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NEW JERSEY CENTER
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Chemistry

The Periodic Table

2015-11-16

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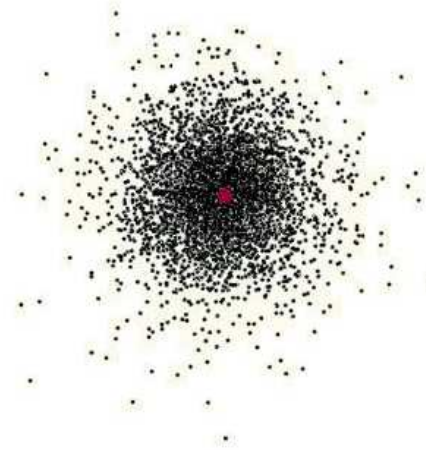
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- **Periodic Trends: Atomic Radius**
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The Periodic Table

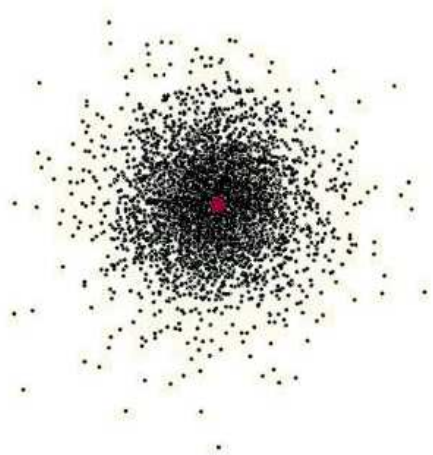
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Identifying Properties of Atoms

Now that we know where (or approximately where) to find the parts of atoms, we can start to understand how these factors all come together to affect how we view the elements.



Identifying Properties of Atoms



We can look at them as individual yet interacting chemicals, and we are able to group them based, not only on the properties they present when in isolation, but also the properties they reveal when exposed to other elements or compounds.

"Periodic" Table of Elements

The Periodic Table of Elements contains physical and chemical information about every element that matter can be made of in the Universe.

The Pillars of Creation, part of the Eagle Nebula shown to the right, *is a cloud of interstellar gases 7,000 light years from Earth made up of the same gaseous elements found on the Periodic Table.



Courtesy of Hubble Telescope

*NASA recently captured this image; however, the Pillars of Creation no longer exists. The Eagle Nebula was destroyed by a Supernova around 6000 years ago, but from our viewpoint, it will be visible for another 1000 years.

"Periodic" Table of Elements

Why is one of the most useful tools ever created by humans called the "Periodic Table"?

When scientists were organizing the known elements, they noticed that certain patterns of chemical and physical behavior kept repeating themselves.

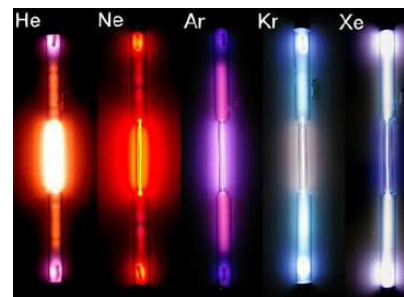
These elements are all shiny metals and react violently in water.



Li	Lithium
Na	Sodium
K	Potassium



He
Ne
Ar
Kr
Xe
Rn



These elements are all very stable gases.

"Periodic" Table of Elements

These patterns were so predictable that Dmitri Mendeleev, the scientist who formulated the Periodic Law, was actually able to predict the existence of elements #31 and #32 and their approximate masses *before they were discovered* based on the existing patterns of known elements.

Gallium, $_{31}\text{Ga}$



Germanium, $_{32}\text{Ge}$



Mendeleev's work preceded the discovery of subatomic particles.

"Periodic" Table of Elements

THE PERIODIC LAW

Mendelejeff's First Periodic Table (March, 1869)

				Ti 50	Zr 90	? 100
				V 51	Nb 94	Ta 182
				Cr 52	Mo 96	W 186
				Mn 55	Rh 104.4	Pt 197.4
				Fe 56	Ru 104.4	Ir 198
			Ni=Co 59	Pd 106.6	Os 199	
			Cu 63.4	Ag 108	Hg 200	
			Zn 65.2	Cd 112		
			? 68	U 116	Au 197?	
			? 70	Sn 118		
			As 75	Sb 122	Bi 210?	
			Se 79.4	Te 128?		
			F 19	Cl 35.5	Br 80	I 127
Li 7	Na 23	K 39		Rb 85.4	Cs 133	Tl 204
		Ca 40		Sr 87.6	Ba 137	Pb 207
		? 45		Ce 92		
		Er? 56		La 94		
		Yt? 60		Di 95		
		In 75.6?		Th 118?		

History of the Periodic Table

Mendeleev argued that elemental properties are periodic functions of their atomic weights.

We now know that element properties are periodic functions of their atomic number.

Atoms are listed on the periodic table in rows, based on number of protons.



Periodic Table

The periodic table is made of rows and columns:

Rows in the periodic table are called Periods.

Columns in the periodic table are called Groups.

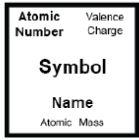
Groups are sometimes referred to as *Families*, but "groups" is more traditional.

groups

periods

Periodic Table of the Elements

		Periodic Table of the Elements																																											
		1 IA 1A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A																											
1	1	H Hydrogen 1.008											5	B Boron 10.811	6	C Carbon 12.011	7	N Nitrogen 14.007	8	O Oxygen 15.999	9	F Fluorine 18.998	10	Ne Neon 20.180																					
2	2	Li Lithium 6.941	4	Be Beryllium 9.012											13	Al Aluminum 26.982	14	Si Silicon 28.086	15	P Phosphorus 30.974	16	S Sulfur 32.065	17	Cl Chlorine 35.453	18	Ar Argon 36.966																			
3	3	Na Sodium 22.990	4	Mg Magnesium 24.305	3	IIIB 3B	4	IVB 4B	5	VB 5B	6	VIB 6B	7	VII B 7B	8	8	9	VIII 8	10	10	11	IB 1B	12	IIB 2B	13	Al Aluminum 26.982	14	Si Silicon 28.086	15	P Phosphorus 30.974	16	S Sulfur 32.065	17	Cl Chlorine 35.453	18	Ar Argon 36.966									
4	19	K Potassium 39.098	20	Ca Calcium 40.078	21	Sc Scandium 44.956	22	Ti Titanium 47.88	23	V Vanadium 50.942	24	Cr Chromium 51.996	25	Mn Manganese 54.938	26	Fe Iron 55.833	27	Co Cobalt 58.933	28	Ni Nickel 58.693	29	Cu Copper 63.546	30	Zn Zinc 65.39	31	Ga Gallium 69.723	32	Ge Germanium 72.61	33	As Arsenic 74.922	34	Se Selenium 78.972	35	Br Bromine 79.904	36	Kr Krypton 84.80									
5	37	Rb Rubidium 84.468	38	Sr Strontium 87.62	39	Y Yttrium 88.906	40	Zr Zirconium 91.224	41	Nb Niobium 92.906	42	Mo Molybdenum 95.94	43	Tc Technetium 98.906	44	Ru Ruthenium 101.07	45	Rh Rhodium 102.905	46	Pd Palladium 106.367	47	Ag Silver 107.868	48	Cd Cadmium 112.411	49	In Indium 114.818	50	Sn Tin 118.71	51	Sb Antimony 121.760	52	Te Tellurium 127.6	53	I Iodine 126.905	54	Xe Xenon 131.29									
6	55	Cs Cesium 132.905	56	Ba Barium 137.327	57-71	*	72	Hf Hafnium 178.49	73	Ta Tantalum 180.948	74	W Tungsten 183.85	75	Re Rhenium 186.207	76	Os Osmium 190.23	77	Ir Iridium 192.22	78	Pt Platinum 195.08	79	Au Gold 196.967	80	Hg Mercury 200.59	81	Tl Thallium 204.387	82	Pb Lead 207.2	83	Bi Bismuth 208.980	84	Po Polonium [209]	85	At Astatine [210]	86	Rn Radon [222]									
7	87	Fr Francium [223]	88	Ra Radium [226]	89-103	**	104	Rf Rutherfordium [261]	105	Db Dubnium [262]	106	Sg Seaborgium [266]	107	Bh Bohrium [264]	108	Hs Hassium [265]	109	Mt Meitnerium [268]	110	Ds Darmstadtium [269]	111	Rg Roentgenium [272]	112	Cn Copernicium [277]	113	Uut Ununtrium [278]	114	Fl Flerovium [277]	115	Uup Ununpentium [278]	116	Lv Livermorium [276]	117	Uus Ununseptium [276]	118	Uuo Ununoctium [276]									
6	*	Lanthanide Series														57	La Lanthanum 138.905	58	Ce Cerium 140.115	59	Pr Praseodymium 140.908	60	Nd Neodymium 144.24	61	Pm Promethium 144.913	62	Sm Samarium 150.36	63	Eu Europium 151.965	64	Gd Gadolinium 157.25	65	Tb Terbium 158.925	66	Dy Dysprosium 162.50	67	Ho Holmium 164.930	68	Er Erbium 167.26	69	Tm Thulium 168.934	70	Yb Ytterbium 173.04	71	Lu Lutetium 174.967
7	**	Actinide Series														89	Ac Actinium 227.028	90	Th Thorium 232.038	91	Pa Protactinium 231.036	92	U Uranium 238.029	93	Np Neptunium 237.048	94	Pu Plutonium 244.064	95	Am Americium 243.061	96	Cm Curium 247.070	97	Bk Berkelium 247.070	98	Cf Californium 251.086	99	Es Einsteinium [254]	100	Fm Fermium 257.095	101	Md Mendelevium 258.1	102	No Nobelium 259.101	103	Lr Lawrencium [262]



1 The elements in the Periodic Table are arranged from left to right in order of increasing ____.

- A mass
- B number of neutrons
- C number of protons
- D number of protons and electrons

2 What is the atomic number for the element in period 3, group 16?

3 What is the atomic number for the element in period 5, group 3?

Groups of Elements

The
Periodic Table
of
Elements

H																	He	
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra	Ac																
			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No			

Alkali metals	Transition elements	Halogens
Alkaline earth metals	Lanthanides	Noble gases
Other metals	Actinides	Other nonmetals
Metalloids		

Enjoy Tom Lehrer's
Famous Element Song!

Metals, Nonmetals, and Metalloids

The periodic table can be divided into metals (blue) and nonmetals (yellow). A few elements retain some of the properties of metals and nonmetals, they are called metalloids (pink).

1																			
2																			
3																			
4																			
5																			
6																			
7																			
6																			
7																			

metals **metalloids** **nonmetals**

Special Groups

Some groups have distinctive properties and are given special names.

Periodic Table of the Elements

Atomic Number	Valence Charge
Symbol	
Name	
Atomic Mass	

	1 IA 1A		2 IIA 2A																18 VIII A 8A	
	H Hydrogen 1.008		He Helium 4.003																	
	Li Lithium 6.941		Be Beryllium 9.012																	
Alkali Metals		Alkaline Earth Metals																		Noble Gases
	11 III A 3A	12 IV A 4A	13 V A 5A	14 VI A 6A	15 VII A 7A	16 VIII A 8A	17 IX A 9A	18 X A 10A	19 XI A 11A	20 XII A 12A										
	B Boron 10.811	C Carbon 12.011	N Nitrogen 14.007	O Oxygen 15.999	F Fluorine 18.998	Ne Neon 20.180														
	31 III B 3B	32 IV B 4B	33 V B 5B	34 VI B 6B	35 VII B 7B	36 VIII B 8	37 IX B 9	38 X B 10	39 XI B 11	40 XII B 12										
	Al Aluminum 26.982	Si Silicon 28.086	P Phosphorus 30.974	S Sulfur 32.060	Cl Chlorine 35.453	Ar Argon 39.948														
	49 III B 3B	50 IV B 4B	51 V B 5B	52 VI B 6B	53 VII B 7B	54 VIII B 8	55 IX B 9	56 X B 10	57-71 XI B 11	58-71 XII B 12										
	Ga Gallium 69.723	Ge Germanium 72.61	As Arsenic 74.922	Se Selenium 78.972	Br Bromine 79.904	Kr Krypton 83.80														
	81 III B 3B	82 IV B 4B	83 V B 5B	84 VI B 6B	85 VII B 7B	86 VIII B 8	87 IX B 9	88 X B 10	89-103 XI B 11	104-108 XII B 12										
	In Indium 114.818	Sn Tin 118.71	Sb Antimony 121.760	Te Tellurium 127.6	I Iodine 126.905	Xe Xenon 131.29														
	113 III B 3B	114 IV B 4B	115 V B 5B	116 VI B 6B	117 VII B 7B	118 VIII B 8	119 IX B 9	120 X B 10	121-1103 XI B 11	112-1108 XII B 12										
	Tl Thallium 204.383	Pb Lead 207.2	Bi Bismuth 208.980	Po Polonium [209]	At Astatine [209]	Rn Radon [222]														
	113 III B 3B	114 IV B 4B	115 V B 5B	116 VI B 6B	117 VII B 7B	118 VIII B 8	119 IX B 9	120 X B 10	121-1103 XI B 11	112-1108 XII B 12										
	Uut Ununtrium [289]	Flerovium [289]	Uup Ununpentium [289]	Lv Livermorium [293]	Uus Ununseptium [289]	Uuo Ununoctium [289]														

	57 Lanthanide Series	58 Lanthanum 138.905	59 Cerium 140.115	60 Praseodymium 140.908	61 Neodymium 144.24	62 Promethium 144.913	63 Samarium 150.36	64 Europium 151.965	65 Gadolinium 157.25	66 Terbium 158.925	67 Dysprosium 162.50	68 Holmium 164.930	69 Erbium 167.26	70 Thulium 168.934	71 Ytterbium 173.04	72 Lutetium 174.967
	Actinide Series	89 Actinium 227.028	90 Thorium 232.038	91 Protactinium 231.036	92 Uranium 238.029	93 Neptunium 237.048	94 Plutonium 244.064	95 Americium 243.061	96 Curium 247.070	97 Berkelium 247.070	98 Californium 251.080	99 Einsteinium [254]	100 Fermium 257.095	101 Mendelevium 258.1	102 Nobelium 259.101	103 Lawrencium [262]

Group 1 Alkali Metals (very reactive metals)

Periodic Table of the Elements

1 IA 1A	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.008	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
3 Li Lithium	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 36.966
19 K Potassium	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.51	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.80
37 Rb Rubidium	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29
55 Cs Cesium	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.09	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon 222.018
87 Fr Francium	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium [284]	114 Fl Flerovium [289]	115 Uup Ununpentium [288]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]

Lanthanide Series	57 La Lanthanum 138.905	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.086	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

Group 2 Alkaline Earth Metals (reactive metals)

Periodic Table of the Elements

1 IA 1A	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A	
1 H Hydrogen 1.008												5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180	
3 Li Lithium 6.941		3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948	
11 Na Sodium 22.990		19 K Potassium 39.098	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.833	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.80
37 Rb Rubidium 84.468		39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.903	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29	
55 Cs Cesium 132.905		57-71 Lanthanide Series	72 Hf Hafnium 178.40	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [209]	86 Rn Radon 222.018	
87 Fr Francium 223.020		89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [269]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium [284]	114 Fl Flerovium [289]	115 Uup Ununpentium [288]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]	
		57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967		
		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.039	92 U Uranium 238.029	93 Np Neptunium 237.045	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [260]		

Groups 3 - 12 *Transition Metals* (low reactivity, typical metals)

Periodic Table of the Elements

1 IA 1A	2 IIA 2A		3 IIIB 3B										4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 9	10 VIII 10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A																
1 H Hydrogen 1.008	2 He Helium 4.003																																										
3 Li Lithium 6.941	4 Be Beryllium 9.012																			5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180																		
11 Na Sodium 22.990	12 Mg Magnesium 24.305																			13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.060	17 Cl Chlorine 35.453	18 Ar Argon 36.948																		
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 83.80																										
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium [98]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.905	46 Pd Palladium 106.367	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29																										
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87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [285]	111 Rg Roentgenium [272]	112 Cn Copernicium [285]	113 Uut Ununtrium [288]	114 Fl Flerovium [289]	115 Uup Ununpentium [289]	116 Lv Livermorium [293]	117 Uus Ununseptium [293]	118 Uuo Ununoctium [294]																										
		57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967																											
		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.073	97 Bk Berkelium 247.070	98 Cf Californium 251.086	99 Es Einsteinium [252]	100 Fm Fermium 257.085	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]																											

Group 16 Oxygen Family (elements of fire)

Periodic Table of the Elements

1 IA 1A																	18 VIIIA 8A	
1 H Hydrogen 1.008	2 IIA 2A												13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180	
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 36.966	
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 83.80	
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.905	42 Mo Molybdenum 95.94	43 Tc Technetium 98.906	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.905	46 Pd Palladium 106.36	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.757	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29	
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [209]	86 Rn Radon [222]	
87 Fr Francium [223]	88 Ra Radium [226]	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [268]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [285]	111 Rg Roentgenium [272]	112 Cn Copernicium [285]	113 Nh Nihonium [284]	114 Fl Flerovium [289]	115 Uup Ununpentium [288]	116 Lv Livermorium [293]	117 Uus Ununseptium [289]	118 Uuo Ununoctium [289]	

Lanthanide Series	57 La Lanthanum 138.905	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.073	97 Bk Berkelium 247.070	98 Cf Californium 251.086	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

Group 17 Halogens (highly reactive, nonmetals)

Periodic Table of the Elements

Periodic Table of the Elements																		
1 IA 1A													13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.008	2 He Helium 4.003												5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
3 Li Lithium 6.941	4 Be Beryllium 9.012											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.060	17 Cl Chlorine 35.453	18 Ar Argon 39.948	
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.060	17 Cl Chlorine 35.453	18 Ar Argon 39.948	
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.89	
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.903	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29	
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.40	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon 222.018	
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium [284]	114 Fl Flerovium [289]	115 Uup Ununpentium [288]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]	
Lanthanide Series			57 La Lanthanum 138.905	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.35	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967	
Actinide Series			89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.039	92 U Uranium 238.029	93 Np Neptunium 237.046	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.079	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]	

Group 18 Noble Gases (nearly inert)

Periodic Table of the Elements

Atomic Number	Valence Charge
Symbol	
Name	
Atomic Mass	

1 IA 1A	2 IIA 2A																	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A																		
1 H Hydrogen 1.008	2 He Helium 4.003																	3 Li Lithium 6.941	4 Be Beryllium 9.012																	5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.060	17 Cl Chlorine 35.453	18 Ar Argon 39.948																								
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.923	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 83.798																								
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.905	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29																								
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [209]	86 Rn Radon [222]																								
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium [284]	114 Fl Flerovium [289]	115 Uup Ununpentium [288]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]																								
		57 La Lanthanum 138.905	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.35	63 Eu Europium 151.965	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967																									
		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.046	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]																									

Noble Gases

Major Groups of the Periodic Table

Periodic Table of the Elements

1 IA 1A	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.008	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
3 Li Lithium 6.941	12 Mg Magnesium 24.305	3 III B 3B	4 IV B 4B	5 V B 5B	6 VI B 6B	7 VII B 7B	8 VIII 8	9 VIII 9	10 VIII 10	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.060	17 Cl Chlorine 35.453	18 Ar Argon 39.948
11 Na Sodium 22.990	19 K Potassium 39.098	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 83.80
19 Ca Calcium 40.078	20 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium [98]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.905	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [271]	111 Rg Roentgenium [272]	112 Cn Copernicium [285]	113 Uut Ununtrium [288]	114 Fl Flerovium [289]	115 Uup Ununpentium [288]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]

57 La Lanthanum 138.905	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.35	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.073	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

4 To which group on the periodic table does Iodine belong?

- A Noble Gases
- B Alkali Metals
- C Transition Metals
- D Halogens

5 To which group on the periodic table does Neon belong?

- A Alkali Metals
- B Transition Metals
- C Noble Gases
- D Alkaline Earth Metals

6 To which group on the periodic table does Fluorine belong?

- A Alkali Metals
- B Transition Metals
- C Noble Gases
- D Halogens

7 To which group on the periodic table does Iron belong?

- A Alkali Metals
- B Transition Metals
- C Halogens
- D Alkaline Earth Metals

8 To which group on the periodic table does Beryllium belong?

- A Alkali Metals
- B Transition Metals
- C Halogens
- D Alkaline Earth Metals

9 Two elements are studied. One with atomic number X and one with atomic number $X+1$. It is known that element X is a Noble Gas. Which group on the periodic table is $X+1$ in?

- A Transition Metals
- B Halogens
- C Alkali Metals
- D There is no way to tell

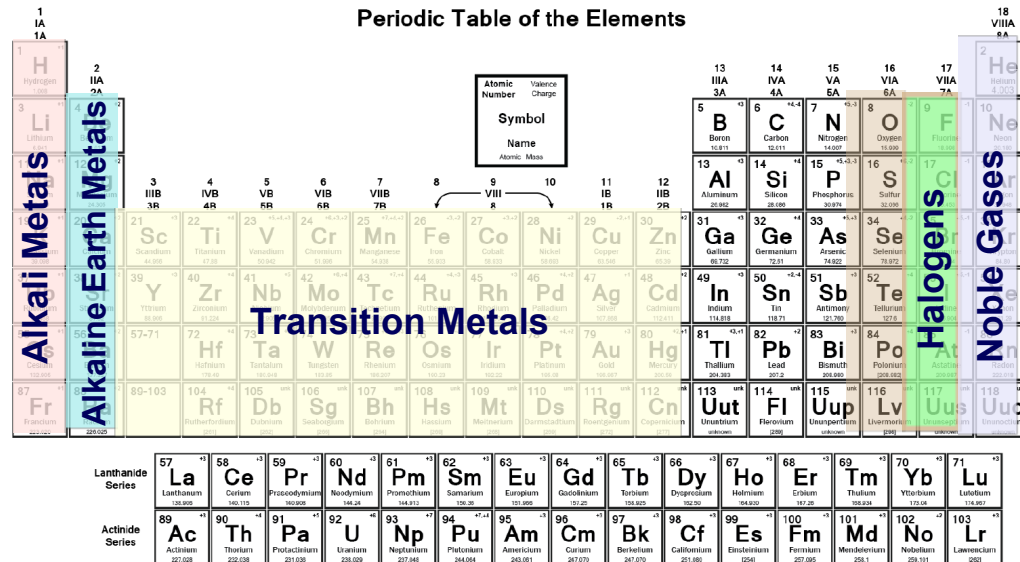
Periodic Table & Electron Configurations

[Return to Table of Contents](#)

Periodic Table & Electron Configuration

The elements are arranged by groups with similar reactivity.

How an element reacts depends on how its electrons are arranged. . .



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. . . we now know that elements in the same groups, with the same chemical properties have very similar electron configurations.

Periodic Table & Electron Configuration

1A 1	2A 2											3A 13	4A 14	5A 15	6A 16	7A 17	8A 18		
1s																		1s	
2s		3B	4B	5B	6B	7B	8B			1B	2B			2p					
3s		3	4	5	6	7	8	9	10	11	12			3p					
4s							3d							4p					
5s							4d							5p					
6s							5d							6p					
7s			6d																

- s-block elements
- d-block elements (transition metals)
- p-block elements
- f-block elements: lanthanides (4f)

There are two methods for labeling the groups, the older method shown in black on the top and the newer method shown in blue on the bottom.

Periodic Table & Electron Configuration

[Click here to view an Interactive Periodic Table that shows orbitals for each Element](#)

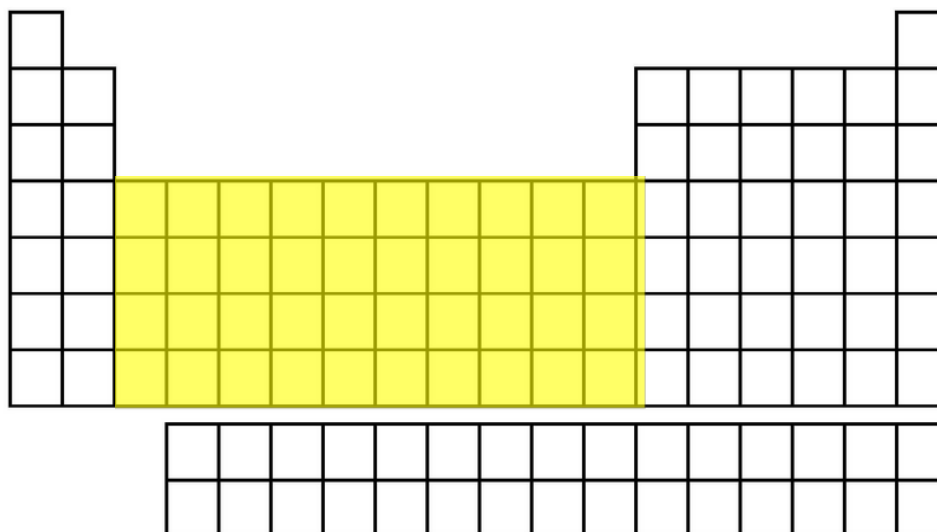
[Click here for an electron orbital game.](#)

Group Names

Group Name	Group #	Electron Configuration	Characteristic
Alkali Metals	1	s^1 ending	Very reactive
Alkaline Earth Metals	2	s^2 ending	Reactive
Transition Metals	3-12 (d block)	$ns^2, (n-1)d$ ending	Somewhat reactive, typical metals
Inner Transition Metals	f block	$ns^2, (n-2)f$ ending	Somewhat reactive, radioactive
Halogens	17	s^2p^5 ending	Highly reactive
Noble Gases	18	s^2p^6 ending	Nonreactive

10 The highlighted elements below are in the ____.

- A s block
- B d block
- C p block
- D f block



11 The highlighted elements below are in the ____.

- A s block
- B d block
- C p block
- D f block

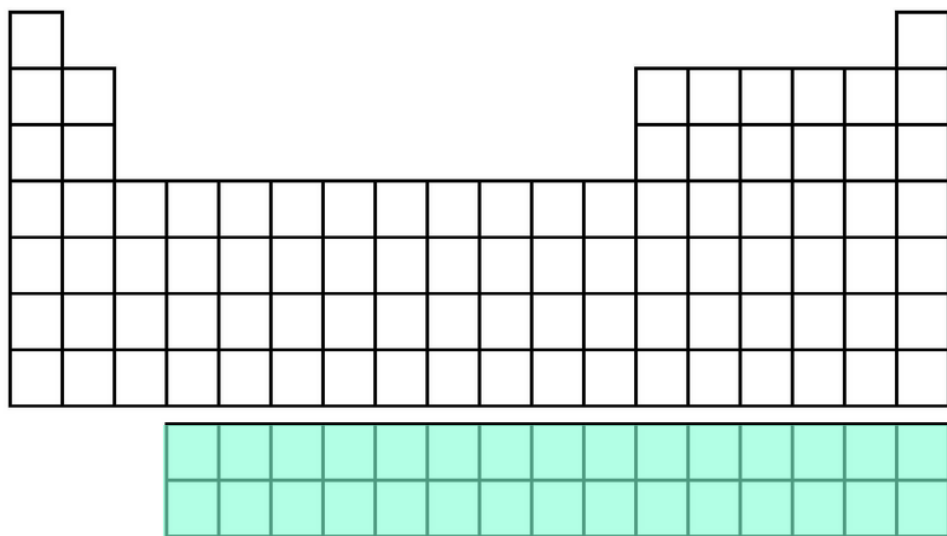
The diagram shows a simplified periodic table with the following structure:

- Period 1: 2 cells (both highlighted).
- Period 2: 8 cells (the first two are highlighted).
- Period 3: 8 cells (the first two are highlighted).
- Period 4: 18 cells (the first two are highlighted).
- Period 5: 18 cells (the first two are highlighted).
- Period 6: 18 cells (the first two are highlighted).
- Period 7: 18 cells (the first two are highlighted).
- Period 8: 10 cells (the last one is highlighted).
- Period 9: 10 cells.
- Period 10: 10 cells.

The highlighted elements are located in the s-block (groups 1 and 2) and one element in the p-block (group 17).

12 The highlighted elements below are in the ____.

- A s block
- B d block
- C p block
- D f block



13 Elements in each group on the Periodic Table have similar ____.

- A mass
- B number of neutrons
- C number of protons and electrons
- D electron configurations

14 The electron configuration ending ns^2p^6 belongs in which group of the periodic table?

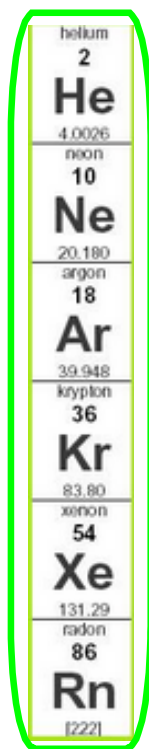
- A Alkali Metals
- B Alkaline Earth Metals
- C Halogens
- D Noble Gases

15 An unknown element has an electron configuration ending in s^2 . It is most likely in which group?

- A Alkaline Earth Metals
- B Halogens
- C Alkali Metals
- D Transition Metals

Shorthand Configurations

Noble Gas elements are used to write shortened electron configurations.



helium	2	He
4.0026		
neon	10	Ne
20.180		
argon	18	Ar
39.948		
krypton	36	Kr
83.80		
xenon	54	Xe
131.29		
radon	86	Rn
[222]		

To write a Shorthand Configuration for an element:

(1) Write the Symbol of the Noble Gas element from the row before it in brackets [].

(2) Add the remaining electrons by starting at the s orbital of the row that the element is in until the configuration is complete.

Shorthand Configurations

Example: Sodium (Na)

1 H 1.008																	2 He 4.003	
3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180	
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948	
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80	
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc 98	44 Ru 101.07	45 Rh 101.07	46 Pd 106.32	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.905	54 Xe 131.29	
55 Cs 132.91	56 Ba 137.33	57-70 *	71 Lu 174.967	72 Hf 178.49	73 Ta 180.948	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po 209	85 At 210	86 Rn 222

Electron Configuration:



Neon's electron configuration

Shorthand Configuration:



Fill in Shorthand Configurations

Element

Shorthand Configuration

Ca

Slide for Answers →

V

→

F

→

Ag

→

I

→

Xe

→

Fe

→

Sg

→

16 What would be the expected "shorthand" electron configuration for Sulfur (S)?

- A $[\text{He}]3s^23p^4$
- B $[\text{Ar}]3s^24p^4$
- C $[\text{Ne}]3s^23p^3$
- D $[\text{Ne}]3s^23p^4$

17 What would be the expected "shorthand" electron configuration for vanadium (V) ?

- A [He]4s²3d¹
- B [Ar]4s²3d¹⁰4p¹
- C [Ar]4s²3d³
- D [Kr]4s²3d¹

18 Which of the following represents an electron configuration of a halogen?

- A $[\text{He}]2s^1$
- B $[\text{Ne}]3s^23p^5$
- C $[\text{Ar}]4s^23d^2$
- D $[\text{Kr}]5s^24d^{10}5p^4$

19 The electron configuration $[\text{Ar}]4s^23d^5$ belongs in which group of the periodic table?

- A Alkali Metals
- B Alkaline Earth Metals
- C Transition Metals
- D Halogens

20 Which of the following represents an electron configuration of an alkaline earth metal?

- A [He]2s¹
- B [Ne]3s²3p⁶
- C [Ar]4s²3d²
- D [Xe]6s²

21 The element iridium is found in a higher abundance in meteorites than in Earth's crust. One specific layer of Earth associated with the end of the Cretaceous Period has an abnormal abundance of iridium, which led scientists to hypothesize that the impact of a massive extraterrestrial object caused the extinction of the dinosaurs 66 million years ago. Using the Periodic Table, choose the correct electron configuration for iridium.

- A $[\text{Xe}]6s^25d^7$
- B $[\text{Xe}]6s^24f^{14}5d^7$
- C $[\text{Xe}]6s^25f^{14}5d^7$
- D $[\text{Xe}]6s^25f^{14}6d^7$

22 The element tin has been known for a long and was even mentioned in the Old Testament of the Bible. During the Bronze Age, humans mixed tin and copper to make a malleable alloy called bronze. Tin's symbol is Sn, which comes from the Latin word "stannum." Which of the following is tin's correct electron configuration?

- A $[\text{Xe}]5s^25d^{10}5p^2$
- B $[\text{Kr}]5s^24f^{14}5d^{10}5p^2$
- C $[\text{Kr}]5s^24d^{10}5p^2$
- D $[\text{Kr}]5s^25d^{10}5p^2$

23 Chemical elements with atomic numbers greater than 92 are called transuranic elements. They are all unstable and decay into other elements. All were discovered in the laboratory by using nuclear reactors or particle accelerators, although neptunium and plutonium were also discovered later in nature. Neptunium, number 93, and plutonium, number 94, were synthesized by bombarding uranium-238 with deuterons (a proton and neutron). What is plutonium's electron configuration?

- A $[\text{Rn}]7s^25d^{10}6f^2$
- B $[\text{Rn}]7s^25f^{14}6d^{10}6p^2$
- C $[\text{Rn}]7s^26d^{10}5f^6$
- D $[\text{Rn}]7s^25f^6$

Stability

When the elements were studied, scientists noticed that, when put in the same situation, some elements reacted while others did not.

The elements that did not react were labeled "stable" because they did not change easily. When these stable elements were grouped together, periodically, they formed a pattern.

Today we recognize that this difference in stability is due to electron configurations.

Based on your knowledge and the electron configurations of argon and zinc, can you predict which electron is more stable?

Argon



Zinc



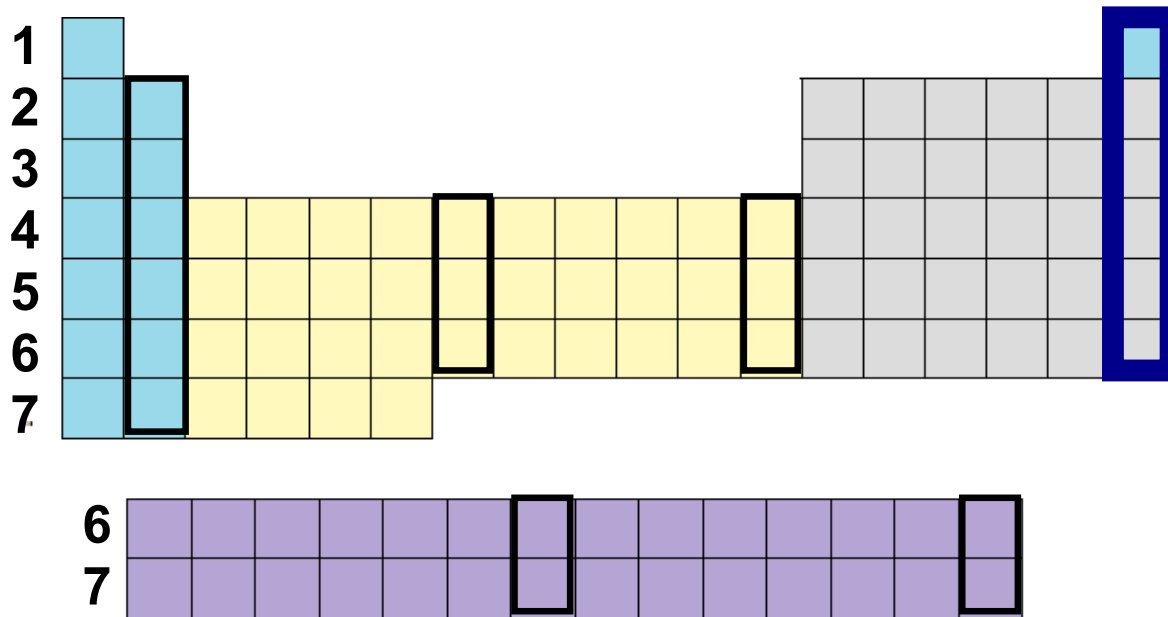
Stability

Elements of varying stability fall into one of 3 categories. The most stable atoms have completely full energy levels.

~Full Energy Level

~Full Sublevel (s, p, d, f)

~Half Full Sublevel (d⁵, f⁷)



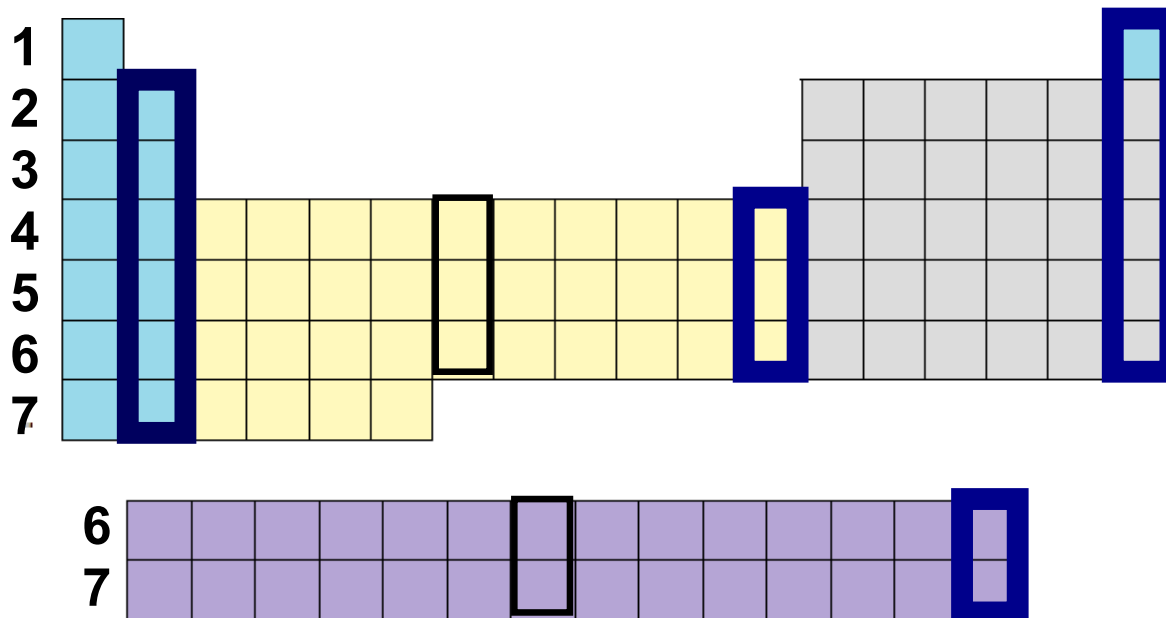
Stability

Next in order of stability are elements with full sublevels.

~Full Energy Level

~**Full Sublevel (s, p, d, f)**

~Half Full Sublevel (d⁵, f⁷)



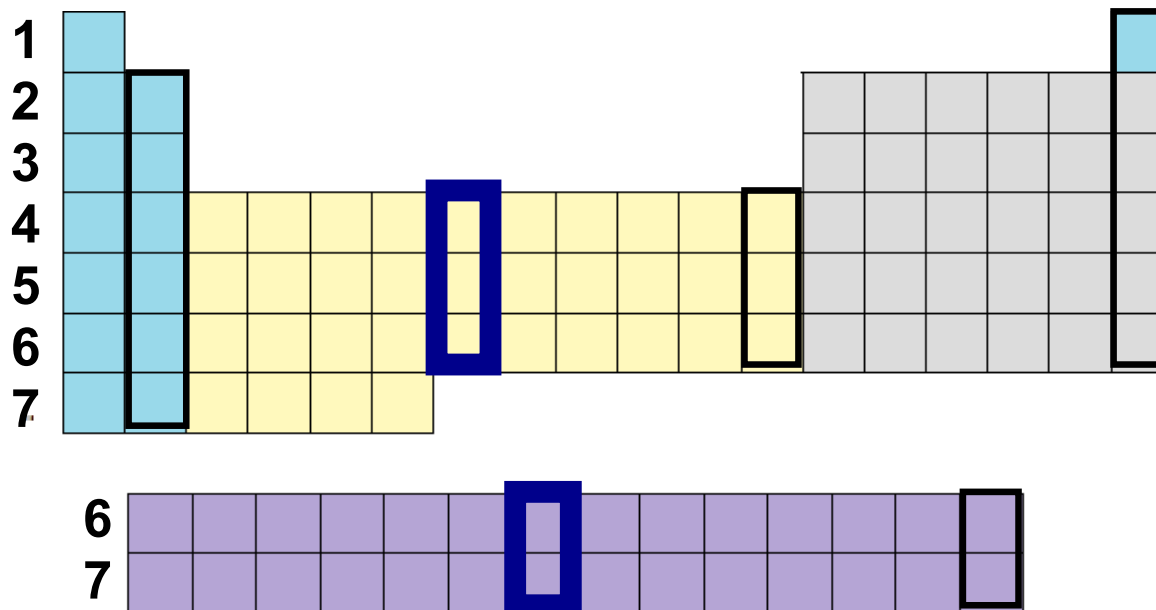
Stability

Finally, the elements with half full sublevels are also stable, but not as stable as elements with fully energy levels or sublevels.

~Full Energy Level

~Full Sublevel (s, p, d, f)

~Half Full Sublevel (d^5 , f^7)



24 The elements in the periodic table that have completely filled shells or subshells are referred to as:

- A noble gases.
- B halogens.
- C alkali metals.
- D transition elements.

25 Alkaline earth metals are more stable than alkali metals because...

- A they have a full shell.
- B they have a full subshell.
- C they have a half-full subshell.
- D they contain no p orbitals.

26 The elements in the periodic table which lack one electron from a filled shell are referred to as ____.

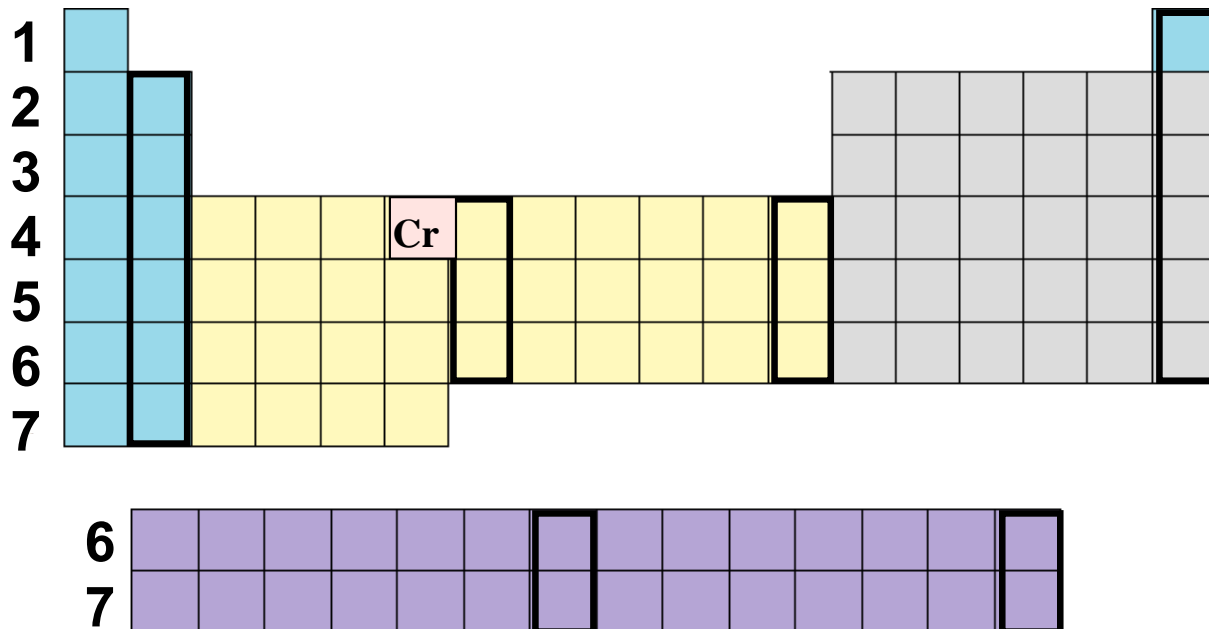
- A noble gases
- B halogens
- C alkali metals
- D transition elements

Electron Configuration Exceptions

Chromium

Expect: $[\text{Ar}] 4s^2 3d^4$ Actually: $[\text{Ar}] 4s^1 3d^5$

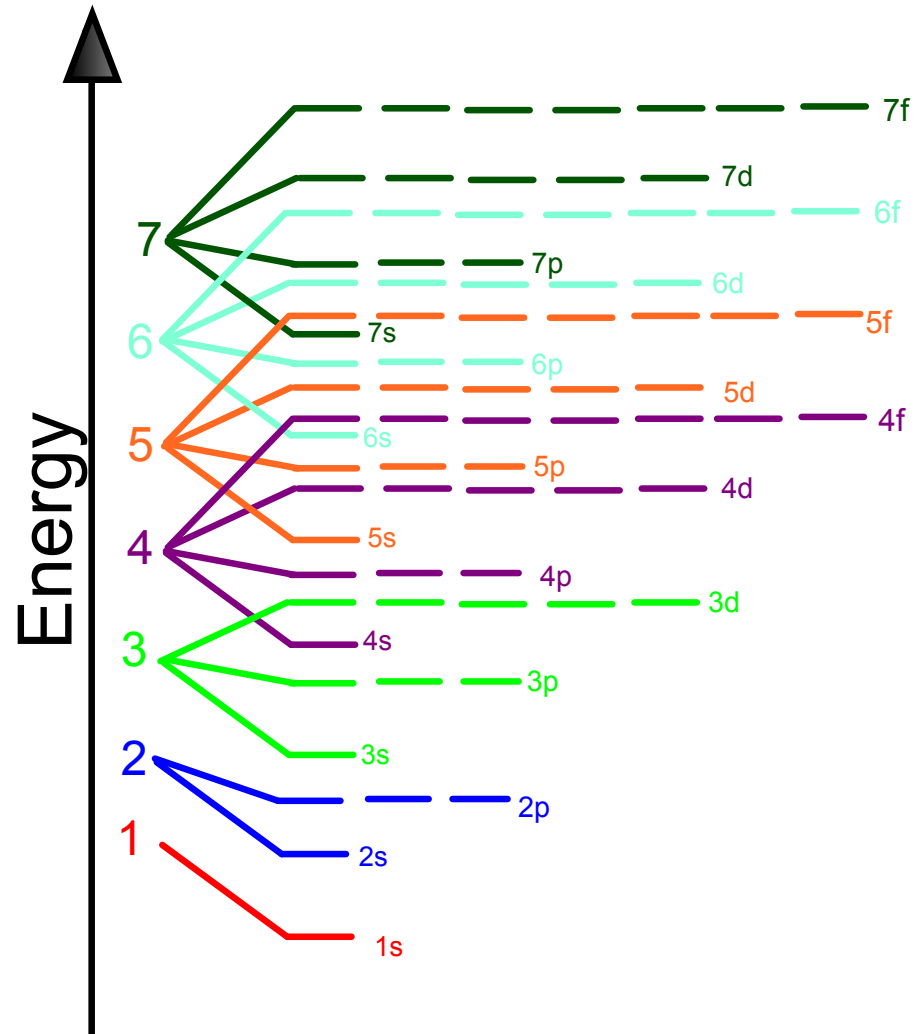
For some elements, in order to exist in a more stable state, electrons from an s sublevel will move to a d sublevel, thus providing the stability of a half-full sublevel. To see why this can happen we need to examine how "close" d and s sublevels are.



Energies of Orbitals

Because of how close the f and d orbitals are to the s orbitals, very little energy is required to move an electron from the s orbital (leaving it half full) to the f or d orbital, causing them to also be half full.

(It's kind of like borrowing a cup of sugar from a neighbor).

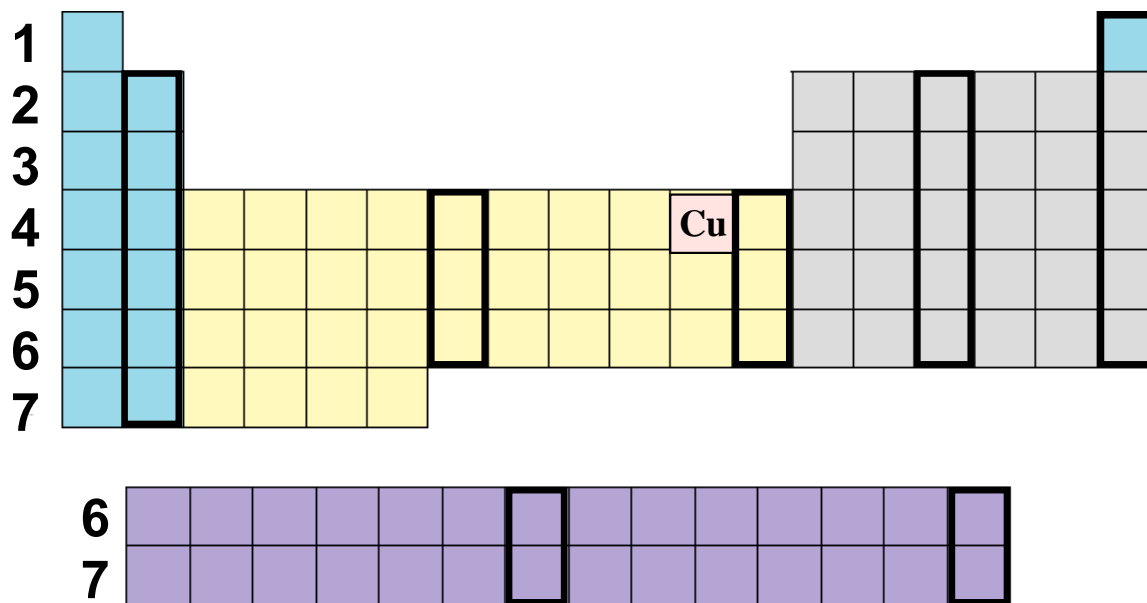


Electron Configuration Exceptions

Copper

Expected: $[\text{Ar}] 4s^2 3d^9$ Actual: $[\text{Ar}] 4s^1 3d^{10}$

Copper gains stability when an electron from the 4s orbital fills the 3d orbital.



27 The electron configuration for Copper (Cu) is

- A [Ar] 4s²4d⁹
- B [Ar] 4s¹4d⁹
- C [Ar] 4s²3d⁹
- D [Ar] 4s¹3d¹⁰

28 What would be the shorthand electron configuration for Silver (Ag)?

- A $[\text{Kr}]5s^25d^9$
- B $[\text{Ar}]5s^14d^{10}$
- C $[\text{Kr}]5s^24d^9$
- D $[\text{Kr}]5s^14d^{10}$

29 What would be the shorthand electron configuration for Molybdenum (Mb)?

- A $[\text{Kr}]5s^25d^4$
- B $[\text{Ar}]5s^24d^4$
- C $[\text{Kr}]5s^14d^5$
- D $[\text{Kr}]5s^24d^4$

Effective Nuclear Charge and Coulomb's Law

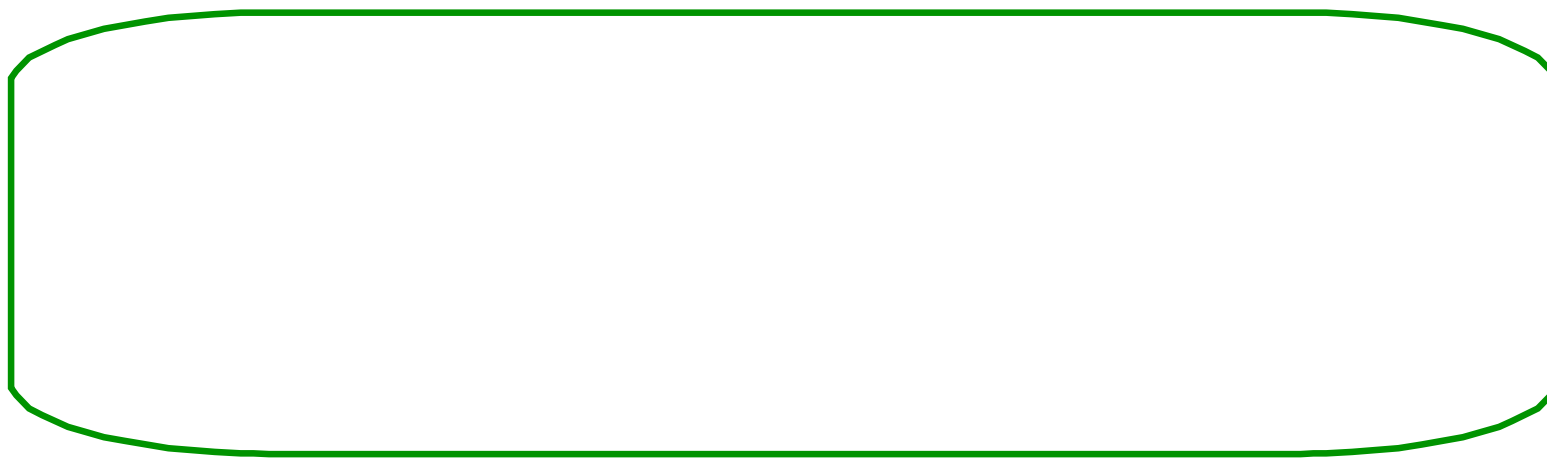
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Periodic Trends

There are four main trends in the periodic table:

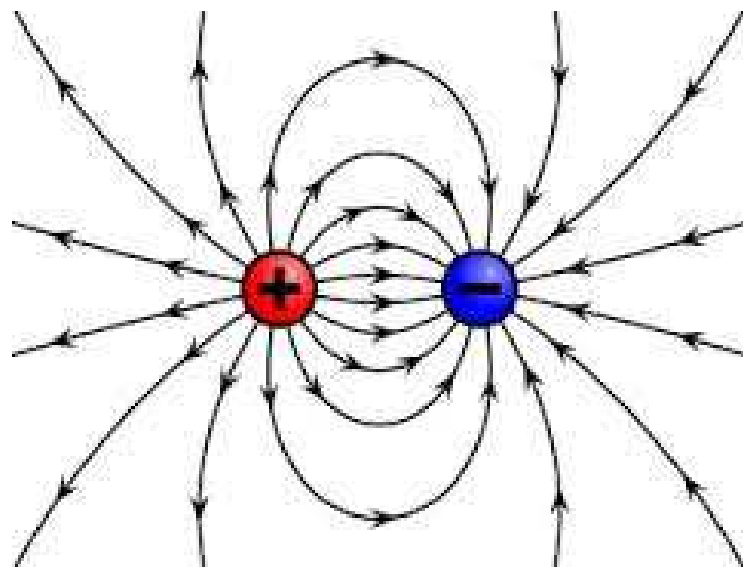
- Radius of atoms
- Electronegativity
- Ionization Energy
- Metallic Character

These four periodic trends are all shaped by the interactions between the positive charge of the atomic nucleus and the negative charge of electrons. How do these charges interact with each other?



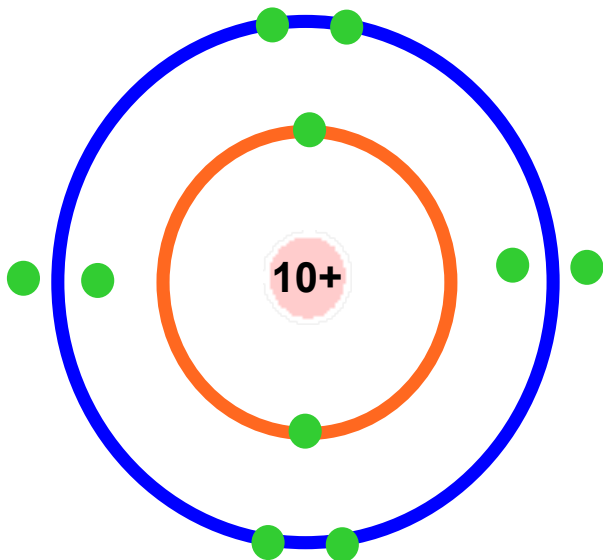
Periodic Trends

Remember that like charges repel and opposite charges attract. The positive protons are attracted to the negative electrons. The negative electrons, on the other hand, are repelled by neighboring electrons.



Atom Diagrams

Atoms of an element are often depicted showing total number of electrons in each energy level, like the diagram below:



For example, Neon's electron configuration:



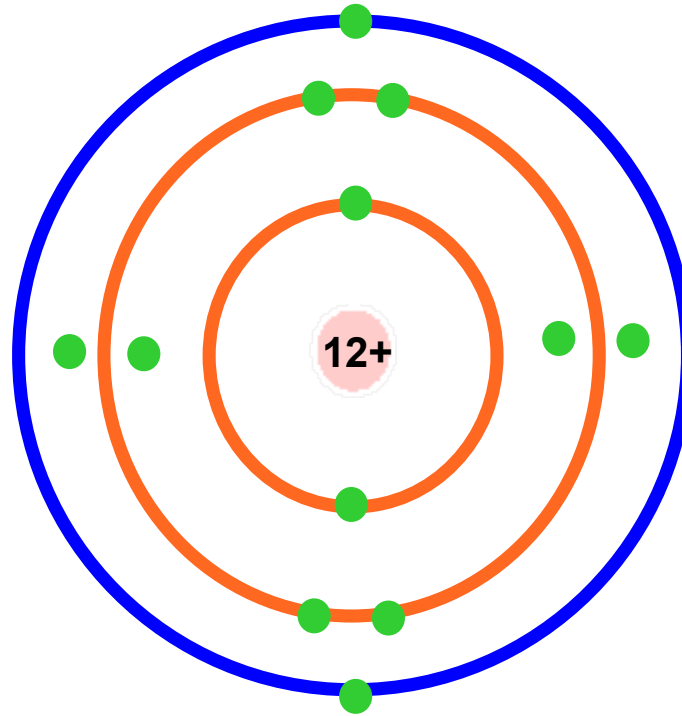
2 electrons
in inner energy levels

8 electrons
in the outer energy level.

These outer electrons are called valence electrons.

30 How many valence electrons does magnesium have?

- A 2
- B 8
- C 10
- D 12



31 Which of the following elements has the largest amount of inner shell electrons: aluminum, silicon or phosphorus?

A Al

B Si

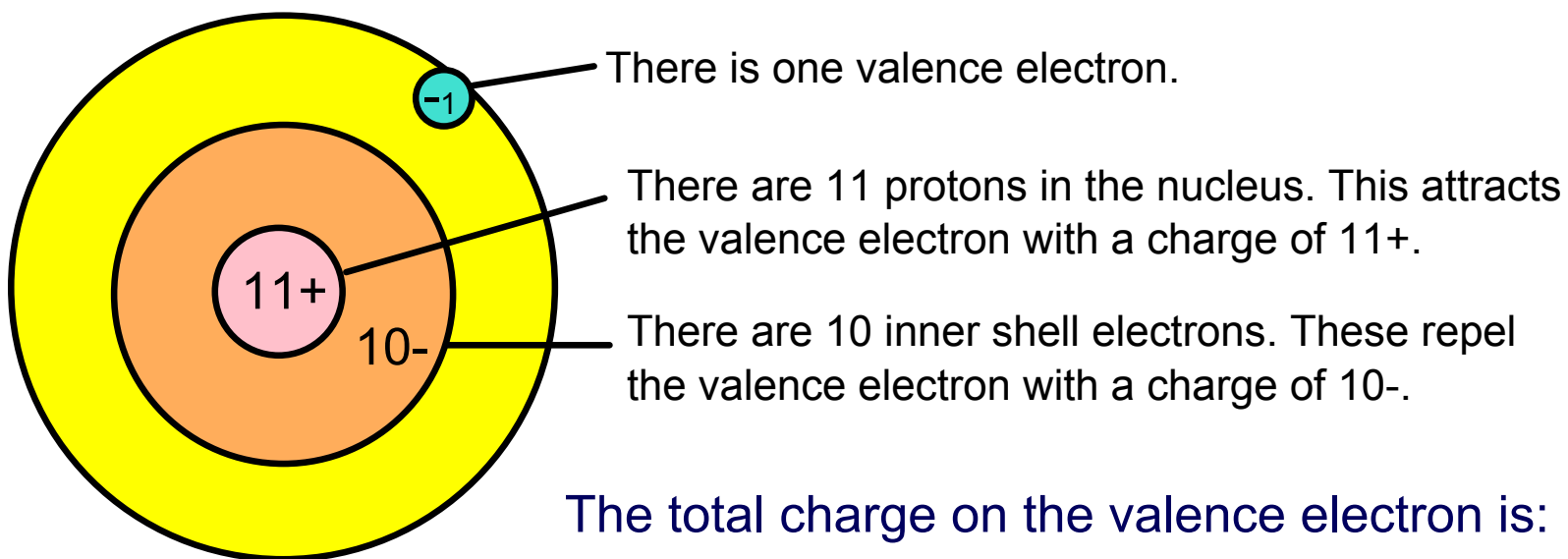
C P

D They all have the same number of inner shell electrons.

Effective Nuclear Charge

In a multi-electron atom, electrons are both attracted to the positive nucleus and repelled by other electrons.

The nuclear charge that an electron experiences depends on both factors. For example, the valence electron of sodium is attracted to the positive nucleus but is repelled by the negative inner electrons.

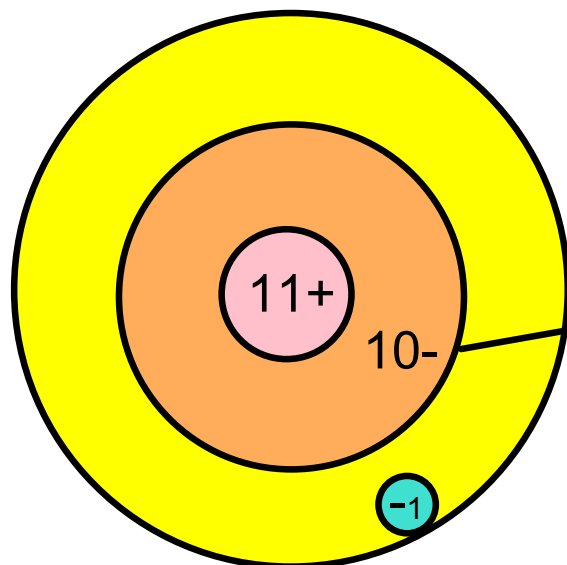


The total charge on the valence electron is:

$$+11 + -10 = +1$$

Effective Nuclear Charge

The inner shell electrons prevent the valence electron from feeling the full attractive force of the positive protons. In other words, the inner electrons are shielding the valence electrons from the nucleus.



These 10 inner electrons prevent the 1 valence electron from feeling the full attractive force of the 11 protons.

Effective Nuclear Charge

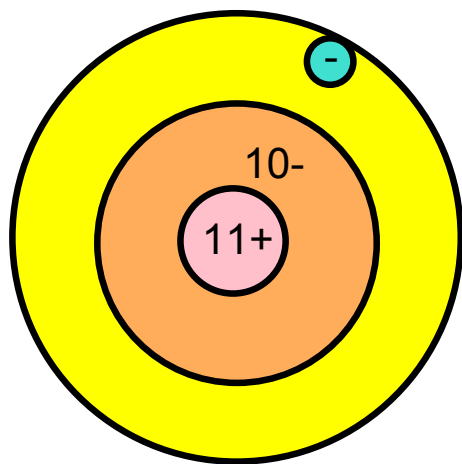
Effective nuclear charge is the amount of charge that the outer electron actually feels.

The formula for effective nuclear charge is:

$$Z_{\text{eff}} = Z - S$$

Z is the atomic number (the number of protons).

S is the shielding constant, the number of inner electrons that shields the valence electrons from the protons.



For sodium:

$$Z_{\text{eff}} = 11 - 10 = 1$$

Effective Nuclear Charge

Beryllium, boron and carbon are all in the same period of the periodic table. Compare their shielding constants.

Beryllium

Move for answer.

Boron

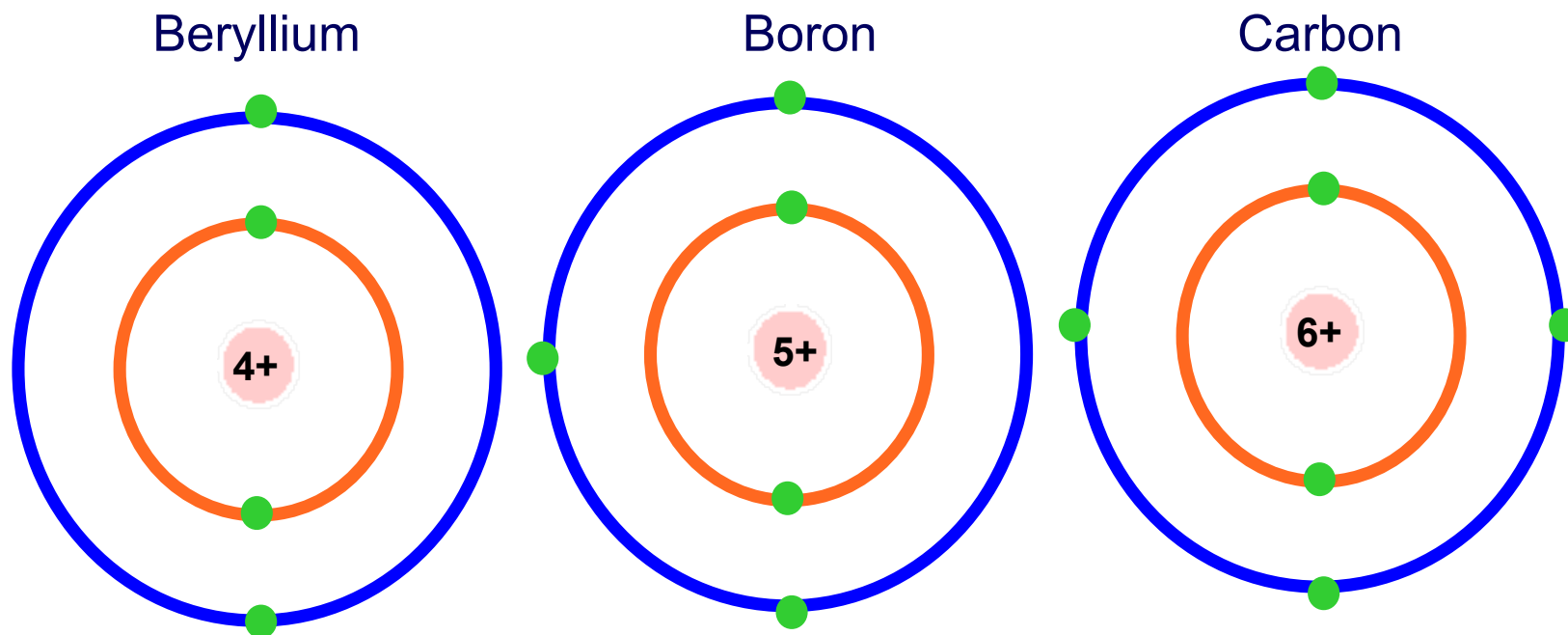
Move for answer.

Carbon

Move for answer.

Effective Nuclear Charge

Elements in the same period will have the same shielding constant because their valence electrons are located in the same energy level.



Each has a different atomic number. Boron and carbon have different subshells from beryllium. BUT, they are all in the same energy level, so they have the same number of shielding electrons.

Effective Nuclear Charge

Now look at effective nuclear charge. Compare the values for beryllium, boron and carbon.

Beryllium

Move for answer.

Boron

Move for answer.

Carbon

Move for answer.

What do these values tell you?

32 What is the shielding constant, S , for Boron (B)?



33 What is the effective nuclear charge, Z_{eff} on electrons in the outer most shell for Boron?

34 What is the shielding constant, S , for Aluminum (Al)?



35 What is the effective nuclear charge on electrons in the outer most shell for Aluminum?

36 Which of the following would have the highest effective nuclear charge?

- A Aluminum
- B Phosphorus
- C Chlorine
- D Neon

37 In which subshell does an electron in an arsenic (As) atom experience the greatest shielding?

- A 2p
- B 4p
- C 3s
- D 1s



38 Two elements are studied: one with atomic number X and one with atomic number $X+1$. Assuming element X is not a noble gas, which element has the larger shielding constant?

- A Element X
- B Element $X+1$
- C They are both the same.
- D More information is needed.

39 Two elements are studied: one with atomic number X and one with atomic number $X+1$. It is known that element X is a noble gas. Which element has the larger shielding constant?

- A Element X
- B Element $X+1$
- C They are both the same.
- D More information is needed.

40 In which subshell does an electron in a calcium atom experience the greatest effective nuclear charge?

- A 1s
- B 2s
- C 2p
- D 3s



41 Compare the following elements: potassium, cobalt and selenium. Which atom feels the strongest attractive force between the nucleus and the valence electrons?

- A K
- B Co
- C Se
- D They all experience the same magnitude of force.

Coulomb's Law

The magnitude of the force between the protons in the nucleus and electrons in the orbitals can be calculated using Coulomb's Law.

$$F = \frac{kq_1 q_2}{r^2}$$

k = Coulomb's constant

q_1 = the charge on the first object

q_2 = the charge on the second object

r^2 = the distance between the two objects

42 According to Coulomb's Law, the stronger the charge of the objects, the ____ the force between the objects.

A stronger

B weaker

$$F = \frac{kq_1 q_2}{r^2}$$

43 According to Coulomb's Law, the greater the distance between two objects, the ____ the force between the objects.

A stronger

B weaker

$$F = \frac{kq_1 q_2}{r^2}$$

Hydrogen

Applying Coulomb's Law to atoms provides useful information about those atoms.

Consider hydrogen. Z_{eff} for hydrogen is 1.

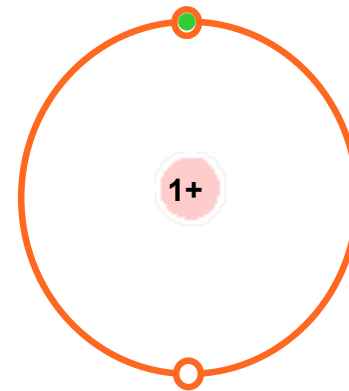
$$Z_{\text{eff}} = 1 \text{ proton} - 0 \text{ inner electron}$$

$$Z_{\text{eff}} = 1$$

The charge between the valence electron and the nucleus is $1e$.

Plugging this into Coulomb's Law:

$$F = \frac{kq_1 q_2}{r^2} \longrightarrow F = \frac{kZ_{\text{eff}}(e)^2}{r^2} \longrightarrow F = \frac{ke^2}{r^2}$$



Helium

Now let's apply Coulomb's Law to helium.

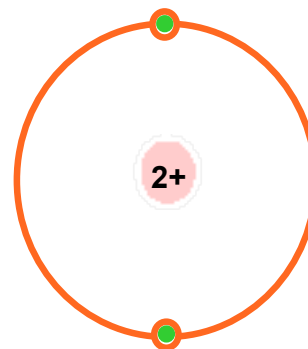
Z_{eff} for hydrogen is 2.

$Z_{\text{eff}} = 2$ protons - 0 inner electron

$Z_{\text{eff}} = 2$

The charge between the valence electron and the nucleus is $2e$.

Plugging this into Coulomb's Law:



$$F = \frac{kq_1 q_2}{r^2} \longrightarrow F = \frac{kZ_{\text{eff}}(e)^2}{r^2} \longrightarrow F = \frac{k(2e)^2}{r^2}$$

Hydrogen vs Helium

Now we can compare hydrogen and helium.

Hydrogen

The force between the valence electron and the nucleus is:

$$F = \frac{ke^2}{r^2}$$

Helium

The force between the valence electrons and the nucleus is:

$$F = \frac{k(2e)^2}{r^2}$$

(Initially, the radius is the same for both since both have valence electrons in the same energy level.)

The force between the nucleus and the electrons in helium is much larger than the force between the nucleus and the electron in hydrogen.

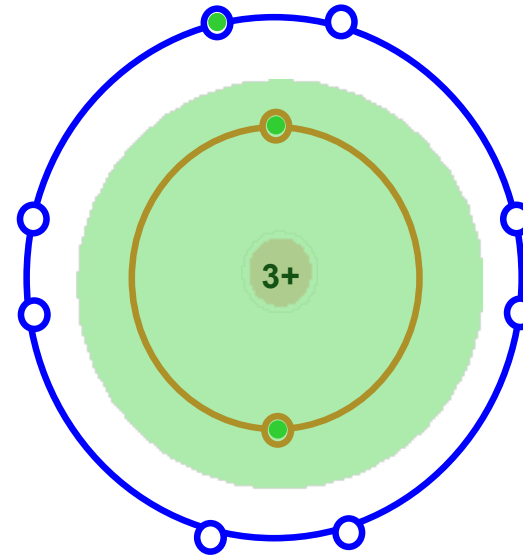
How does this affect the radii of the atoms?

Lithium

$$Z_{\text{eff}} = Z - S$$

$$Z_{\text{eff}} = 3 - 2$$

$$Z_{\text{eff}} = 1$$

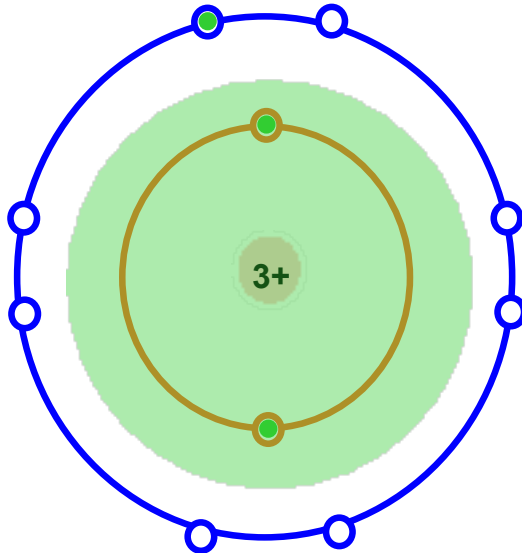


Plugging this into Coulomb's Law:

$$F = \frac{kq_1 q_2}{r^2} \longrightarrow F = \frac{kZ_{\text{eff}}(e)^2}{r^2} \longrightarrow F = \frac{ke^2}{r^2}$$

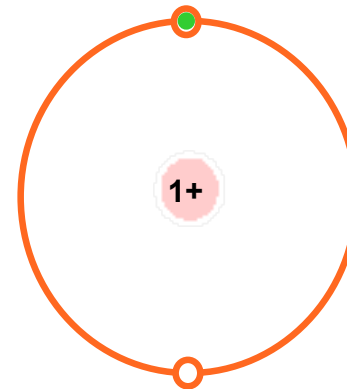
Lithium vs Hydrogen

Lithium



$$F = \frac{ke^2}{r^2}$$

Hydrogen



$$F = \frac{ke^2}{r^2}$$

The Z_{eff} is the same for both atoms. However, lithium has valence electrons in a higher energy level.

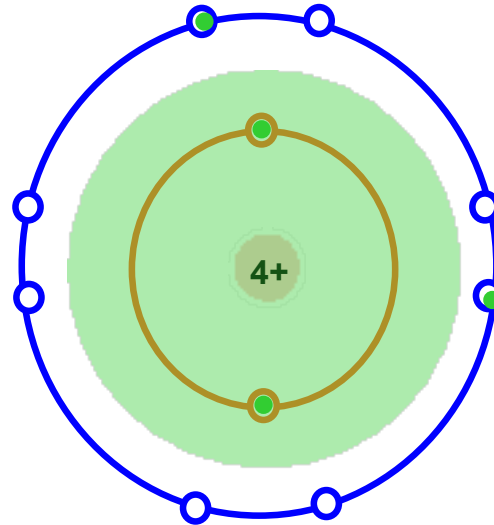
How does this affect the radii of the atoms?

Beryllium

$$Z_{\text{eff}} = Z - S$$

$$Z_{\text{eff}} = 4 - 2$$

$$Z_{\text{eff}} = 2$$



Plug this into Coulomb's Law.

$$F = \frac{kq_1 q_2}{r^2}$$

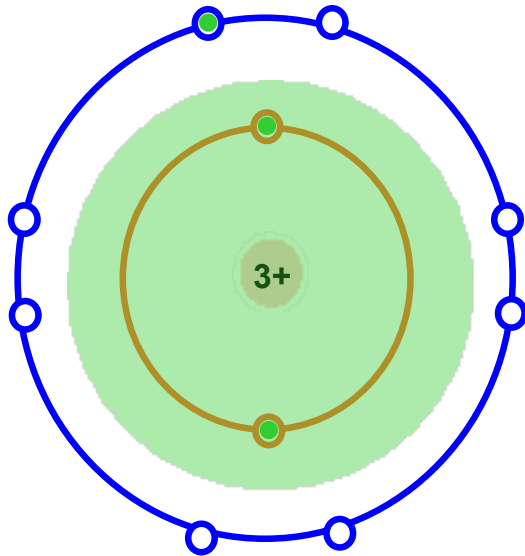


Slide for
answer.



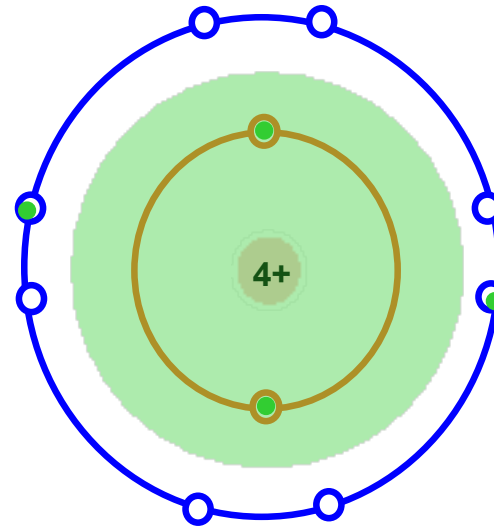
Lithium vs Beryllium

Lithium



$$F = \frac{ke^2}{r^2}$$

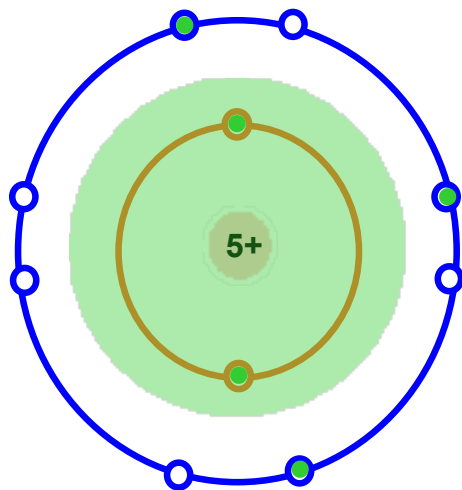
Beryllium



$$F = \frac{k(2e)^2}{r^2}$$

How do the radii of beryllium and lithium compare?

44 What is Z_{eff} for Boron (B)?



45 Compare the radial size of boron to lithium and beryllium.

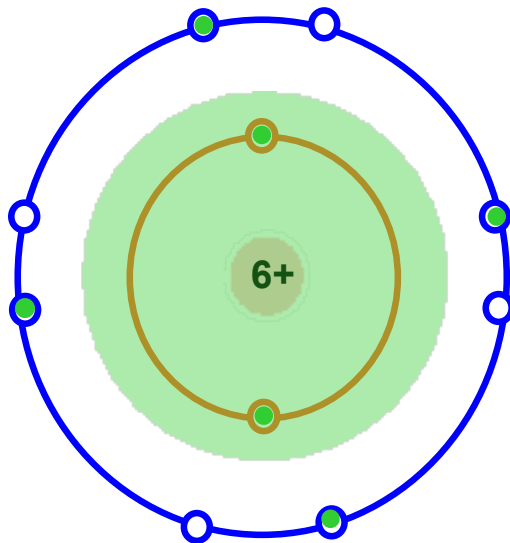
A $\text{Li} > \text{Be} > \text{B}$

B $\text{Li} < \text{Be} < \text{B}$

C $\text{Li} > \text{B} > \text{Be}$

D $\text{Be} < \text{Li} < \text{B}$

46 What is Z_{eff} for Carbon (C)?



47 Compare the radial size of carbon to boron and nitrogen.

A $C > N > B$

B $C < N < B$

C $B > C > N$

D $B < C < N$

48 Which of the following equations correctly calculates the Coulombic force between the valence electrons and the nucleus of an oxygen atom?

A $F = k(2e)^2/r^2$

B $F = k(4e)^2/r^2$

C $F = k(6e)^2/r^2$

D $F = k(8e)^2/r^2$

49 Give the atomic number of the smallest element in the 2nd period.

Periodic Trends: Atomic Radius

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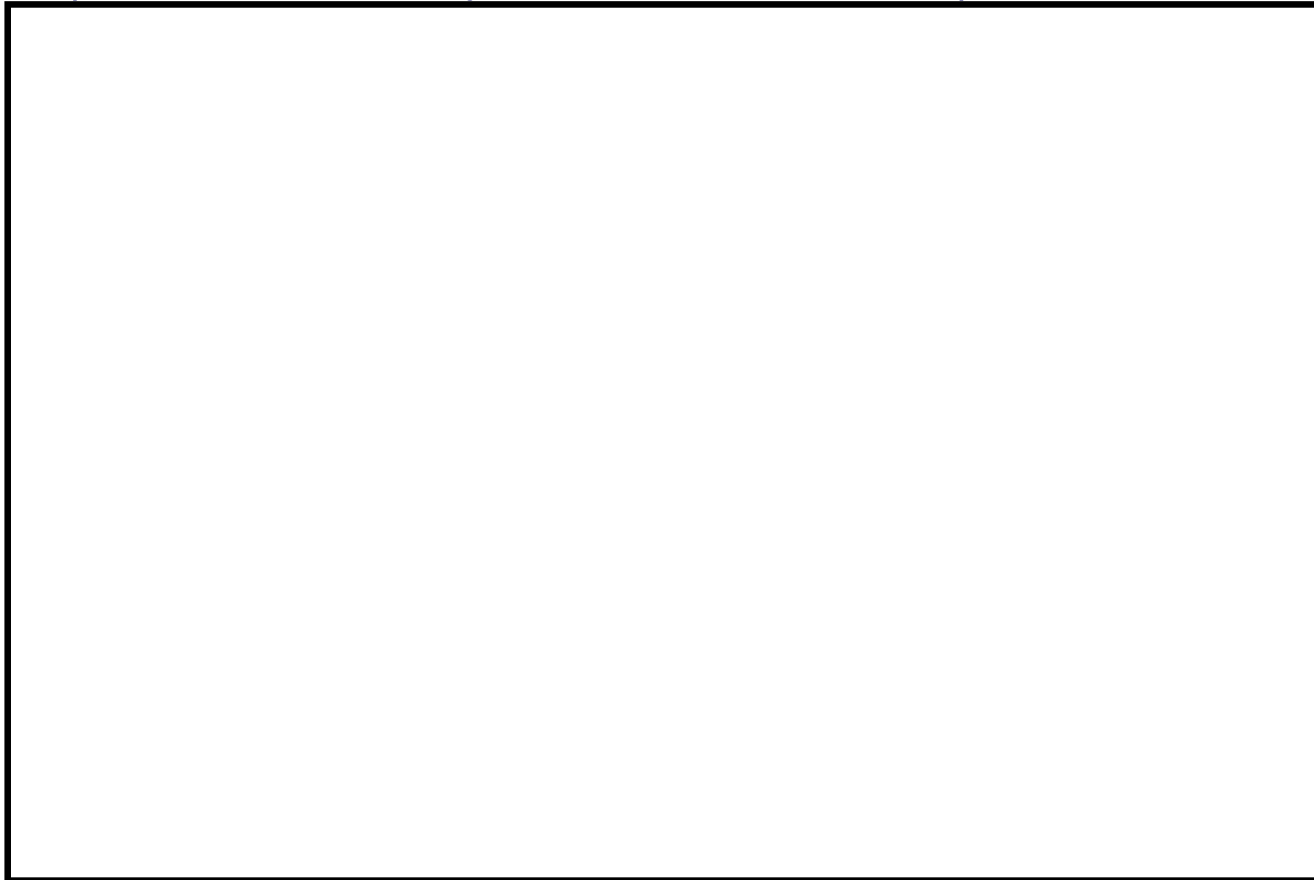
50

Atomic Radii Trend

What is the trend in atomic size across a period?

What is the trend in atomic size down a group?

(Pull the box away to see the answers.)



51 Across a period from left to right Z_{eff} _____.

- A increases
- B decreases
- C remains the same

52 Down a group from top to bottom Z_{eff} _____.

- A increases
- B decreases
- C remains the same

53 Atomic radius generally increases as we move

_____.

- A down a group and from right to left across a period
- B up a group and from left to right across a period
- C down a group and from left to right across a period
- D up a group and from right to left across a period

54 Which one of the following atoms has the smallest radius?

A O

B F

C S

D Cl

55 Which one of the following atoms has the largest radius?

A Cs

B Al

C Be

D Ne

56 Which one of the following atoms has the smallest radius?

A Fe

B N

C S

D I

57 Of the following, which gives the correct order for atomic radius for Mg, Na, P, Si and Ar?

A Mg > Na > P > Si > Ar

B Ar > Si > P > Na > Mg

C Si > P > Ar > Na > Mg

D Na > Mg > Si > P > Ar

58 Which of the following correctly lists the five atoms in order of increasing size (smallest to largest)?

- A O < F < S < Mg < Ba
- B F < O < S < Mg < Ba
- C F < O < S < Ba < Mg
- D F < S < O < Mg < Ba

59 Two elements are studied. One with atomic number X and one with atomic number $X+1$. Assuming element X is not a Noble Gas, which element has the larger atomic radius?

- A Element X
- B Element $X+1$
- C They are both the same.
- D More information is needed.

60 Two elements are studied. One with atomic number X and one with atomic number $X+1$. It is known that element X is a Noble Gas. Which element has the larger atomic radius?

- A Element X
- B Element $X+1$
- C They are both the same.
- D More information is needed.

Summary of Atomic Radius Trends

- Across a period, effective nuclear charge increases while energy level remains the same. The force of attraction between the nucleus and valence electrons gets stronger. Valence electrons are pulled in tighter, so radius gets smaller.

$$F = \frac{kq_1 q_2}{r^2}$$

This value gets larger, so force is larger. (Radius is smaller.)

- Down a period, effective nuclear charge remains the same while the energy level increases. The increased distance from the nucleus to valence electrons makes the force of attraction decrease. Electrons are not held as tightly, so radius gets larger.

$$F = \frac{kq_1 q_2}{r^2}$$

This value gets larger, so force is smaller. (Radius is larger.)

[Click here for an animation on the atomic radius trend.](#)

Periodic Trends: Ionization Energy

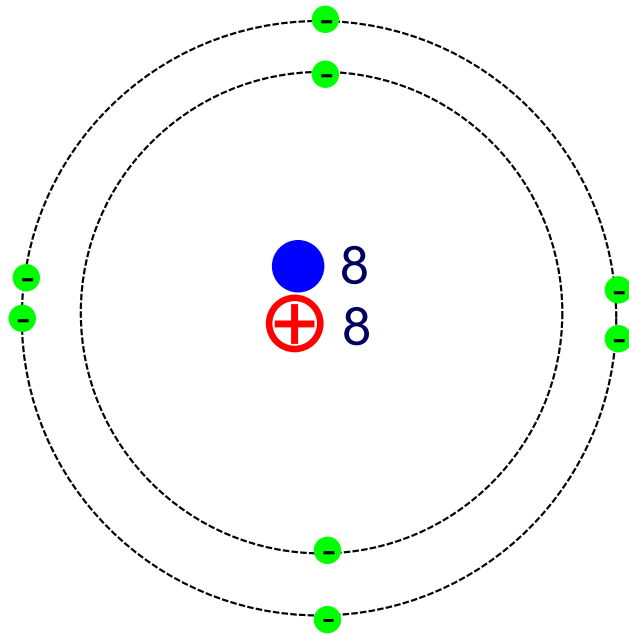
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Ionization Energy

Atoms of the same element have equal numbers of protons and electrons.

Neutral Oxygen ---> 8 (+) protons and 8 (-) electrons

Neutral Magnesium ---> 12 (+) protons and 12 (-) electrons



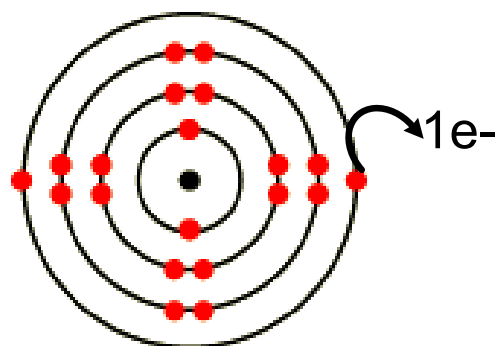
$$\begin{array}{r}
 \oplus 8 \\
 + \ominus 8 \\
 \hline
 0 \text{ charge} \quad \text{Neutral atom}
 \end{array}$$

Ionization Energy

The ionization energy is the amount of energy required to remove an electron from an atom.

Removing an electron creates a positively charged atom called a cation.

Calcium cation

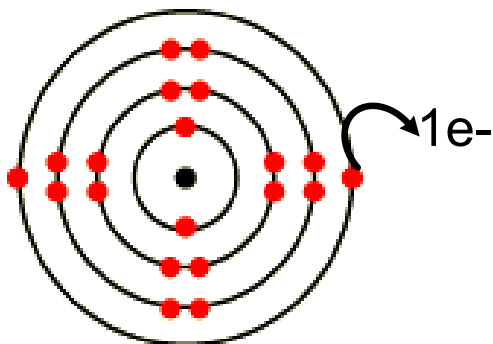


$$\begin{array}{r} \oplus 20 \\ + \ominus 19 \\ \hline +1 \text{ charge} \end{array}$$

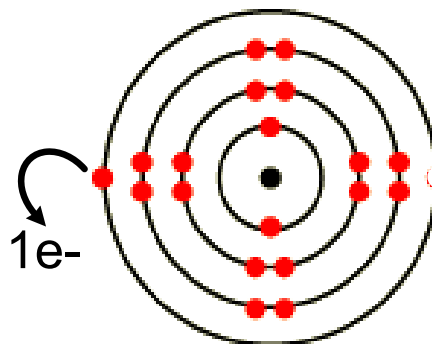
Ionization Energy

The ionization energy is the amount of energy required to remove an electron from an atom. Removing an electron creates a positively charged atom called a cation.

The first ionization energy is the energy required to remove the first electron.



The second ionization energy is the energy required to remove the second electron, etc.



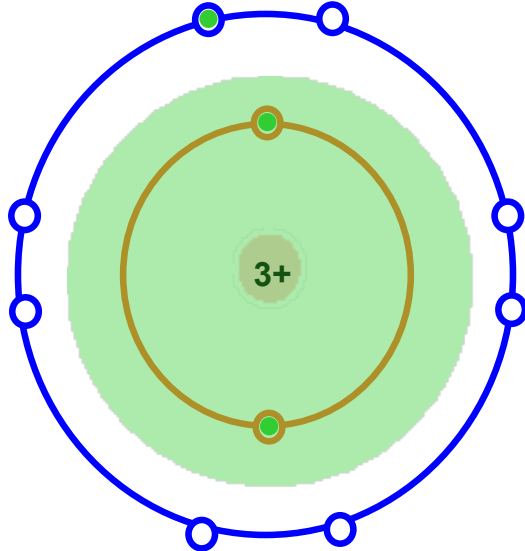
61 If an electron is removed from a sodium (Na) atom, what charge does the Na cation have?

62 If two electrons are removed from a Magnesium (Mg) atom, what charge does the Mg cation have?

Lithium vs Beryllium

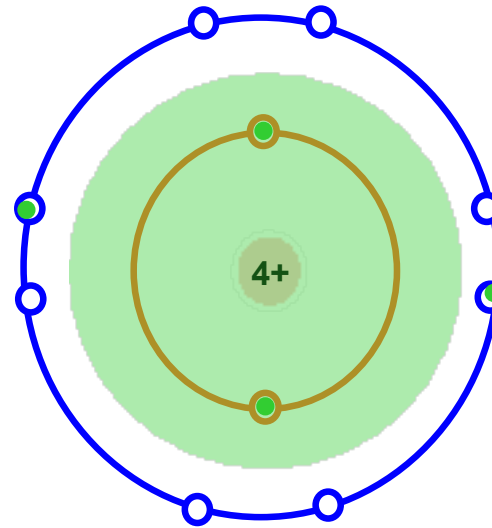
Applying Coulomb's Law helps us to understand how ionization energy changes among elements.

Lithium



$$F = \frac{ke^2}{r^2}$$

Beryllium

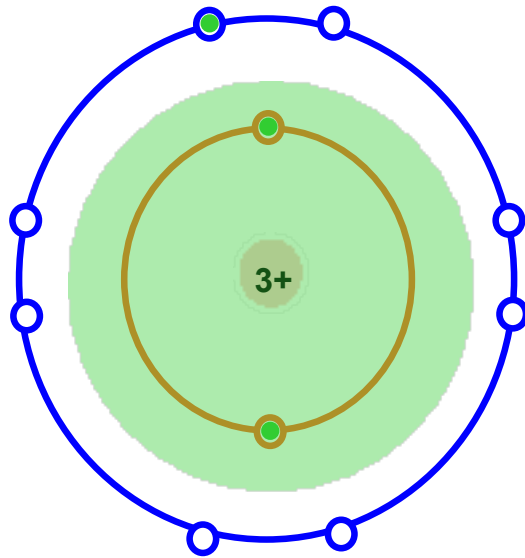


$$F = \frac{k(2e)^2}{r^2}$$

Which atom is held together more closely?

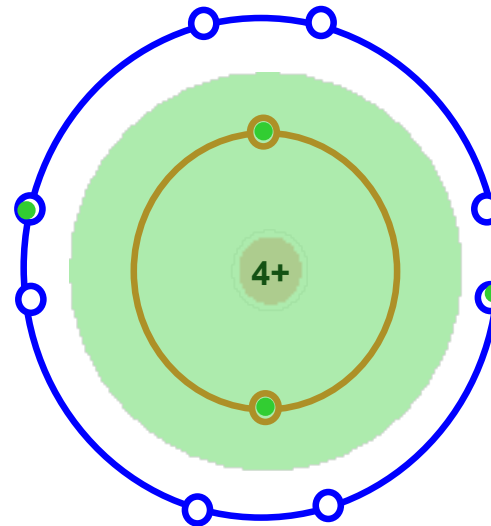
Lithium vs Beryllium

Lithium



$$F = \frac{ke^2}{r^2}$$

Beryllium



$$F = \frac{k(2e)^2}{r^2}$$

Since beryllium holds onto its electrons tighter, it will require more energy to take away an electron. The ionization energy of beryllium is higher than lithium.

Ionization Energy and Coulomb's Law

As the force increases, the atom holds onto electrons tighter. These electrons will require more energy (ionization energy) to take them away than an atom with a lower force.

As force increases, ionization energy increases.

Think back to atomic radius. How does atomic radius relate to Coulomb's Law? How does it relate to ionization energy?

Trends in First Ionization Energies

Compare ionization energies for magnesium, aluminum and silicon.

First, find Coulomb's equation for each. Then, order the elements in increasing ionization energy.

Magnesium

Pull for
answer →

Aluminum

Pull for
answer →

Silicon

Pull for
answer →

Increasing order of ionization energies:

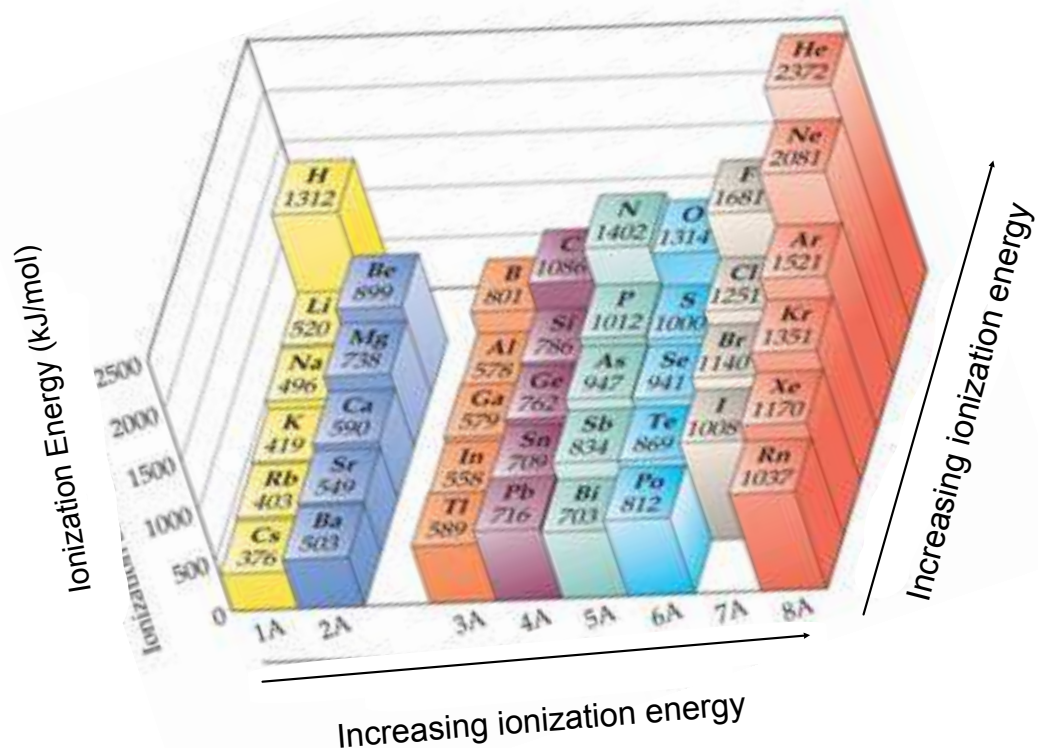
Pull for answer →

How does ionization energy change as you go across a period?

Trends in First Ionization Energies

Across a period, Z_{eff} increases and the force on electrons increases. This makes it harder for an electron to be taken away.

Ionization energy increases across a period.



Trends in First Ionization Energies

Compare ionization energies for sodium and potassium.

First, find Coulomb's equation for each. Then, order the elements in increasing ionization energy.

Sodium

Pull for
answer →

Potassium

Pull for
answer →

Increasing order of ionization energies:

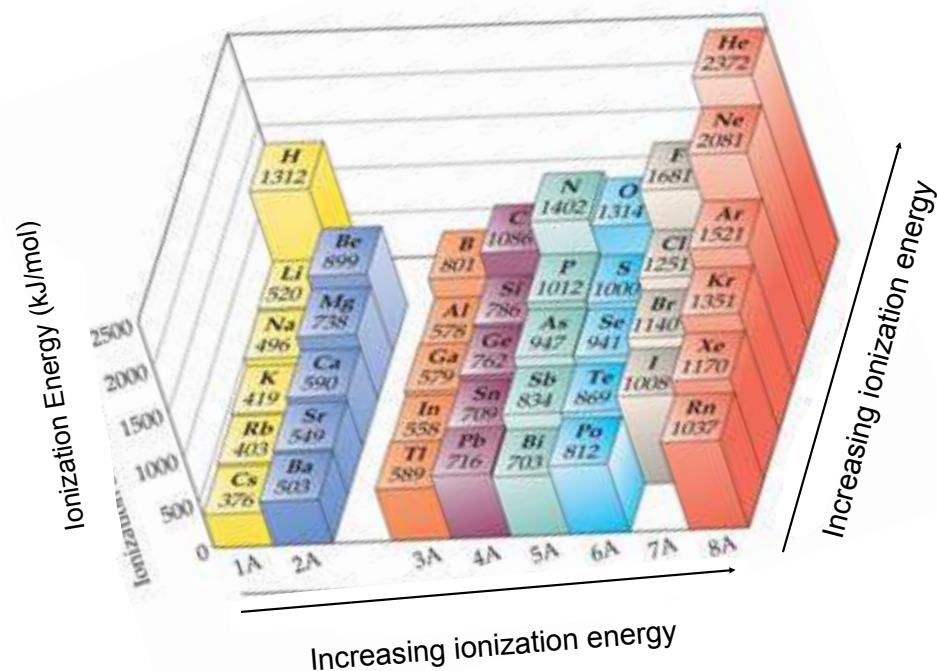
Pull for answer →

How does ionization energy change as you go down a group?

Trends in First Ionization Energies

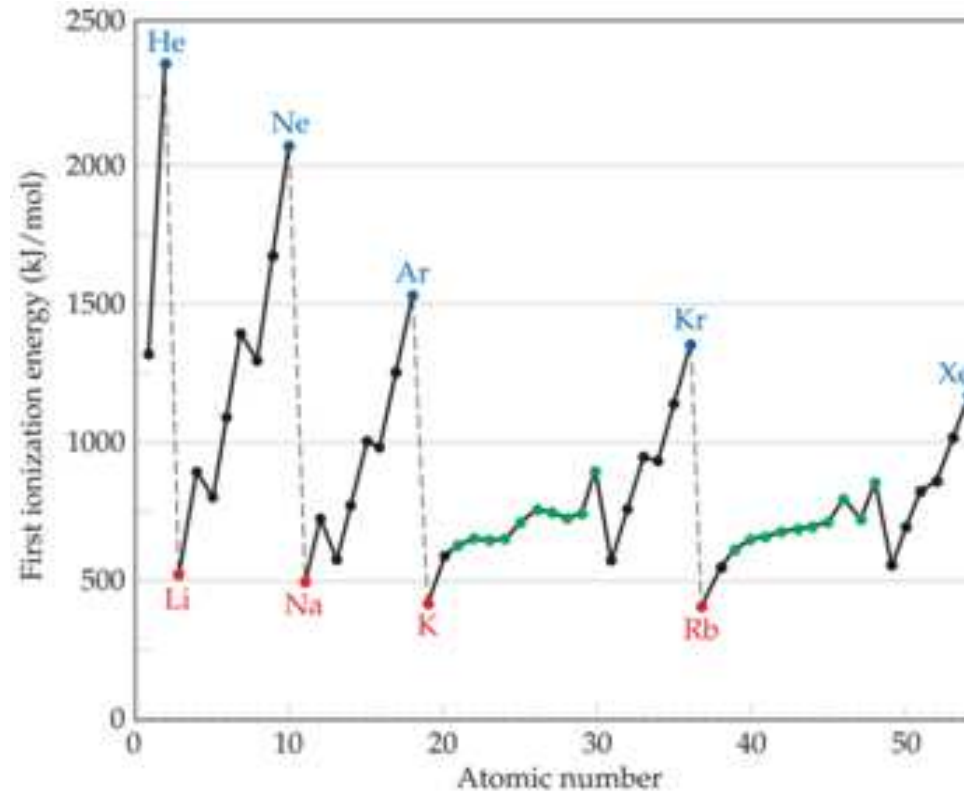
Down a group, Z_{eff} stays the same but the extra energy levels make the radius larger which make the force less. It is easier to take electrons away.

Ionization energy decreases as you go down a period.



[Click here for an animation on Ionization Energy](#)

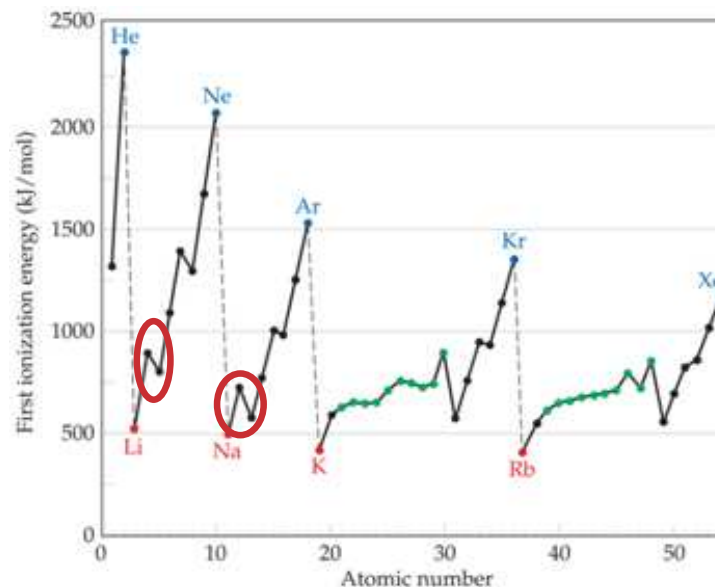
Trends in First Ionization Energies



However, there are two apparent discontinuities in this trend.

Discontinuity #1

The first is between Groups 2 and 13 (3A). As you can see on the chart to the right, the ionization energy actually decreases from Group 2 to Group 13 elements. The electron removed for Group 13 elements is from a p orbital and removing this electron actually adds stability.

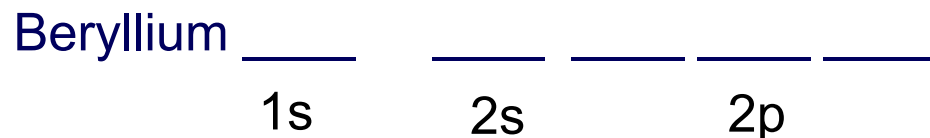
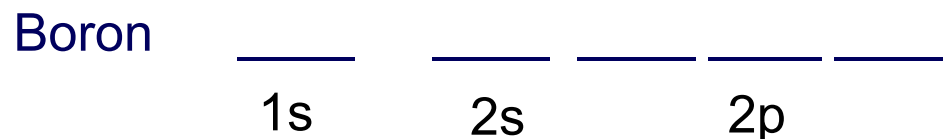


The electron removed is farther from nucleus, there is a small amount of repulsion by the s electrons.

The atom gains stability by having a full s orbital, and an empty p orbital.

Discontinuity #1

More energy is required to remove an electron from Group 2 elements than Group 13 elements. Draw the orbital diagrams for Group 2 Boron and Group 13 Beryllium to illustrate why.



The atom gains stability by having a full *s* orbital, and an empty *p* orbital.

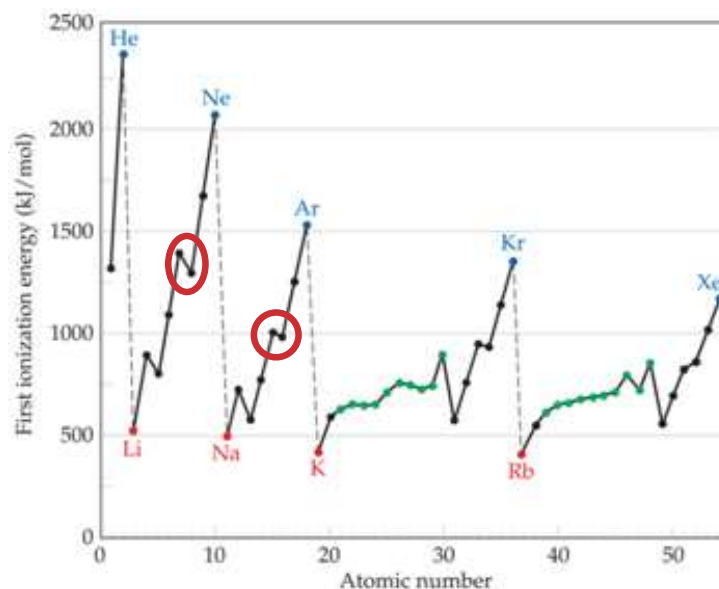
63

Discontinuity #2

Students type their answers here

The second is between
Groups 15 and 16.

Using your knowledge of electron configurations and the stability of atoms explain why the first ionization energy for a Group 16 element would be less than that for a Group 15 element in the same period.



64 Of the elements below, _____ has the largest first ionization energy.

A Li

B K

C Rb

D H

65 Of the following atoms, which has the largest first ionization energy?

A Br

B O

C C

D P

66 Of the following elements, which has the largest first ionization energy?

A Na

B Al

C Se

D Cl

67 Which noble gas has the lowest first ionization energy (enter the atomic number)?

Periodic Trends: Electronegativity

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Electronegativity

Electronegativity is the ability of an atom to attract other electrons.

Using Coulomb's Law, an atom with a high attractive force with its own electrons will also have a high attractive force with other electrons.

Use Coulomb's Law to rank boron, carbon and nitrogen in terms of increasing force.

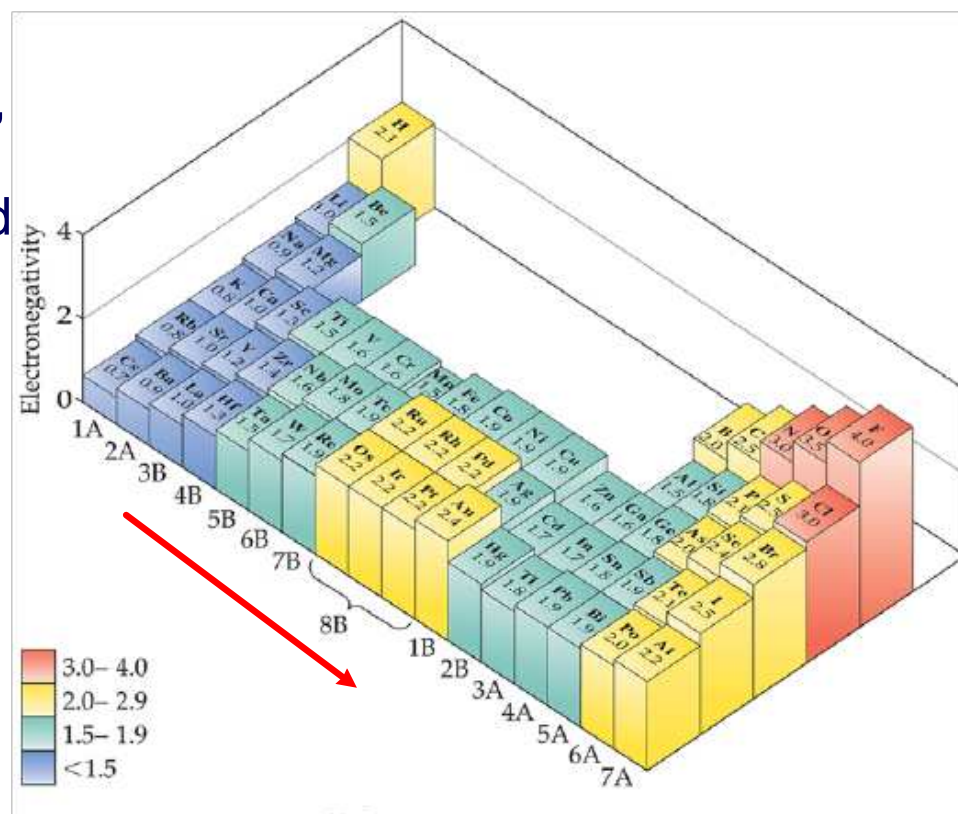
Pull for answer 

How does electronegativity relate to ionization energy and atomic radius?

Electronegativity Trends

As you go across a period, the Z_{eff} increases and the force between nucleus and electrons increases. As this force increases, it is easier for the atom to attract other electrons, so electronegativity increases.

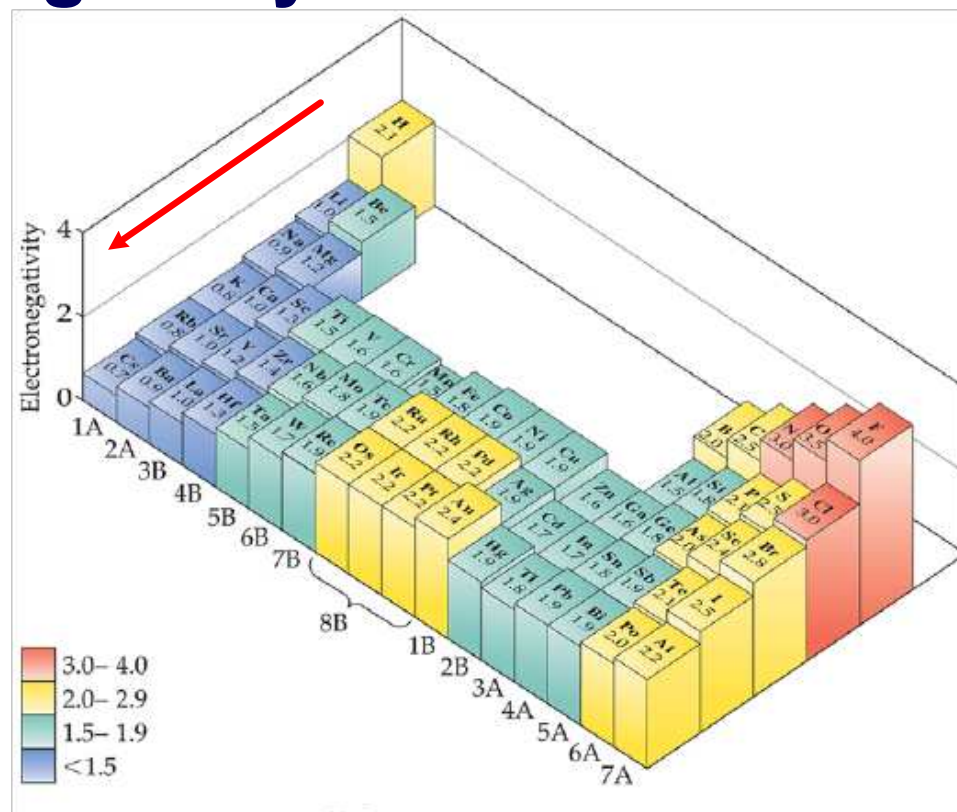
Electronegativity increases as you go across a period.



Electronegativity Trends

As you go down a group, the increased energy levels increase the radius. The force between nucleus and electrons decreases and it is harder for the atom to attract other electrons.

Electronegativity decreases down a group.





Electronegativity Exception #1

The Noble Gases are some of the smallest atoms, but are usually left out of electronegativity trends since they neither want electrons nor want to get rid of electrons.

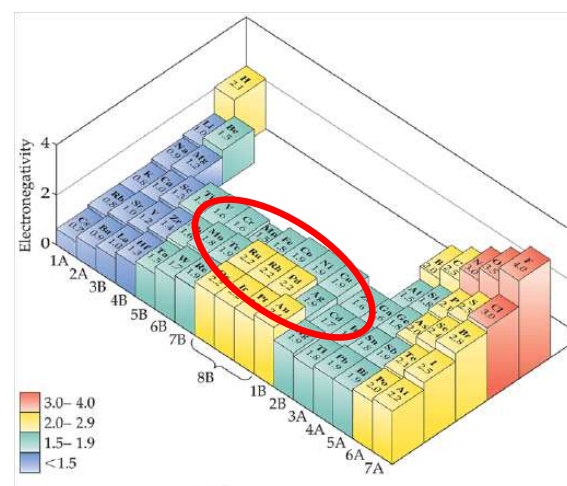
Using your knowledge of electron configurations, why do you think noble gases are left out of electronegativity trends?



Electronegativity Exception #2

The Transition Metals have some unexpected trends in electronegativity because of their d and sometimes f orbitals.

The electrons located in the 3d orbitals (and all d and f orbitals after that) do not contribute as much to the shielding constants of the elements as electrons in the s and p orbitals.



As such, elements with configurations that end in a **d** or **f** orbital will frequently have atomic radii that do not match up with the normal trend.

68 The ability of an atom in a molecule to attract electrons is best quantified by its _____.

- A electronegativity
- B electron charge-to-mass ratio
- C atomic radius
- D number of protons

69 Electronegativity _____ from left to right within a period and _____ from top to bottom within a group.

- A decreases, increases
- B increases, increases
- C increases, decreases
- D decreases, decreases

70 Which of the following correctly ranks the elements from highest to lowest electronegativity?

- A $\text{Cl} > \text{S} > \text{P}$
- B $\text{Br} > \text{Cl} > \text{F}$
- C $\text{K} > \text{Na} > \text{Li}$
- D $\text{N} > \text{O} > \text{F}$

Summary of Electronegativity & First Ionization Energy Trends

Electronegativity & Ionization Energy increases left to right across a period.

Z_{eff} increases and the force of attraction between the nucleus and valence electrons is strengthened. More energy is required to remove these electrons.

Electronegativity & First Ionization Energy decrease going down a group.

The size of shells increases significantly. The distance between the nucleus and outer electrons increases. The force of attraction decreases.

*Additional Ionization Energies

It requires more energy to remove each successive electron.
 ie: *second* ionization energy is greater than *first*,
third ionization energy is greater than *second*, etc.

The periodic table below illustrates the trend of ionization energy. Red arrows indicate that ionization energy increases from left to right across a period and from bottom to top down a group.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Uuq	Uup	Uuh	Uus	Uuo
		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

When all valence electrons have been removed, leaving the atom with a full p subshell, the ionization energy becomes incredibly large.

71 An atom has the following values for its first four ionization energies. Which of the following elements would fit this data?

- A Li
- B Be
- C C
- D F

1st IE = 899.5 kJ/mol
2nd IE = 1,757 kJ/mol
3rd IE = 14,849 kJ/mol
4th IE = 21,007 kJ/mol

Periodic Trends: Metallic Character

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Metallic Character

For a metal to conduct electricity or heat, it needs to have electrons that are free to move through it, not tightly bound to a particular atom.

The metallic character of an element is a measure of how loosely it holds onto its outer electrons.



72

Metallic Character

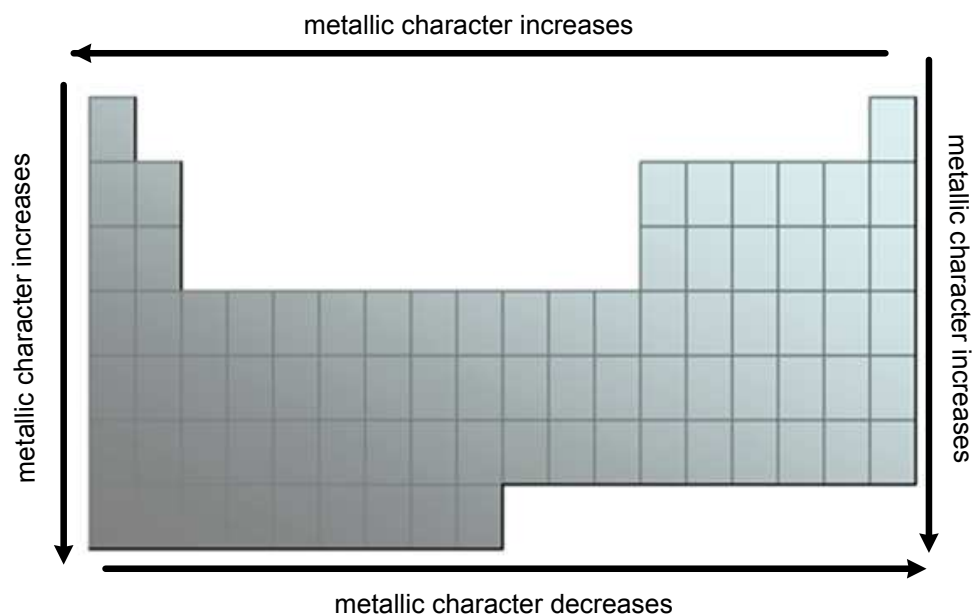
Students type their answers here

So the metallic character of an element is inversely related to its electronegativity.

On the periodic chart, metallic character increases as you go...

from right to left
across a row.

from the top to the
bottom of a column.



What is the relationship between first ionization energy and metallic character?

73 Because of the relationship between metallic character and electronegativity, you can say that metals tend to

_____.

- A take in electrons, becoming positive.
- B give off electrons, becoming negative.
- C take in electrons, becoming negative.
- D give off electrons, becoming positive.

74 Of the elements below, _____ is the most metallic.

- A Sodium
- B Magnesium
- C Calcium
- D Cesium

75 Which of the elements below is the most metallic.

A Na

B Mg

C Al

D K

76 Which of the atoms below is the most metallic?

A Br

B O

C Cl

D N

77 Which of the atoms below is the most metallic?

- A Si
- B Cl
- C Rb
- D Ca

