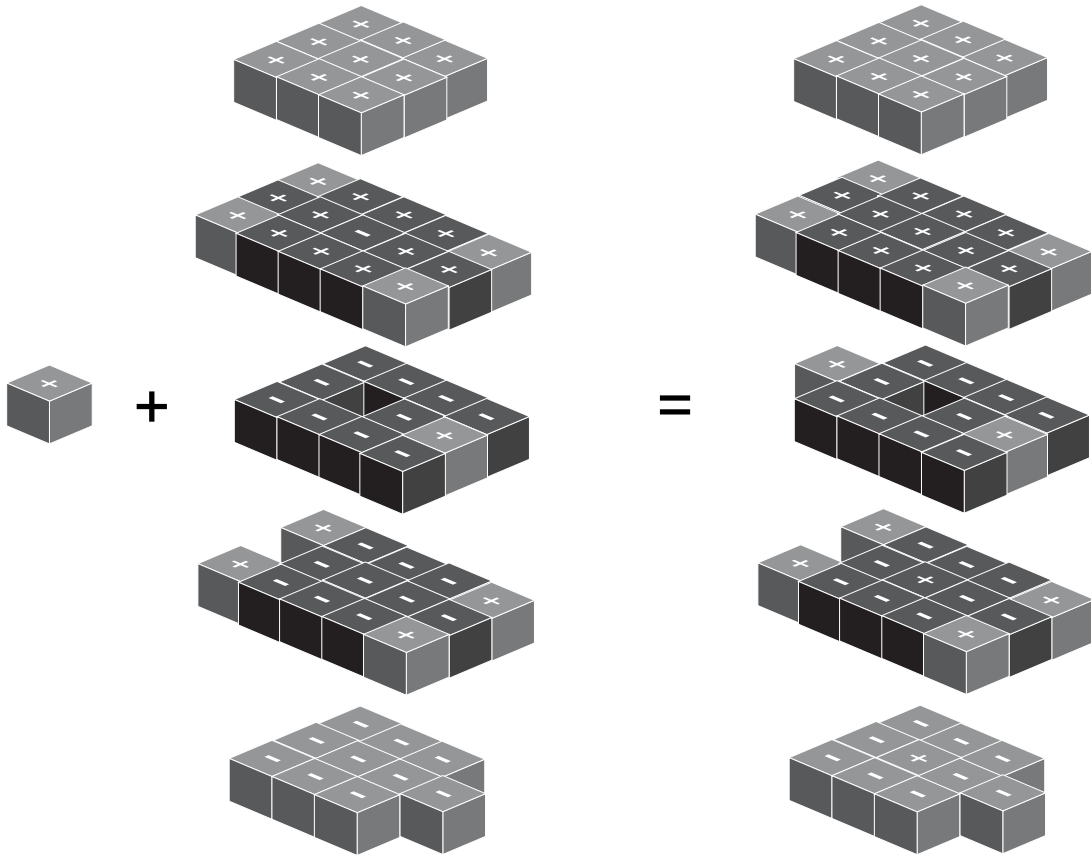


Nickel copper nuclear transmutation

Step 2.1 $p + \text{Ni}59 = \text{Cu}60$

Ni 59
Proton 28
Neutron 31
Spin: -3/2

Cu 60
Proton 29
Neutron 31
Spin: 2
Half life:



Nickel copper nuclear transmutation

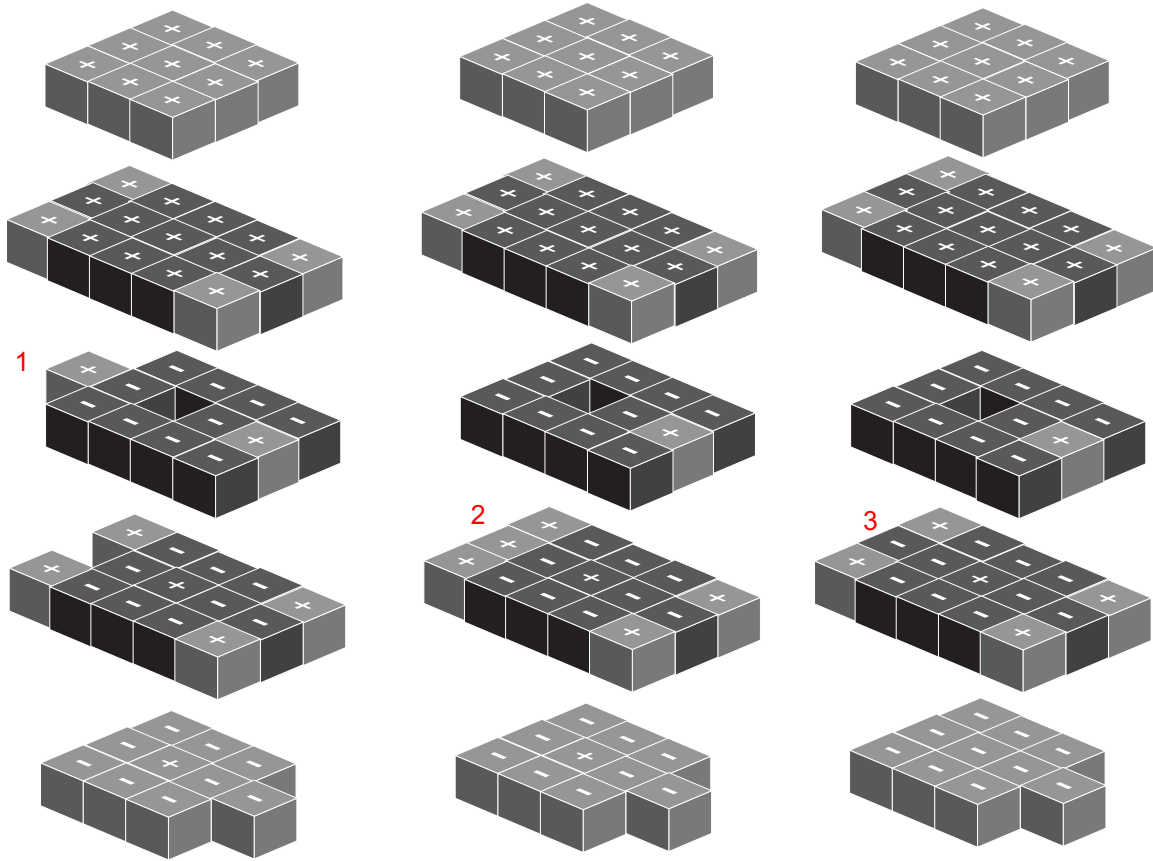
Step 2.2

^{60}Cu β^+ decay ^{60}Ni

$\text{Cu}60 \rightarrow \text{Ni}60$

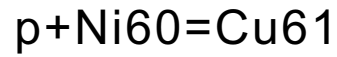
Cu 60
Proton 29
Neutron 31
Spin:2
Half life:

Ni 60
Proton: 28
Neutron: 32
Spin: 0
Stable



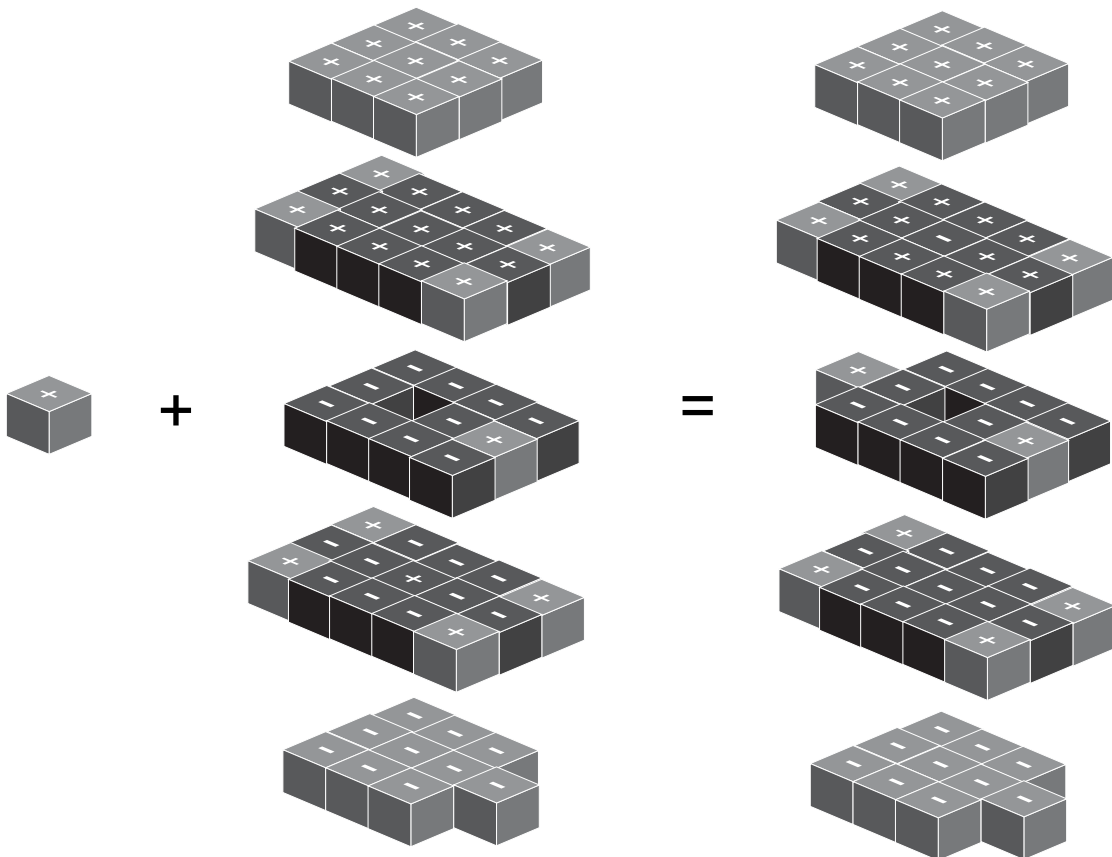
Nickel copper nuclear transmutation

Step 3.1



Ni 60
Proton: 28
Neutron: 32
Spin: 0
Stable

Cu 61
Proton 29
Neutron 32
Spin:-3/2



Nickel copper nuclear transmutation

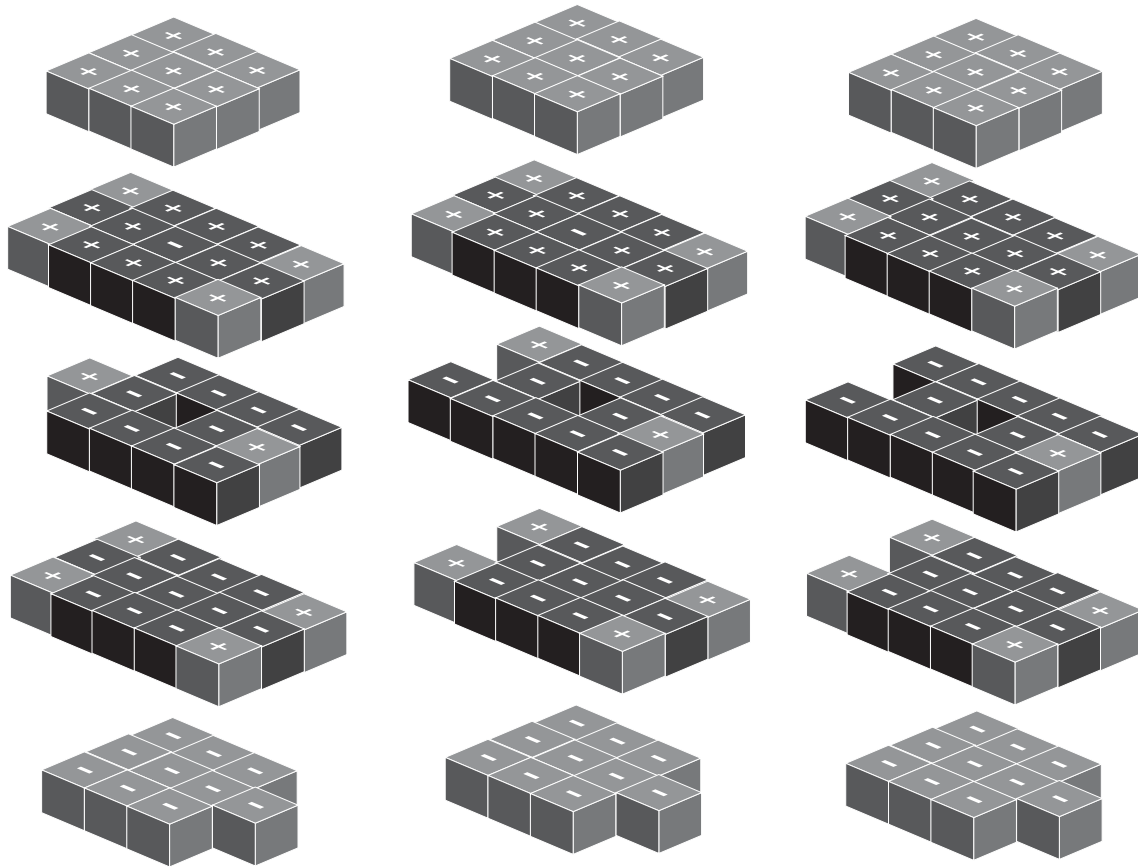
$^{59}\text{Cu} \beta^+$ decay to ^{59}Ni

Step 3.2

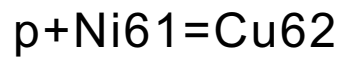
$\text{Cu}61 \rightarrow \text{Ni}61$

Cu 61
Proton 29
Neutron 32
Spin: -3/2

Ni 61
Proton: 28
Neutron: 33
Spin: -3/2
Stable



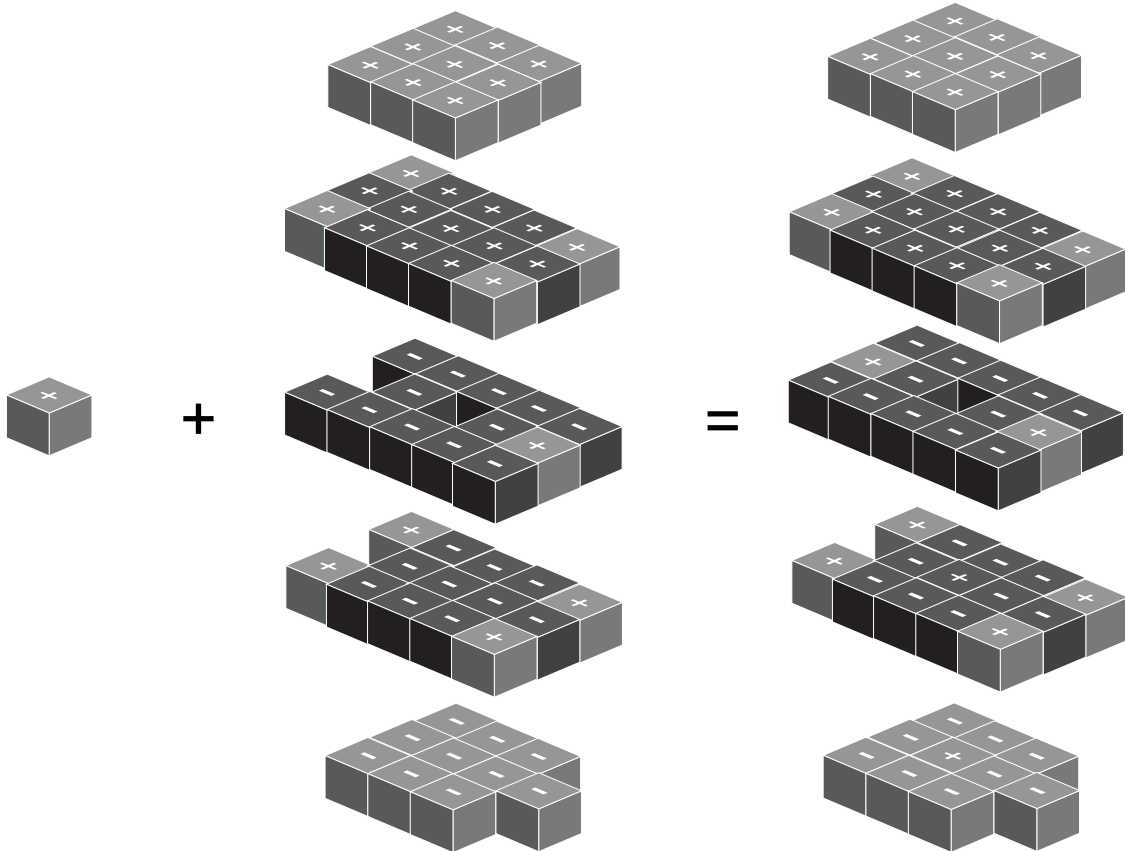
Nickel copper nuclear transmutation



Step 4.1

Ni 61
Proton: 28
Neutron: 33
Spin: -3/2
Stable

Cu 62
Proton 29
Neutron 33
Spin:1



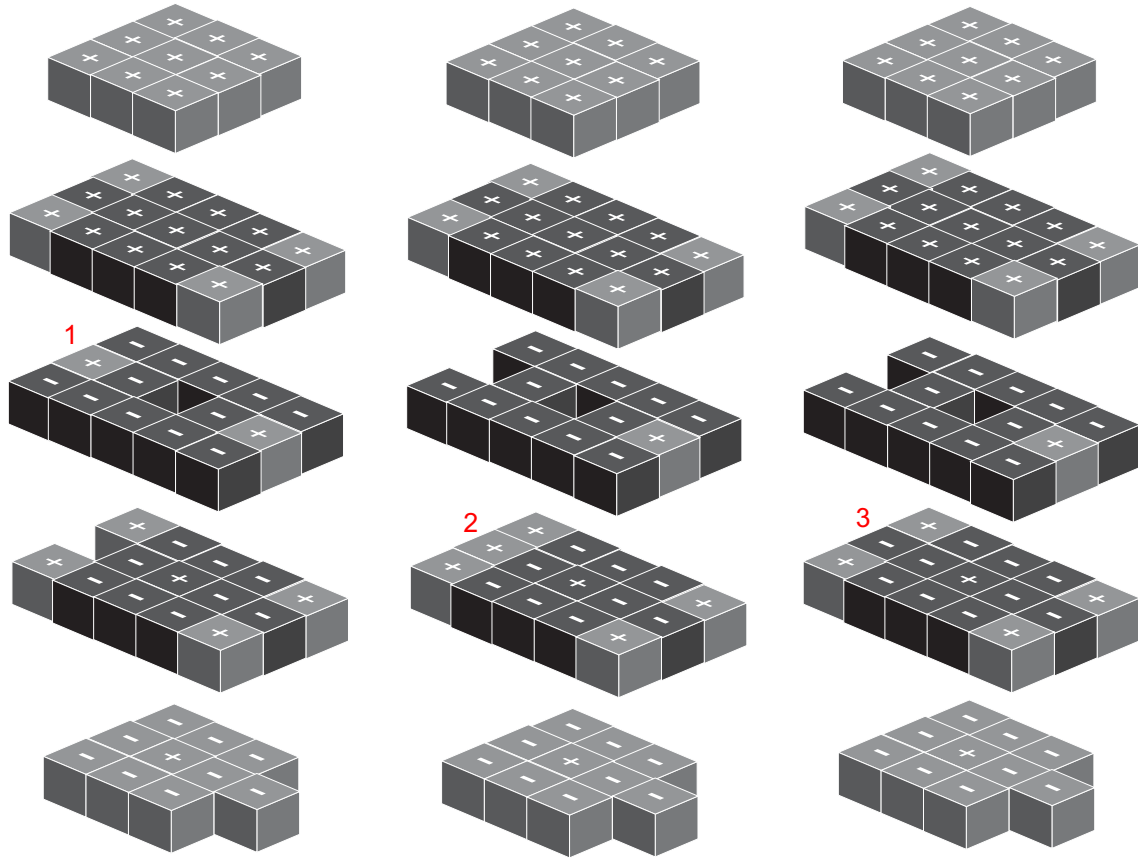
Nickel copper nuclear transmutation

$62\text{Cu} \beta^+$ decay to 59Ni
 $\text{Cu}62 \rightarrow \text{Ni}62$

Step 4.2

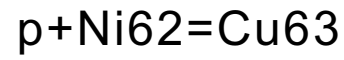
Cu 62
Proton 29
Neutron 33
Spin:1

Ni 62
Proton: 28
Neutron: 34
Spin: 0
Stable



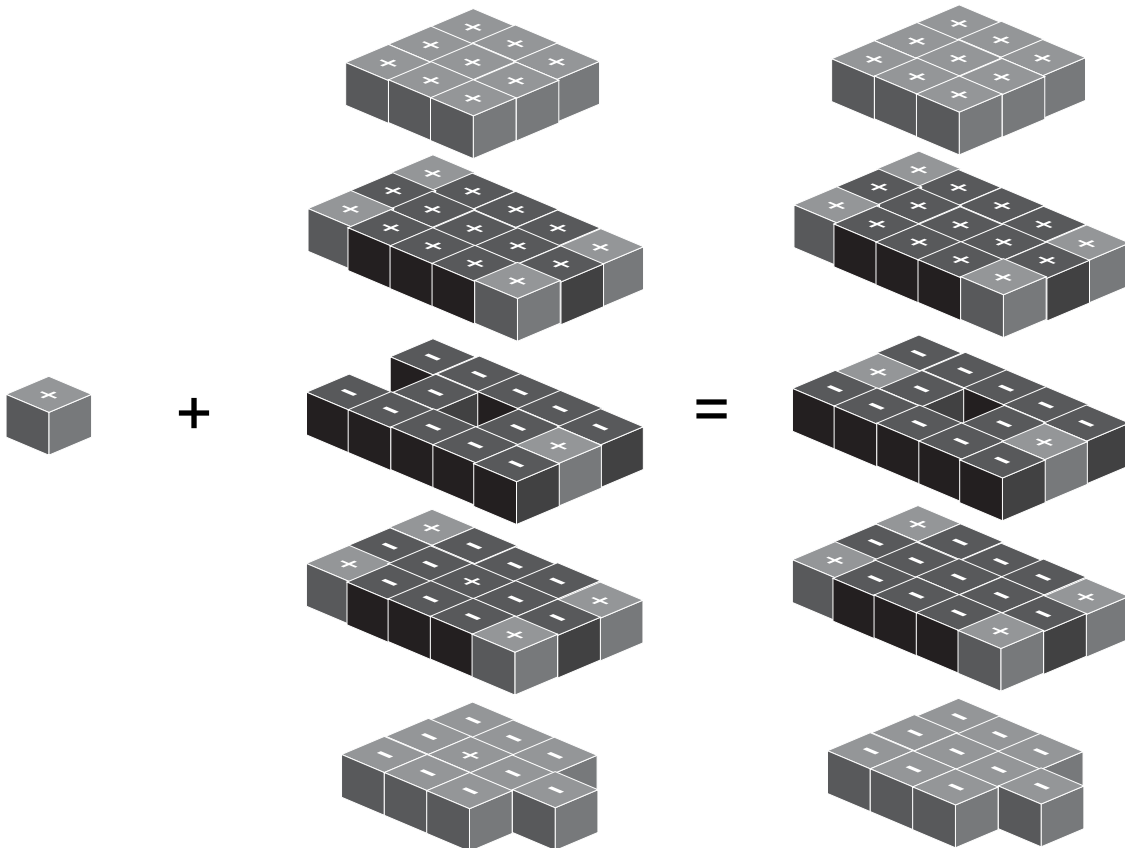
Nickel copper nuclear transmutation

Step 5

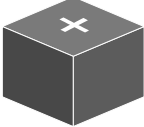

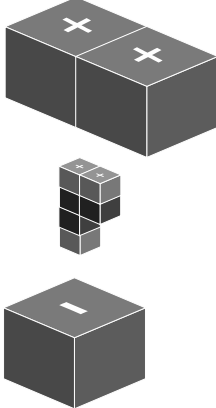


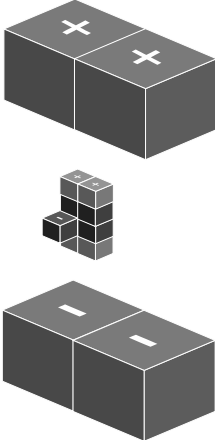
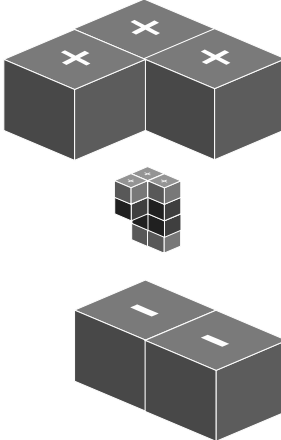
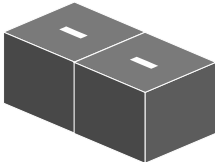
Ni 62
Proton: 28
Neutron: 34
Spin: 0
Stable

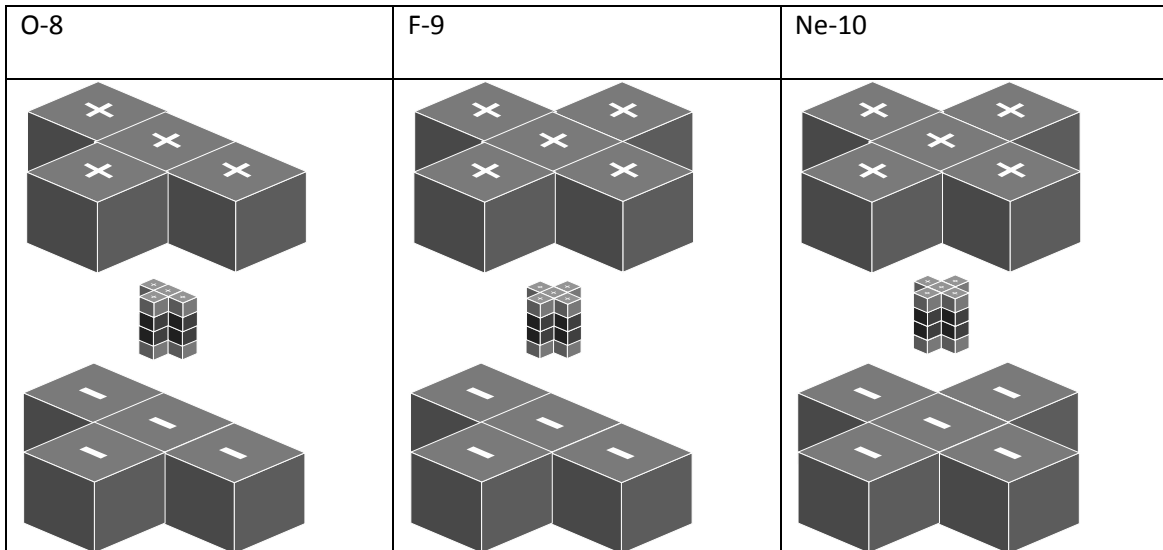
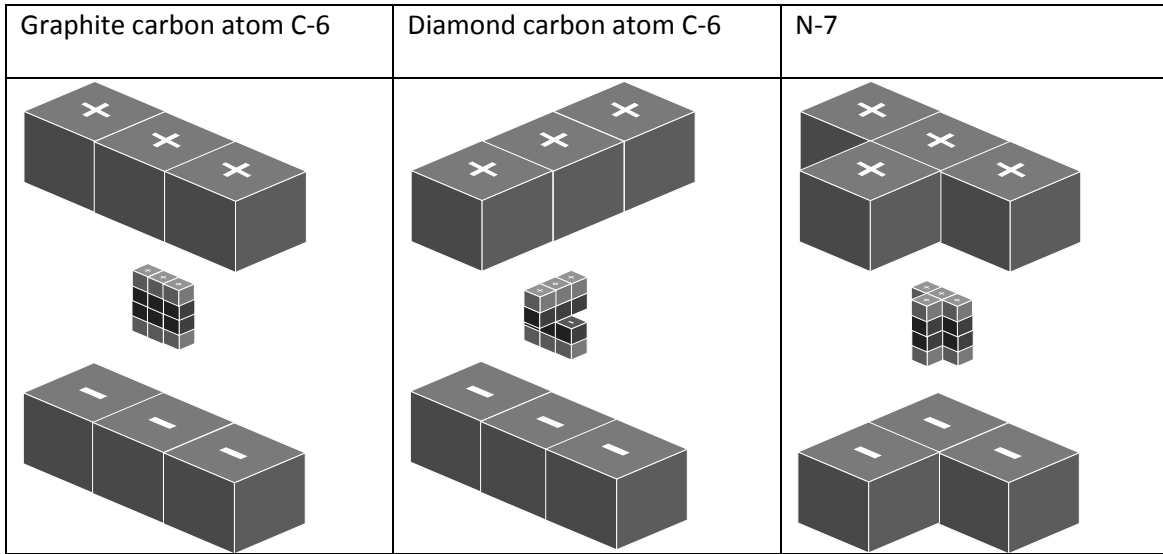
Cu 63
Proton 29
Neutron 34
Spin: -3/2
Stable

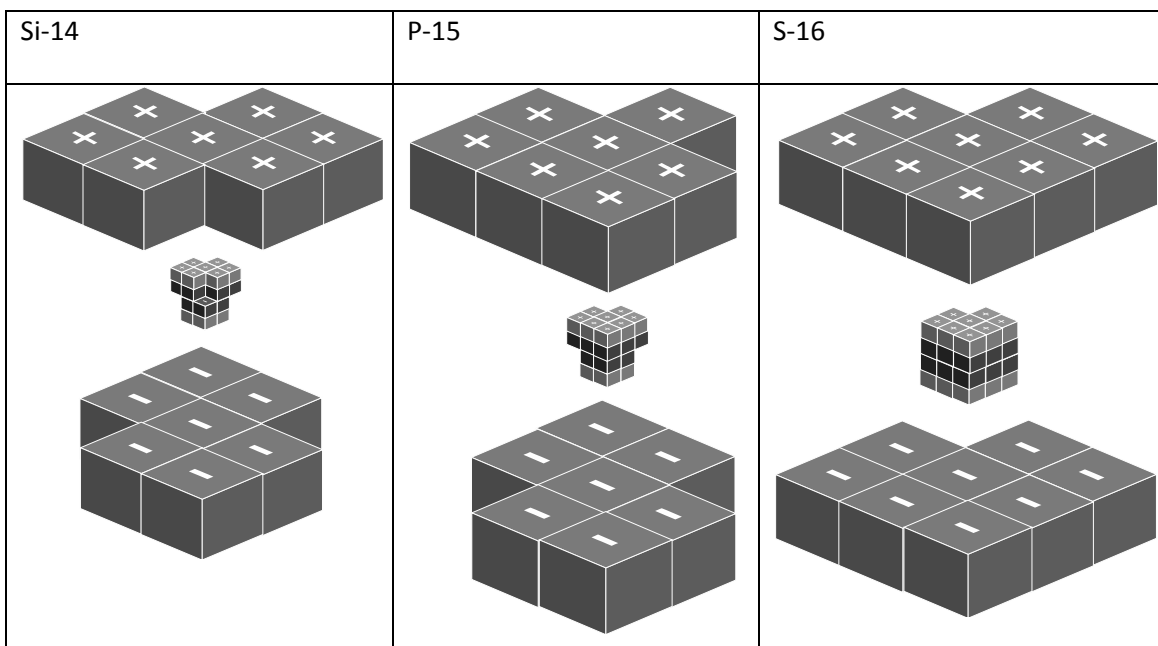
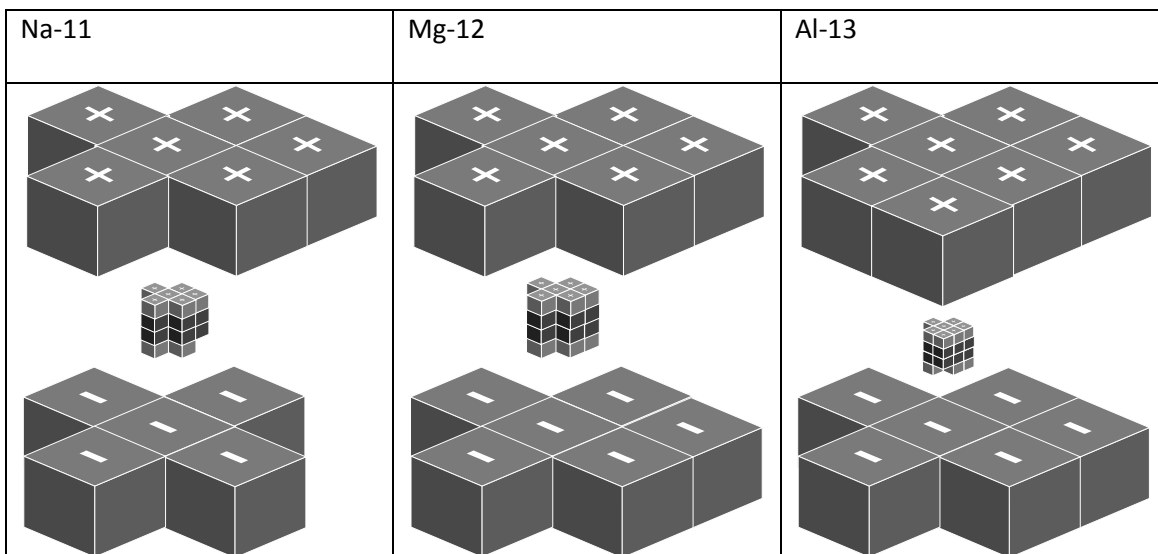


Atom Cubic Structure

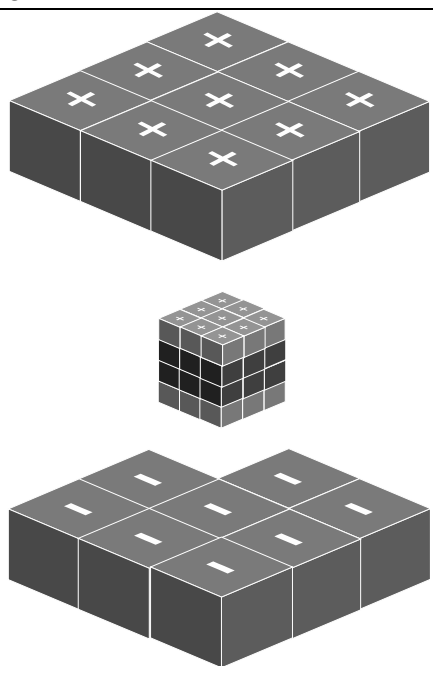
H-1	He-2	Li-3
		

Be-4	B-5	
		

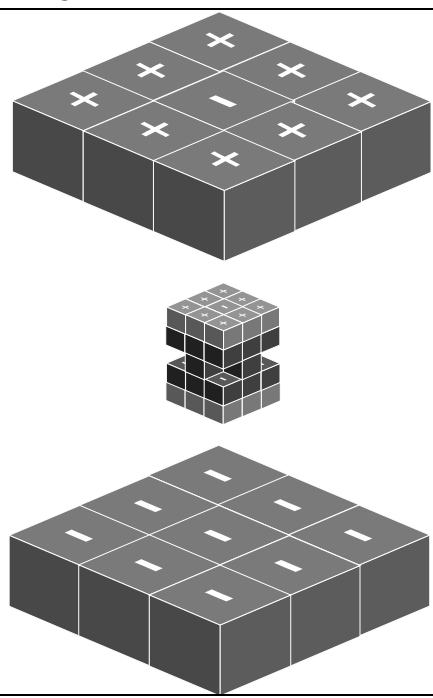




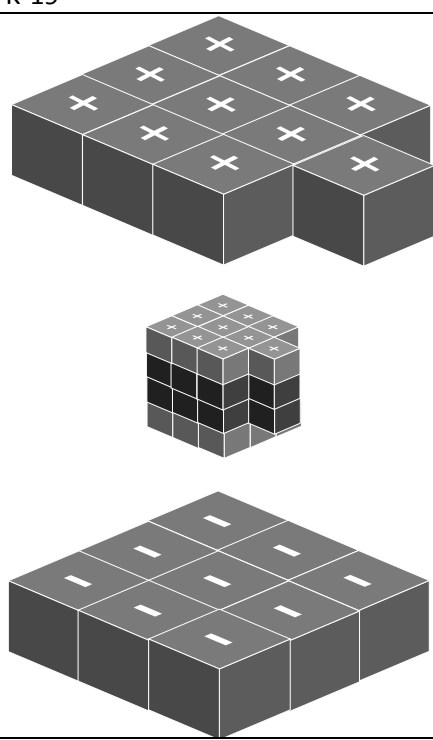
Cl-17



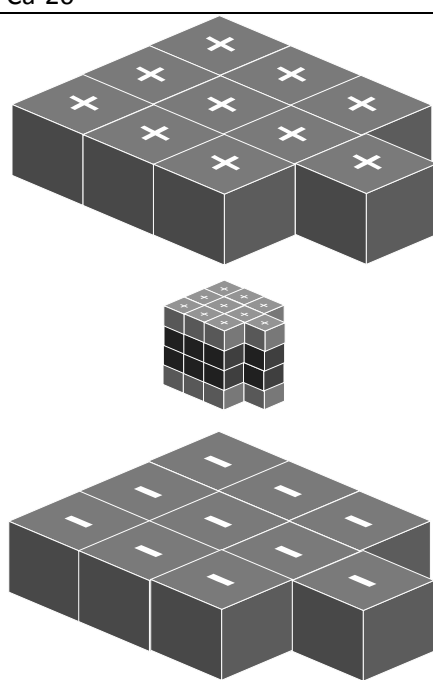
Ar-18



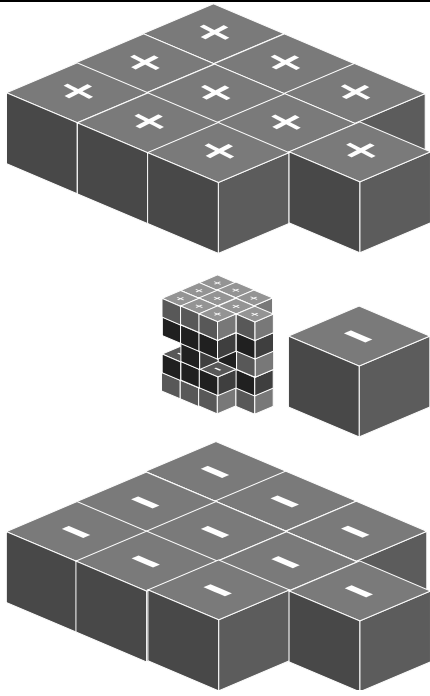
K-19



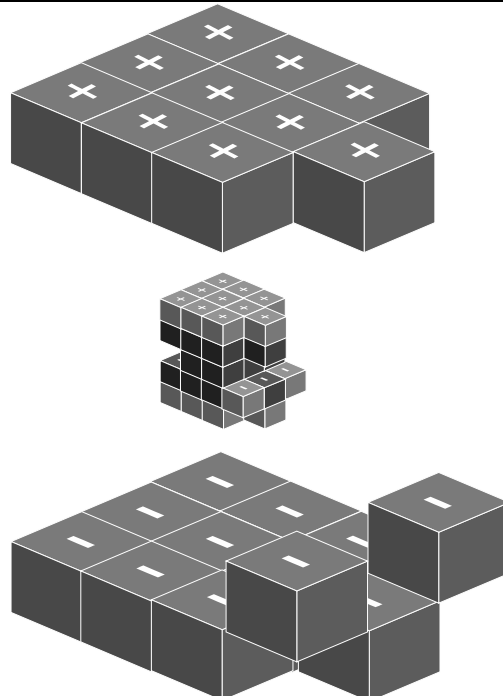
Ca-20



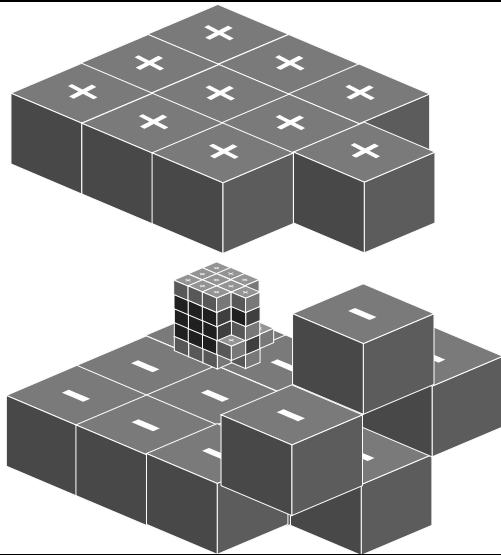
Sc-21



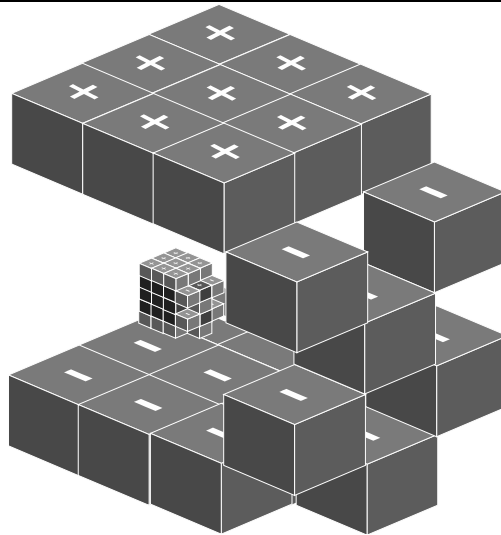
Ti-22



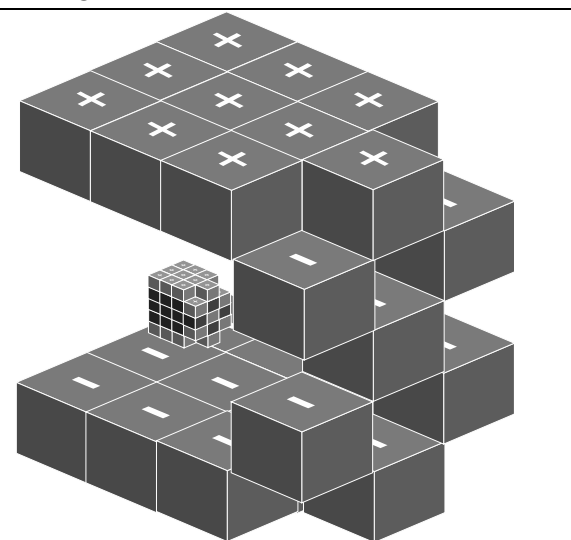
V-23



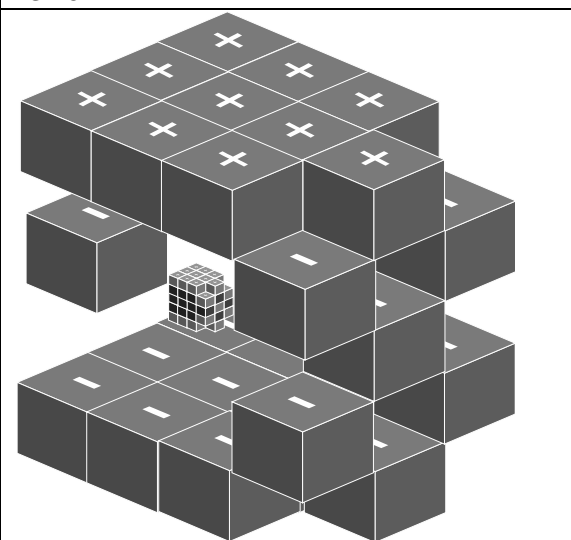
Cr-24



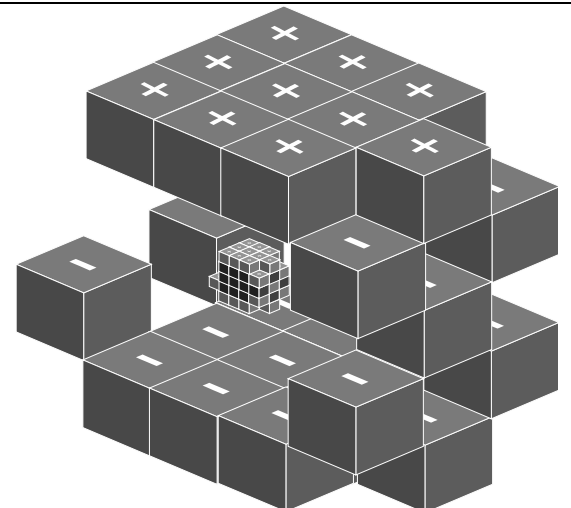
Mn-25



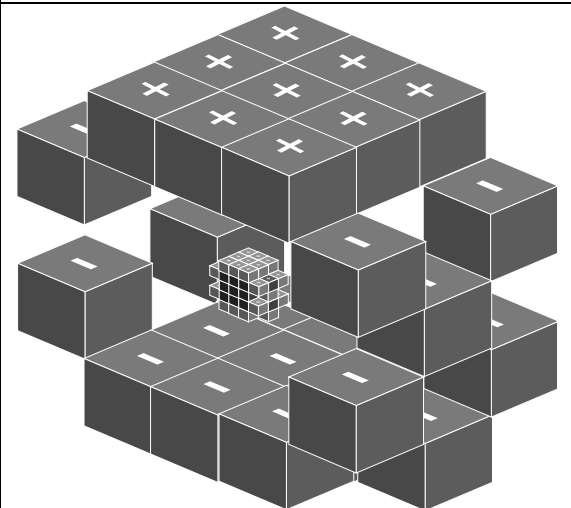
Fe-26



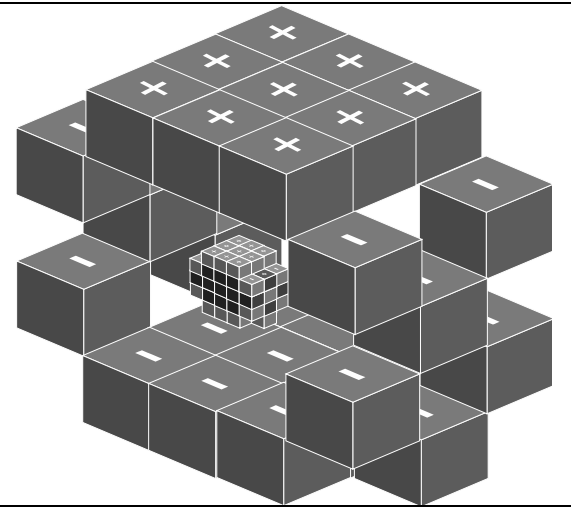
Co-27



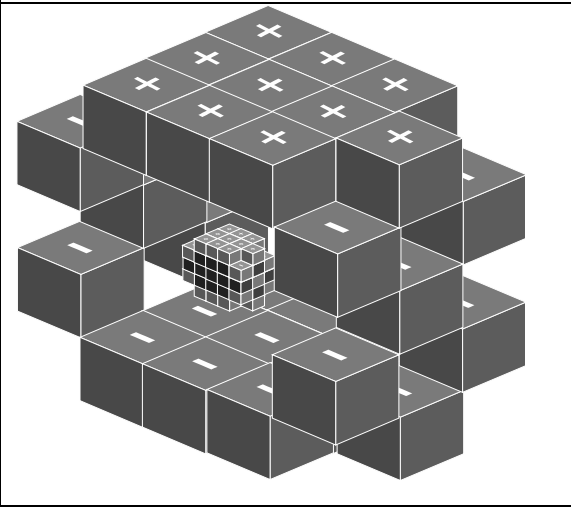
Ni-28



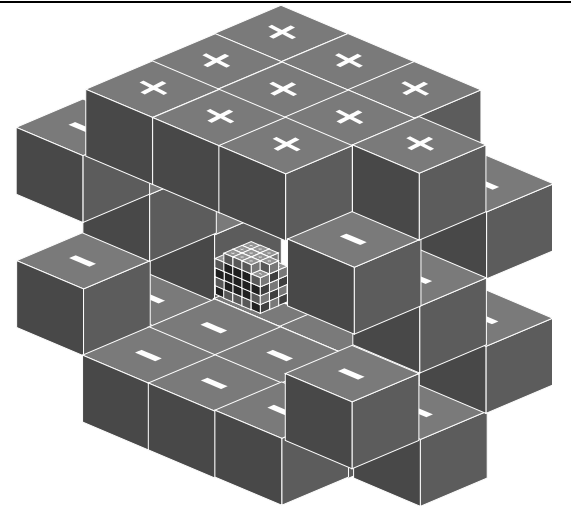
Cu-29



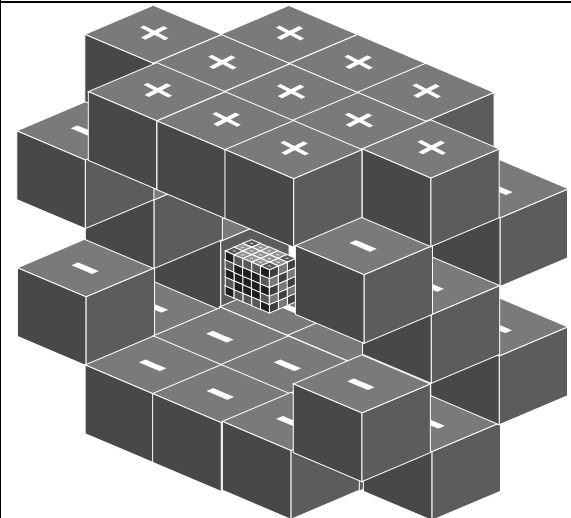
Zn-30



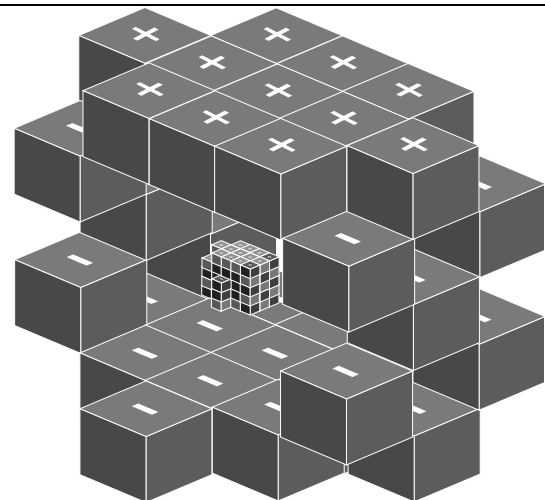
Ga-31



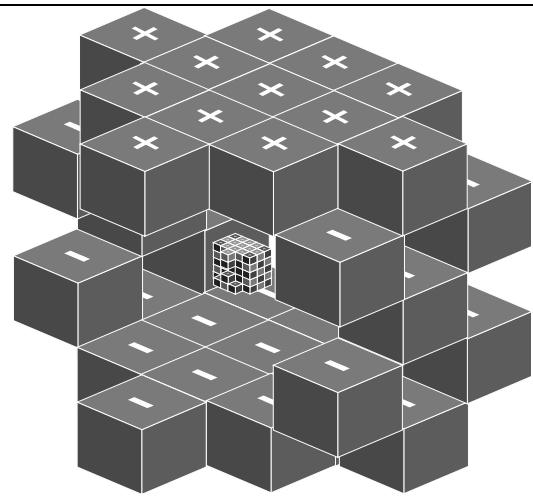
Ge-32



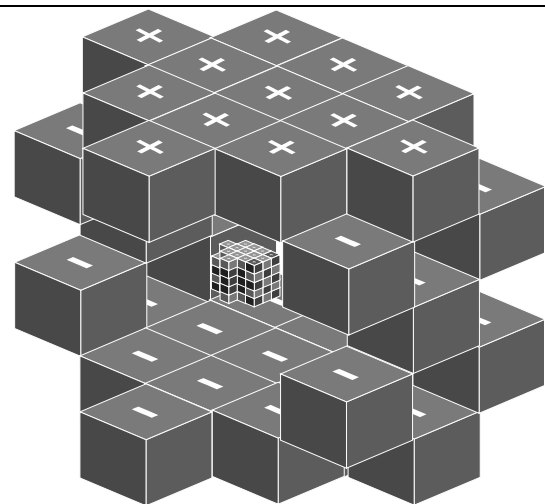
As-33



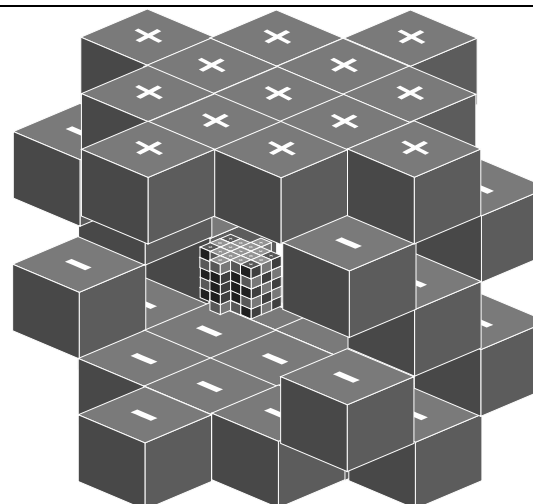
Se-34



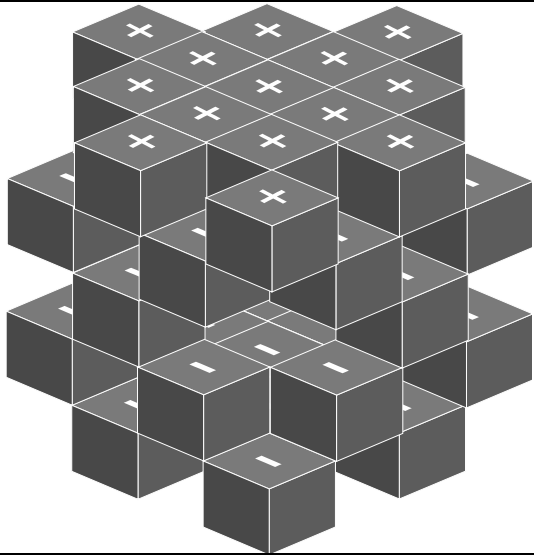
Br-35



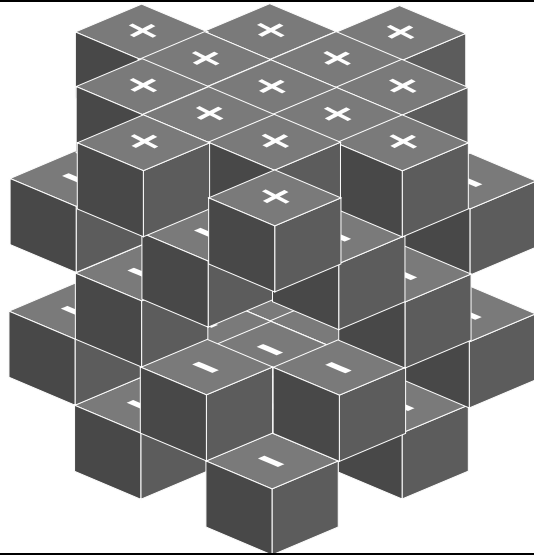
Kr-36



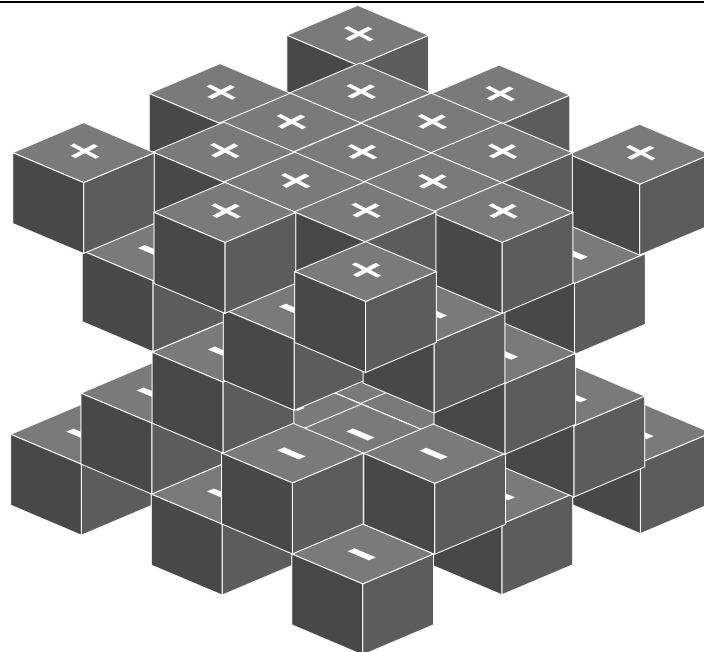
Ag-47



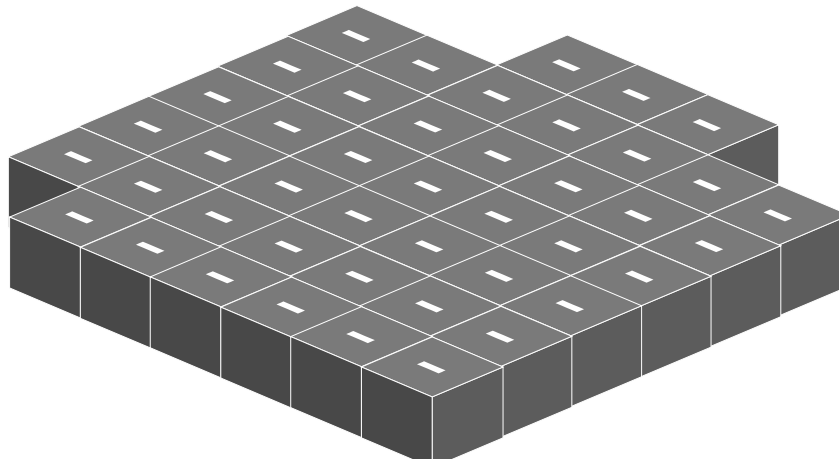
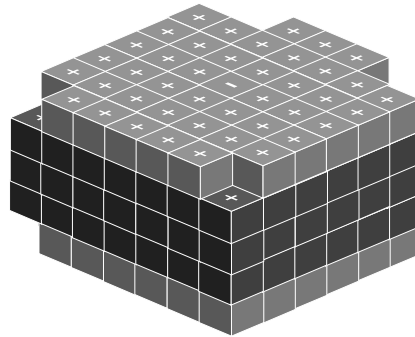
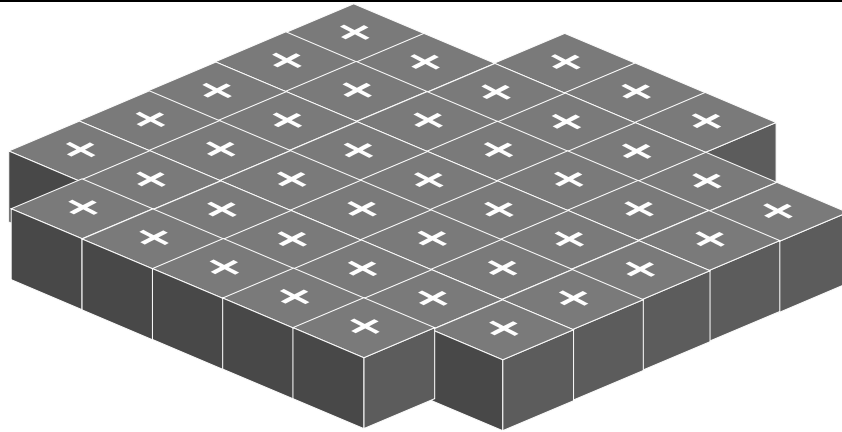
Cd-48



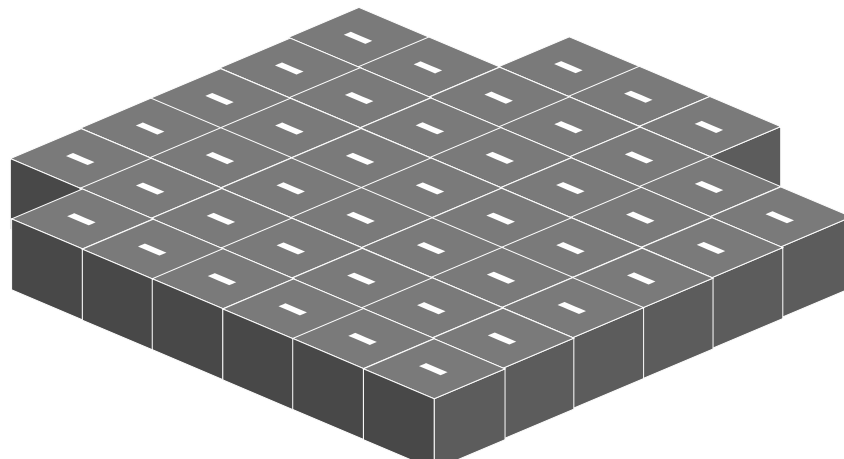
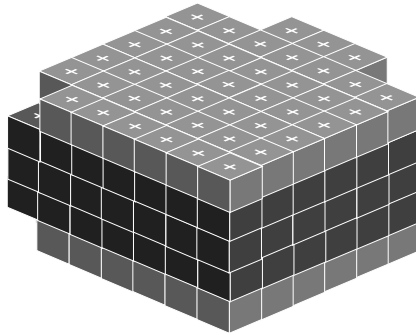
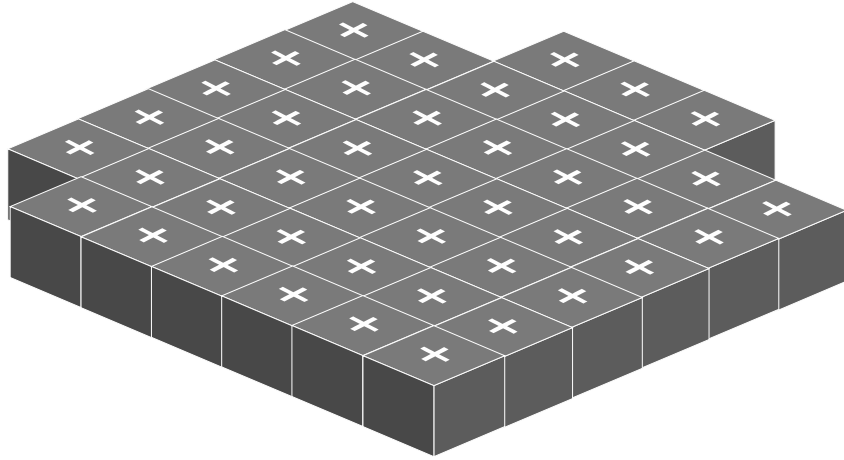
Xe-54

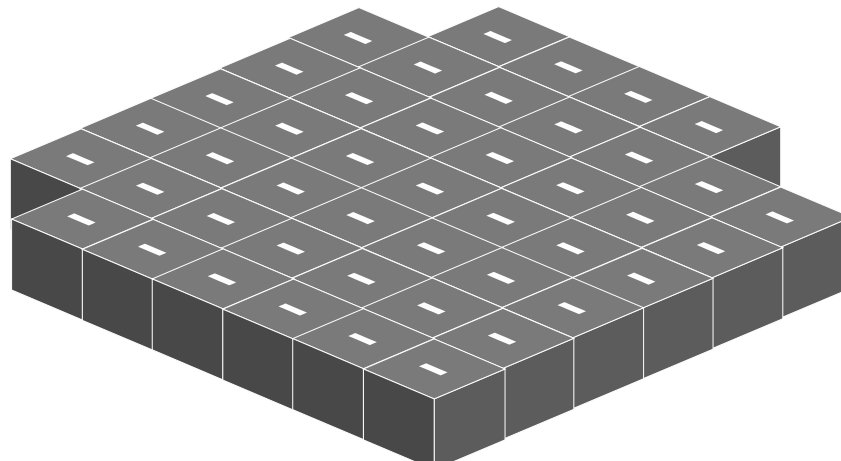
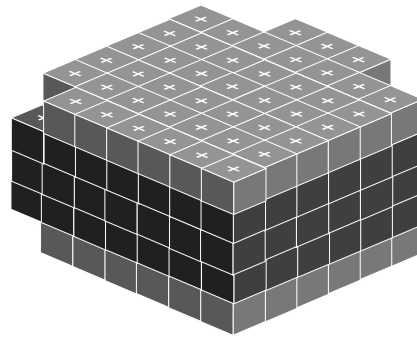
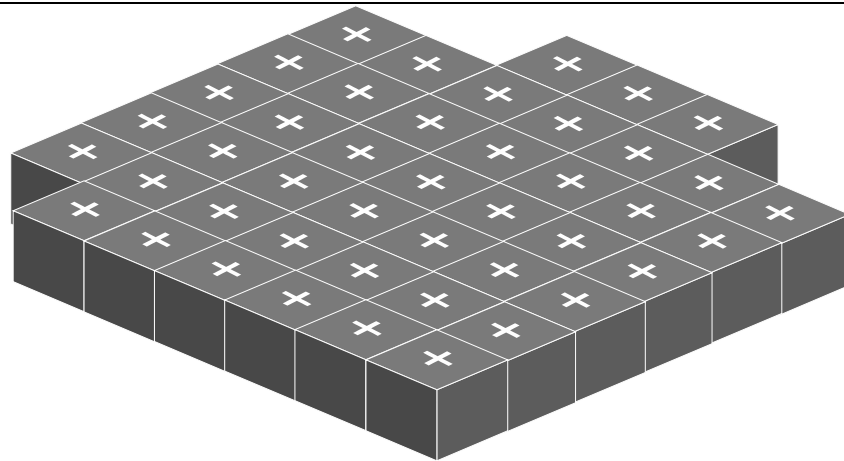


Fr-87

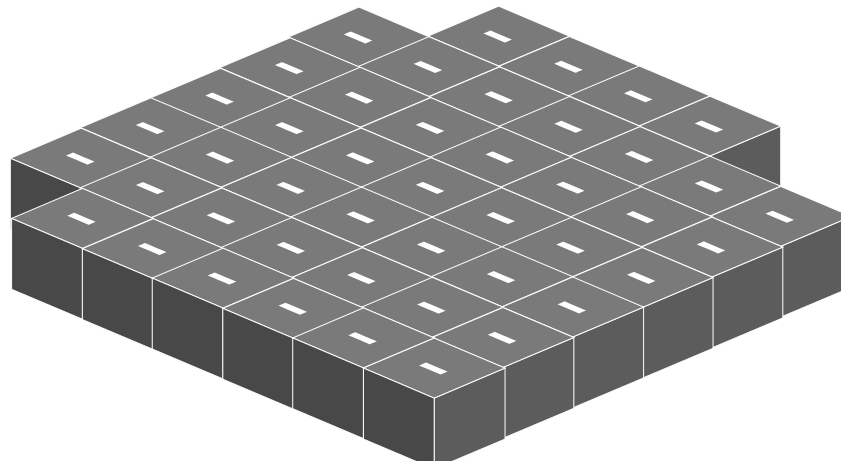
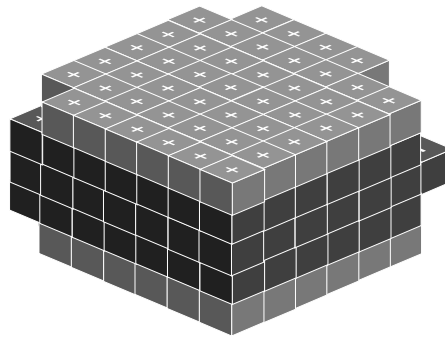
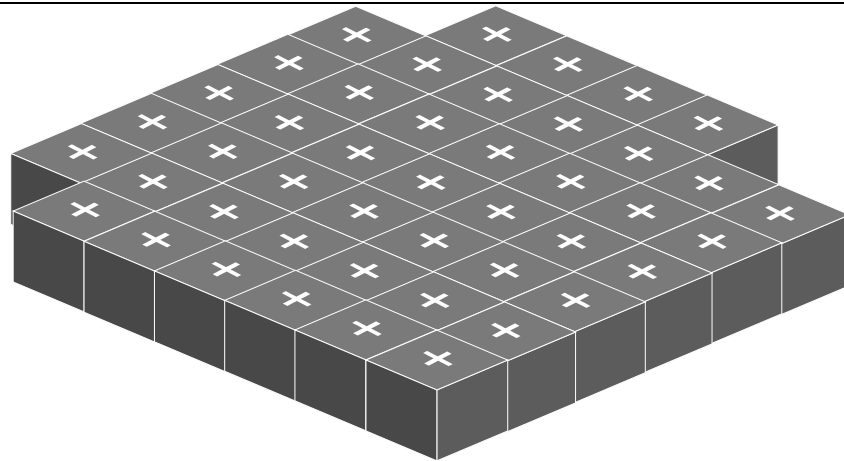


Ra-88

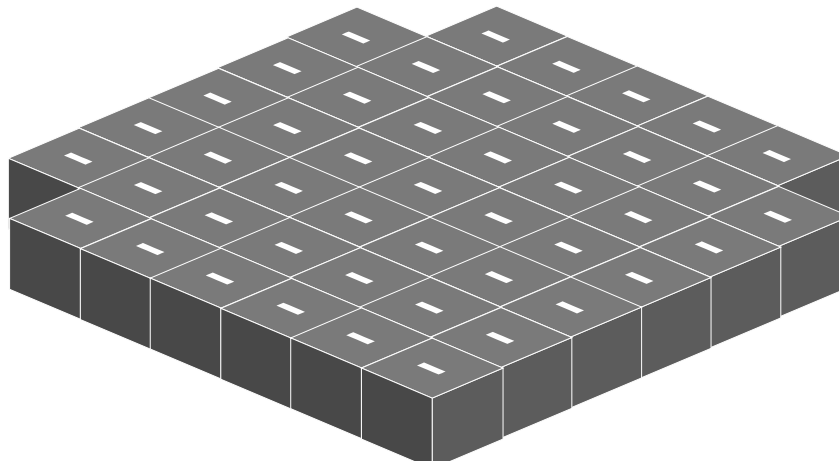
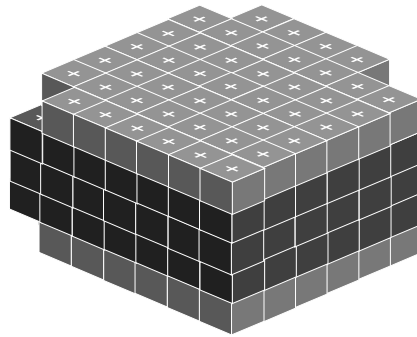
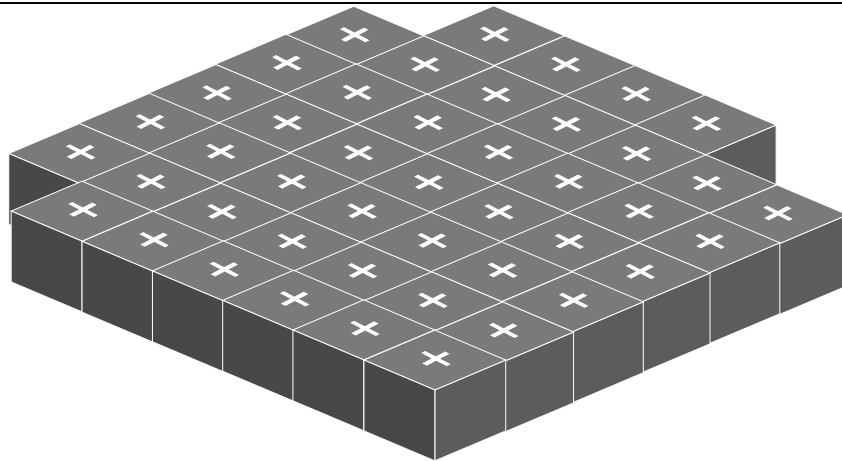


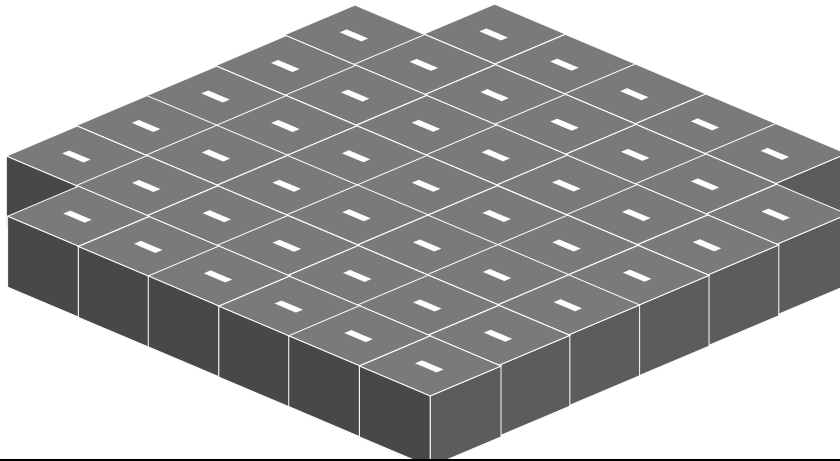
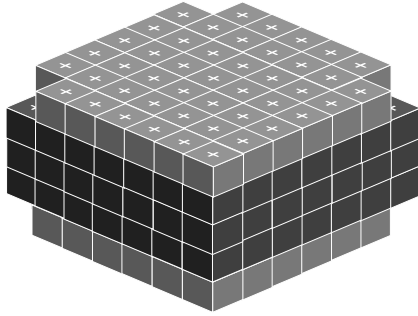
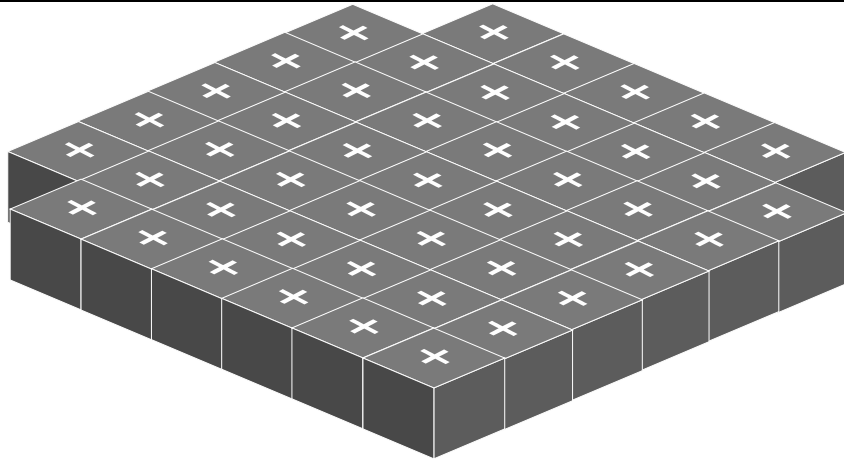


Th-90



Pa-91

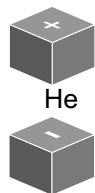




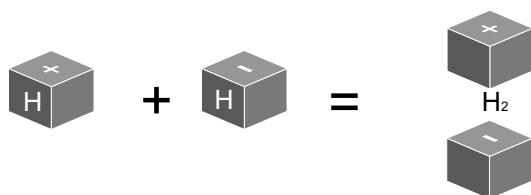
Molecule Cubic Structure

Hydrogen molecule H₂

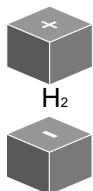
Helium atom electron configuration



Hydrogen molecule formation



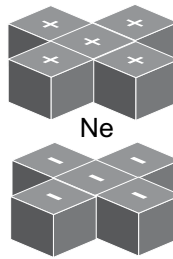
Hydrogen molecule electron configuration



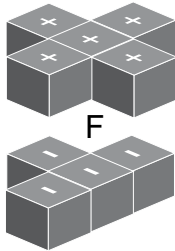
Helium atom and hydrogen molecule have the same electron configuration

Neon like molecule

Neon atom



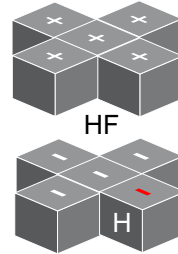
Fluoride atom



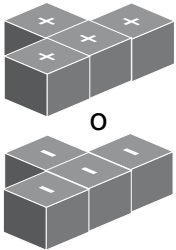
Hydrogen atom



Hydrogen fluoride molecule



Oxygen atom

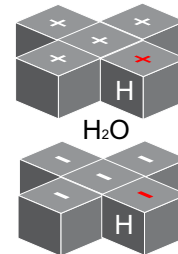


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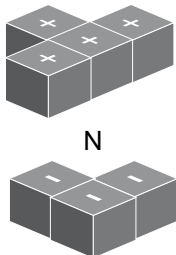


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Water molecule



Nitrogen atom

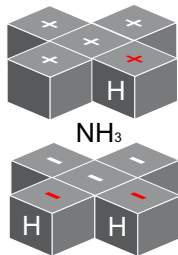


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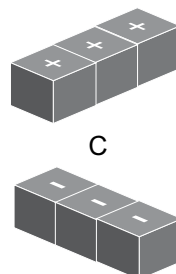


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Ammonia molecule



Carbon atom

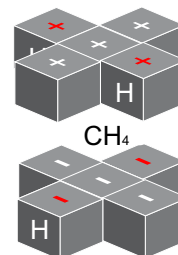


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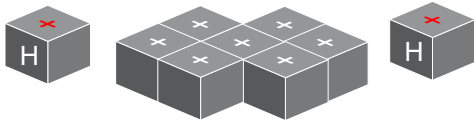
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Methane molecule

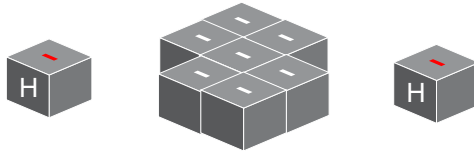


Argon like molecule

Silicon atom

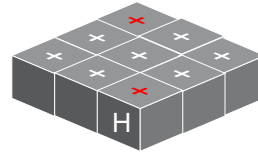


Si

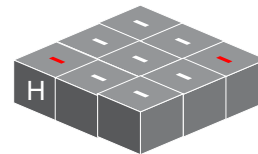


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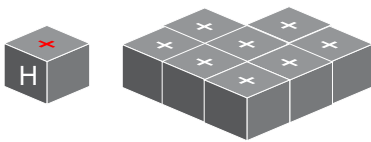
Silane molecule



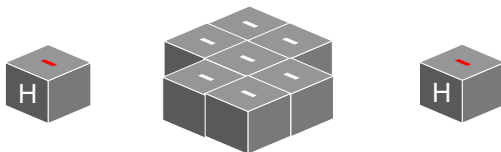
SiH₄



Phosphorus atom

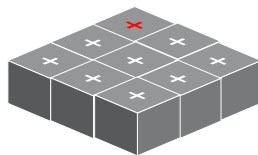


P

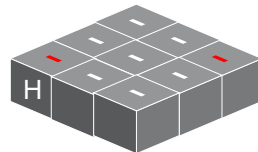


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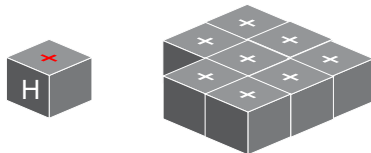
Phosphine molecule



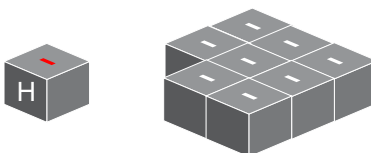
PH₃



Sulfur atom

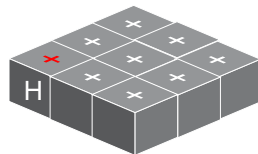


S

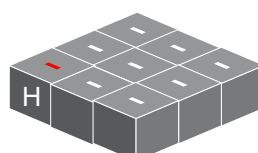


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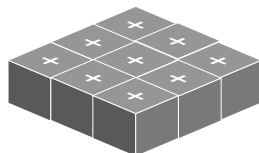
Hydrogen sulfide molecule



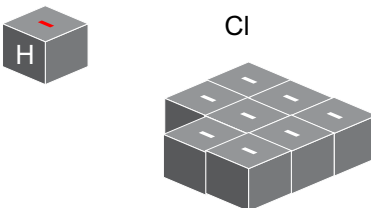
H₂S



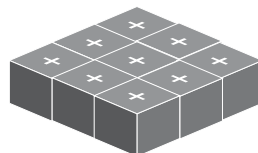
Sulfur atom



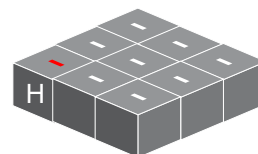
Cl



Hydrogen chloride molecule

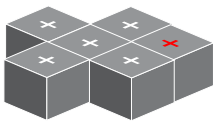


HCL



Molecule Cubic Structure

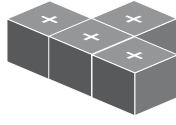
Sodium atom



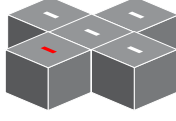
Na



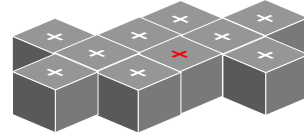
Fluoride atom



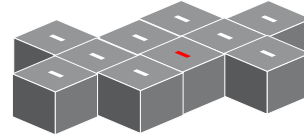
F



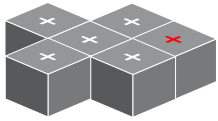
Sodium fluoride molecule



NaF



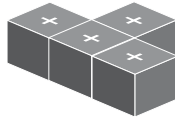
Magnesium atom



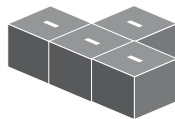
Mg



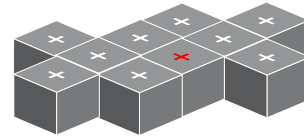
Oxygen atom



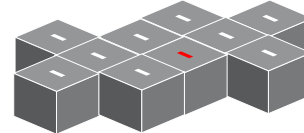
O



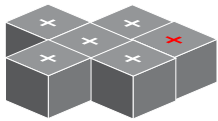
Magnesium oxide molecule



MgO



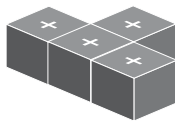
Sodium atom



Na



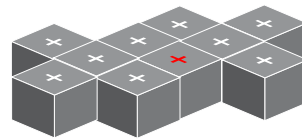
Oxygen atom



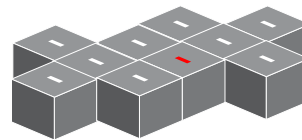
O



Sodium hydroxide molecule



NaOH



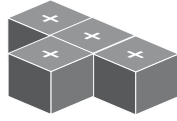
Molecule Cubic Structure

Oxygen atom



O

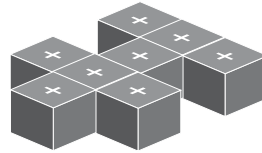
+



O

=

Oxygen molecule



O₂

Oxygen atom



O

+



O

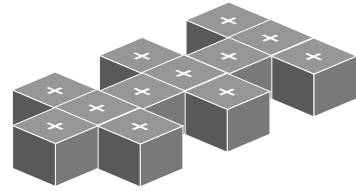
+



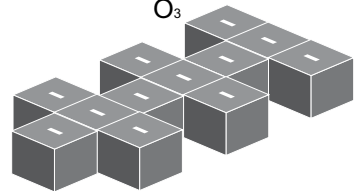
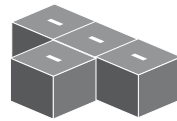
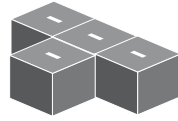
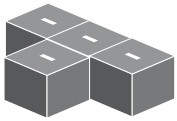
O

=

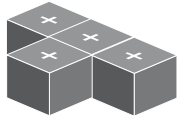
Ozone molecule



O₃



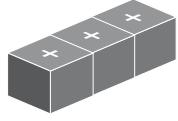
Oxygen atom



O

+

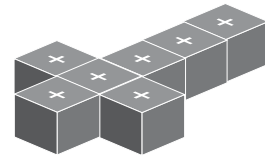
Carbon atom



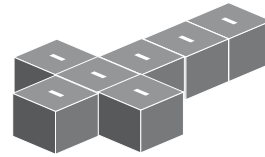
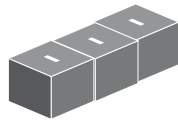
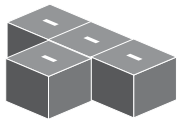
C

=

Carbon monoxide molecule



CO



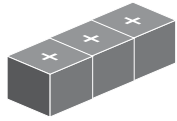
Oxygen atom



O

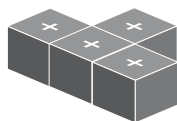
+

Carbon atom



C

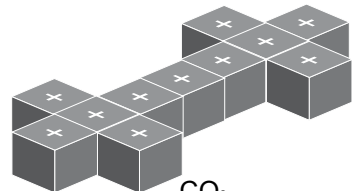
+



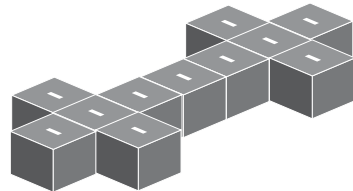
O

=

Carbon dioxide molecule

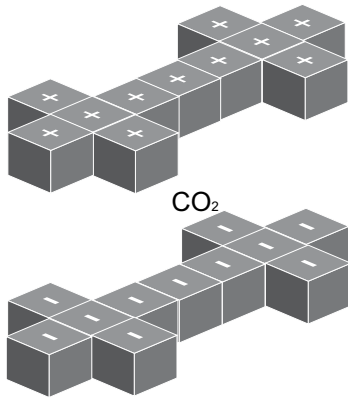


CO₂

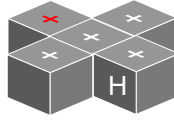


Molecule Cubic Structure

Carbon dioxide molecule



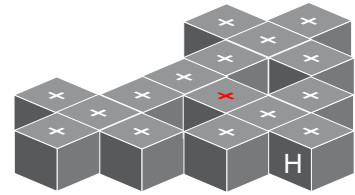
+



H_2O

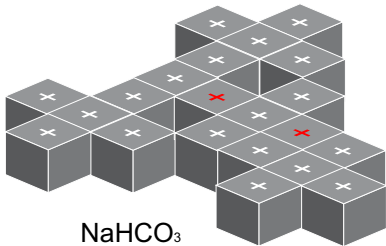
=

Carbonic acid

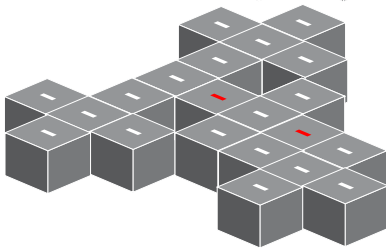


H_2CO_3

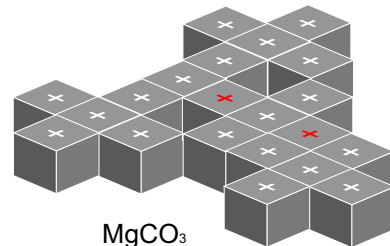
Sodium bicarbonate



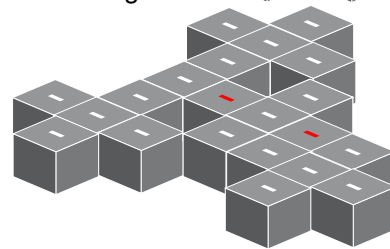
NaHCO_3



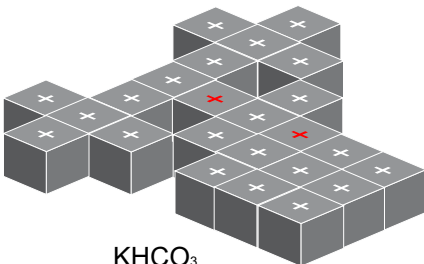
Magnesium carbonate



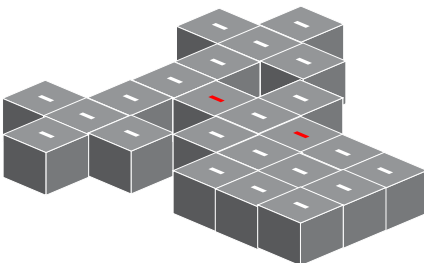
MgCO_3



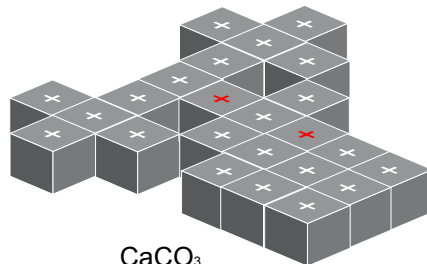
Potassium bicarbonate



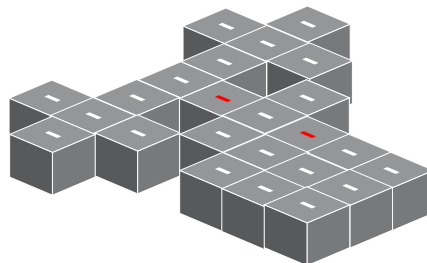
KHCO_3



Calcium carbonate



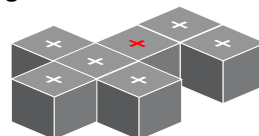
CaCO_3



Molecule Cubic Structure

Nitrogen Atom

Nitrogen Molecule



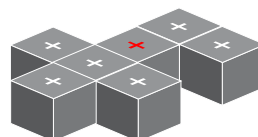
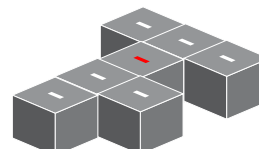
N

+

N

=

N₂



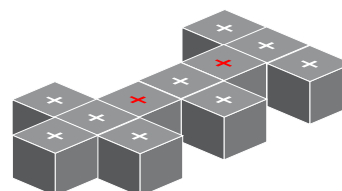
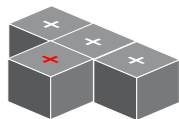
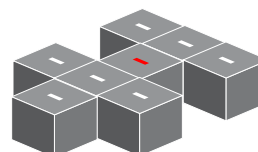
O

+

N

=

NO



O

+

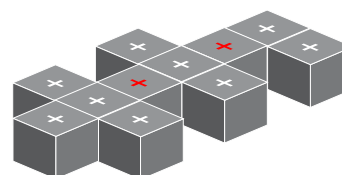
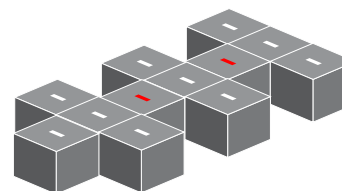
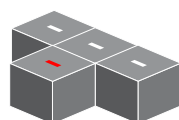
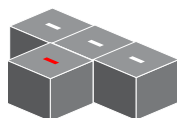
N

+

O

=

NO₂



N

+

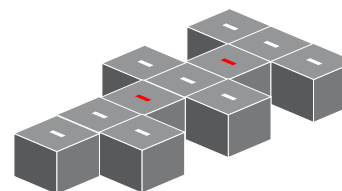
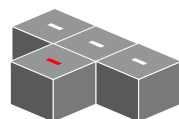
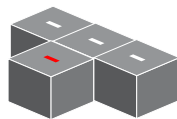
O

+

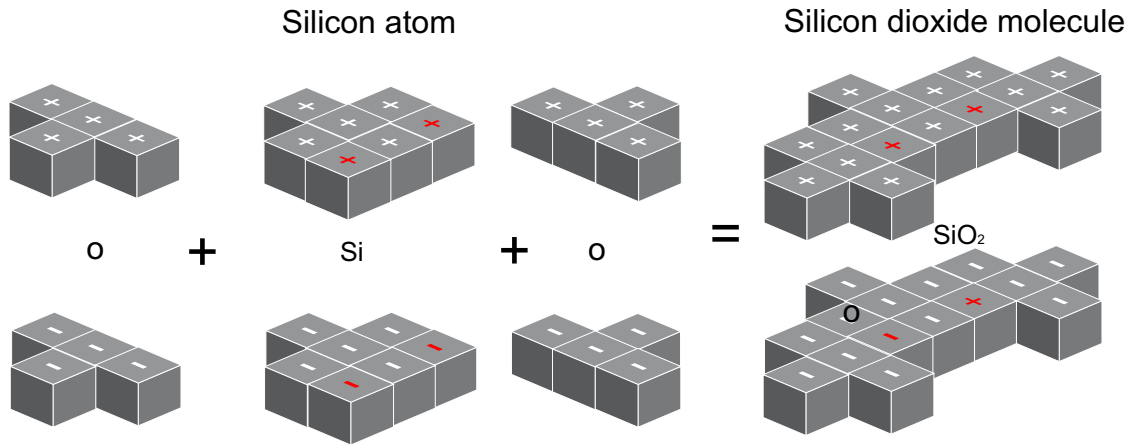
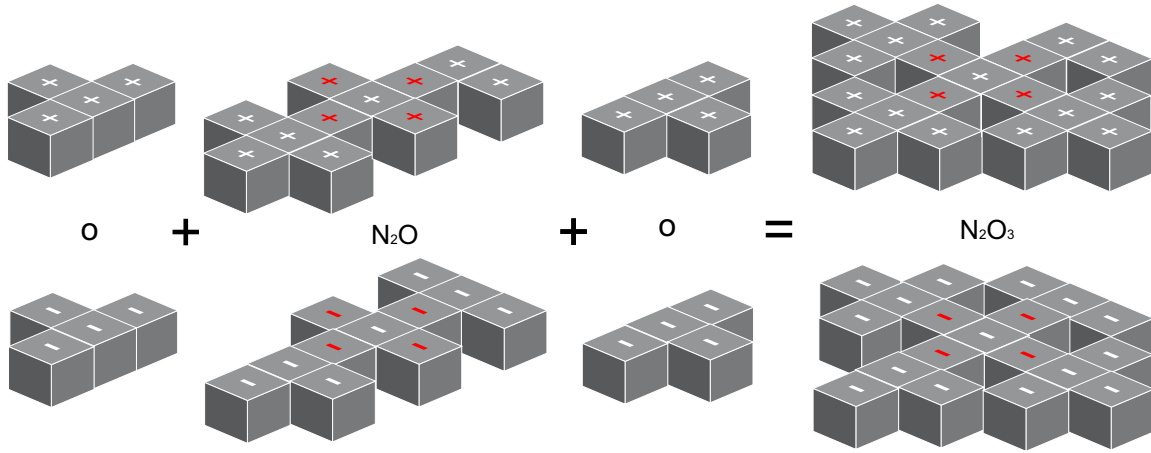
N

=

N₂O

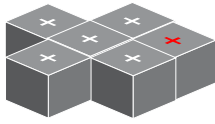


Molecule Cubic Structure



Molecule Cubic Structure

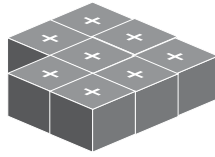
Sodium atom



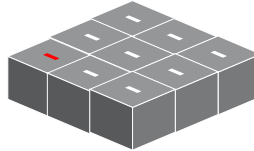
Na



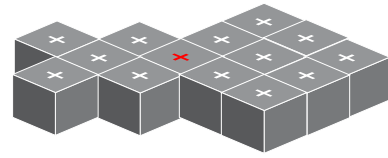
Chlorine atom



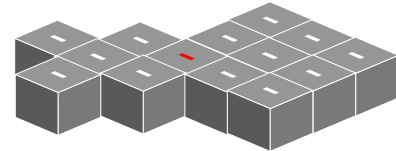
Cl



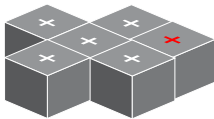
Sodium chloride molecule



NaCl



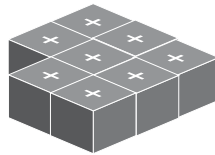
Magnesium atom



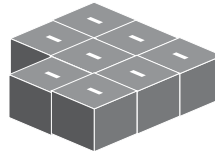
Mg



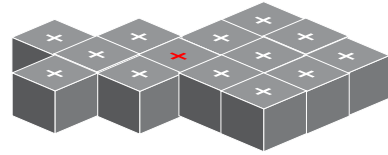
Sulfur atom



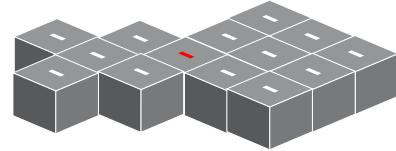
S



Magnesium sulfide molecule



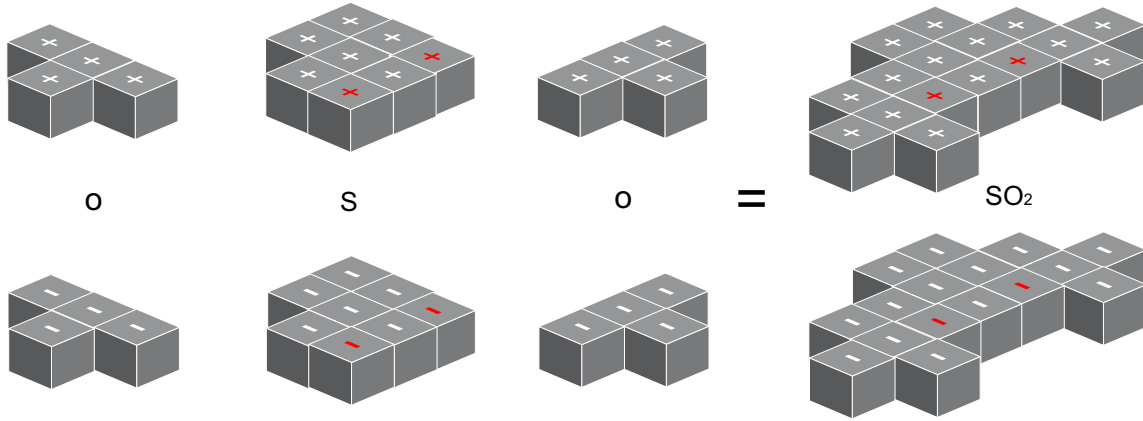
MgS



Molecule Cubic Structure

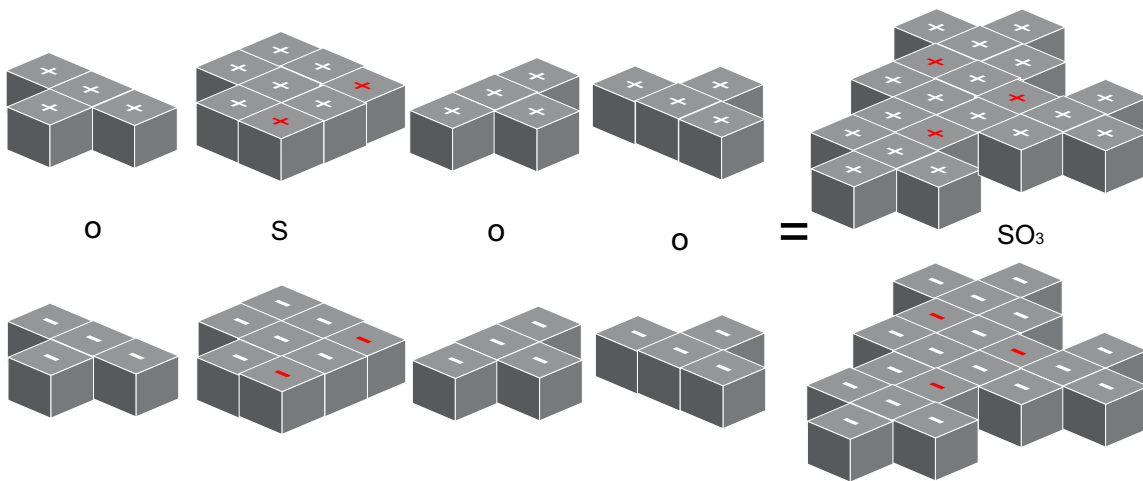
Sulfur atom

Sulfur dioxide molecule



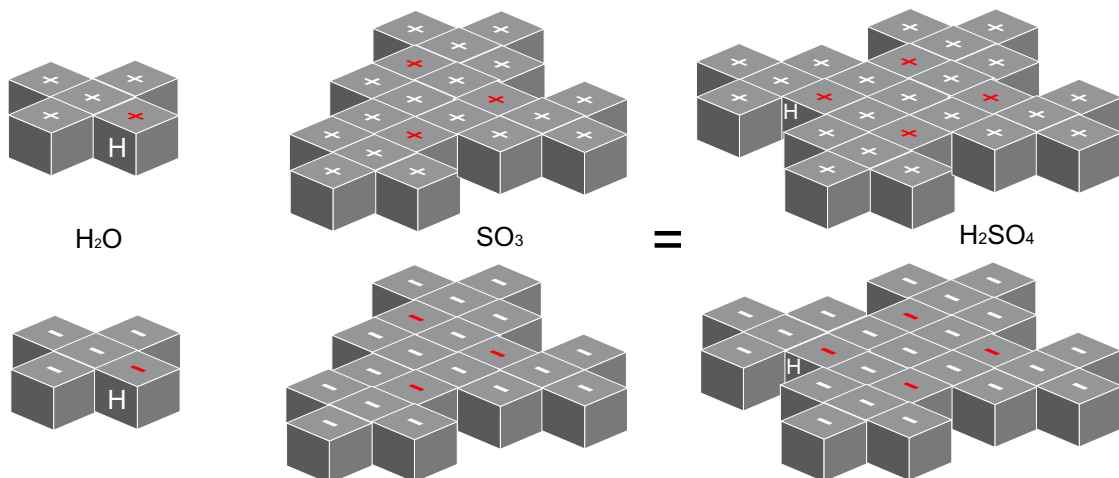
Sulfur atom

Sulfur trioxide molecule



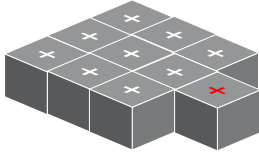
Water molecule

Sulfuric acid molecule H₂SO₄

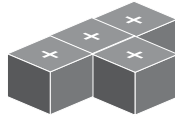


Molecule Cubic Structure

Calcium atom



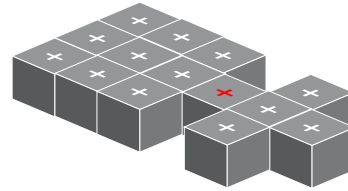
Ca



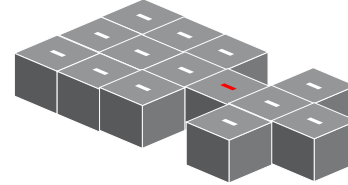
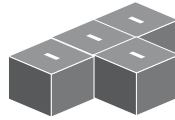
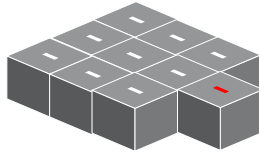
O

=

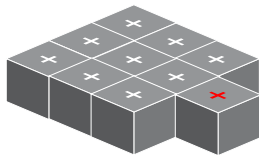
Calcium oxide molecule



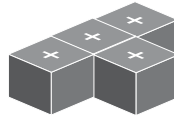
CaO



Potassium atom



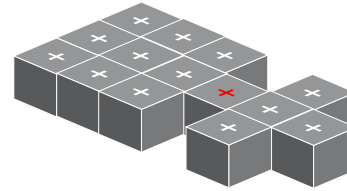
K



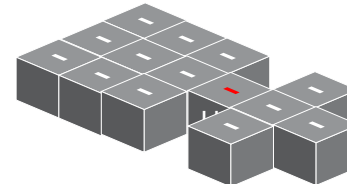
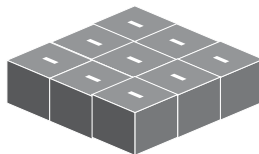
O

=

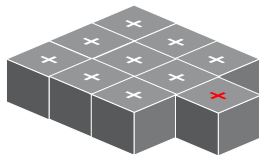
Potassium hydroxide molecule



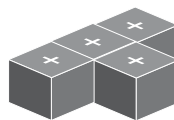
KOH



Potassium atom



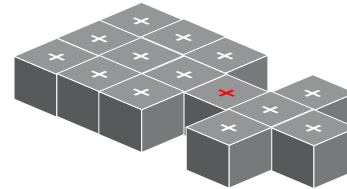
K



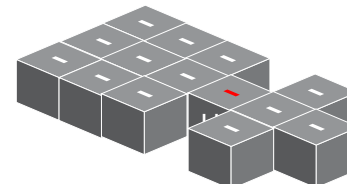
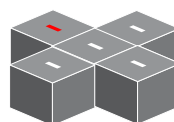
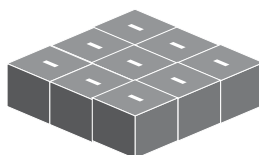
F

=

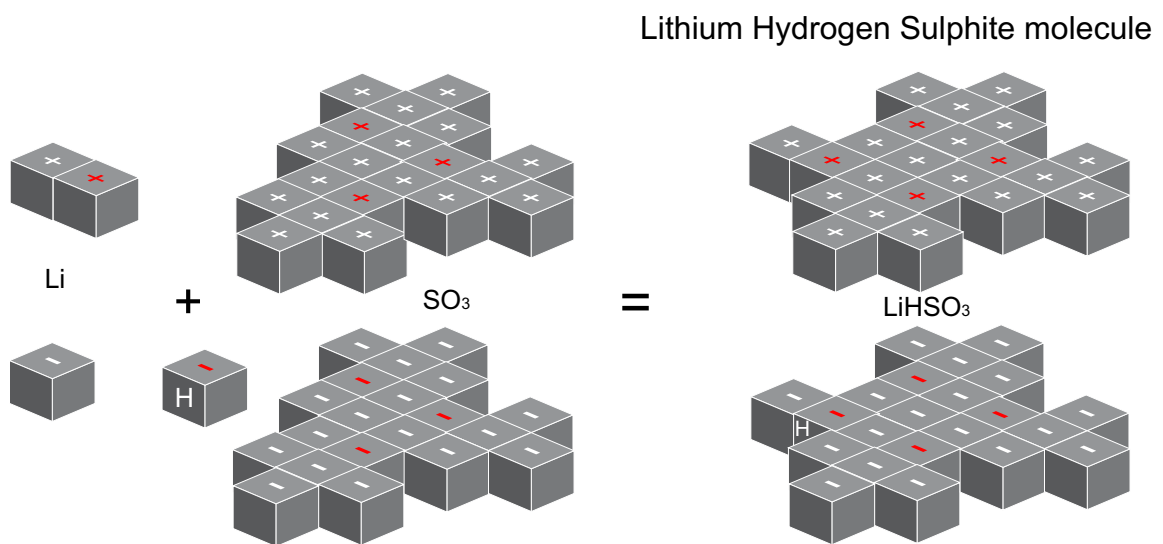
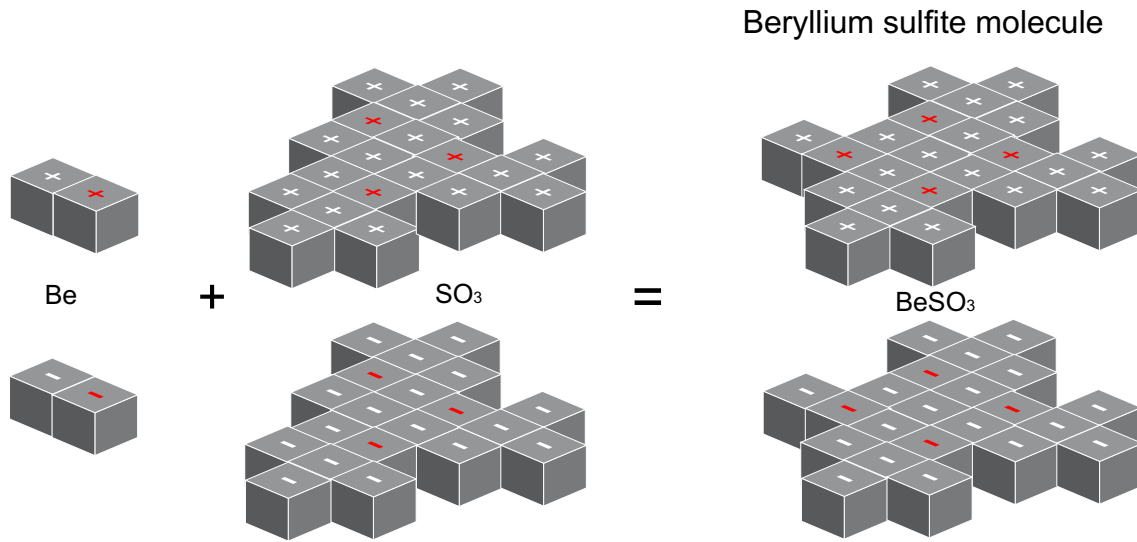
Potassium fluoride molecule



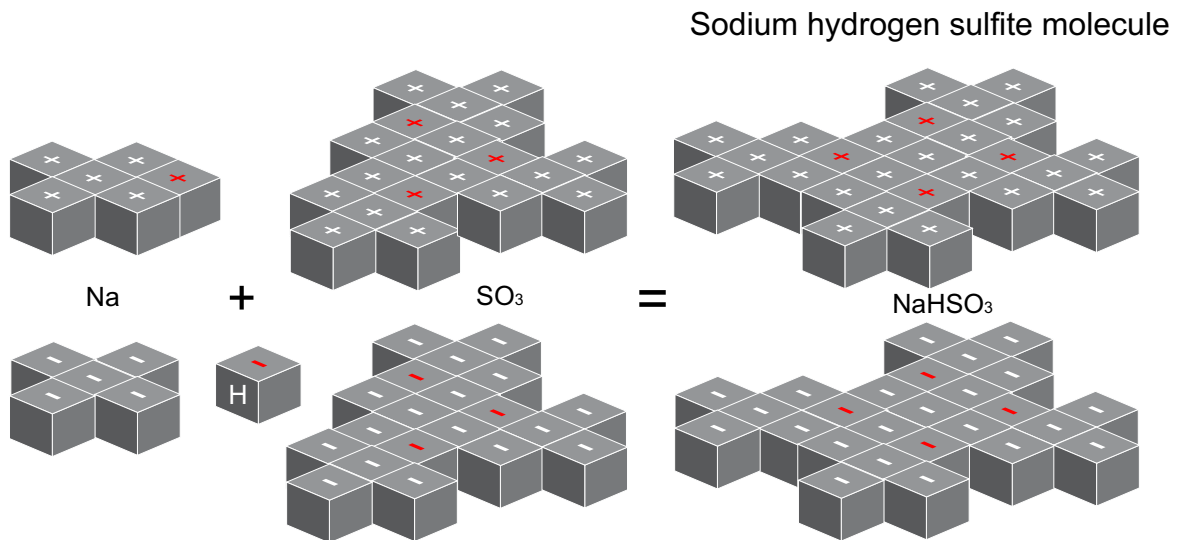
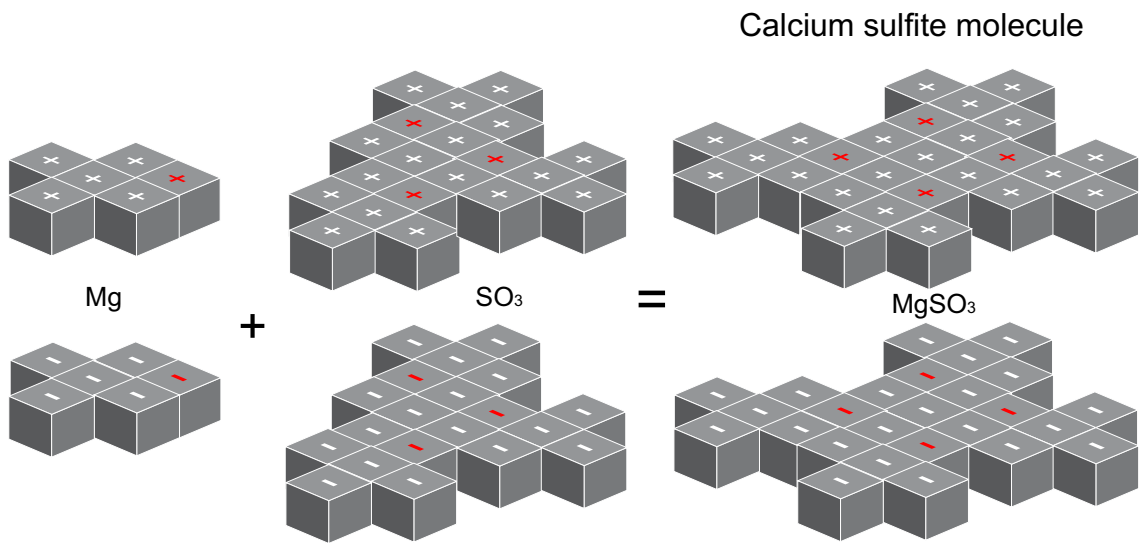
KF



Molecule Cubic Structure

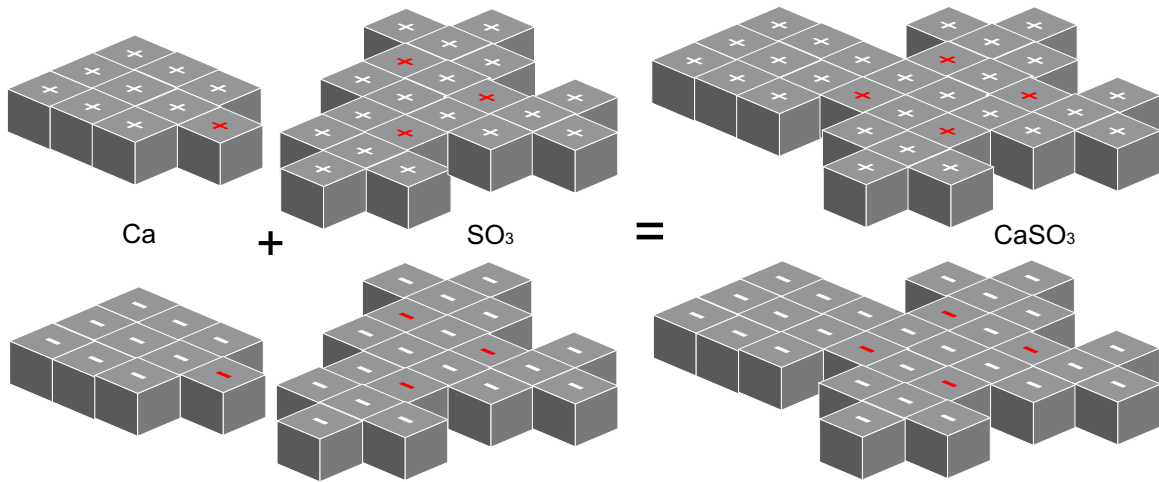


Molecule Cubic Structure



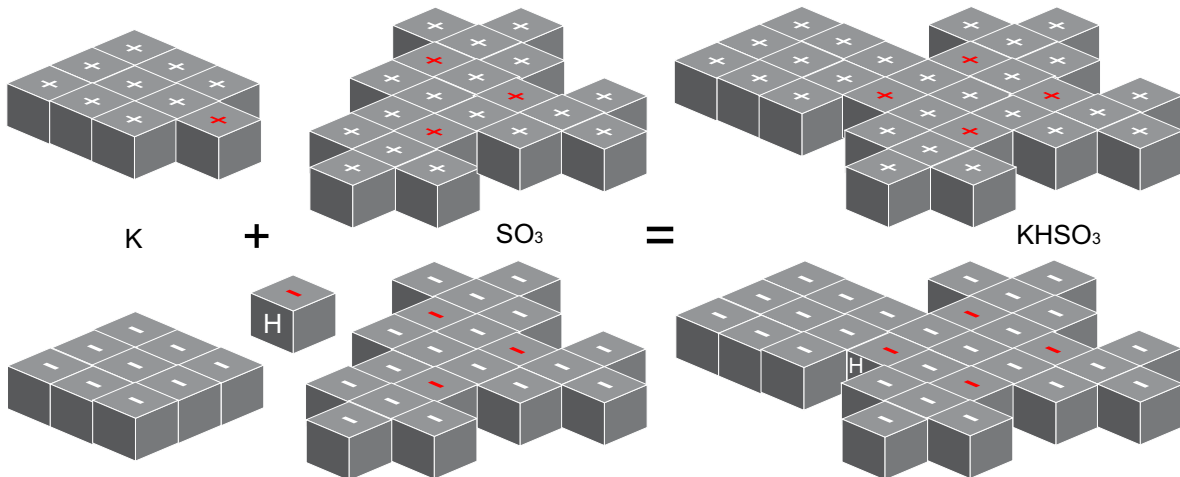
Molecule Cubic Structure

Calcium sulfite molecule



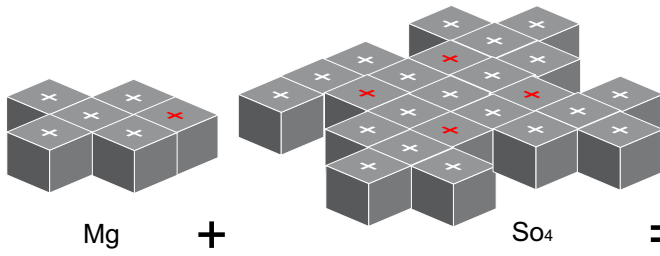
Potassium atom

potassium hydrogen sulfite molecule

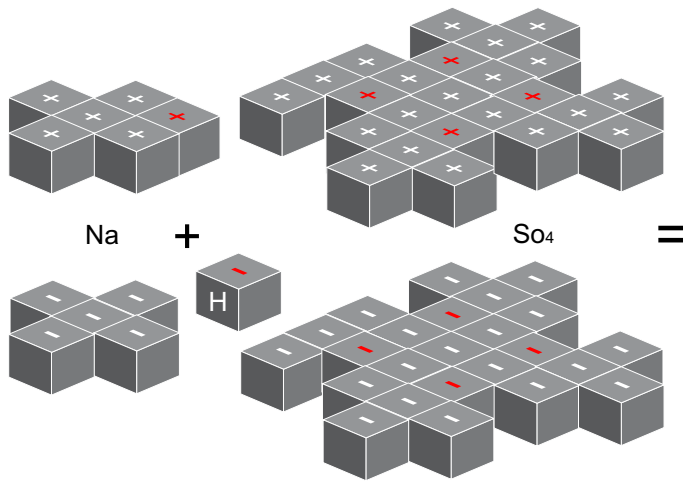
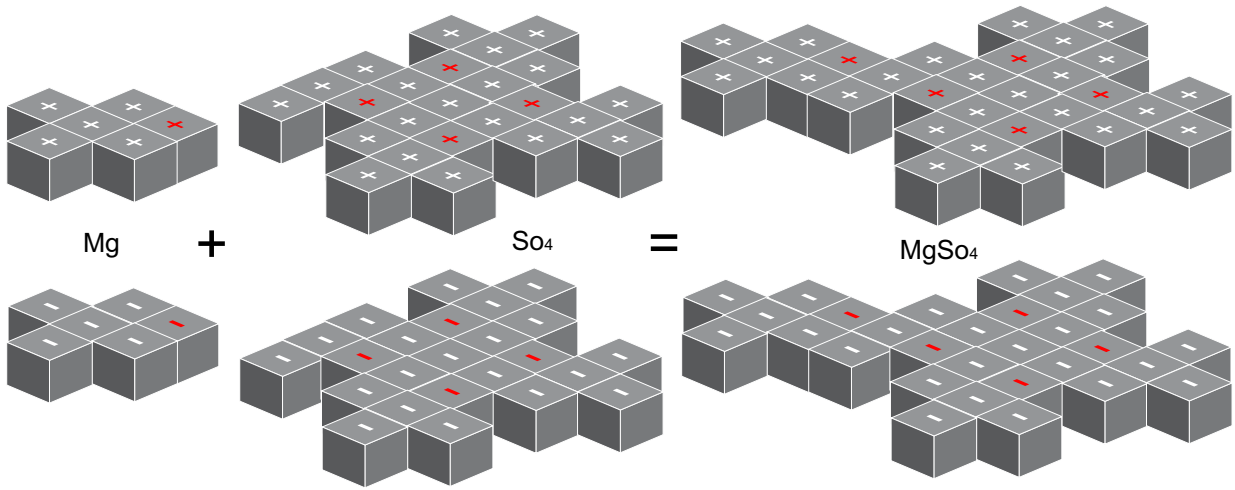


Molecule Cubic Structure

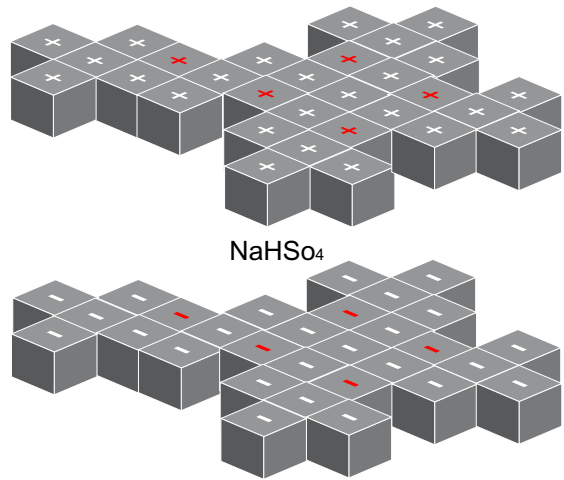
Magnesium atom

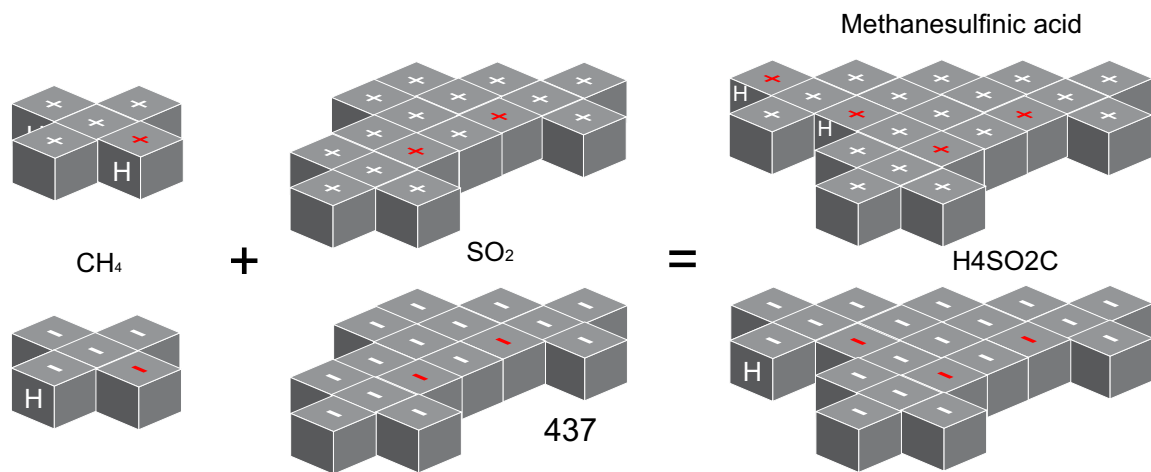
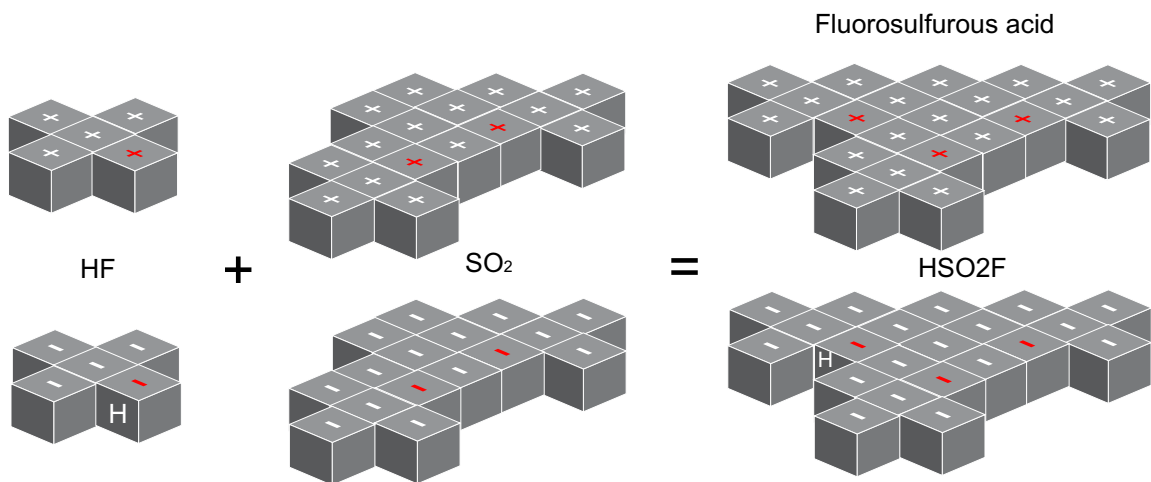
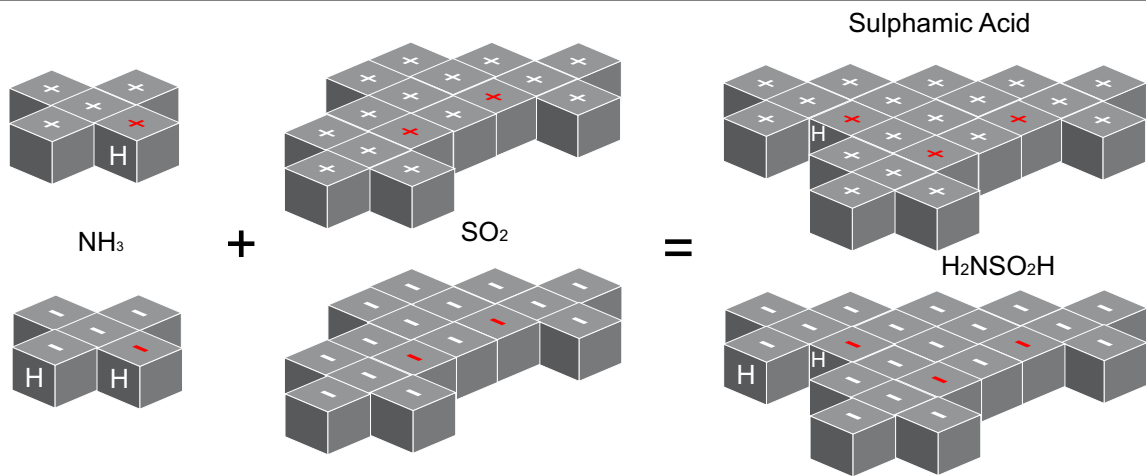
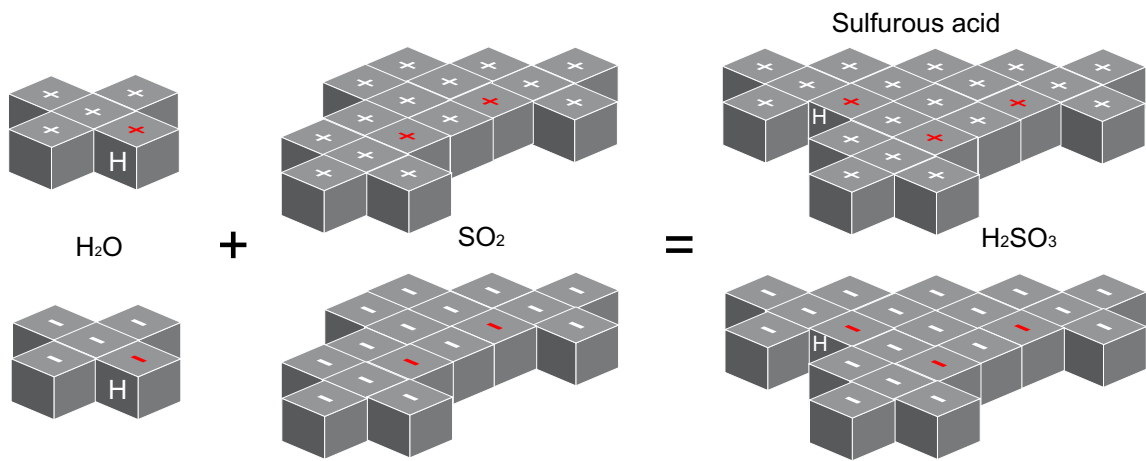


Magnesium sulfate



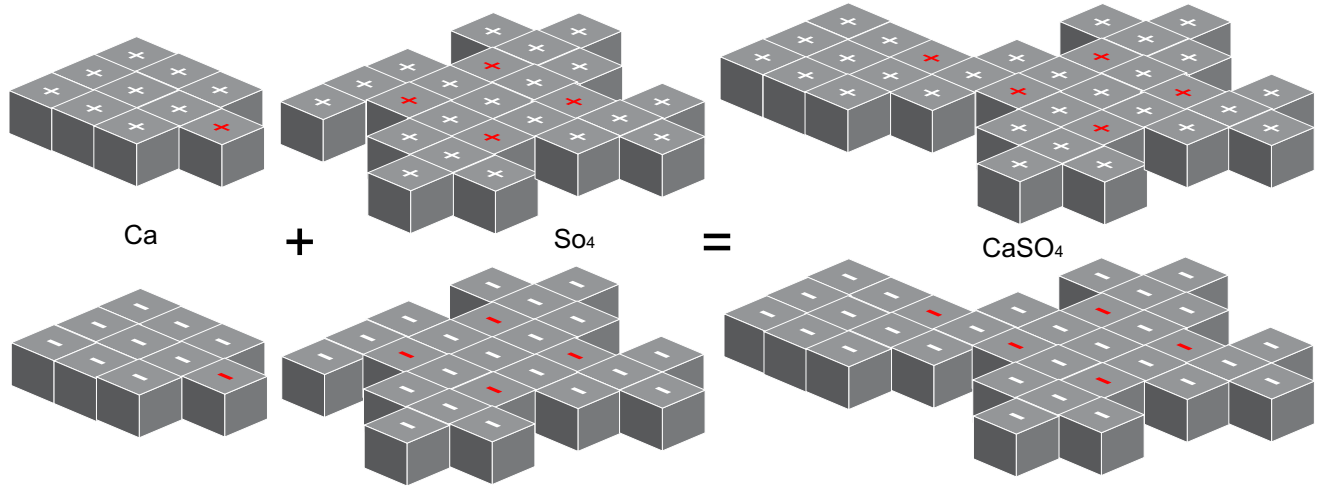
sodium hydrogen sulfate





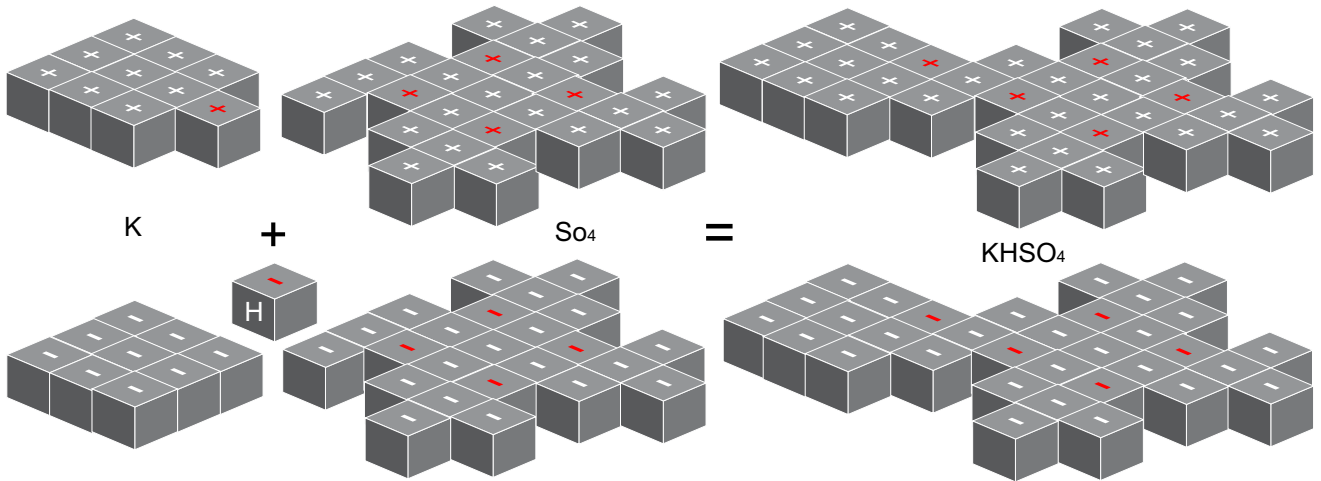
Molecule Cubic Structure

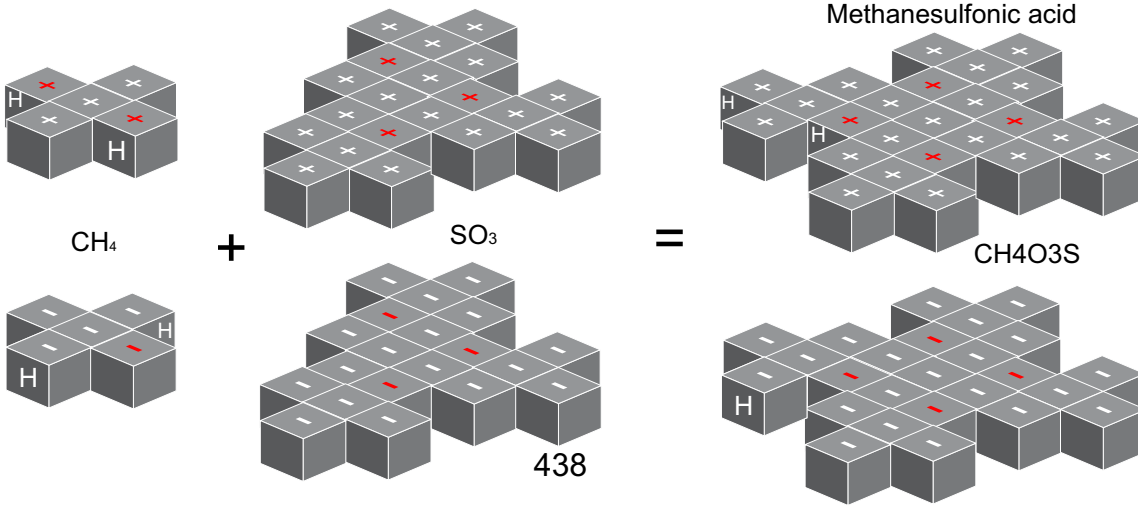
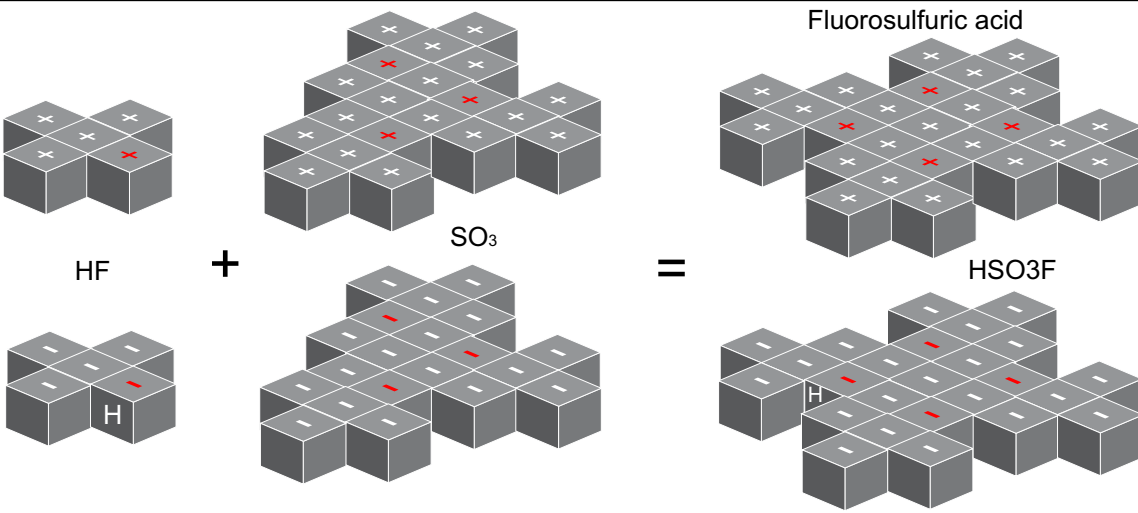
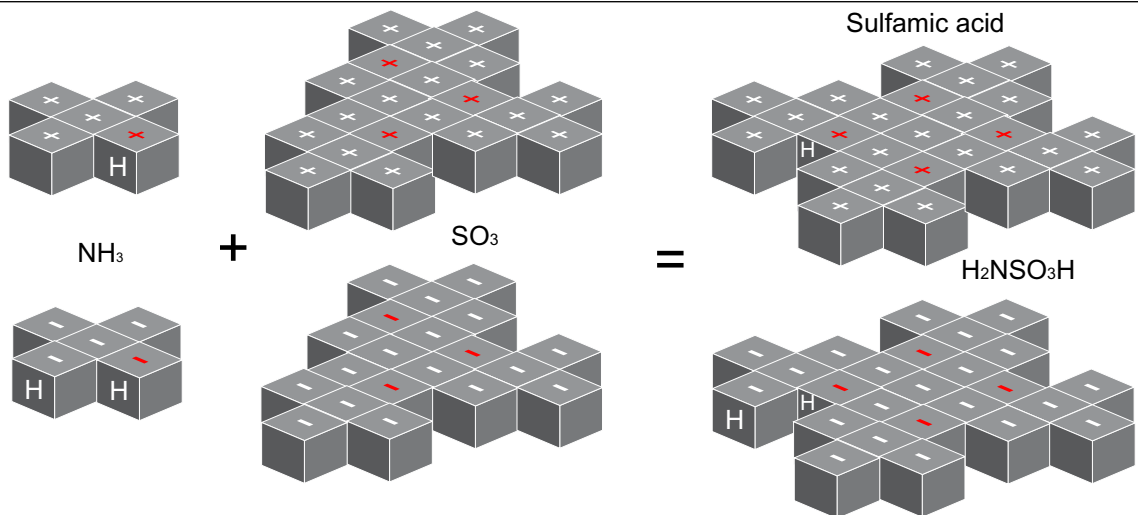
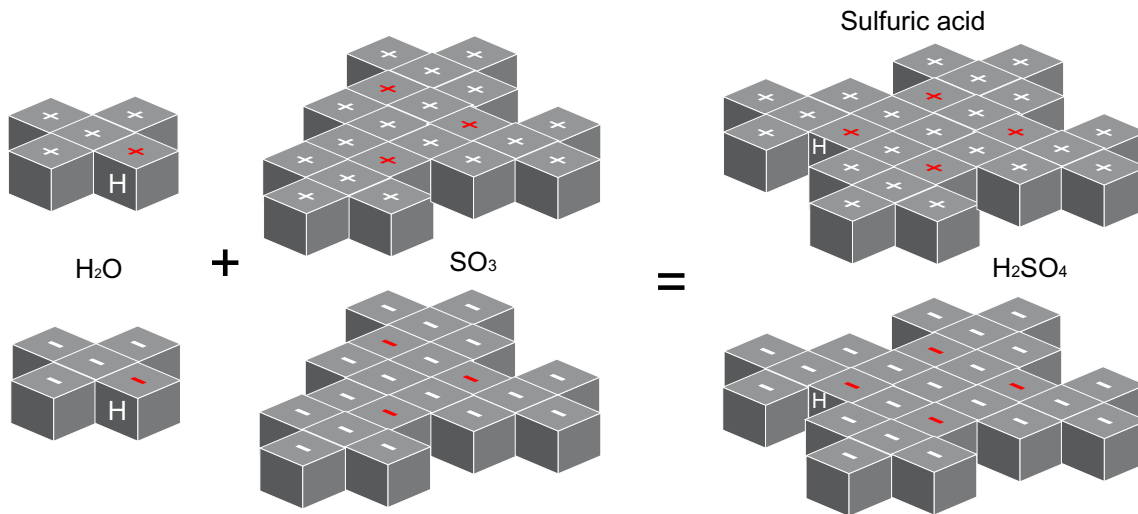
Calcium sulfate



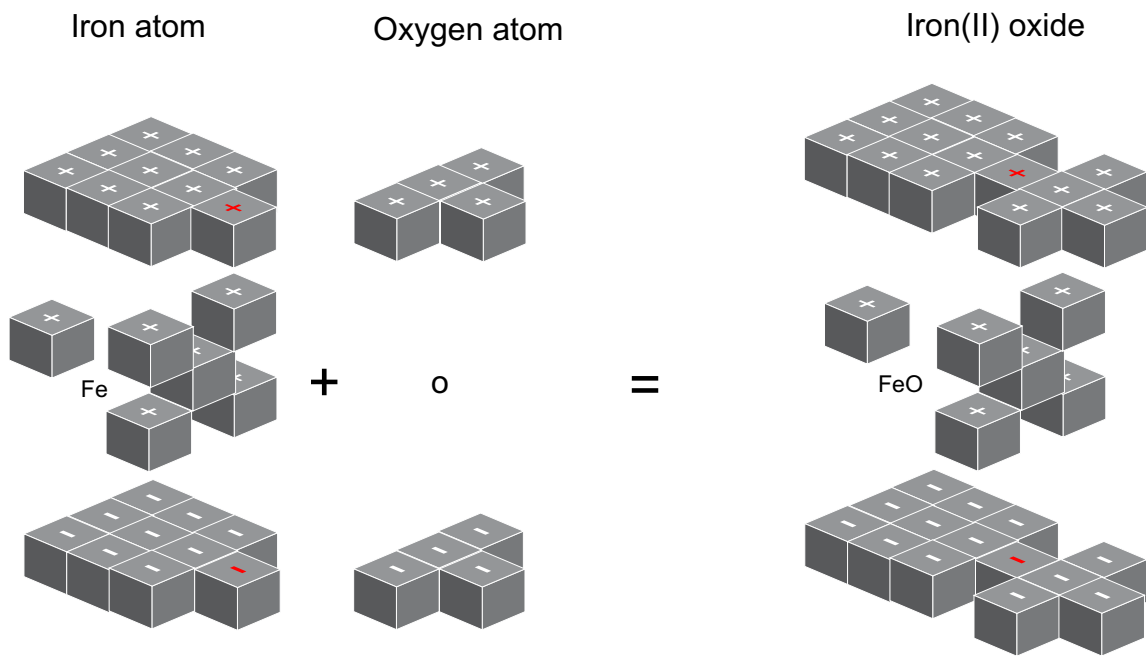
Potassium atom

Potassium bisulfate

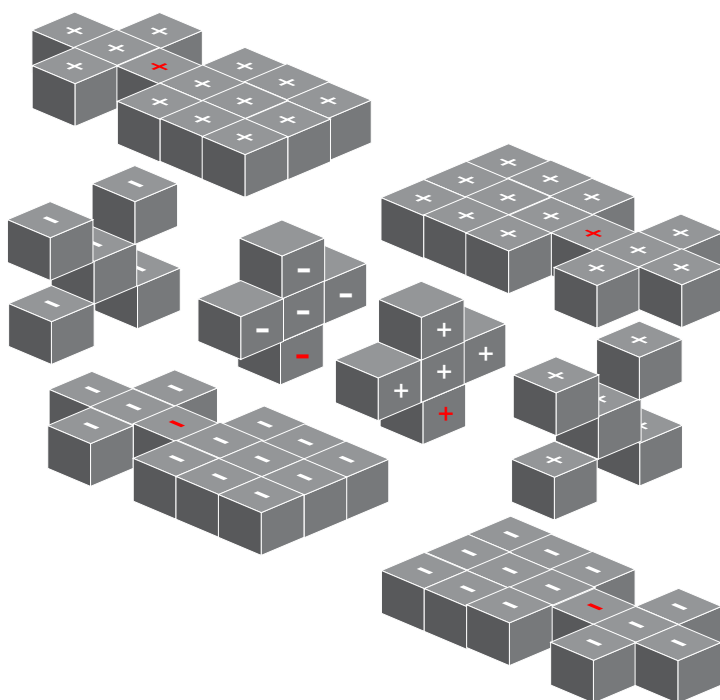




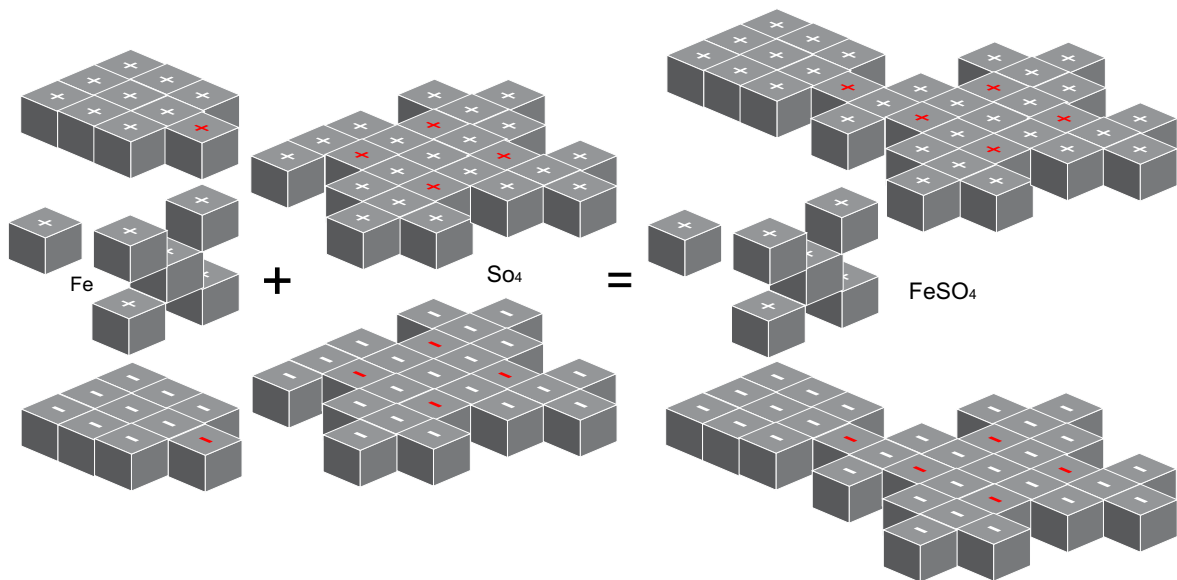
Molecule Cubic Structure



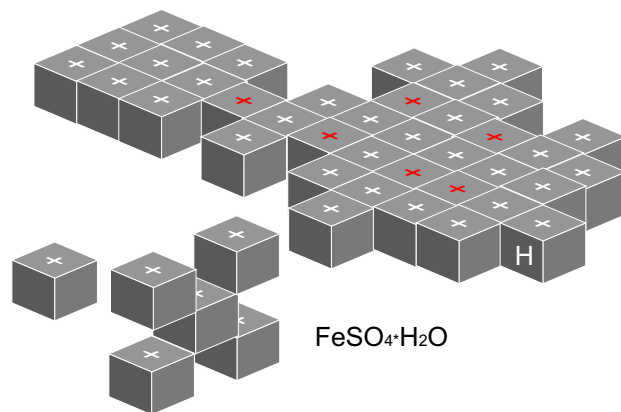
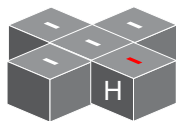
Iron(III) oxide Fe_2O_3



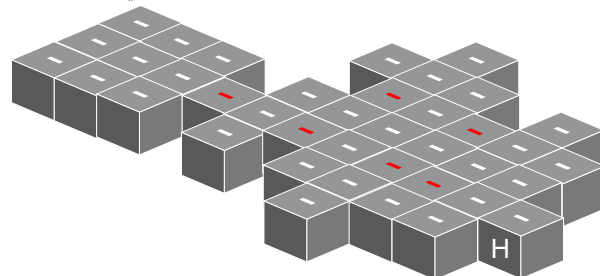
Molecule Cubic Structure



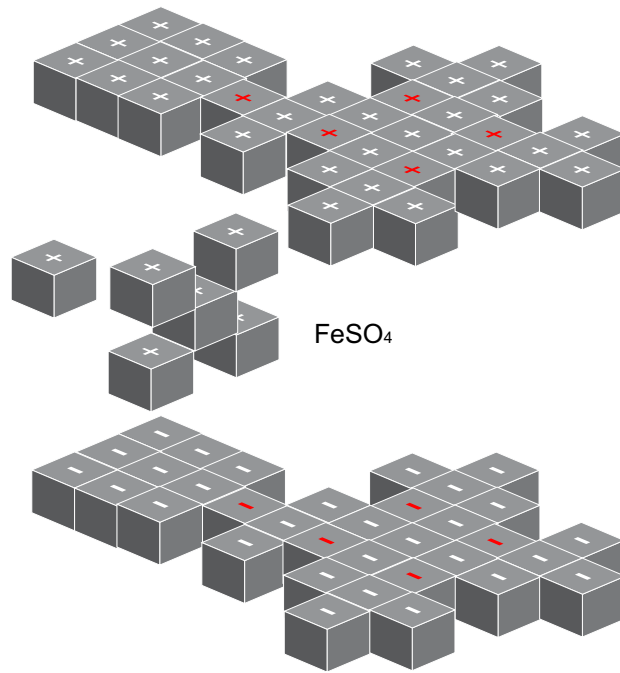
H_2O



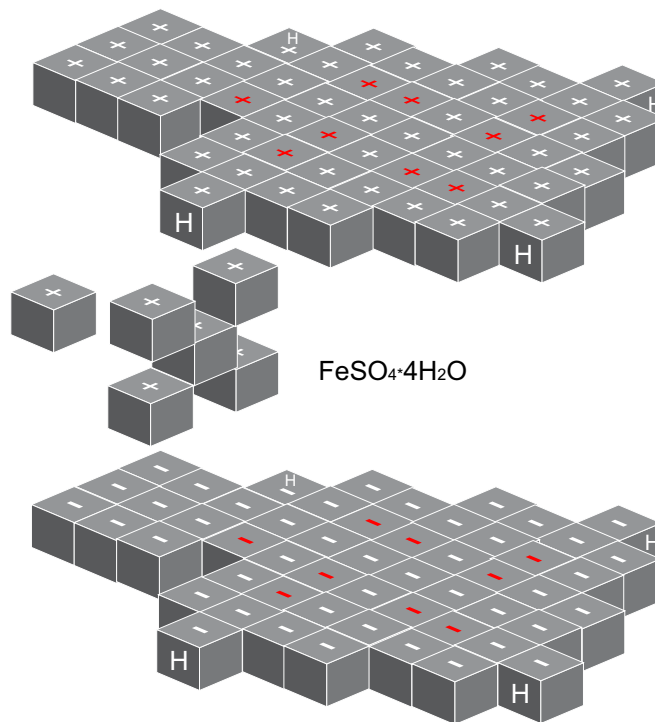
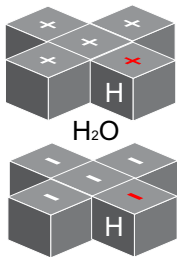
$\text{FeSO}_4 \cdot \text{H}_2\text{O}$



Molecule Cubic Structure



Water molecule



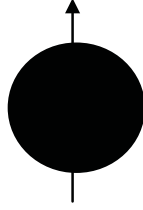
Nuclide structure conclusion

In this book, we have listed more than 500 nuclear structure diagrams, including all the stable nuclides and call the 118 elements.

This is a summary of the nuclear structure in this book:

1. Neutrons and protons act as unit cube to form cubic nucleus.
2. Inside the nucleus, the proton can be only located on the nucleus surface.
3. Inside the nucleus, most neutrons form the kernel of the nucleus, which is called the kernel neutron. Some neutrons may be located on the nucleus surface, which is called the surface neutron.
4. Inside the nucleus, the spin of the neutron and proton has only two options, up or down.
5. The nucleus has a layered structure, the layer perpendicular to their spin direction.
6. Inside the nucleus, when the number of the kernel neutron is greater than 18 and the center cubic unit of the nucleus is empty, then the layer with the empty cube unit is called hollow layer, and all the other layers are called solid layers.
7. From the first to the third element period, the proton is located only at the top and bottom of the nucleus. From the fourth period, the proton starts to distribute on the four side of the cube nucleus (front and back, left and right)
8. At the top or bottom of the nucleus, except one center proton, all the protons have the same spin direction; the spin of the center proton can be either up or down.
9. Except the center proton, the spin of top layer proton is always contrary to the spin of bottom layer proton.
10. On the four side of the nucleus (not include the top and bottom), all protons have the same spin direction
11. Inside the nucleus, on the hollow layer, except of innermost or outermost neutron, all the neutrons have the same spin direction, the spin of the innermost or outermost neutrons can be either up or down.
12. Inside the nuclide, on the solid layer, except the one center nucleon, all other neutrons have the same spin direction; the spin of the center nucleon can be either up or down.

The electron point model



The electron has four basic parameters, which are: one unit negative electric charge $-e$, half spin $\frac{\hbar}{2}$, electron self energy $m_e c^2$, and also electron magnetic moment μ .

The simplest electromagnetic model of the electron is shown below:

$$\vec{E} = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \hat{r} \quad (1)$$

$$\vec{H} = -\frac{\mu}{4\pi} \frac{1}{r^3} (\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta) \quad (2)$$

Where the electron's electric field is the point charge field, the electron's magnetic field is the magnetic dipole field, μ is the electron magnetic moment.

Based on the above two equations, we can see that the electric field has a spherical distribution, but the magnetic field does not have a spherical distribution.

In this model when $r \rightarrow 0$, both electric field strength and magnetic field strength become infinity, at the point $r = 0$, it has the singularity problem.

Electron's electric point charge field

As we know, the electron has one unit electric charge and its own intrinsic electric field. The simplest model for the electron's electric field is the point charge model; electric charge only at the electron center $r = 0$. Based on the point charge model, the electron's electric field equation is shown below:

$$\vec{E} = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \hat{r} \quad (3)$$

Where e is the electric charge unit.

As we can see in the above equation, the electric field strength E becomes infinity when $r \rightarrow 0$, electric field has a singularity when $r = 0$.

We can find out that the electric field in the electron's point charge model has a spherical symmetry. The electric energy density is:

$$u_e = \frac{1}{2} \epsilon_0 E^2 \quad (4)$$

Thus we can get the electron's electric field energy density as follows:

$$u_e = \frac{e^2}{32\pi^2 \epsilon_0 r^4} \quad (5)$$

Let us calculate the electric field energy outside the sphere of radius r , which is:

$$U_e = \int_r^\infty \frac{e^2}{32\pi^2 \epsilon_0 r^4} dv \quad (6)$$

$$U_e = \int_r^\infty \frac{e^2}{32\pi^2 \epsilon_0 r^4} 4\pi r^2 dr \quad (7)$$

$$U_e = \frac{e^2}{8\pi\epsilon_0} \int_r^\infty \frac{1}{r^2} dr \quad (8)$$

$$U_e = -\frac{e^2}{8\pi\epsilon_0} \int_r^\infty d\frac{1}{r} \quad (9)$$

Thus, outside the sphere of radius r , the total electric energy is:

$$U_e = \frac{e^2}{8\pi\epsilon_0 r} \quad (10)$$

When $r \rightarrow 0$

Then $U_e \rightarrow \infty$

From the above the electron's total electric field energy based on the point charge model becomes infinity.

Electron's magnetic dipole field

The electron has the magnetic dipole moment, the electron act like a small magnet; the simplest model for the electron's magnetic field is the magnetic dipole field model For the magnetic dipole field, the equation is as follows:

$$\vec{H} = -\frac{\mu}{4\pi} \frac{1}{r^3} (\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta) \quad (11)$$

Where μ is the electron magnetic moment, \vec{H} is the electron's magnetic field strength.

Based on the above equation, when $r \rightarrow 0$, the magnetic field strength becomes infinity, the point $r = 0$ has magnetic singularity.

The divergence of magnetic field in spherical reference is as follows:

$$\nabla \cdot \vec{H} = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 H_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta H_\theta) + \frac{1}{r \sin \theta} \frac{\partial H_\varphi}{\partial \varphi} \quad (12)$$

Where

$$H_r = -\frac{\mu}{4\pi} \frac{1}{r^3} 2 \cos \theta \quad (13)$$

$$H_\theta = -\frac{\mu}{4\pi} \frac{1}{r^3} \sin \theta \quad (14)$$

$$\nabla \cdot \vec{H} = \frac{\mu}{4\pi} \frac{1}{r^4} 2 \cos \theta - \frac{\mu}{4\pi} \frac{1}{r^4} 2 \cos \theta \quad (15)$$

$$\nabla \cdot \vec{H} = 0 \quad (16)$$

Thus we can see that the magnetic charge density is always kept at zero; so the total magnetic charge of the electron is also zero based on the magnetic dipole field model.

As we know, the magnetic field energy density is:

$$u_m = \frac{1}{2} \mu_0 H^2 \quad (17)$$

The magnetic field energy base on the magnetic dipole field model is:

$$u_m = \frac{1}{2} \mu_0 \frac{\mu^2}{16\pi^2} \frac{1}{r^6} (4 \cos^2 \theta + \sin^2 \theta) \quad (18)$$

$$u_m = \frac{1}{2} \mu_0 \frac{\mu^2}{16\pi^2} \frac{1}{r^6} (1 + 3 \cos^2 \theta) \quad (19)$$

Let us calculate the electron's magnetic field energy outside the sphere of radius r , which is as follows:

$$U_m = \frac{\mu^2 \mu_0}{32\pi^2} \int \frac{1}{r^6} (1 + 3 \cos^2 \theta) dv \quad (20)$$

$$U_m = \frac{\mu^2 \mu_0}{32\pi^2} \int_r^\infty \int_0^\pi \frac{1}{r^6} (1 + 3 \cos^2 \theta) 2\pi r^2 dr \sin \theta d\theta \quad (11)$$

$$U_m = \frac{\mu^2 \mu_0}{16\pi} \int_r^\infty \frac{1}{r^4} dr \int_0^\pi (1 + 3 \cos^2 \theta) \sin \theta d\theta \quad (12)$$

$$U_m = \frac{\mu^2 \mu_0}{4\pi} \int_r^\infty \frac{1}{r^4} dr \quad (13)$$

$$U_m = \frac{\mu^2 \mu_0}{12\pi} \frac{1}{r^3} \quad (14)$$

This is the electron's magnetic energy outside the sphere of radius r .

Thus, when $r \rightarrow 0$

$$U_m \rightarrow \infty \quad (15)$$

The total magnetic field energy becoming infinity is based on the magnetic dipole field model.

Similar to the electron's point charge model, the magnetic dipole model of the electron's magnetic fields also has the singularity problem.

The electron's electromagnetic field energy

The electron's electric field energy outside sphere of radius r based on the point charge model is as follows:

$$U_e = \frac{e^2}{8\pi\epsilon_0 r} \quad (16)$$

The electron's magnetic field energy outside sphere of radius r based on the dipole field model is:

$$U_m = \frac{\mu_0 \mu^2}{12\pi} \frac{1}{r^3} \quad (17)$$

So the electromagnetic field energy outside sphere of radius r is as follows:

$$U = U_e + U_m \quad (18)$$

Where:

$$U(r) = \frac{e^2}{8\pi\epsilon_0 r} + \frac{\mu^2 \mu_0}{12\pi} \frac{1}{r^3} \quad (19)$$

From the above, when $r \rightarrow 0$, then the total electromagnetic field energy of the electron becomes infinity.

Let us calculate the radius r in which the electromagnetic field energy equates to electron's self energy

$$U(r) = m_e c^2 \quad (20)$$

Thus

$$\frac{e^2}{8\pi\epsilon_0 r} + \frac{\mu^2 \mu_0}{12\pi} \frac{1}{r^3} = m_e c^2 \quad (21)$$

$$\frac{r_0}{2r} + \frac{\mu^2 \mu_0}{12\pi m_e c^2} \frac{1}{r^3} = 1 \quad (22)$$

Where $r_0 = \frac{e^2}{4\pi\epsilon_0 m_e c^2}$ is the electron's classical radius.

The electron magnetic moment is as follows:

$$\mu = j_e \mu_B \quad (23)$$

$$\mu_B = \frac{e\hbar}{2m_e} \quad (24)$$

$$j_e = -1.00115965218111$$

Thus

$$\frac{r_0}{2r} + \frac{\mu^2 \mu_0}{12\pi m_e c^2} \frac{1}{r^3} = 1 \quad (25)$$

$$\frac{r_0}{2r} + \left(j_e \frac{e\hbar}{2m_e}\right)^2 \frac{\mu_0}{12\pi m_e c^2} \frac{1}{r^3} = 1 \quad (26)$$

$$\frac{r_0}{2r} + (2j_e)^2 \frac{e^2 \hbar^2}{192m_e^3 \epsilon_0 \pi c^4} \frac{1}{r^3} = 1 \quad (27)$$

$$\frac{r_0}{2r} + \frac{2}{3} \frac{j_e^2}{\alpha^2} \left(\frac{r_0}{2r}\right)^3 = 1 \quad (28)$$

We can get the solution as:

$$\frac{r_0}{2r} \approx 0.0424234 \quad (29)$$

$$r \approx 11.7859 r_0 \quad (30)$$

This is the radius value in which the electromagnetic field energy outside of sphere of radius r is equal to electron's self energy.

The electron's electromagnetic field angular momentum

The electron not only has self-energy, it also has electron spin, which is the electron intrinsic angular momentum. What is the origin of the electron spin? As the electromagnetic field can carry angular momentum, is it possible that the electron's electromagnetic field carry angular momentum? Furthermore, is it possible that the electron spin has an electromagnetic origin?

The electromagnetic field angular momentum density is defined as:

$$\xi = \frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) \quad (31)$$

Based on the point model of electron's electromagnetic field:

$$\vec{E} = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \hat{r} \quad (32)$$

$$\vec{H} = -\frac{\mu}{4\pi} \frac{1}{r^3} (\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta) \quad (33)$$

Let us calculate its electromagnetic angular momentum density:

$$\vec{\xi} = \frac{1}{c^2} \frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \frac{\mu}{4\pi} \frac{r}{r^3} \hat{r} \times \hat{\phi} \quad (34)$$

$$\vec{\xi} = \frac{1}{c^2} \frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \frac{\mu}{4\pi} \frac{r}{r^3} \hat{r} \times \hat{\phi} \quad (35)$$

Thus

$$\vec{\xi} = -\frac{1}{c^2} \frac{e\mu}{16\pi^2 \epsilon_0} \frac{1}{r^4} \hat{\theta} \quad (36)$$

$$\xi_\rho = -\frac{e\mu_0\mu}{16\pi^2} \frac{1}{r^4} \cos \theta \quad (37)$$

$$\xi_z = \frac{e\mu_0\mu}{16\pi^2} \frac{1}{r^4} \sin \theta \quad (38)$$

Due to the symmetry of the ρ direction, the total ρ direction component of angular momentum becomes zero.

The z component of angular momentum is as follows:

$$L_z = \int \frac{e\mu_0\mu}{16\pi^2} \frac{1}{r^4} \sin \theta dv \quad (39)$$

$$L_z = \int \frac{e\mu_0\mu}{16\pi^2} \frac{1}{r^4} \sin \theta 2\pi r^2 dr \sin \theta d\theta \quad (40)$$

$$L_z = \frac{e\mu_0\mu}{8\pi} \int \frac{1}{r^2} dr \sin^2 \theta d\theta \quad (41)$$

The total angular momentum outside the sphere of radius r is as follows:

$$L_z = \frac{e\mu_0\mu}{16} \int_r^\infty \frac{1}{r^2} dr \quad (42)$$

$$L_z = -\frac{e\mu_0\mu}{16} \int_r^\infty d \frac{1}{r} \quad (43)$$

$$L_z = \frac{e\mu_0\mu}{16r} \quad (44)$$

When $r \rightarrow 0$

Then

$$L_z \rightarrow \infty \quad (45)$$

The angular momentum of the electron's electromagnetic field becomes infinity.

Let us calculate the radius r in which the outside sphere of radius r , the electromagnetic field angular momentum equals to electron spin value, which is:

$$L_z = \frac{e\mu_0\mu}{16r} \quad (46)$$

$$L_z = \frac{\hbar}{2} \quad (47)$$

Then we have

$$r = \frac{e\mu_0\mu}{8\hbar} \quad (48)$$

We know the Bohr magnetic moment is:

$$\mu_B = \frac{e\hbar}{2m_e} \quad (49)$$

And the electron magnetic moment value is:

$$\mu = j_e \mu_B \quad (50)$$

$$\mu = j_e \frac{e\hbar}{2m_e} \quad (51)$$

Then

$$r = \frac{e\mu_0}{8\hbar} j_e \mu_B \quad (52)$$

$$r = \frac{e\mu_0}{8\hbar} j_e \frac{e\hbar}{2m_e} \quad (53)$$

$$r = j_e \frac{e^2 \mu_0}{16m_e} \quad (54)$$

$$r = j_e \frac{e^2}{16m_e \epsilon_0 c^2} \quad (55)$$

Furthermore, the classical electron radius is:

$$r_0 = \frac{e^2}{4\pi\epsilon_0 m_e c^2} \quad (56)$$

Thus

$$r = \pi \frac{j_e e^2}{4 * 4\pi\epsilon_0 m_e c^2} \quad (57)$$

$$r = j_e \frac{\pi}{4} r_0 \quad (58)$$

$$r \approx 0.7859 r_0 \quad (59)$$

This is the radius in which the electromagnetic field angular momentum outside the sphere of radius r is equal to electron spin.

Electron electromagnetic model

As we know, for the electron point model, there are singularity problems. In order to avoid the singularity problem, let us assume that the electron electromagnetic model is as follows:

$$\vec{E} = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a}{r}\right) \hat{r}$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_e}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta$$

Where e is electron's electric charge unit, μ_e is the electron magnetic moment.

g is the magnetic charge unit defined as:

$$g = \frac{h}{e}$$

Electron Electric charge

Since we know the electric charge density:

$$\nabla \cdot \vec{E} = \frac{\rho_e}{\epsilon_0}$$

Then we have

$$\nabla \cdot \vec{E} = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 E_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta E_\theta) + \frac{1}{r \sin \theta} \frac{\partial E_\phi}{\partial \phi}$$

$$E_r = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a_e}{r}\right)$$

$$\frac{1}{r^2} \frac{\partial}{\partial r} (r^2 E_r) = -\frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a_e}{r}\right) \right)$$

$$\frac{1}{r^2} \frac{\partial}{\partial r} (r^2 E_r) = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \frac{\partial}{\partial r} \left(\exp\left(-\frac{a_e}{r}\right) \right)$$

$$\frac{1}{r^2} \frac{\partial}{\partial r} (r^2 E_r) = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a_e}{r}\right) \frac{a_e}{r^2}$$

$$\frac{1}{r^2} \frac{\partial}{\partial r} (r^2 E_r) = -\frac{e}{4\pi\epsilon_0} \frac{a_e}{r^4} \exp\left(-\frac{a_e}{r}\right)$$

$$\nabla \cdot \vec{E} = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 E_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta E_\theta) + \frac{1}{r \sin \theta} \frac{\partial E_\phi}{\partial \phi}$$

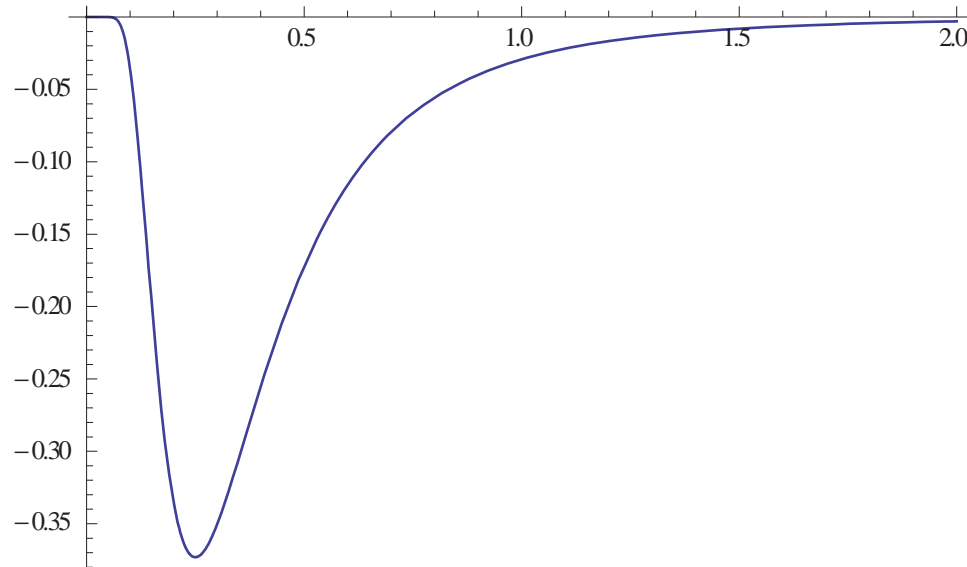
$$\nabla \cdot \vec{E} = -\frac{e}{4\pi\epsilon_0} \frac{a_e}{r^4} \exp\left(-\frac{a_e}{r}\right)$$

Thus we get the electron's electric charge density distribution as:

$$\rho_e = -\frac{e}{4\pi} \frac{a_e}{r^4} \exp\left(-\frac{a_e}{r}\right)$$

X coordinate is the radius with a_e as the distance unit

Y coordinate is the electric charge density with e as the electric charge unit.



The electric charge within the sphere of radius r is as follows:

$$Q_e(r) = -\int_0^r \frac{e}{4\pi} \frac{a_e}{r^4} \exp\left(-\frac{a_e}{r}\right) 4\pi r^2 dr$$

$$Q_e(r) = -e \int_0^r \frac{a_e}{r^2} \exp\left(-\frac{a_e}{r}\right) dr$$

$$Q_e(r) = e \int_0^r \exp\left(-\frac{a_e}{r}\right) d\frac{a_e}{r}$$

$$Q_e(r) = -e \int_0^r d\left[\exp\left(-\frac{a_e}{r}\right)\right]$$

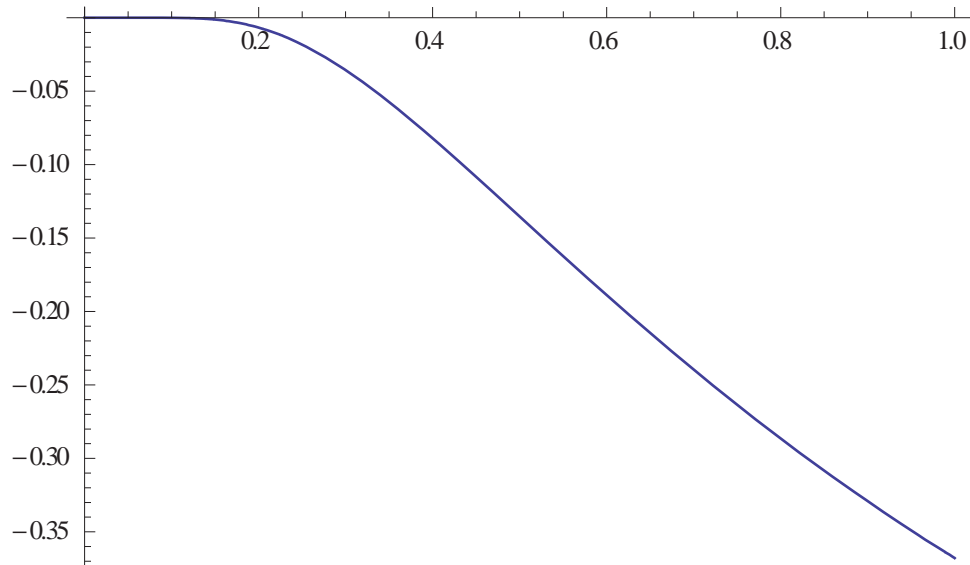
$$Q_e(r) = -e \exp\left(-\frac{a_e}{r}\right) \Big|_0^r$$

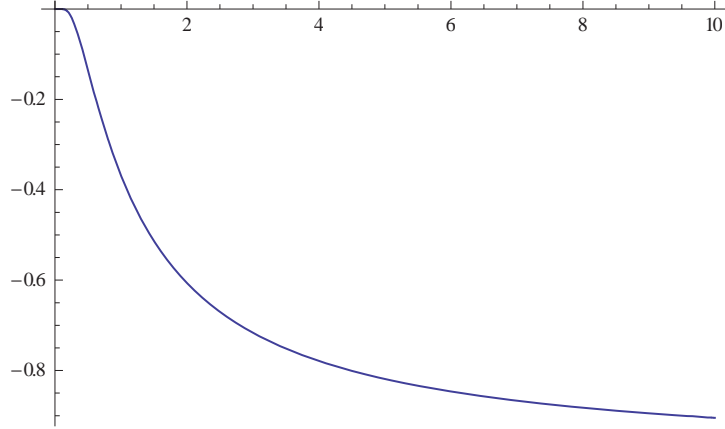
$$Q_e(r) = -e \exp\left(-\frac{a_e}{r}\right)$$

$$\frac{Q_e(r)}{e} = -\exp\left(-\frac{a_e}{r}\right)$$

X coordinate is the radius with a_e as the distance unit

Y coordinate is the electric charge density with e as the electric charge unit.





When $r \rightarrow \infty$

$$Q_e(\infty) = -e$$

The electron as a whole has one unit negative electric charge.

Electron Magnetic Charge

Given the magnetic charge density is:

$$\nabla \cdot \vec{H} = \frac{\rho_m}{\mu_0}$$

$$\nabla \cdot \vec{H} = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 H_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta H_\theta) + \frac{1}{r \sin \theta} \frac{\partial H_\phi}{\partial \phi}$$

Then the electron magnetic charge is as the following

$$Q_m(r, \theta) = \int_0^r \int_0^\theta \rho_m 2\pi \sin \theta d\theta r^2 dr$$

$$\rho_m = \mu_0 \nabla \cdot \vec{H}$$

$$Q_m(r, \theta) = \mu_0 \int_0^r \int_0^\theta \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta H_\theta) 2\pi \sin \theta d\theta r^2 dr$$

$$H_\theta = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \sin \theta$$

$$Q_m(r, \theta) = \mu_0 \int_0^r \int_0^\theta \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \sin \theta \right) 2\pi \sin \theta d\theta r^2 dr$$

$$Q_m(r, \theta) = 2\pi\mu_0 \int_0^r \frac{3ga}{4\pi\mu_0} \frac{1}{r^2} \exp\left(-\frac{a}{r}\right) dr \int_0^\theta \frac{\partial}{\partial \theta} (\sin^2 \theta) d\theta$$

$$Q_m(r, \theta) = 2\pi\mu_0 \int_0^r \frac{3ga}{4\pi\mu_0} \frac{1}{r^2} \exp\left(-\frac{a}{r}\right) dr \sin^2 \theta$$

$$Q_m(r, \theta) = 2\pi\mu_0 \frac{3g}{4\pi\mu_0} \sin^2 \theta \int_0^r \frac{a}{r^2} \exp\left(-\frac{a}{r}\right) dr$$

$$Q_m(r, \theta) = -2\pi\mu_0 \frac{3g}{4\pi\mu_0} \sin^2 \theta \int_0^r \exp\left(-\frac{a}{r}\right) d\frac{a}{r}$$

$$Q_m(r, \theta) = -2\pi\mu_0 \frac{3g}{4\pi\mu_0} \sin^2 \theta \int_0^r \exp\left(-\frac{a}{r}\right) d\frac{a}{r}$$

$$Q_m(r, \theta) = -2\pi\mu_0 \frac{3g}{4\pi\mu_0} \exp\left(-\frac{a}{r}\right) \sin^2 \theta$$

$$Q_m(r, \theta) = -\frac{3g}{2} \exp\left(-\frac{a}{r}\right) \sin^2 \theta$$

The above equation is the magnetic charge distribution equation inside the electron.

When

$$r \rightarrow \infty \text{ and } \theta = \frac{\pi}{2}$$

We get electron magnetic charge of northern hemisphere as:

$$Q_m\left(\infty, \frac{\pi}{2}\right) = -\frac{3g}{2}$$

The electron northern hemisphere has a magnetic charge of $3/2g$

When

$$r \rightarrow \infty \text{ and } \theta = \pi$$

We get

$$Q_m(\infty, \pi) = 0$$

The electron as whole has zero magnetic charge.

The electron's electromagnetic field angular momentum

The electromagnetic field angular momentum density is defined as:

$$\xi = \frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H})$$

Below is the electromagnetic angular momentum:

$$\vec{L} = \int_V \frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) dv$$

Using the electron electromagnetic field equation, we can get the following:

$$\vec{E} \times \vec{H} = -\frac{e}{4\pi\epsilon_0 r^2} \exp\left(-\frac{a}{r}\right) \frac{3ga}{r} \frac{1}{4\pi\mu_0 r^3} \exp\left(-\frac{a}{r}\right) \sin\theta \vec{\varphi}$$

$$\frac{1}{c^2} \vec{E} \times \vec{H} = -\frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^5} \exp\left(-\frac{2a}{r}\right) \sin\theta \vec{\varphi}$$

$$\frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) = -\frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^4} \exp\left(-\frac{2a}{r}\right) \sin\theta \hat{\theta}$$

$$\vec{L} = \int_V \frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) dv$$

$$\vec{L} = L_z \vec{z}$$

$$\left[\frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) \right]_z = -\frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^4} \exp\left(-\frac{2a}{r}\right) \sin^2\theta$$

$$L_z = -3 \int_V \frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^4} \exp\left(-\frac{2a}{r}\right) \sin^2\theta dv$$

$$dv = 2\pi r^2 dr \sin\theta d\theta$$

$$L_z = -3 \int_V \frac{h}{4\pi} \frac{a}{2} \frac{1}{r^2} \exp\left(-\frac{2a}{r}\right) dr \sin^3\theta d\theta$$

$$L_z = 3 \int_V \frac{h}{4\pi} \frac{1}{4} \exp\left(-\frac{2a}{r}\right) d \frac{2a}{r} \sin^3\theta d\theta$$

$$L_z = 3 \frac{4}{3} \int_V \frac{h}{4\pi} \frac{1}{4} \exp\left(-\frac{2a}{r}\right) d \frac{2a}{r}$$

$$L_z = \int_V \frac{h}{4\pi} \exp\left(-\frac{2a}{r}\right) d \frac{2a}{r}$$

$$L_z = \frac{h}{4\pi}$$

$$L_z = \frac{\hbar}{2}$$

Based on our electron model, the electron always has half spin, the electron spin has an electromagnetic origin and the electron spin is the electromagnetic field angular moment.

Electron's magnetic moment

The potential energy of the electron magnetic moment in a z direction magnetic field is as follows:

$$U_+ = -\mu_0\mu_z H$$

The potential energy of the electron magnetic moment in a negative z direction magnetic field is as follows:

$$U_- = \mu_0\mu_z H$$

Thus we have

$$\Delta U = U_+ - U_-$$

$$\Delta U = -2\mu\mu_0 H$$

As we also know:

$$U_+ = \frac{1}{2}\mu_0 \int (H_z + H)^2 dv$$

$$U_- = \frac{1}{2}\mu_0 \int (H_z - H)^2 dv$$

$$\Delta U = U_+ - U_-$$

$$U_+ - U_- = \frac{1}{2}\mu_0 \int 4H_z H dv$$

$$U_+ - U_- = 2\mu_0 H \int H_z dv$$

$$-2\mu\mu_0 H = 2\mu_0 H \int H_z dv$$

$$\mu_z = -\int H_z dv$$

Thus we can get the electron magnetic moment as

$$\vec{\mu} = -\int \vec{H} dv$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r}2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_e}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta$$

$$\vec{\mu} = -\mu_z \vec{z}$$

$$\mu_z = -\int H_z dv$$

As we know

$$(\hat{r}2 \cos \theta + \hat{\theta} \sin \theta)_z = 2 \cos^2 \theta - \sin^2 \theta$$

When

$$\int_0^\pi (2 \cos^2 \theta - \sin^2 \theta) \sin \theta d\theta = 0$$

Then

$$\mu_z = -\int \frac{3\mu_e}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta dv$$

$$\mu_z = -\mu_e \int \frac{3}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta dv$$

$$dv = 2\pi r^2 dr \sin \theta d\theta$$

$$\mu_z = -\mu_e \int \frac{3}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \cos^2 \theta 2\pi r^2 dr \sin \theta d\theta$$

$$\mu_z = -\mu_e \int \frac{3}{2} \frac{1}{r^2} a \exp\left(-\frac{a}{r}\right) dr \cos^2 \theta \sin \theta d\theta$$

$$\mu_z = \mu_e \int \frac{3}{2} \exp\left(-\frac{a}{r}\right) d \frac{a}{r} \cos^2 \theta \sin \theta d\theta$$

$$\mu_z = \mu_e \int_0^\infty \int_0^\pi \frac{3}{2} \exp\left(-\frac{a}{r}\right) d \frac{a}{r} \cos^2 \theta \sin \theta d\theta$$

$$\mu_z = \mu_e \int_0^\infty \int_0^\pi \frac{3}{2} \exp\left(-\frac{a}{r}\right) d \frac{a}{r} \cos^2 \theta \sin \theta d\theta$$

$$\mu_z = \mu_e \int_0^\pi \frac{3}{2} \cos^2 \theta \sin \theta d\theta$$

Thus

$$\mu_z = \mu_e$$

Electron's Electric field energy

The electric field energy density is as follows:

$$u_e = \frac{1}{2} \epsilon_0 E^2$$

$$U_e = \int \frac{1}{2} \epsilon_0 E^2 dv$$

$$\vec{E} = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a_e}{r}\right) \hat{r}$$

$$U_e = \frac{1}{2} \epsilon_0 \frac{e^2}{(4\pi\epsilon_0)^2} \int_0^r \frac{1}{r^4} \exp\left(-\frac{2a}{r}\right) 4\pi r^2 dr$$

$$U_e = \frac{1}{2} \frac{e^2}{(4\pi\epsilon_0)} \int_0^r \frac{1}{r^2} \exp\left(-\frac{2a}{r}\right) dr$$

$$U_e = -\frac{e^2}{8\pi\epsilon_0} \int_0^r \exp\left(-\frac{2a}{r}\right) d\frac{1}{r}$$

$$U_e = -\frac{e^2}{8\pi\epsilon_0 2a} \int_0^r \exp\left(-\frac{2a}{r}\right) d\frac{2a}{r}$$

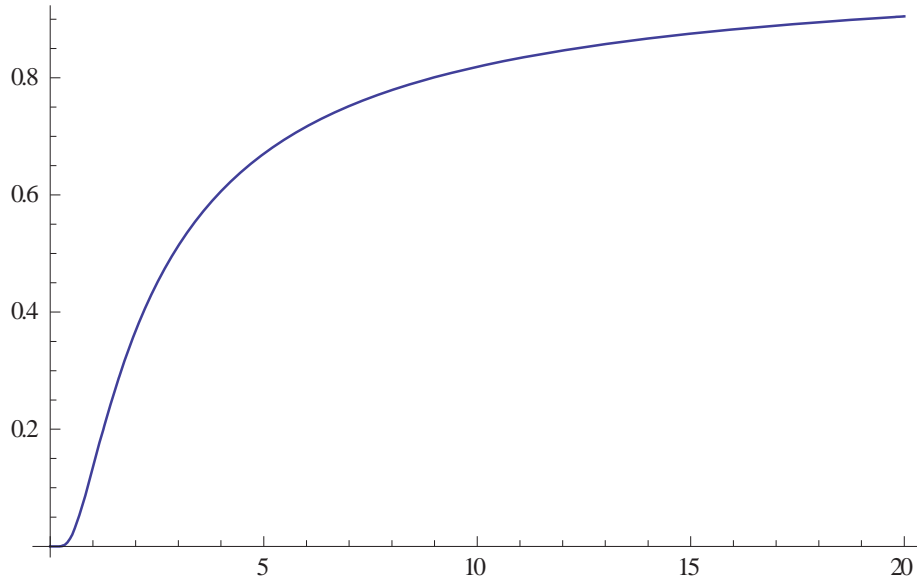
$$U_e = \frac{e^2}{16\pi\epsilon_0 a} \int_0^r \exp\left(-\frac{2a}{r}\right) d\left(-\frac{2a}{r}\right)$$

$$U_e(r) = \frac{e^2}{16\pi\epsilon_0 a} \exp\left(-\frac{2a}{r}\right)$$

X coordinate is the radius with a as the distance unit

Y coordinate is the electric energy with $\frac{e^2}{16\pi\epsilon_0 a}$ as the energy unit.

$$U_e(r) = \frac{e^2}{16\pi\epsilon_0 a} \exp\left(-\frac{2a}{r}\right)$$



When

$$r \rightarrow \infty$$

We can get electron's total electric field energy as

$$U_e(\infty) = \frac{e^2}{16\pi\epsilon_0 a}$$

Think of the electron as a capacitor C, thus we have

$$U_e(\infty) = \frac{e^2}{2C}$$

From the above, we get the electron capacitor as

$$C = 8\pi\epsilon_0 a$$

Electron's magnetic field energy

The magnetic field energy density is:

$$u_m = \frac{1}{2} \mu_0 H^2$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r}2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_e}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta$$

$$a_0 = a_e = \frac{\hbar}{m_e c \alpha}$$

$$\mu_e = j_e \mu_B$$

$$j_e = -1.00115965218111$$

$$\mu_B = \frac{e\hbar}{2m}$$

$$\frac{3\mu a}{4\pi} = \frac{ga}{4\pi\mu_0} 3j_e \frac{\hbar\alpha}{mc}$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r}2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3ga}{4\pi\mu_0} j_e \frac{\alpha\hbar}{mc} \frac{1}{r^4} \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r}2 \cos \theta + \hat{\theta} \sin \theta + j_e \frac{\hbar\alpha}{mc} \frac{1}{r} \hat{r} \cos \theta\}$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r} \cos \theta [2 + j_e \frac{\hbar\alpha}{mc} \frac{1}{r}] + \hat{\theta} \sin \theta\}$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r} \cos \theta [2 + j_e \frac{\hbar\alpha}{mc} \frac{1}{r}] + \hat{\theta} \sin \theta\}$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r} \cos \theta [2 + j_e \alpha^2 \frac{a_0}{r}] + \hat{\theta} \sin \theta\}$$

The electron's magnetic field energy is as the following

$$U_m = \int \frac{1}{2} \mu_0 H^2 dv$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{(\hat{r} \cos \theta (2 + j_e \frac{\alpha\hbar}{mc} \frac{1}{r}) + \hat{\theta} \sin \theta)\}$$

$$H^2 = \left(\frac{3ga}{4\pi\mu_0}\right)^2 \frac{1}{r^6} \exp\left(-\frac{2a}{r}\right) \{(2 + j_e \frac{\alpha\hbar}{mc} \frac{1}{r})^2 \cos^2 \theta + \sin^2 \theta\}$$

$$dv = 2\pi r^2 dr \sin \theta d\theta$$

$$U = \int \frac{1}{2} \mu_0 H^2 dv$$

$$U = \frac{1}{2} \mu_0 \left(\frac{3ga}{4\pi\mu_0}\right)^2 \int \frac{1}{r^6} \exp\left(-\frac{2a}{r}\right) [(2 + j_e \frac{\alpha\hbar}{mc} \frac{1}{r})^2 \cos^2 \theta + \sin^2 \theta] 2\pi r^2 dr \sin \theta d\theta$$

$$U = \frac{1}{2} \mu_0 \left(\frac{3ga}{4\pi\mu_0} \right)^2 2\pi \int \frac{1}{r^6} \exp\left(-\frac{2a}{r}\right) dr \left[\left(2 + j_e \frac{\alpha\hbar}{mc} \frac{1}{r} \right)^2 \cos^2 \theta + \sin^2 \theta \right] \sin \theta d\theta$$

$$U = \frac{1}{2} \mu_0 \left(\frac{3ga}{4\pi\mu_0} \right)^2 \int \frac{1}{r^4} \exp\left(-\frac{2a}{r}\right) 2\pi dr \left[\left(2 + j_e \frac{\alpha\hbar}{mc} \frac{1}{r} \right)^2 \cos^2 \theta + \sin^2 \theta \right] \sin \theta d\theta$$

$$U = -\frac{9g^2}{16\pi\mu_0 a} \int \frac{a^2}{r^2} \exp\left(-\frac{2a}{r}\right) d\frac{a}{r} \left[\left(2 + j_e \frac{\alpha\hbar}{mca} \frac{a}{r} \right)^2 \cos^2 \theta + \sin^2 \theta \right] \sin \theta d\theta$$

$$\frac{\alpha\hbar}{mca} = \frac{\alpha\hbar}{mca_0} \frac{a_0}{a} = \alpha^2 \frac{a_0}{a}$$

$$U = -\frac{9g^2}{16\pi\mu_0 a} \int \frac{a^2}{r^2} \exp\left(-\frac{2a}{r}\right) d\frac{a}{r} \left[\left(2 + j_e \alpha^2 \frac{a_0}{a} \frac{a}{r} \right)^2 \cos^2 \theta + \sin^2 \theta \right] \sin \theta d\theta$$

$$U_m = -\frac{9g^2}{16\pi\mu_0 a} \int_0^\infty \int_0^\pi \frac{a^2}{r^2} \exp\left(-\frac{2a}{r}\right) d\frac{a}{r} \left[\left(2 + j_e \alpha^2 \frac{a_0}{a} \frac{a}{r} \right)^2 \cos^2 \theta + \sin^2 \theta \right] \sin \theta d\theta$$

$$U_m = \frac{9g^2}{16\pi\mu_0 a} \int_0^\infty \int_0^\pi x^2 \exp(-2x) dx \left[\left(2 + j_e \alpha^2 \frac{a_0}{a} x \right)^2 \cos^2 \theta + \sin^2 \theta \right] \sin \theta d\theta$$

$$U_m = \frac{9g^2}{16\pi\mu_0 a} \int_0^\pi \left\{ \frac{1}{4} \left[4 + 3j_e \alpha^2 \frac{a_0}{a} \left(2 + j_e \alpha^2 \frac{a_0}{a} \right) \right] \cos^2 \theta + \frac{1}{4} \sin^2 \theta \right\} \sin \theta d\theta$$

$$U_m = \frac{3g^2}{16\pi\mu_0 a} \left\{ \frac{1}{2} \left[4 + 3j_e \alpha^2 \frac{a_0}{a} \left(2 + j_e \alpha^2 \frac{a_0}{a} \right) \right] + 1 \right\}$$

$$U_m = \frac{3g^2}{32\pi\mu_0 a} \left[6 + 3j_e \alpha^2 \frac{a_0}{a} \left(2 + j_e \alpha^2 \frac{a_0}{a} \right) \right]$$

$$U_m = \frac{9g^2}{32\pi\mu_0 a} \left[2 + j_e \alpha^2 \frac{a_0}{a} \left(2 + j_e \alpha^2 \frac{a_0}{a} \right) \right]$$

$$U_m = \frac{9g^2}{32\pi\mu_0 a} \left[1 + \left(1 + j_e \alpha^2 \frac{a_0}{a} \right)^2 \right]$$

This is the electron's magnetic field energy

The electron's electric field energy then becomes

$$U_e = \frac{e^2}{16\pi\epsilon_0 a}$$

So we get the electron's electromagnetic field energy as

$$U = \frac{e^2}{16\pi\epsilon_0 a} + \frac{9g^2}{32\pi\mu_0 a} [1 + (1 + j_e \alpha^2 \frac{a_0}{a})^2]$$

Let us define

$$k = \frac{a}{a_0}$$

Then we have

$$U = \frac{e^2}{16\pi\epsilon_0 k a_0} + \frac{9g^2}{32\pi\mu_0 k a_0} [1 + (1 + j_e \alpha^2 \frac{1}{k})^2]$$

$$U = \frac{m_e c^2 \alpha^2}{4k} + \frac{9m_e c^2}{32k} [1 + (1 + j_e \alpha^2 \frac{1}{k})^2]$$

Let us assume that the electron's mass has an electromagnetic origin, thus we have

$$m_e c^2 = \frac{m_e c^2 \alpha^2}{4k} + \frac{9m_e c^2}{32k} [1 + (1 + j_e \alpha^2 \frac{1}{k})^2]$$

$$1 = \frac{\alpha^2}{4k} + \frac{9}{32k} [1 + (1 + j_e \alpha^2 \frac{1}{k})^2]$$

$$k \approx 0.56246$$

$$a_e \approx 0.56246 a_0$$

For the electron, the ratio of the magnetic energy to the electric field energy is

$$\frac{U_m}{U_e} = \frac{1 - \frac{\alpha^2}{4k}}{\frac{\alpha^2}{4k}} = 42248.4$$

Proton electromagnetic field model

Let us assume that the following is the proton electromagnetic structure:

$$\vec{E} = \frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a}{r}\right) \hat{r}$$

$$\vec{H} = -\frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_p}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta$$

Proton Electric charge

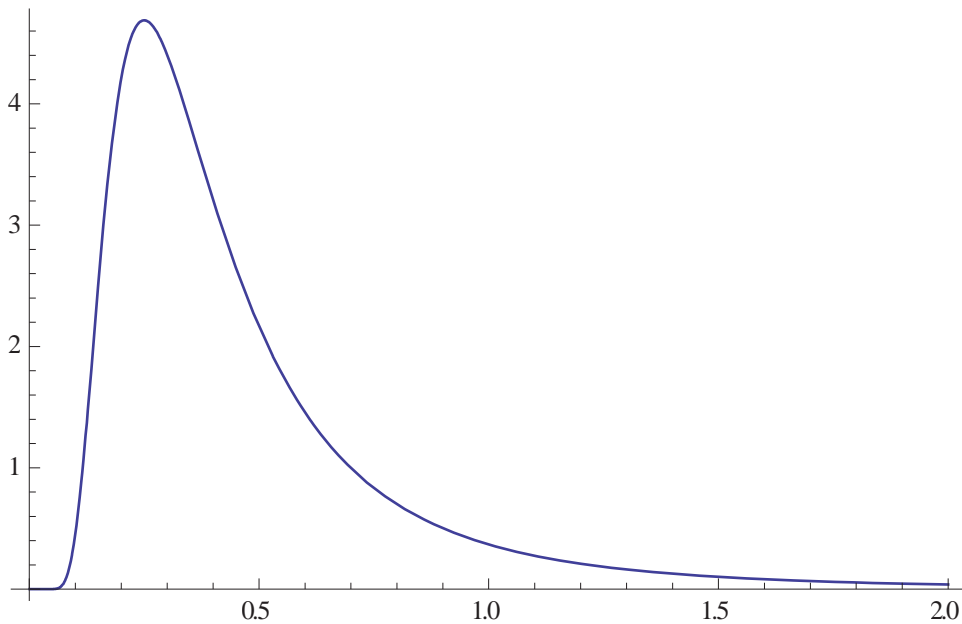
The proton electric charge density distribution is given as:

$$\rho_e = \frac{e}{4\pi} \frac{a_p}{r^4} \exp\left(-\frac{a_p}{r}\right)$$

$$\frac{\rho_e}{e} = \frac{1}{4\pi a_p^3} \left(\frac{a_p}{r}\right)^4 \exp\left(-\frac{a_p}{r}\right)$$

X coordinate is the radius with a_e as the distance unit

Y coordinate is the electric charge density with e as the electric charge unit.



Proton electric charge of radius r sphere distribution

$$Q_e(r) = e \exp\left(-\frac{a_p}{r}\right)$$

Proton Magnetic Charge

Since we know the magnetic charge density is:

$$\nabla \cdot \vec{H} = \frac{\rho_m}{\mu_0}$$

$$\nabla \cdot \vec{H} = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 H_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta H_\theta) + \frac{1}{r \sin \theta} \frac{\partial H_\phi}{\partial \phi}$$

Then the electron magnetic charge becomes

$$Q_m(r, \theta) = \int_0^r \int_0^\theta \rho_m 2\pi \sin \theta d\theta r^2 dr$$

$$\rho_m = \mu_0 \nabla \cdot \vec{H}$$

$$Q_m(r, \theta) = \frac{3g}{2} \exp\left(-\frac{a}{r}\right) \sin^2 \theta$$

When

$$r \rightarrow \infty \text{ and } \theta = \frac{\pi}{2}$$

We get the electron magnetic charge of the northern hemisphere as the following:

$$Q_m\left(\infty, \frac{\pi}{2}\right) = \frac{3g}{2}$$

When

$$r \rightarrow \infty \text{ and } \theta = \pi$$

Then

$$Q_m(\infty, \pi) = 0$$

The proton as a whole has zero magnetic charge

The proton's electromagnetic field angular momentum

$$\vec{L} = \int_v \frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) dv$$

The proton electromagnetic field equation is given as:

$$\frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) = -\frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^4} \exp\left(-\frac{2a}{r}\right) \sin \theta \hat{\theta}$$

$$\vec{L} = \int_v \frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) dv$$

$$\vec{L} = L_z \vec{z}$$

$$L_z = \frac{\hbar}{2}$$

Based on the proton electromagnetic model, the proton always has half spin, the proton spin has electromagnetic origin.

Proton's magnetic moment

The proton magnetic moment is shown below

$$\vec{\mu} = -\int \vec{H} dv$$

$$\vec{H} = -\frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_p}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta$$

$$\vec{\mu} = -\mu_z \vec{z}$$

$$\mu_z = -\int H_z dv$$

$$\mu_z = \mu_p$$

Proton's Electric field energy

The electric field energy density is as the following:

$$u_e = \frac{1}{2} \epsilon_0 E^2$$

$$U_e = \int \frac{1}{2} \epsilon_0 E^2 dv$$

$$\vec{E} = \frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a_p}{r}\right) \hat{r}$$

The total electric energy of sphere of radius r

$$U_e(r) = \frac{e^2}{16\pi\epsilon_0 a} \exp\left(-\frac{2a}{r}\right)$$

When

$$r \rightarrow \infty$$

We can get the proton's total electric field energy as

$$U_e(\infty) = \frac{e^2}{16\pi\epsilon_0 a}$$

Proton's magnetic field energy

The magnetic field energy density is:

$$u_m = \frac{1}{2} \mu_0 H^2$$

$$\vec{H} = -\frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_p}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta$$

$$a_{p0} = \frac{\hbar}{m_p c \alpha}$$

$$\mu_p = j_p \mu_{PB}$$

$$j_p = 2.792847356$$

$$\mu_{BP} = \frac{e\hbar}{2m_p}$$

$$\frac{3\mu a}{4\pi} = \frac{ga}{4\pi\mu_0} 3j_p \frac{\hbar\alpha}{m_p c}$$

$$\vec{H} = -\frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r} \cos \theta [2 + j_p \alpha^2 \frac{a_{p0}}{r}] + \hat{\theta} \sin \theta\}$$

The proton's magnetic field energy then becomes

$$U_m = \int \frac{1}{2} \mu_0 H^2 dv$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0 r^3} \exp\left(-\frac{a}{r}\right) \left\{ (\hat{r} \cos \theta (2 + j_p \frac{\alpha \hbar}{m_p c r}) + \hat{\theta} \sin \theta) \right\}$$

$$U = \int \frac{1}{2} \mu_0 H^2 dv$$

$$U = \frac{1}{2} \mu_0 \left(\frac{3ga}{4\pi\mu_0} \right)^2 \int \frac{1}{r^6} \exp\left(-\frac{2a}{r}\right) [(2 + j_p \frac{\alpha \hbar}{m_p c r})^2 \cos^2 \theta + \sin^2 \theta] 2\pi r^2 dr \sin \theta d\theta$$

$$U_m = -\frac{9g^2}{16\pi\mu_0 a} \int_0^\infty \int_0^\pi \frac{a^2}{r^2} \exp\left(-\frac{2a}{r}\right) d\frac{a}{r} [(2 + j_p \alpha^2 \frac{a_0}{a} \frac{a}{r})^2 \cos^2 \theta + \sin^2 \theta] \sin \theta d\theta$$

$$U_m = \frac{9g^2}{32\pi\mu_0 a} [1 + (1 + j_p \alpha^2 \frac{a_{p0}}{a})^2]$$

If the proton's electric field energy is

$$U_e = \frac{e^2}{16\pi\epsilon_0 a}$$

Then we get the proton's electromagnetic field energy as the following

$$U = \frac{e^2}{16\pi\epsilon_0 a} + \frac{9g^2}{32\pi\mu_0 a} [1 + (1 + j_p \alpha^2 \frac{a_{p0}}{a})^2]$$

Let us define

$$k = \frac{a}{a_{p0}}$$

By substituting k into the above formula, we have

$$U = \frac{e^2}{16\pi\epsilon_0 k a_{p0}} + \frac{9g^2}{32\pi\mu_0 k a_{p0}} [1 + (1 + j_e \alpha^2 \frac{1}{k})^2]$$

$$U = \frac{m_p c^2 \alpha^2}{4k} + \frac{9m_p c^2}{32k} [1 + (1 + j_p \alpha^2 \frac{1}{k})^2]$$

Assuming the proton's mass has an electromagnetic origin, then we have

$$m_p c^2 = \frac{m_p c^2 \alpha^2}{4k} + \frac{9m_p c^2}{32k} [1 + (1 + j_p \alpha^2 \frac{1}{k})^2]$$

$$1 = \frac{\alpha^2}{4k} + \frac{9}{32k} \left[1 + \left(1 + j_p \alpha^2 \frac{1}{k} \right)^2 \right]$$

$$k \approx 0.562662$$

$$a_p = 0.562662 a_{p0}$$

$$a_{p0} = \frac{\hbar}{m c \alpha}$$

For the proton, the ratio of the magnetic energy to the electric field energy is:

$$\frac{U_m}{U_e} = \frac{1 - \frac{\alpha^2}{4k}}{\frac{\alpha^2}{4k}} = 42263.6$$

Neutron electromagnetic model

Let us assume that the following is the neutron electromagnetic structure

$$\vec{E} = \frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \left\{ \exp\left(-\frac{3a_n}{r}\right) - \exp\left(-\frac{a_n}{3r}\right) \right\} \hat{r}$$

$$\vec{H} = \frac{3ga_n}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a_n}{r}\right) \left\{ \hat{r} 2 \cos \theta + \hat{\theta} \sin \theta \right\} + \frac{3\mu_n}{4\pi} \frac{1}{r^4} a_n \exp\left(-\frac{a_n}{r}\right) \hat{r} \cos \theta$$

Neutron Electric charge

The Electric charge density is as follows:

$$\nabla \cdot \vec{E} = \frac{\rho_e}{\epsilon_0}$$

Thus we have

$$\nabla \cdot \vec{E} = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 E_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta E_\theta) + \frac{1}{r \sin \theta} \frac{\partial E_\phi}{\partial \phi}$$

$$E_r = \frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \left\{ \exp\left(-\frac{3a_n}{r}\right) - \exp\left(-\frac{a_n}{3r}\right) \right\}$$

The neutron electric charge density is as follows:

$$\rho_e = \frac{e}{4\pi} \frac{a_n}{r^4} \left\{ 3 \exp\left(-\frac{3a_n}{r}\right) - \frac{1}{3} \exp\left(-\frac{a_n}{3r}\right) \right\}$$

$$\rho_e = \frac{e}{4\pi a_n^3} \left(\frac{a_n}{r}\right)^4 \left\{ 3 \exp\left(-\frac{3a_n}{r}\right) - \frac{1}{3} \exp\left(-\frac{a_n}{3r}\right) \right\}$$

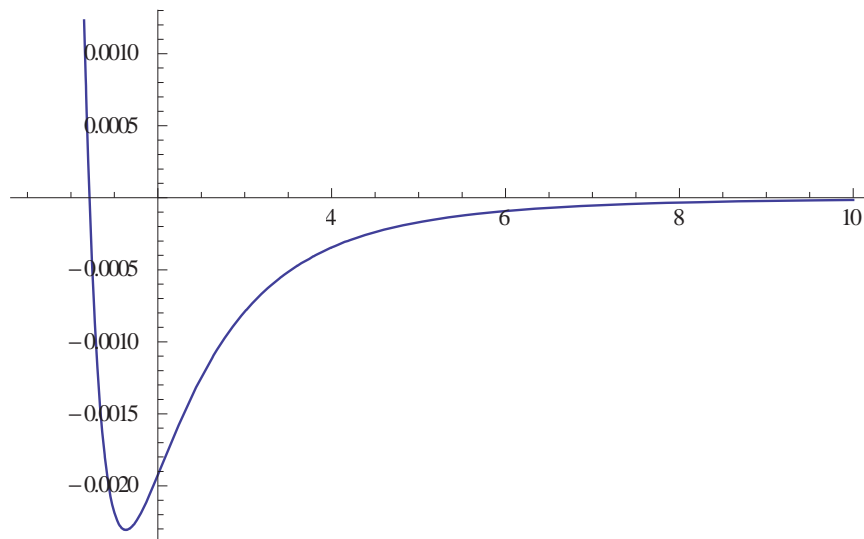
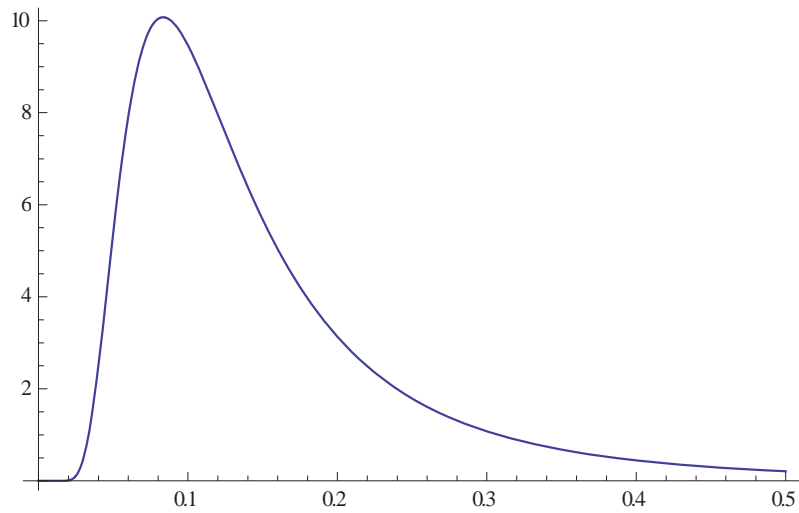
$$\frac{\rho_e}{e} = \frac{1}{4\pi a_n^3} \left(\frac{a_n}{r}\right)^4 \left\{ 3 \exp\left(-\frac{3a_n}{r}\right) - \frac{1}{3} \exp\left(-\frac{a_n}{3r}\right) \right\}$$

X coordinate is the radius with a_n as the length unit

Y coordinate is the electric charge density with e as the electric charge unit

Neutron electric charge density

$$\frac{\rho_e}{e} = \frac{1}{4\pi a_n^3} \left(\frac{a_n}{r}\right)^4 \left\{ 3 \exp\left(-\frac{3a_n}{r}\right) - \frac{1}{3} \exp\left(-\frac{a_n}{r}\right) \right\}$$



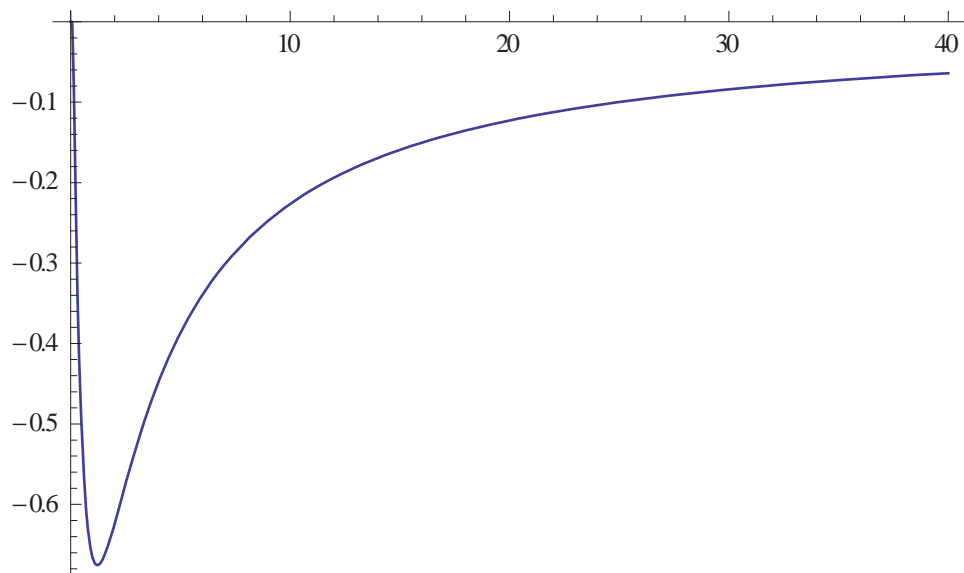
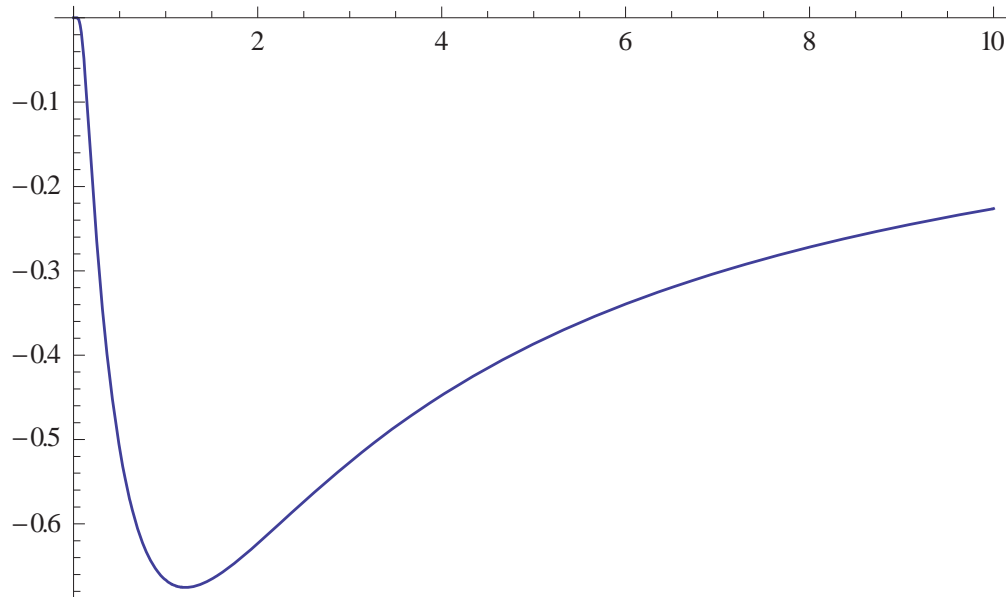
Neutron electric charge within sphere of radius r:

$$Q_e(r) = e[\exp(-\frac{3a_n}{r}) - \exp(-\frac{a_n}{3r})]$$

$$\frac{Q_e(r)}{e} = \exp(-\frac{3a_n}{r}) - \exp(-\frac{a_n}{3r})$$

X coordinate is the radius with a_n as the length unit

Y coordinate is the electric charge with e as the electric charge unit



$$Q_e(r) = e[\exp(-\frac{3a_n}{r}) - \exp(-\frac{a_n}{3r})]$$

When $r \rightarrow \infty$

$$Q_e(\infty) = 0$$

The neutron as a whole has zero electric charge.

Neutron Magnetic Charge

If the magnetic charge density is:

$$\nabla \cdot \vec{H} = \frac{\rho_m}{\mu_0}$$

$$\nabla \cdot \vec{H} = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 H_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta H_\theta) + \frac{1}{r \sin \theta} \frac{\partial H_\phi}{\partial \phi}$$

Then the neutron magnetic charge can be written as

$$Q_m(r, \theta) = \int_0^r \int_0^\theta \rho_m 2\pi \sin \theta d\theta r^2 dr$$

$$\rho_m = \mu_0 \nabla \cdot \vec{H}$$

$$Q_m(r, \theta) = \mu_0 \int_0^r \int_0^\theta \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta H_\theta) 2\pi \sin \theta d\theta r^2 dr$$

$$H_\theta = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp(-\frac{a}{r}) \sin \theta$$

$$Q_m(r, \theta) = \mu_0 \int_0^r \int_0^\theta \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\sin \theta \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp(-\frac{a}{r}) \sin \theta) 2\pi \sin \theta d\theta r^2 dr$$

$$Q_m(r, \theta) = 2\pi\mu_0 \int_0^r \frac{3ga}{4\pi\mu_0} \frac{1}{r^2} \exp(-\frac{a}{r}) dr \int_0^\theta \frac{\partial}{\partial \theta} (\sin^2 \theta) d\theta$$

$$Q_m(r, \theta) = 2\pi\mu_0 \int_0^r \frac{3ga}{4\pi\mu_0} \frac{1}{r^2} \exp(-\frac{a}{r}) dr \sin^2 \theta$$

$$Q_m(r, \theta) = 2\pi\mu_0 \frac{3g}{4\pi\mu_0} \sin^2 \theta \int_0^r \frac{a}{r^2} \exp(-\frac{a}{r}) dr$$

$$Q_m(r, \theta) = -2\pi\mu_0 \frac{3g}{4\pi\mu_0} \sin^2 \theta \int_0^r \exp(-\frac{a}{r}) d\frac{a}{r}$$

$$Q_m(r, \theta) = -2\pi\mu_0 \frac{3g}{4\pi\mu_0} \sin^2 \theta \int_0^r \exp\left(-\frac{a}{r}\right) d\frac{a}{r}$$

$$Q_m(r, \theta) = -2\pi\mu_0 \frac{3g}{4\pi\mu_0} \exp\left(-\frac{a}{r}\right) \sin^2 \theta$$

$$Q_m(r, \theta) = -\frac{3g}{2} \exp\left(-\frac{a}{r}\right) \sin^2 \theta$$

When

$$r \rightarrow \infty \text{ and } \theta = \frac{\pi}{2}$$

We can get the neutron magnetic charge of the northern hemisphere as the following:

$$Q_m\left(\infty, \frac{\pi}{2}\right) = -\frac{3g}{2}$$

When

$$r \rightarrow \infty \text{ and } \theta = \pi$$

Then

$$Q_m(\infty, \pi) = 0$$

The neutron as a whole has zero magnetic charge

The neutron's electromagnetic field angular momentum

The electromagnetic field angular momentum density is defined as:

$$\xi = \frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H})$$

$$\vec{L} = \int_v \frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) dv$$

is the electromagnetic angular momentum

Base on the neutron electromagnetic field equation, we can get the following:

$$\vec{E} \times \vec{H} = \frac{e}{4\pi\epsilon_0 r^2} \left[\exp\left(-\frac{3a}{r}\right) - \exp\left(-\frac{a}{r}\right) \right] \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \sin \theta \vec{\varphi}$$

$$\frac{1}{c^2} \vec{E} \times \vec{H} = \frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^5} \left[\exp\left(-\frac{4a}{r}\right) - \exp\left(-\frac{4a}{3r}\right) \right] \sin \theta \vec{\varphi}$$

$$\frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) = \frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^4} [\exp(-\frac{4a}{r}) - \exp(-\frac{4a}{3r})] \sin \theta \hat{\theta}$$

$$\vec{L} = \int_{\mathcal{V}} \frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H}) dv$$

$$\vec{L} = L_z \vec{z}$$

$$[\frac{1}{c^2} \vec{r} \times (\vec{E} \times \vec{H})]_z = \frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^4} [\exp(-\frac{4a}{r}) - \exp(-\frac{4a}{3r})] \sin^2 \theta$$

$$L_z = 3 \int_{\mathcal{V}} \frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^4} [\exp(-\frac{4a}{r}) - \exp(-\frac{4a}{3r})] \sin^2 \theta dv$$

$$dv = 2\pi r^2 dr \sin \theta d\theta$$

$$L_z = 3 \int_{\mathcal{V}} \frac{h}{4\pi} \frac{a}{2} \frac{1}{r^2} [\exp(-\frac{4a}{r}) - \exp(-\frac{4a}{3r})] dr \sin^3 \theta d\theta$$

$$L_z = 3 \int_{\mathcal{V}} \frac{h}{4\pi} \frac{1}{4} [\exp(-\frac{4a}{3r}) - \exp(-\frac{4a}{r})] d \frac{2a}{r} \sin^3 \theta d\theta$$

$$L_z = 3 \frac{4}{3} \int_{\mathcal{V}} \frac{h}{4\pi} \frac{1}{4} [\exp(-\frac{4a}{3r}) - \exp(-\frac{4a}{r})] d \frac{2a}{r}$$

$$L_z = \frac{h}{4\pi} \int_{\mathcal{V}} [\exp(-\frac{4a}{3r}) - \exp(-\frac{4a}{r})] d \frac{2a}{r}$$

$$L_z = \frac{h}{2\pi} \int_{\mathcal{V}} [\exp(-\frac{4a}{3r}) - \exp(-\frac{4a}{r})] d \frac{a}{r}$$

$$L_z = \frac{h}{2\pi} \int_{\mathcal{V}} [\exp(-\frac{4a}{3r}) - \exp(-\frac{4a}{r})] d \frac{a}{r}$$

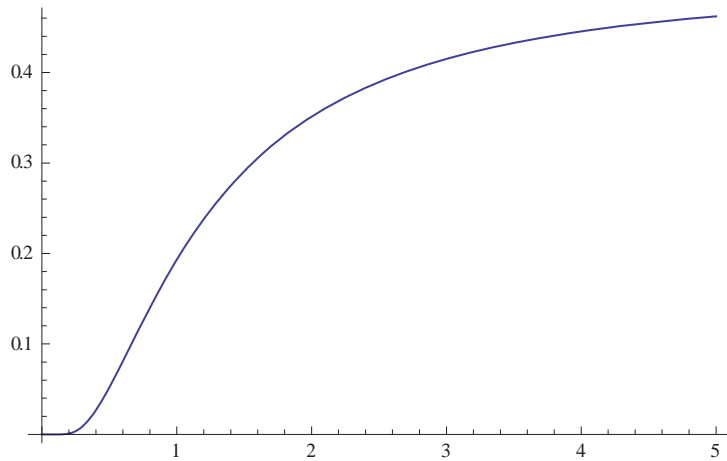
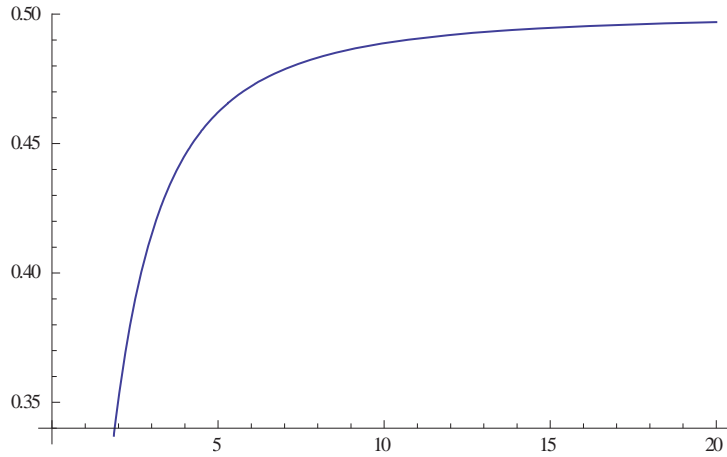
$$L_z(r) = \frac{h}{2\pi} \int_{\mathcal{V}} [\exp(-\frac{4a}{3r}) - \exp(-\frac{4a}{r})] d \frac{a}{r}$$

$$L_z(r) = \frac{\hbar}{4} \exp(-\frac{4a}{r}) [3 \exp(\frac{8a}{3r}) - 1]$$

X coordinate is the radius with a_n as the length unit

Y coordinate is the angular momentum with \hbar as unit

$$L_z(r) = \frac{\hbar}{4} \exp\left(-\frac{4a}{r}\right) \left[3 \exp\left(\frac{8a}{3r}\right) - 1\right]$$



When

$$r \rightarrow \infty$$

Then

$$L_z(\infty) = \frac{h}{2\pi}$$

Based on our neutron electromagnetic model, the neutron always has half spin, the neutron spin has an electromagnetic origin. The neutron spin is the neutron's electromagnetic field angular moment.

Neutron's magnetic moment

The neutron magnetic moment is as follows

$$\vec{\mu} = -\int \vec{H} dv$$

$$\vec{H} = \frac{3g a_n}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a_n}{r}\right) \{\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_n}{4\pi} \frac{1}{r^4} a_n \exp\left(-\frac{a_n}{r}\right) \hat{r} \cos \theta$$

$$\vec{\mu} = -\mu_z \vec{z}$$

$$\mu_z = -\int H_z dv$$

As we know

$$(\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta)_z = 2 \cos^2 \theta - \sin^2 \theta$$

Because

$$\int_0^\pi (2 \cos^2 \theta - \sin^2 \theta) \sin \theta d\theta = 0$$

Thus we have

$$\mu_z = -\int \frac{3\mu_n}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a_n}{r}\right) \hat{r} \cos \theta dv$$

$$\mu_z = -\mu_n \int \frac{3}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a_n}{r}\right) \hat{r} \cos \theta dv$$

$$dv = 2\pi r^2 dr \sin \theta d\theta$$

$$\mu_z = -\mu_n \int \frac{3}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a_n}{r}\right) \cos^2 \theta 2\pi r^2 dr \sin \theta d\theta$$

$$\mu_z = -\mu_n \int \frac{3}{2} \frac{1}{r^2} a_n \exp\left(-\frac{a_n}{r}\right) dr \cos^2 \theta \sin \theta d\theta$$

$$\mu_z = \mu_n \int \frac{3}{2} \exp\left(-\frac{a_n}{r}\right) d \frac{a_n}{r} \cos^2 \theta \sin \theta d\theta$$

$$\mu_z = \mu_n \int_0^\infty \int_0^\pi \frac{3}{2} \exp\left(-\frac{a_n}{r}\right) d \frac{a_n}{r} \cos^2 \theta \sin \theta d\theta$$

$$\mu_z = \mu_n \int_0^\infty \int_0^\pi \frac{3}{2} \exp\left(-\frac{a_n}{r}\right) d \frac{a_n}{r} \cos^2 \theta \sin \theta d\theta$$

$$\mu_z = \mu_n \int_0^\pi \frac{3}{2} \cos^2 \theta \sin \theta d\theta$$

$$\mu_z = \mu_n$$

Neutron's Electric field energy

The electric field energy density is as follows:

$$u_e = \frac{1}{2} \varepsilon_0 E^2$$

$$U_e = \int \frac{1}{2} \varepsilon_0 E^2 dv$$

$$\vec{E} = \frac{e}{4\pi\varepsilon_0 r^2} [\exp(-\frac{3a_n}{r}) - \exp(-\frac{a_n}{3r})] \hat{r}$$

$$U_e = \frac{1}{2} \varepsilon_0 \frac{e^2}{(4\pi\varepsilon_0)^2} \int_0^r \frac{1}{r^4} [\exp(-\frac{3a_n}{r}) - \exp(-\frac{a_n}{3r})]^2 4\pi r^2 dr$$

$$U_e = \frac{1}{2} \frac{e^2}{(4\pi\varepsilon_0)} \int_0^r \frac{1}{r^2} [\exp(-\frac{6a_n}{r}) - 2\exp(-\frac{10}{3} \frac{a_n}{r}) + \exp(-\frac{a_n}{6r})] dr$$

$$U_e = -\frac{e^2}{8\pi\varepsilon_0} \int_0^r [\exp(-\frac{6a_n}{r}) - 2\exp(-\frac{10}{3} \frac{a_n}{r}) + \exp(-\frac{a_n}{6r})] d \frac{1}{r}$$

$$U_e = -\frac{e^2}{8\pi\varepsilon_0 a_n} \int_0^r [\exp(-\frac{6a_n}{r}) - 2\exp(-\frac{10}{3} \frac{a_n}{r}) + \exp(-\frac{a_n}{6r})] d \frac{a_n}{r}$$

$$U_e(r) = \frac{e^2}{8\pi\varepsilon_0 a_n} [\frac{1}{6} \exp(-\frac{6a_n}{r}) - \frac{3}{5} \exp(-\frac{10}{3} \frac{a_n}{r}) + 6 \exp(-\frac{a_n}{6r})]$$

This is the electron electric energy within the sphere of radius r.

When

$$r \rightarrow \infty$$

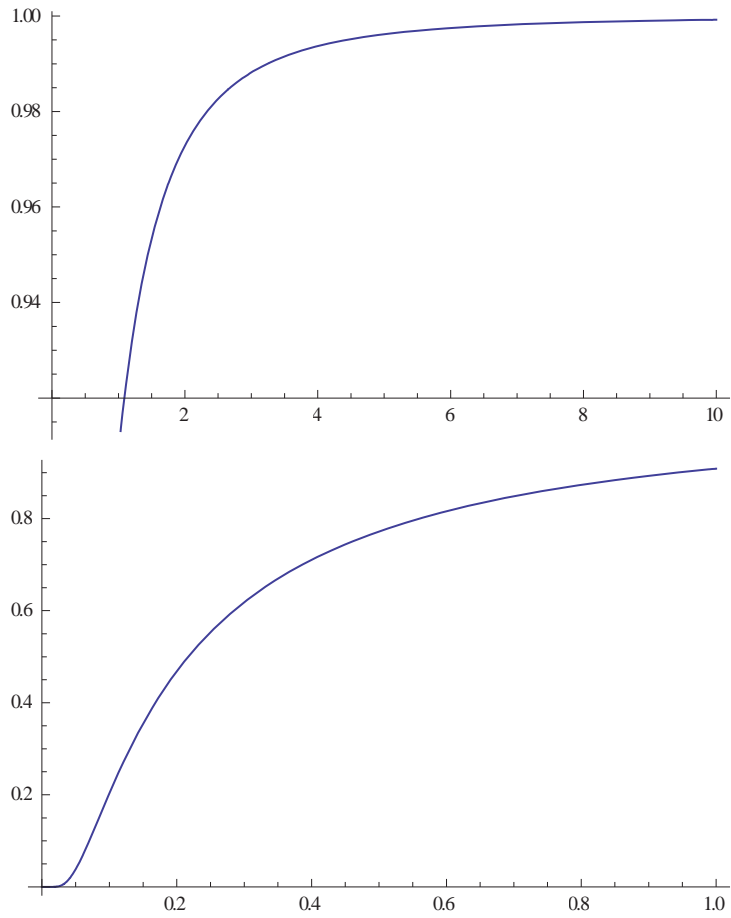
We can get the neutron's total electric field energy as

$$U_e(\infty) = \frac{167}{30} \frac{e^2}{8\pi\varepsilon_0 a_n}$$

$$U_e(r) = U_e(\infty) \frac{30}{167} [\frac{1}{6} \exp(-\frac{6a_n}{r}) - \frac{3}{5} \exp(-\frac{10}{3} \frac{a_n}{r}) + 6 \exp(-\frac{a_n}{6r})]$$

X coordinate is the radius with a_n as the distance unit

Y coordinate is the electric energy with $\frac{167}{30} \frac{e^2}{8\pi\varepsilon_0 a_n}$ as the energy unit.



Let us define

$$k = \frac{a_n}{a_{n0}}$$

$$a_{n0} = \frac{\hbar}{m_n c \alpha}$$

$$U_e(\infty) = \frac{167}{30} \frac{e^2}{8\pi\epsilon_0 k a_{n0}}$$

$$U_e(\infty) = \frac{167}{30} \frac{e^2}{8\pi\epsilon_0 k} \frac{m_n c \alpha}{\hbar}$$

$$U_e(\infty) = \frac{167}{60} \frac{m_n c^2 \alpha^2}{k}$$

Neutron's magnetic field energy

The magnetic field energy density is:

$$u_m = \frac{1}{2} \mu_0 H^2$$

$$\vec{H} = \frac{3g a_n}{4\pi\mu_0 r^3} \exp\left(-\frac{a_n}{r}\right) \{\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_n}{4\pi} \frac{1}{r^4} a_n \exp\left(-\frac{a_n}{r}\right) \hat{r} \cos \theta$$

$$a_{n0} = \frac{\hbar}{m_n c \alpha}$$

$$\mu_n = j_n \mu_B$$

$$j_n = -1.9130427$$

$$\mu_{NB} = \frac{e\hbar}{2m_n}$$

$$\vec{H} = \frac{3g a_n}{4\pi\mu_0 r^3} \exp\left(-\frac{a_n}{r}\right) \{\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_n}{4\pi} \frac{1}{r^4} a_n \exp\left(-\frac{a_n}{r}\right) \hat{r} \cos \theta$$

$$\vec{H} = \frac{3g a_n}{4\pi\mu_0 r^3} \exp\left(-\frac{a_n}{r}\right) \{\hat{r} \cos \theta [2 + j_n \frac{\hbar \alpha}{m_n c r}] + \hat{\theta} \sin \theta\}$$

$$\vec{H} = \frac{3g a_n}{4\pi\mu_0 r^3} \exp\left(-\frac{a_n}{r}\right) \{\hat{r} \cos \theta [2 + j_n \alpha^2 \frac{a_{n0}}{r}] + \hat{\theta} \sin \theta\}$$

The neutron's magnetic field energy is as follows

$$U_m = \int \frac{1}{2} \mu_0 H^2 dv$$

$$U_m = \frac{9g^2}{32\pi\mu_0 a_n} [1 + (1 + j_n \alpha^2 \frac{1}{k})^2]$$

$$U_m = \frac{9g^2}{32\pi\mu_0 k} \frac{m_n c \alpha}{\hbar} [1 + (1 + j_n \alpha^2 \frac{1}{k})^2]$$

$$U_m = \frac{9m_n c^2}{32k} [1 + (1 + j_n \alpha^2 \frac{1}{k})^2]$$

This is the neutron's magnetic field energy

Since we know the neutron's electric field energy as

$$U_e(\infty) = \frac{167}{60} \frac{m_n c^2 \alpha^2}{k}$$

Then the neutron's electromagnetic field energy becomes

$$U = \frac{167}{60} \frac{m_n c^2 \alpha^2}{k} + \frac{9m_n c^2}{32k} [1 + (1 + j_n \alpha^2 \frac{1}{k})^2]$$

$$U = \frac{m_n c^2}{4k} \left\{ \frac{167}{15} \alpha^2 + \frac{9}{8} [1 + (1 + j_n \alpha^2 \frac{1}{k})^2] \right\}$$

Assuming the neutron's mass has an electromagnetic field origin, then

$$m_n c^2 = \frac{m_n c^2}{4k} \left\{ \frac{167}{15} \alpha^2 + \frac{9}{8} [1 + (1 + j_n \alpha^2 \frac{1}{k})^2] \right\}$$

$$1 = \frac{1}{4k} \left\{ \frac{167}{15} \alpha^2 + \frac{9}{8} [1 + (1 + j_n \alpha^2 \frac{1}{k})^2] \right\}$$

$$k \approx 0.562546$$

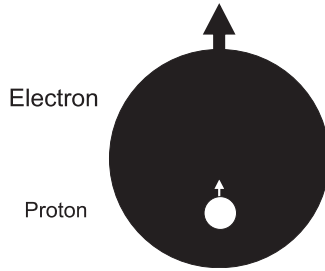
$$a \approx 0.562546 a_{n0}$$

For the neutron, the ratio of the magnetic energy to the electric field energy is

$$\frac{U_m}{U_e} = 3794.44$$

Electric binding energy of proton-electron

The hydrogen atom has only one proton and one electron. Below is the model of the hydrogen atom:



The spin direction is indicated by the direction of the arrow. The electron and proton have the same spin direction. The distance of the electron and proton, from the center of the electron to the center of the proton, is $2d$. Often written as $z_{12} = 2d$

Let 1 represent electron, 2 represent proton. Then we have the electron electric field equation as:

$$\vec{E}_1 = -\frac{e}{4\pi\epsilon_0} \frac{1}{r_1^2} \exp\left(-\frac{a_1}{r_1}\right)$$

If

$$f_{e1} = \exp\left(-\frac{a_1}{r_1}\right)$$

Then

$$\vec{E}_1 = -\frac{e}{4\pi\epsilon_0} \frac{1}{r_1^2} f_{e1}$$

Given that the proton electric field is:

$$\vec{E}_2 = \frac{e}{4\pi\epsilon_0} \frac{1}{r_2^2} \exp\left(-\frac{a_2}{r_2}\right)$$

If

$$f_{e2} = \exp\left(-\frac{a_2}{r_2}\right)$$

Then

$$\vec{E}_2 = \frac{e}{4\pi\epsilon_0} \frac{1}{r_2^2} f_{e2}$$

$$\vec{E} = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a}{r}\right)$$

$$f_{e1} = \exp\left(-\frac{a}{r_1}\right)$$

Thus the Hydrogen atom electric field is as the following:

$$\vec{E}_1 = -\frac{e}{4\pi\epsilon_0} \frac{1}{r_1^2} \exp\left(-\frac{a_1}{r_1}\right)$$

$$\vec{E}_2 = \frac{e}{4\pi\epsilon_0} \frac{1}{r_2^2} \exp\left(-\frac{a_2}{r_2}\right)$$

$$f_{e1} = \exp\left(-\frac{a_1}{r_1}\right)$$

$$f_{e2} = \exp\left(-\frac{a_2}{r_2}\right)$$

We know that the electric field energy density is:

$$u_e = \frac{1}{2} \epsilon_0 E^2$$

$$u_e = u_{e1} + u_{e2} + u_{e12}$$

Where u_{e1} is the first electron's electric field energy density, which is:

$$u_{e1} = \frac{1}{2} \frac{e^2}{16\pi^2 \epsilon_0} \frac{f_{e1}^2}{r_1^4}$$

And u_{e2} is the proton's electric field energy density, which is:

$$u_{e2} = \frac{1}{2} \frac{e^2}{16\pi^2 \epsilon_0} \frac{f_{e2}^2}{r_2^4}$$

$$u_{e12} = -\frac{e^2}{16\pi^2 \epsilon_0} \frac{1}{r_1^2 r_2^2} f_{e1} f_{e2}$$

From the above u_{e12} is the Hydrogen atom's electric field binding energy density.

We can get the Hydrogen atom's electric binding energy as the following:

$$U_{e12} = -\frac{e^2}{16\pi^2 \epsilon_0} \int \frac{1}{r_1^2 r_2^2} f_{e1} f_{e2} dv$$

$$x = \frac{d}{r}$$

$$r_1 = \sqrt{r^2 + d^2 - 2dr \cos \theta}$$

$$r_2 = \sqrt{r^2 + d^2 + 2dr \cos \theta}$$

$$\frac{1}{r_1} = \frac{1}{\sqrt{r^2 + d^2 - 2dr \cos \theta}}$$

$$\frac{1}{r_1} = \frac{1}{r\sqrt{1+x^2 - 2x \cos \theta}}$$

$$\frac{a_1}{r_1} = \frac{a_1}{r\sqrt{1+x^2 - 2x \cos \theta}}$$

$$\frac{a_1}{r_1} = \frac{a_1}{d} \frac{d}{r\sqrt{1+x^2 - 2x \cos \theta}}$$

$$\frac{a_1}{r_1} = \frac{a_1}{d} \frac{x}{\sqrt{1+x^2 - 2x \cos \theta}}$$

$$\frac{a_1}{r_1} = 2 \frac{a_1}{2d} \frac{x}{\sqrt{1+x^2 - 2x \cos \theta}}$$

$$k = \frac{2d}{a_1}$$

$$\frac{a_1}{r_1} = 2 \frac{1}{k} \frac{x}{\sqrt{1+x^2 - 2x \cos \theta}}$$

$$x_1 = 2 \frac{1}{k} \frac{x}{\sqrt{1+x^2 - 2x \cos \theta}}$$

$$x_1 = 2 \frac{1}{k} \frac{x}{v_1}$$

$$\frac{1}{r_2} = \frac{1}{r\sqrt{1+x^2 + 2x \cos \theta}}$$

$$\frac{a_2}{r_2} = \frac{a_2}{d} \frac{d}{r\sqrt{1+x^2 + 2x \cos \theta}}$$

$$\frac{a_2}{r_2} = \frac{a_2}{a_1} \frac{a_1}{d} \frac{x}{\sqrt{1+x^2 + 2x \cos \theta}}$$

$$\frac{a_2}{r_2} = 2 \frac{a_2}{a_1} \frac{a_1}{2d} \frac{x}{\sqrt{1+x^2 + 2x \cos \theta}}$$

$$x_2 = 2 \frac{a_2}{a_1} \frac{1}{k} \frac{x}{\sqrt{1+x^2+2x\cos\theta}}$$

$$x_2 = 2 \frac{a_2}{a_1} \frac{1}{k} \frac{x}{v_2}$$

$$U_{e12} = -\frac{e^2}{16\pi^2 \varepsilon_0} \int_0^\infty \int_0^\pi \frac{1}{r_1^2 r_2^2} f_{e1} f_{e2} dv$$

$$U_{e12} = -\frac{e^2}{16\pi^2 \varepsilon_0 a_1^2 a_2^2} \int_0^\infty \int_0^\pi x_1^2 x_2^2 f_{e1} f_{e2} dv$$

$$dv = 2\pi r^2 dr \sin\theta d\theta$$

$$x = \frac{d}{r}$$

$$r^2 = \frac{d^2}{x^2}$$

$$dr = -\frac{d}{x^2} dx$$

$$dv = 2\pi r^2 dr \sin\theta d\theta$$

$$dv = -2\pi \frac{d^3}{x^4} \sin\theta d\theta dx$$

$$U_{e12} = \frac{e^2}{16\pi^2 \varepsilon_0 a_1^2 a_2^2} \int_0^\infty \int_0^\pi x_1^2 x_2^2 f_{e1} f_{e2} 2\pi \frac{d^3}{x^4} \sin\theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{16\pi^2 \varepsilon_0 a_1^2 a_2^2} \int_0^\infty \int_0^\pi x_1^2 x_2^2 f_{e1} f_{e2} 2\pi \frac{d^3}{x^4} \sin\theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{16\pi^2 \varepsilon_0 a_1^2 a_2^2} 2\pi d^3 \int_0^\infty \int_0^\pi \frac{1}{x^4} x_1^2 x_2^2 f_{e1} f_{e2} \sin\theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{8\pi \varepsilon_0 a_1^2 a_2^2} d^3 \int_0^\infty \int_0^\pi \frac{1}{x^4} x_1^2 x_2^2 f_{e1} f_{e2} \sin\theta d\theta dx$$

$$x_1 = 2 \frac{1}{k} \frac{x}{\sqrt{1+x^2-2x\cos\theta}}$$

$$v_1 = \sqrt{1+x^2-2x\cos\theta}$$

$$x_1 = 2 \frac{1}{k} \frac{x}{v_1}$$

$$x_2 = 2 \frac{a_2}{a_1} \frac{1}{k} \frac{x}{\sqrt{1+x^2+2x \cos \theta}}$$

$$v_2 = \sqrt{1+x^2+2x \cos \theta}$$

$$x_2 = 2 \frac{a_2}{a_1} \frac{1}{k} \frac{x}{v_2}$$

$$x_1 = 2 \frac{1}{k} \frac{x}{v_1}$$

$$U_{e12} = -\frac{e^2}{8\pi\epsilon_0 a_1^2 a_2^2} d^3 \int_0^\infty \int_0^\pi \frac{1}{x^4} \left(2 \frac{1}{k} \frac{x}{v_1}\right)^2 \left(2 \frac{a_2}{a_1} \frac{1}{k} \frac{x}{v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{8\pi\epsilon_0 a_1^2 a_2^2} d^3 \int_0^\infty \int_0^\pi \left(2 \frac{1}{k} \frac{1}{v_1}\right)^2 \left(2 \frac{a_2}{a_1} \frac{1}{k} \frac{1}{v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{2e^2}{\pi\epsilon_0 a_1^2 a_2^2} d^3 \int_0^\infty \int_0^\pi \left(\frac{1}{k} \frac{1}{v_1}\right)^2 \left(\frac{a_2}{a_1} \frac{1}{k} \frac{1}{v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{2e^2}{\pi\epsilon_0 a_1^2 a_2^2} d^3 \frac{1}{k^4} \left(\frac{a_2}{a_1}\right)^2 \int_0^\infty \int_0^\pi \left(\frac{1}{v_1}\right)^2 \left(\frac{1}{v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{2e^2}{\pi\epsilon_0 a_1^2 a_2^2} d^3 \frac{1}{k^4} \left(\frac{a_2}{a_1}\right)^2 \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{2e^2}{\pi\epsilon_0 a_1^4} d^3 \frac{1}{k^4} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{8e^2}{4\pi\epsilon_0 a_1^4} d^3 \frac{1}{k^4} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{4\pi\epsilon_0 a_1} \frac{8d^3}{a_1^3} \frac{1}{k^4} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{4\pi\epsilon_0 a_1} \frac{k^3}{k^4} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{4\pi\epsilon_0 a_1} \frac{1}{k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$\bar{E}_1 = -\frac{e}{4\pi\epsilon_0} \frac{1}{r_1^2} \exp\left(-\frac{a_1}{r_1}\right)$$

$$f_{e1} = \exp\left(-\frac{a_1}{r_1}\right)$$

$$f_{e1} = \exp(-x_1)$$

$$f_{e1} = \exp\left(-2\frac{1}{k} \frac{x}{v_1}\right)$$

$$f_{e1} = \exp\left(-2\frac{1}{k} \frac{x}{v_1}\right)$$

$$\bar{E}_2 = \frac{e}{4\pi\epsilon_0 r_2^2} \exp\left(-\frac{a_2}{r_2}\right)$$

$$f_{e2} = \exp\left(-\frac{a_2}{r_2}\right)$$

$$f_{e2} = \exp(-x_2)$$

$$f_{e2} = \exp\left(-2\frac{a_2}{a_1} \frac{1}{k} \frac{x}{v_2}\right)$$

$$f_{e2} = \exp\left(-2\frac{a_2}{a_1} \frac{1}{k} \frac{x}{v_2}\right)$$

$$x_2 = 2\frac{a_2}{a_1} \frac{1}{k} \frac{x}{v_2}$$

$$x_1 = 2\frac{1}{k} \frac{x}{v_1}$$

$$U_{e12} = -\frac{e^2}{4\pi\epsilon_0 a_1 k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 f_{e1} f_{e2} \sin \theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{4\pi\epsilon_0 a_1 k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left(-2\frac{1}{k} \frac{x}{v_1}\right) \exp\left(-2\frac{a_2}{a_1} \frac{1}{k} \frac{x}{v_2}\right) \sin \theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{4\pi\epsilon_0 a_1 k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{1}{v_1} + \frac{a_2}{a_1} \frac{1}{v_2}\right)\right] \sin \theta d\theta dx$$

$$U_{e12} = -\frac{e^2}{4\pi\epsilon_0 a_0} \frac{a_0}{a_1 k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{1}{v_1} + \frac{a_2}{a_1} \frac{1}{v_2}\right)\right] \sin \theta d\theta dx$$

$$\frac{e^2}{4\pi\epsilon_0 a_0} = mc^2 \alpha^2$$

$$\frac{1}{2} mc^2 \alpha^2 \approx 13.6 \text{ eV}$$

$$mc^2 = 0.510998910 \text{ MeV}$$

$$U_{e12} = -mc^2 \alpha^2 \left(\frac{a_0}{a_1}\right) \frac{1}{k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{1}{v_1} + \frac{a_2}{a_1} \frac{1}{v_2}\right)\right] \sin \theta d\theta dx$$

$$a_e \approx 0.56246 a_0$$

$$a_1 = 0.56246 a_{10}$$

$$a_2 = 0.562662 a_{20}$$

$$k = \frac{2d}{a_1}$$

$$x = \frac{d}{r}$$

$$v_1 = \sqrt{1 + x^2 - 2x \cos \theta}$$

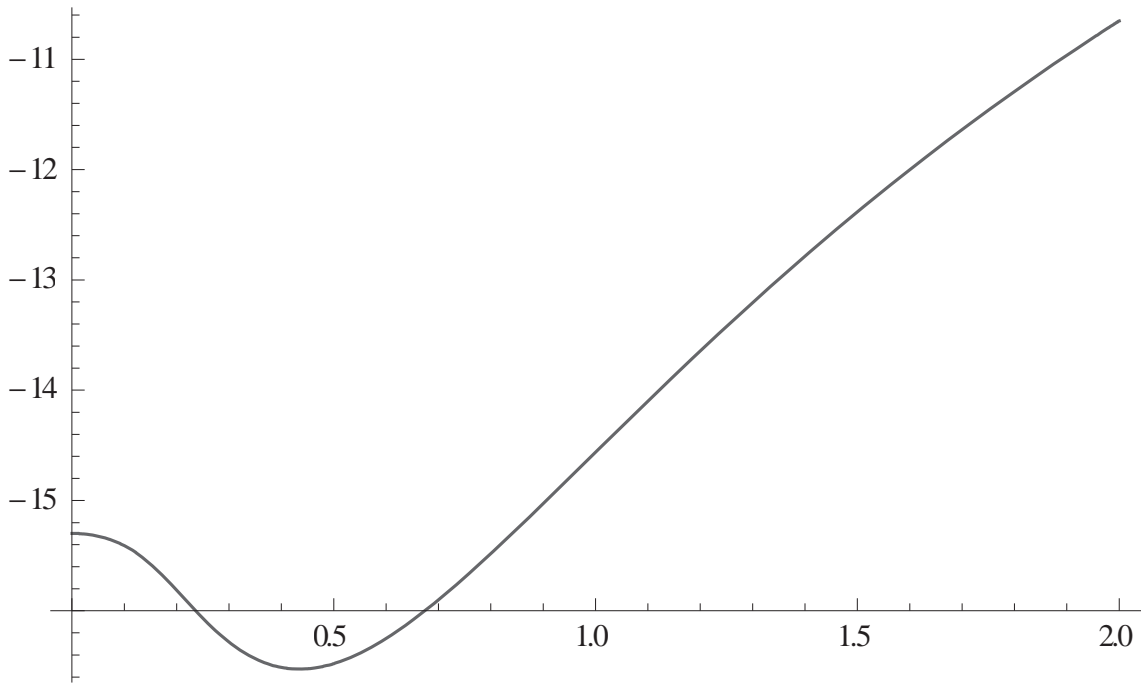
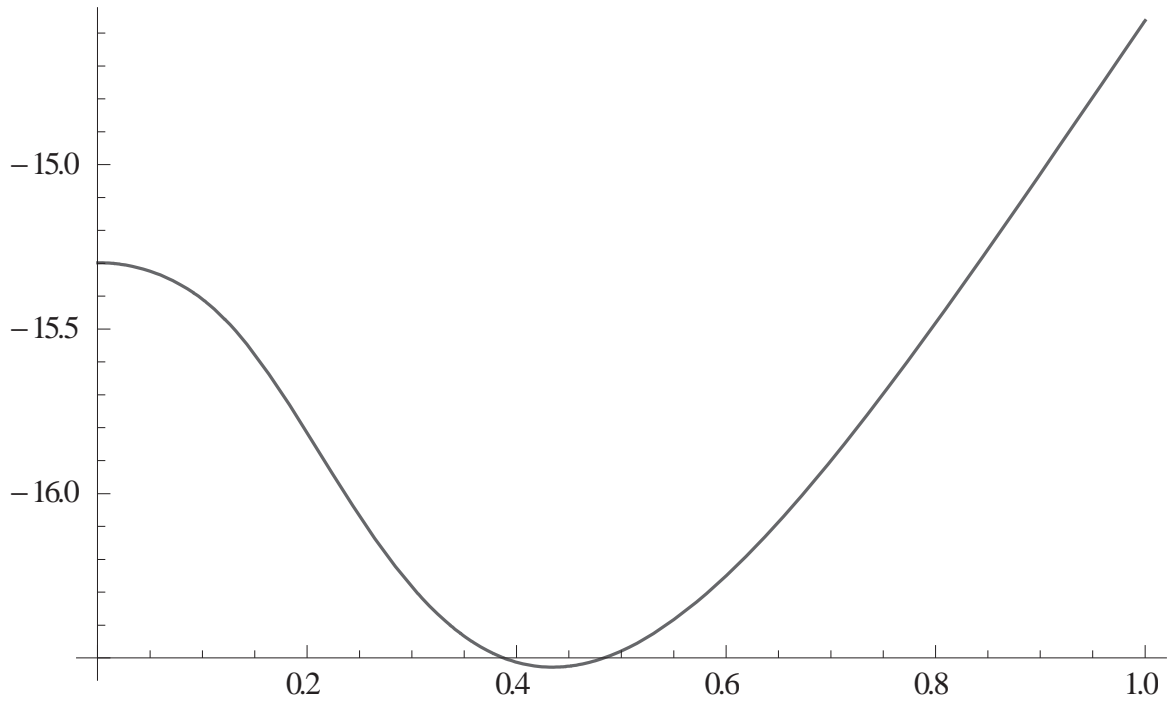
$$v_2 = \sqrt{1 + x^2 + 2x \cos \theta}$$

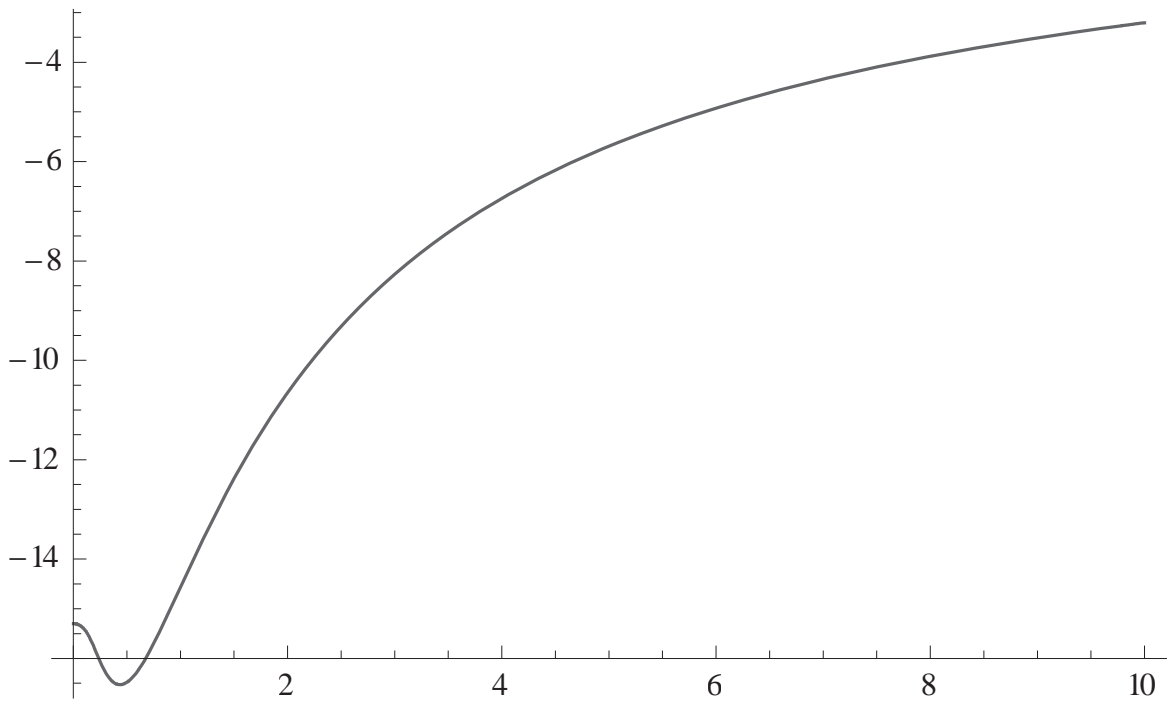
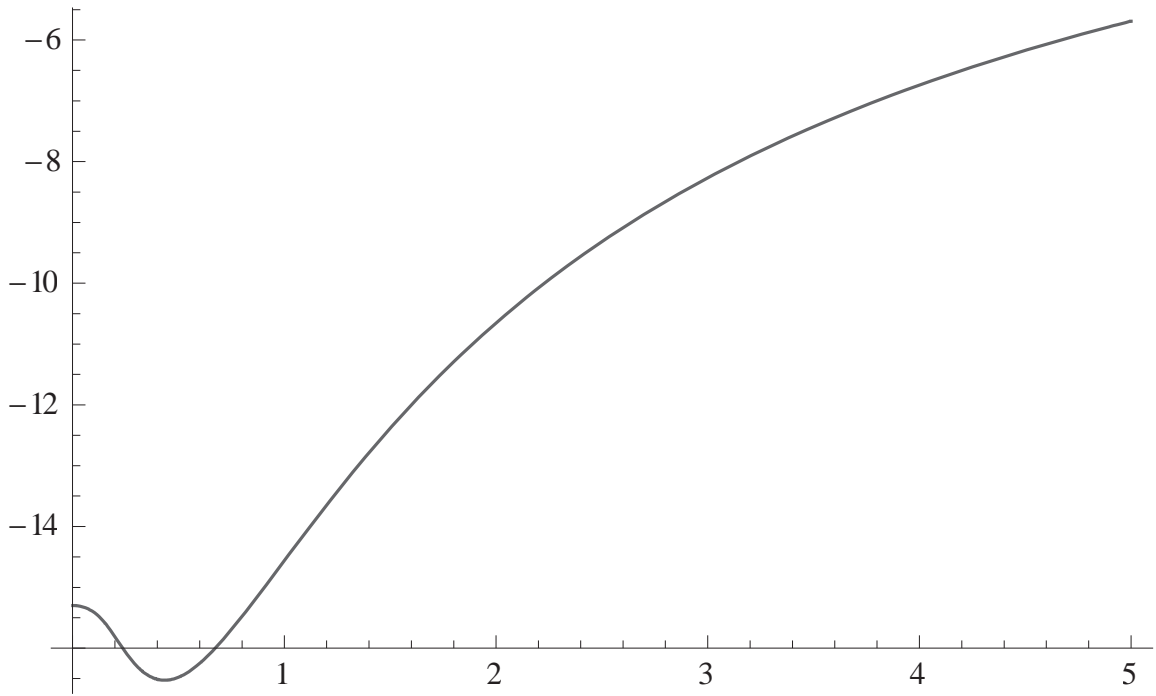
$$\frac{U_{e12}}{mc^2 \alpha^2} = -\frac{1}{k} \left(\frac{a_0}{a_1}\right) \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{1}{v_1} + \frac{a_2}{a_1} \frac{1}{v_2}\right)\right] \sin \theta d\theta dx$$

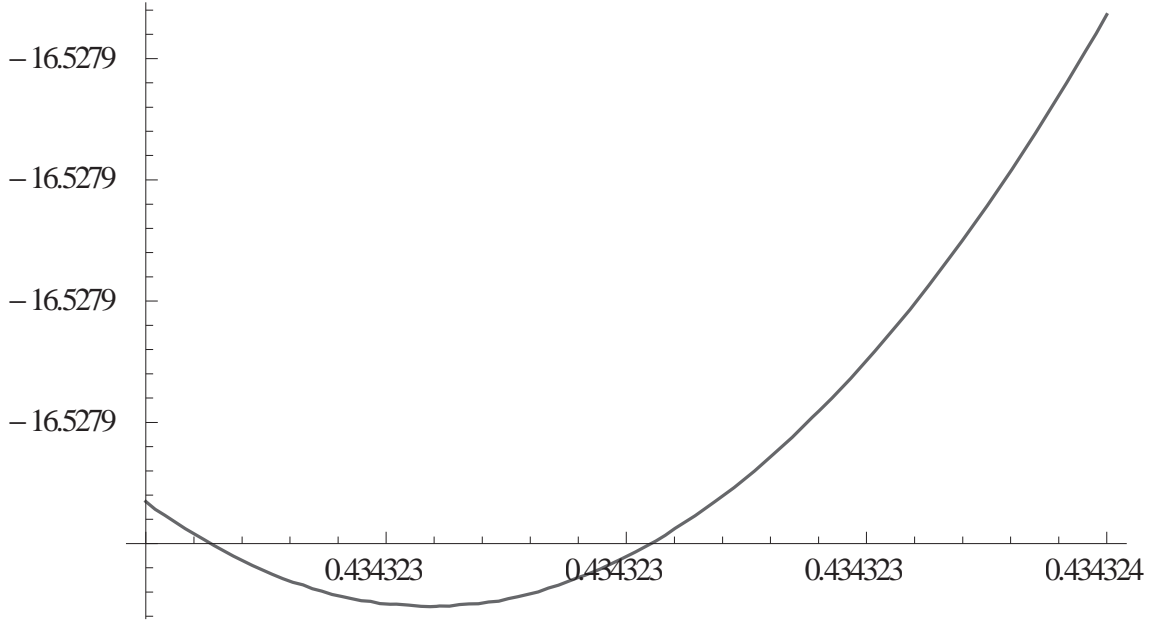
$$U_{e12} = -\frac{mc^2 \alpha^2}{2} \frac{1}{k} \left(\frac{a_0}{a_1}\right) \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{1}{v_1} + \frac{a_2}{a_1} \frac{1}{v_2}\right)\right] \sin \theta d\theta dx$$

X coordinate is the distance between the proton and the electron with a_0 as the unit

Y coordinate is the electron proton binding energy with eV as the unit







$$U_{e12} = -mc^2 \alpha^2 \left(\frac{a_0}{a_1}\right) \frac{1}{k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{k_1}{v_1} + \frac{a_2}{a_1} \frac{k_2}{v_2}\right)\right] \sin \theta d\theta dx$$

$$k = \frac{2d}{a_1}$$

$$F_{e12} = mc^2 \alpha^2 \left(\frac{a_0}{a_1}\right) \frac{d}{dz} \left[\frac{1}{k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{k_1}{v_1} + \frac{a_2}{a_1} \frac{k_2}{v_2}\right)\right] \sin \theta d\theta dx \right]$$

$$F_{e12} = mc^2 \alpha^2 \left(\frac{a_0}{a_1}\right) \frac{d}{dz} \left[\frac{1}{k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{k_1}{v_1} + \frac{a_2}{a_1} \frac{k_2}{v_2}\right)\right] \sin \theta d\theta dx \right]$$

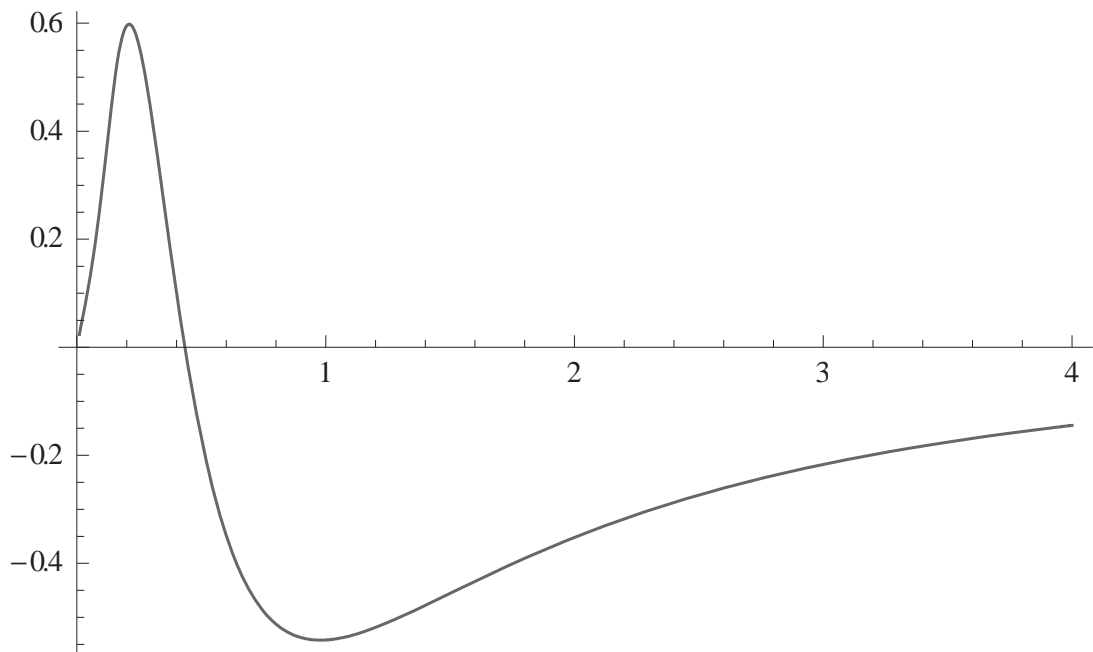
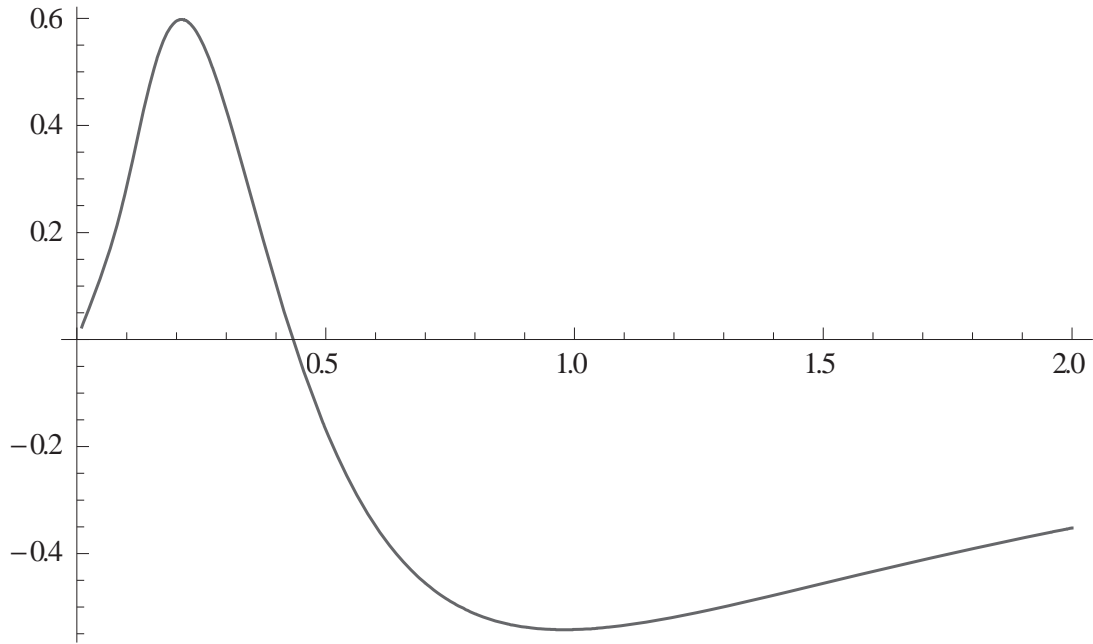
$$F_{e12} = \frac{mc^2 \alpha^2}{a_0} \left(\frac{a_0}{a_1}\right) \frac{d}{dk} \left[\frac{1}{k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{k_1}{v_1} + \frac{a_2}{a_1} \frac{k_2}{v_2}\right)\right] \sin \theta d\theta dx \right]$$

$$\frac{d}{dz} F_{e12} = \frac{mc^2 \alpha^2}{a_0^2} \left(\frac{a_0}{a_1}\right) \frac{d^2}{dk^2} \left[\frac{1}{k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{k_1}{v_1} + \frac{a_2}{a_1} \frac{k_2}{v_2}\right)\right] \sin \theta d\theta dx \right]$$

$$F_{e12} = \frac{mc^2\alpha^2}{a_0} \left(\frac{a_0}{a_1}\right) \frac{d}{dk} \left[\frac{1}{k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{k_1}{v_1} + \frac{a_2}{a_1} \frac{k_2}{v_2}\right)\right] \sin\theta d\theta dx \right]$$

X coordinate is the distance between proton and electron with a_0 as the unit

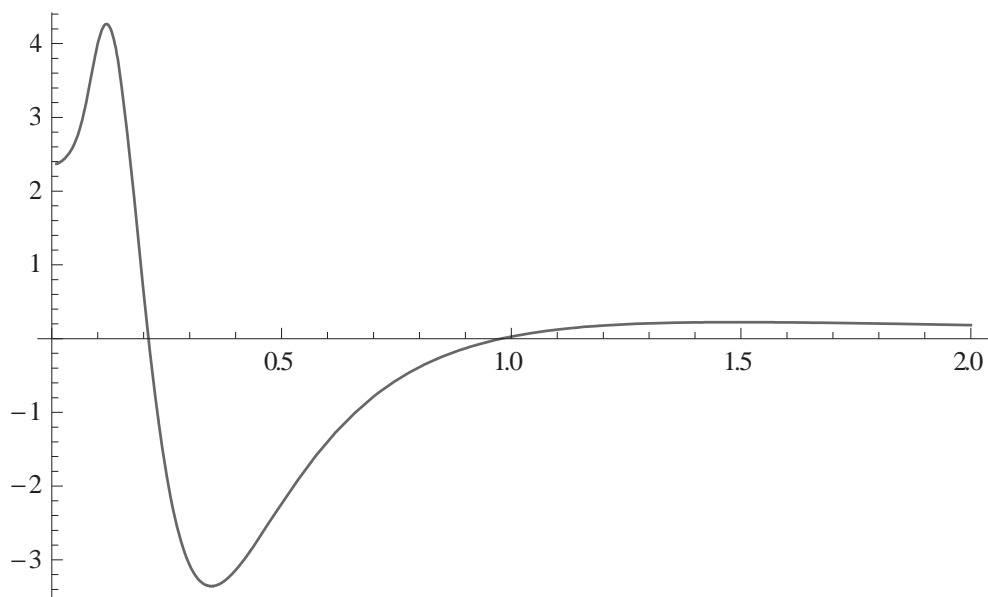
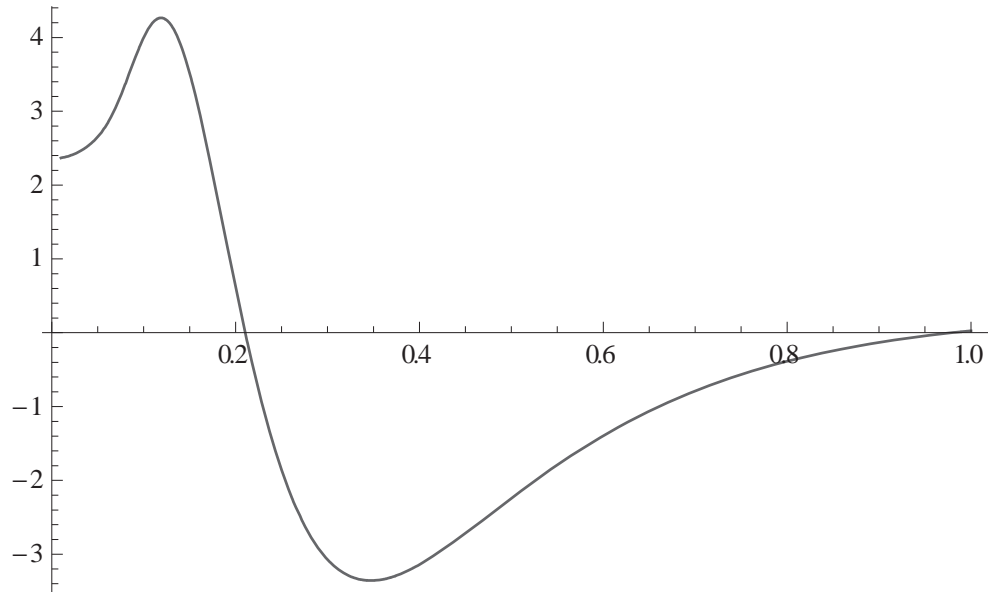
Y coordinate is the electron proton force with $mc^2\alpha^2/a_0$ as the force unit



$$\frac{d}{dz} F_{e12} = \frac{mc^2 \alpha^2}{a_0^2} \left(\frac{a_0}{a_1}\right) \frac{d}{dk^2} \left[\frac{1}{k} \int_0^\infty \int_0^\pi \left(\frac{1}{v_1 v_2}\right)^2 \exp\left[-\frac{2x}{k} \left(\frac{k_1}{v_1} + \frac{a_2 k_2}{a_1 v_2}\right)\right] \sin \theta d\theta dx \right]$$

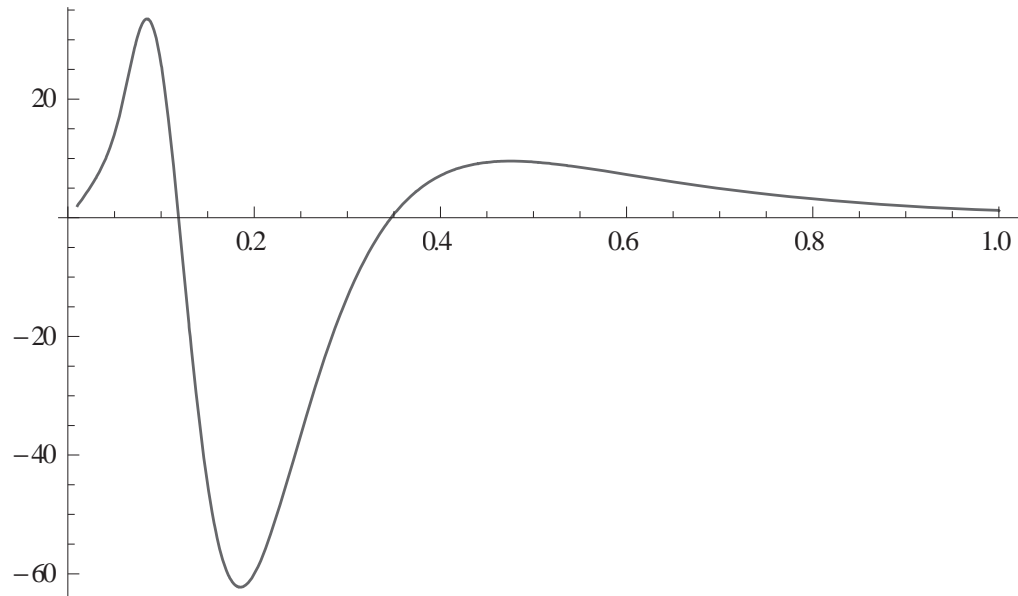
X coordinate is the distance between proton and electron with a_0 as the unit

Y coordinate is the electron proton force differential with $\frac{mc^2 \alpha^2}{a_0^2}$ as the unit



X coordinate is the distance between proton and electron with a_0 as the unit

Y coordinate is the electron proton force 2nd differential with $\frac{mc^2\alpha^2}{a_0^3}$ as the unit



Hydrogen has only one proton and electron therefore in our hydrogen atom model, it does not get any extra energy. This is most likely to correspond to the near absolute zero temperature state such as solid or liquid state.

When

$$r = 0.434323a_0$$

$$U_i = -16.5279ev$$

When hydrogen is heated in its solid or liquid state, it will emit light with all kinds of wavelengths, which corresponds to the hydrogen continuum spectrum.

When the hydrogen is in the thin gas state, and it absorbs enough extra energy with a flame or electric arc, the hydrogen will emit discrete spectrum called the hydrogen atom spectrum. Its ionization energy is

$$U_i = -13.59844 ev$$

Let us assume that when the hydrogen atom emits discrete spectrum, the electron proton form a one-dimensional harmonic oscillator. The electron simple harmonic movement is as follows:

$$Z(t) = A \sin(\nu t)$$

Electron proton within the hydrogen atom act like a simple LC circuit:

We represent

$$E_{e-\max} = \frac{e^2}{2C} \text{ as the maximum electric energy}$$

$$\text{We represent } E_{m-\max} = \frac{LI^2}{2} \text{ as the maximum magnetic energy}$$

Current as we know is

$$I = e\nu$$

Where ν is the electron vibration frequency.

Then the total electromagnetic resonance energy will be as the following

$$E_{total} = E_e = E_m$$

Thus we have

$$\frac{e^2}{2C} = \frac{LI^2}{2}$$

$$\frac{e^2}{2C} = \frac{Le^2\nu^2}{2}$$

Thus we got the electron resonance frequency as

$$\nu = \frac{1}{\sqrt{LC}}$$

Since we know the characteristic impedance of electron as:

$$Z = \sqrt{\frac{L}{C}}$$

Then let us assume that the electron characteristic impedance is as follows:

$$Z = \frac{2g}{e}$$

In which $g = \frac{h}{e}$

Thus

$$Z = \frac{2h}{e^2}$$

Then we have

$$v = \frac{1}{\sqrt{LC}}$$

$$v = \frac{1}{C} \sqrt{\frac{C}{L}}$$

$$v = \frac{1}{C} \frac{1}{Z}$$

$$v = \frac{e^2}{2hC}$$

$$v = \frac{E}{h}$$

$$E = hv$$

Thus we find out that $E = hv$ is the result of electron electromagnetic resonance with the characteristic impedance $\frac{2g}{e}$

With $Z_0 = \sqrt{\frac{\mu_0}{\epsilon_0}}$ as the impedance of free space

The EM wave velocity within free space is light speed.

For the instance with EM characteristic impedance Z , their EM wave velocity V will be

$$\frac{V}{c} = \frac{Z_0}{Z}$$

The EM wave velocity is inversely proportional to the EM wave impedance.

Thus EM wave velocity inside the hydrogen becomes

$$\frac{V}{c} = \frac{Z_0}{Z}$$

$$\text{In which } Z = \frac{2g}{e}$$

Thus

$$\frac{Z}{Z_0} = \frac{2g}{e} \sqrt{\frac{\epsilon_0}{\mu_0}}$$

$$\frac{Z}{Z_0} = \frac{2h\epsilon_0 c}{e^2}$$

$$\frac{Z}{Z_0} = \frac{1}{\alpha}$$

$$Z_0 = \alpha Z$$

$$\frac{V}{c} = \alpha$$

$$V = \alpha c$$

From the above, within the hydrogen atom, the EM velocity is αc

Additionally, for the static electron, there is no φ direction magnetic field, therefore the static electron EM equation becomes:

$$\vec{E} = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a}{r}\right) \hat{r}$$

$$\vec{H} = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \{\hat{r} 2 \cos \theta + \hat{\theta} \sin \theta\} + \frac{3\mu_e}{4\pi} \frac{1}{r^4} a \exp\left(-\frac{a}{r}\right) \hat{r} \cos \theta$$

By assuming that when the electron makes a simple harmonic movement inside the hydrogen atom, the electron φ direction magnetic field is:

$$\vec{H}_\varphi = \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \hat{\varphi} \sin \theta$$

Then we have the electron electromagnetic moment as follows

$$\vec{P}_\theta = \int \frac{1}{c^2} \vec{E}_r \times \vec{H}_\varphi dv$$

$$\vec{E} \times \vec{H} = \frac{e}{4\pi\epsilon_0 r^2} \exp\left(-\frac{a}{r}\right) \frac{3ga}{4\pi\mu_0} \frac{1}{r^3} \exp\left(-\frac{a}{r}\right) \sin \theta \hat{\theta}$$

$$\frac{1}{c^2} \vec{E} \times \vec{H} = \frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^5} \exp\left(-\frac{2a}{r}\right) \sin \theta \hat{\theta}$$

$$\vec{P} = \int \frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^5} \exp\left(-\frac{2a}{r}\right) \sin \theta \hat{\theta} dv$$

$$dv = 2\pi r^2 dr \sin \theta d\theta$$

$$P_\rho = \int \frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^5} \exp\left(-\frac{2a}{r}\right) \sin \theta \cos \theta 2\pi r^2 dr \sin \theta d\theta$$

$$P_\rho = 0$$

$$P_z = - \int \frac{h}{4\pi} \frac{3a}{4\pi} \frac{1}{r^5} \exp\left(-\frac{2a}{r}\right) \sin^2 \theta 2\pi r^2 dr \sin \theta d\theta$$

$$P_z = - \frac{h}{4\pi} \frac{3}{8a} \int \frac{2a}{r} \exp\left(-\frac{2a}{r}\right) d \frac{2a}{r} \sin^3 \theta d\theta$$

$$\int_0^\pi \sin^3 \theta d\theta = \frac{4}{3}$$

$$\int_0^\infty \frac{2a}{r} \exp\left(-\frac{2a}{r}\right) d \frac{2a}{r} = - \int_0^\infty x \exp(-x) dx = -1$$

$$P_z = \frac{h}{4\pi} \frac{3}{8a} \frac{4}{3}$$

$$P_z = \frac{h}{8\pi a}$$

We know the electron electromagnetic field energy as

$$U_e = \frac{e^2}{16\pi\epsilon_0 a}$$

And we know,

$$U_e = \frac{e^2}{2C}$$

Equating both equations we get the electron capacitor C as

$$C = 8\pi\epsilon_0 a$$

For the electron harmonic oscillator, we have

$$U_e = h\nu$$

$$\frac{e^2}{16\pi\epsilon_0 a} = \frac{h}{T}$$

$$\frac{e^2}{16\pi\epsilon_0 a} = \frac{h\alpha c}{T\alpha c}$$

$$\lambda = \alpha c T$$

Where λ is the EM wave length, αc is the EM wave velocity, T is the EM wave period,

$$\frac{e^2 c}{2 \epsilon_0 h c} \frac{h}{8 \pi a} = \frac{h \alpha c}{\lambda}$$

Given that

$$P_z = \frac{h}{8 \pi a}$$

After substitution we have

$$P_z = \frac{h}{\lambda}$$

P_z is the electron electromagnetic moment, λ is the electron electromagnetic resonance wavelength.

$$\lambda = 8 \pi a$$

$$V_{wave} = \alpha c$$

Thus we can get the electron resonance vibration moving equation as the following:

$$V(t) = \alpha c * \cos\left(\frac{\alpha c}{8 \pi a} t\right)$$

$$Z(t) = 8 \pi a * \sin\left(\frac{\alpha c}{8 \pi a} t\right)$$

$$Z(t) = \lambda * \sin\left(\frac{\alpha c}{\lambda} t\right)$$

$$Z(t) = \frac{h}{P_z} \sin\left(\frac{P_z \alpha c}{h} t\right)$$

For the hydrogen atom, when it is in the thin gas state, and in the environment of flame or electric arc, it will emit a series of concrete spectrum. Its first spectrum series, the Lyman series is given as

$$U = \frac{1}{2} m c^2 \alpha^2 \left[1 - \frac{1}{n^2}\right]$$

Where m is the reduced mass of electron and proton

$$m = \frac{m_e m_p}{m_e + m_p}$$

As we know the electron's electric energy

$$U_e = \frac{e^2}{16 \pi \epsilon_0 a}$$

$$U_e = \frac{e^2}{16 \pi \epsilon_0 a_0} \frac{a_0}{a}$$

$$U_e = \frac{e^2}{16\pi\epsilon_0} \frac{mc\alpha}{\hbar} \frac{a_0}{a}$$

$$U_e = \frac{mc^2\alpha^2}{4} \frac{a_0}{a}$$

$$\frac{mc^2\alpha^2}{4} \frac{a_0}{a} = \frac{1}{2} mc^2\alpha^2 \left[1 - \frac{1}{n^2}\right]$$

$$\frac{a_0}{2a} = \left[1 - \frac{1}{n^2}\right]$$

$$a = \frac{a_0}{2\left[1 - \frac{1}{n^2}\right]}$$

$$\lambda = 8\pi a$$

$$C = \frac{4\pi\epsilon_0 a_0}{\left[1 - \frac{1}{n^2}\right]}$$

$$\lambda = \frac{4\pi a_0}{\left[1 - \frac{1}{n^2}\right]}$$

$$\vec{E} = -\frac{e}{4\pi\epsilon_0} \frac{1}{r^2} \exp\left(-\frac{a_0}{2\left(1 - \frac{1}{n^2}\right)} \frac{1}{r}\right) \hat{r}$$

When

$$n \rightarrow \infty$$

The ionization energy of the electron escaping from the hydrogen atom can be calculated as:

$$U_{ion} = \frac{1}{2} mc^2\alpha^2 = 13.59844 \text{ eV}$$

In the Ionization process, the electron ionization capacitor is:

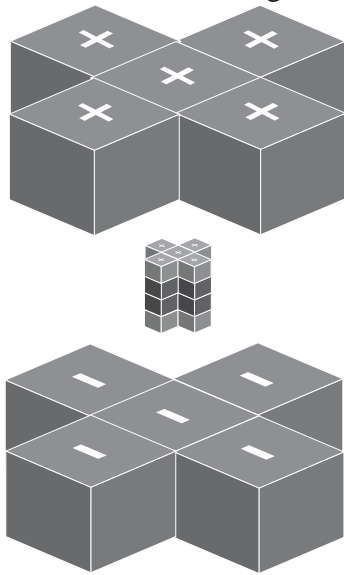
$$C_{ion} = 4\pi\epsilon_0 a_0$$

The hydrogen atom ionization energy can be rewritten as:

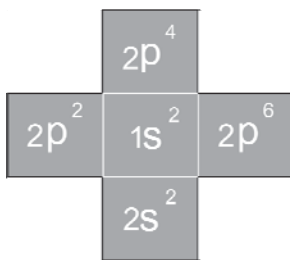
$$U_{ion} = \frac{e^2}{2C_{ion}}$$

For the Z element, the atom has Z electron, according to their ionization energy from large to small, we can number these electron as K electron. When K=1, it relates to the largest ionization energy electron, when K=Z, it relates to the smallest ionization energy electron. Let us take for example, the atomic structure diagram of the element Neon:

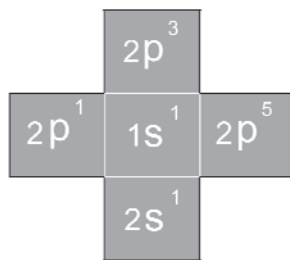
Ne-10 electron configuration



Top



Bottom



Element 1-10 Ionization energy table (ev as energy unit)

		1s ¹	1s ²	2s ¹	2s ²	2p ¹	2p ²	2p ³	2p ⁴	2p ⁵	2p ⁶
Z	K	1	2	3	4	5	6	7	8	9	10
1	H	13.59844									
2	He	54.41778	24.58741								
3	Li	122.45429	75.64018	5.39172							
4	Be	217.71865	153.89661	18.21116	9.3227						
5	B	340.22580	259.37521	37.93064	25.15484	8.29803					
6	C	489.99334	392.087	64.4939	47.8878	24.38332	11.26030				
7	N	667.046	552.0718	97.8902	77.4735	47.44924	29.6013	14.53414			
8	O	871.4101	739.29	138.1197	113.8990	77.41353	54.9355	35.11730	13.61806		
9	F	1103.1176	953.9112	185.186	157.1651	114.2428	87.1398	62.7084	34.97082	17.42282	
10	Ne	1362.1995	1195.8286	239.0989	207.2759	157.93	126.21	97.12	63.45	40.96328	21.5646

As we know, for the hydrogen atom, when it is in the resonance ionization process, their ionization energy is given as:

$$U_{ion} = \frac{e^2}{2C_{ion}}$$

$$C_{ion} = 4\pi\epsilon_0 a_0$$

In generation, for the Z element, K electron, let us assume that their effective nuclear charge is:

$$Z_{eff} = (Z - K + 1) * (1 + \Delta)$$

$$Z_{eff} = L(1 - \Delta)$$

Where

$$L = Z - K + 1$$

For K=1, the Z element first electron,

$$L = Z$$

For $K=Z$, the Z element last electron,

$$L = 1$$

Thus we can get Z element, K electron ionization energy as:

$$U_{ion} = \frac{Z_{eff}^2 e^2}{2C_{ion}}$$

Where

$$C_{ion} = 4\pi\epsilon_0 a_0$$

$$Z_{eff} = L(1 - \Delta)$$

$$U_{ion} = \frac{L^2 (1 - \Delta)^2 e^2}{8\pi\epsilon_0 a_0}$$

$$U_{ion} = \frac{1}{2} mc^2 \alpha^2 L^2 (1 - \Delta)^2$$

$$U_{ion} = \frac{1}{2} m [c\alpha L(1 - \Delta)]^2$$

$$U_{ion} = \frac{1}{2} m V_{ion}^2$$

$$V_{ion} = Z_{eff} * c\alpha$$

Within the Ionization process, the electron electromagnetic energy converted into kinetic energy, electrons escape from the nucleus, the escape speed is proportional to the effective charge of the nuclei.

$$\Delta = 1 - \frac{1}{L} \sqrt{\frac{U_{ion}}{13.59844ev}}$$

Thus we can rewrite element 1-10 ionization energy table as Δ value table

Δ Value Table

		1s ¹	1s ²	2s ¹	2s ²	2p ¹	2p ²	2p ³	2p ⁴	2p ⁵	2p ⁶
Z	K	1	2	3	4	5	6	7	8	9	10
1	H	0									
2	He	-0.000221	-0.3447								
3	Li	-0.000279	-0.179	0.37							
4	Be	-0.00033	-0.1214	0.421	0.172						
5	B	-0.000389	-0.0918	0.443	0.32	0.219					
6	C	-0.000459	-0.0739	0.456	0.374	0.33	0.09				
7	N	-0.000542	-0.0619	0.463	0.403	0.377	0.262	-0.0338			
8	O	-0.000637	-0.0533	0.469	0.421	0.404	0.33	0.197	-0.0007		
9	F	-0.000746	-0.0469	0.473	0.433	0.42	0.367	0.284	0.198	-0.132	
10	Ne	-0.000866	-0.042	0.476	0.442	0.432	0.391	0.33	0.28	0.132	-0.259

Inside the hydrogen atom, we have

$$U = \frac{1}{2}mc^2\alpha^2\left[1 - \frac{1}{n^2}\right]$$

$$h\nu = \frac{1}{2}mc^2\alpha^2\left[1 - \frac{1}{n^2}\right]$$

$$h\frac{c\alpha}{\lambda} = \frac{1}{2}mc^2\alpha^2\left[1 - \frac{1}{n^2}\right]$$

$$\frac{1}{\lambda} = \frac{1}{4\pi\hbar}m\alpha\left[1 - \frac{1}{n^2}\right]$$

$$\frac{a_0}{\lambda} = \frac{1}{4\pi}\left[1 - \frac{1}{n^2}\right]$$

$$\lambda = \frac{4\pi a_0}{\left[1 - \frac{1}{n^2}\right]}$$

For the element Z, K electron, let us assume that the electron energy of the first spectra serial is as follows:

$$U = \frac{1}{2}mc^2\alpha^2\left[\frac{(1-\Delta)^2}{\frac{1}{l^2}} - \frac{(1+\Delta_n)^2}{\left(\frac{n}{l}\right)^2}\right]$$

Where $l = Z - K + 1$

$$n > l$$

$$|\Delta| < 1$$

Then the electron energy of the j spectra serial is given as:

$$U = \frac{1}{2}mc^2\alpha^2\left[\frac{(1-\Delta)^2}{\left(\frac{j}{l}\right)^2} - \frac{(1+\Delta_n)^2}{\left(\frac{n}{l}\right)^2}\right]$$

When

$$l = Z - K + 1$$

$$n > l$$

$$j > l$$

$$|\Delta| < 1$$

Δ_n Can be determined by a specific spectra line wavelength value

For the hydrogen atom, the first spectra serial

$$Z = 1$$

$$K = 1$$

$$l = 1$$

$$\Delta = 0$$

$$U = \frac{1}{2}mc^2\alpha^2\left[1 - \frac{(1+\Delta_n)^2}{n^2}\right]$$

Hydrogen first spectra serial			
n	Intensity	Wavelength(vacuum)	Δ_n
2	500	1215.674	0.00079492
2	1000	1215.668	0.00078827
3	300	1025.722	0.00210893
4	100	972.5367	0.00395135
5	50	949.743	0.00631632
6	30	937.8034	0.00919858
7	20	930.7482	0.0125948
8	15	926.2256	0.0164982

For the helium atom, the first spectra serial of the first electron is given as

$$Z = 2, K = 1, l = 2, \Delta = -0.000221$$

$$U = \frac{1}{2} mc^2 \alpha^2 \left[\frac{(1 + 0.000221)^2}{\left(\frac{1}{2}\right)} - \frac{(1 + \Delta_n)^2}{\left(\frac{n}{2}\right)^2} \right]$$

Helium first electron first spectra serial			
n	Intensity	Wavelength(vacuum) $\overset{\circ}{\text{A}}$	Δ_n
2	500 P	303.7858	0.001024
2	1000 P	303.7804	0.000998
3	150 P	256.3177	0.002337
3	300 P	256.3166	0.00232
4	100 c	243.0266	0.004169
5	50 c	237.3307	0.006532
6	30 c	234.3472	0.009417
7	20 c	232.5842	0.012815
8	15 c	231.4541	0.016725

For the helium atom, the second spectra serial of the first electron is given as

$$Z = 2$$

$$K = 1$$

$$l = 2$$

$$\Delta = -0.000221$$

$$j = 2$$

$$U = \frac{1}{2} mc^2 \alpha^2 \left[\frac{(1 + 0.000221)^2}{\left(\frac{2}{2}\right)} - \frac{(1 + \Delta_n)^2}{\left(\frac{n}{2}\right)^2} \right]$$

$$n \geq 3$$

Helium first electron second spectra serial			
n	Intensity	Wavelength(vacuum) $\overset{0}{\text{A}}$	Δ_n
3	15P	1640.5326	0.000589808
3	25P	1640.4897	0.000573476
3	180P	1640.4742	0.000567574
3	25P	1640.3914	0.000536048
3	7P	1640.3750	0.000529803
3	50P	1640.3447	0.000518265
3	120P	1640.3321	0.000513467
4	50c	1215.17	0.00105742
4	35	1215.09	0.00095877
5	30c	1084.94	0.00160405
6	15c	1025.27	0.00233436
7	8c	992.36	0.00319109
8	6c	972.11	0.00419641
9	5c	958.70	0.00535842

For the helium atom, the first spectra serial of the second electron is as follows:

$$Z = 2$$

$$K = 2$$

$$l = 1$$

$$\Delta = 0.3447$$

$$U = \frac{1}{2}mc^2\alpha^2\left[(1+0.3447)^2 - \frac{(1+\Delta_n)^2}{n^2}\right]$$

Helium second electron first spectra serial			
n	Intensity	Wavelength(vacuum) $\overset{0}{\text{Å}}$	Δ_n
2	50	591.4121	0.0341709
2	1000	584.3339	-0.0025752
3	400	537.0293	0.0010497
4	100	522.186	0.00485533
5	50	515.596	0.00999475
6	35	512.07	0.0152871
7	25	509.97	0.0217464
8	20	508.63	0.030658
9	15	507.71	0.0399277
10	10	507.08	0.0545745
11	7	506.56	0.0594603
12	5	506.31	0.0990477
13	4	505.90	0.0821738
14	3	505.75	0.119593
15	2	505.61	0.151823

For the Lithium atom, the first spectra serial of the first electron is written as

$$Z = 3$$

$$K = 1$$

$$l = 3$$

$$\Delta = -0.000279$$

$$U = \frac{1}{2}mc^2\alpha^2\left[\frac{(1+0.000279)^2}{\left(\frac{1}{3}\right)^2} - \frac{(1+\Delta_n)^2}{\left(\frac{n}{3}\right)^2}\right]$$

Lithium first electron first spectra serial			
n		Wavelength(vacuum) $\overset{0}{\text{Å}}$	Δ_n
2		135.0011661	0.00109254
2		134.9957610	0.00103255
3		113.9057091	0.00239356
3		113.9045690	0.00235362
4		107.9992230	0.00422188
4		107.9987906	0.00419198
5		105.4679379	0.00657418
5		105.4677267	0.0065503
6		104.1420509	0.00944562
6		104.1419318	0.00942579
7		103.3585830	0.0128311
7		103.3585091	0.0128142
8		102.8563652	0.016725
8		102.8563162	0.0167103

For the Lithium atom, the first spectra serial of the second electron is as the following

$$Z = 3$$

$$K = 2$$

$$l = 2$$

$$\Delta = -0.000279$$

$$U = \frac{1}{2} mc^2 \alpha^2 \left[\frac{(1+0.000279)^2}{\left(\frac{1}{2}\right)} - \frac{(1+\Delta_n)^2}{\left(\frac{n}{2}\right)^2} \right]$$

Lithium second electron first spectra serial			
n	Intensity	Wavelength(vacuum) $\overset{0}{\text{Å}}$	Δ_n
2	500 P	303.7858	0.001024
2	1000 P	303.7804	0.000998
3	150 P	256.3177	0.002337
3	300 P	256.3166	0.00232
4	100 c	243.0266	0.004169
5	50 c	237.3307	0.006532
6	30 c	234.3472	0.009417
7	20 c	232.5842	0.012815
8	15 c	231.4541	0.016725

The velocity of electromagnetic field

Momentum is defined as

$$\vec{P} = m\vec{V} \quad (1)$$

Where V is the velocity, P is the momentum, and m is the mass.

For the continuum medium, the momentum density is defined as

$$\vec{p} = \rho\vec{V} \quad (2)$$

Where \vec{p} is the momentum density, ρ_m is the mass density, V is the field velocity.

As we know, the electromagnetic field momentum density is:

$$\vec{p} = \frac{1}{c^2} \vec{E} \times \vec{H} \quad (3)$$

The electromagnetic field energy density is given as:

$$u = \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 H^2 \quad (4)$$

Based on the relationship between mass and energy

$$E = mc^2 \quad (5)$$

Then we can get the mass density of electromagnetic field as:

$$\rho = (\frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 H^2) / c^2 \quad (6)$$

Thus the velocity of the electromagnetic field is given as:

$$\vec{V} = \frac{\vec{p}}{\rho} \quad (7)$$

Thus

$$\vec{V} = \frac{\vec{E} \times \vec{H}}{(\frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 H^2)} \quad (8)$$

Then

$$\frac{\vec{V}}{c} = \frac{(\sqrt{\epsilon_0} \vec{E}) \times (\sqrt{\mu_0} \vec{H})}{\frac{1}{2} (\sqrt{\epsilon_0} E)^2 + \frac{1}{2} (\sqrt{\mu_0} H)^2} \quad (9)$$

From the above velocity equation of electromagnetic field, we find that the value of velocity is always less than the speed of light c, if and only when the following two conditions are satisfied:

$$\vec{E} \cdot \vec{H} = 0 \quad (10)$$

And

$$\varepsilon_0 E^2 = \mu_0 H^2 \quad (11)$$

The value of electromagnetic field velocity will become the speed of light c .

The equation (11) can be rewritten as following:

$$\frac{E}{H} = \sqrt{\frac{\mu_0}{\varepsilon_0}} \quad (12)$$

Why can't any particle go faster than light?

Let us assume that every particle has electromagnetic origin. Then the particle mass energy is pure electromagnetic energy

$$E = \int \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 H^2 dv$$

$$E = mc^2$$

The particle momentum is pure electromagnetic moment:

$$\vec{P} = \int \frac{1}{c^2} \vec{E} \times \vec{H} dv$$

The speed of the moving particle is given as

$$\vec{V} = \frac{\vec{P}}{m}$$

$$\vec{V} = \frac{\int \vec{E} \times \vec{H} dv}{\int \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 H^2 dv}$$

Since we know

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

then

$$\frac{\vec{V}}{c} = \frac{\int \sqrt{\epsilon_0} \vec{E} \times \sqrt{\mu_0} \vec{H} dv}{\int \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 H^2 dv}$$

Thus

$$\frac{\vec{V}}{c} = \frac{\int \sqrt{\epsilon_0} \vec{E} \times \sqrt{\mu_0} \vec{H} dv}{\int \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 H^2 dv}$$

Given that

$$\left| \sqrt{\epsilon_0} \vec{E} \times \sqrt{\mu_0} \vec{H} \right| < \frac{1}{2} (\sqrt{\epsilon_0} E)^2 + \frac{1}{2} (\sqrt{\mu_0} H)^2$$

Then

$$\frac{V}{c} < 1$$

Thus, if the particle has pure electromagnetic origin, then it can't travel faster than light.

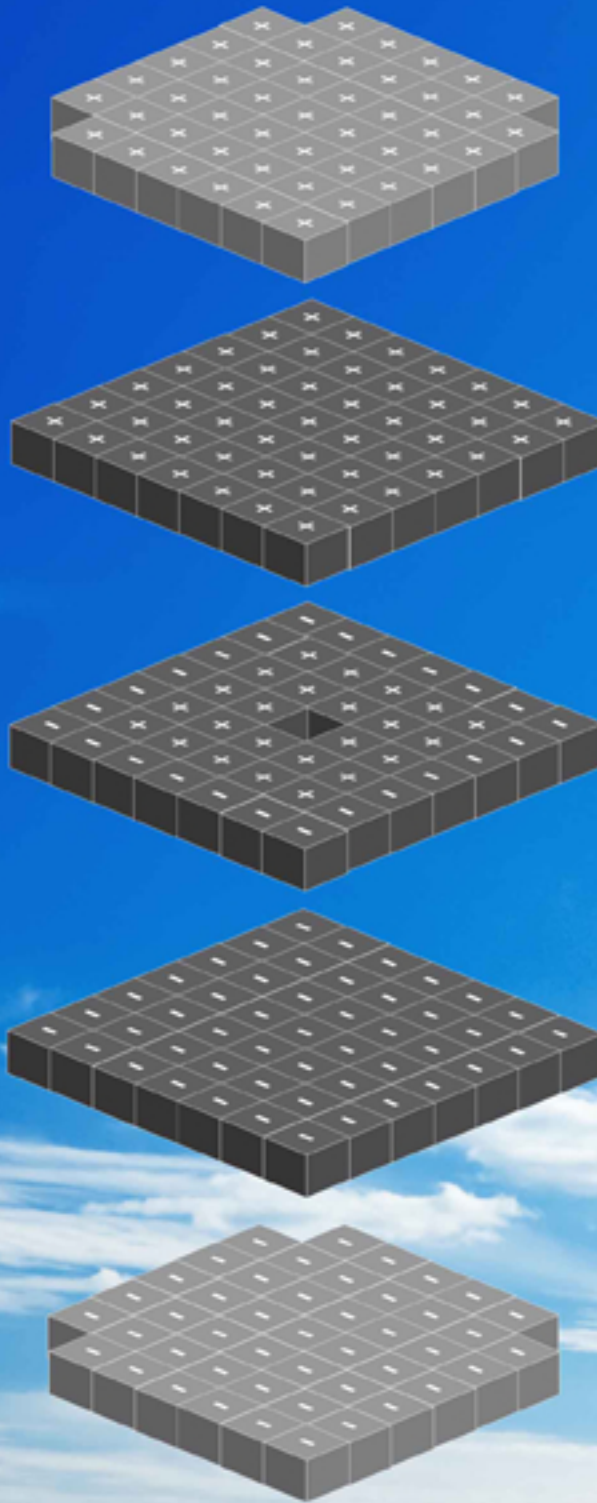
Uranium Nucleus

U 238

Proton: 92

Neutron: 146

Spin:0



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