

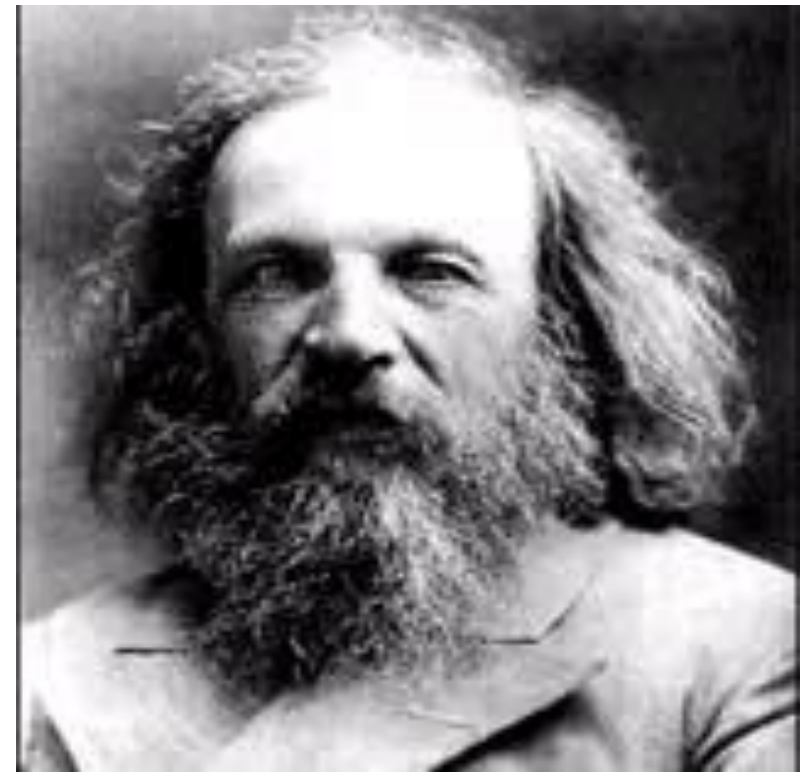
Unit 3 – The Periodic Table, Electron Configuration, & Periodic Trends

Chapters 4 & 5

Creation of the Periodic Table

Mendeleev's Table

THE PERIODICITY OF THE ELEMENTS										
The Elements	Their Properties in the Free State				The Composition of the Hydrogen and Organic-metallic Compounds	Symbols and Atomic Weights	The Composition of the Saline Oxides	The Properties of the Saline Oxides	Small Periods or Series	
	<i>t</i>	<i>a</i>	<i>d</i>	$\frac{A}{Z}$	$\frac{RH_2}{R_2(CH_4)}$ or $\frac{R_2}{R_2(CH_4)}$	B A	R_2O_x	$\frac{d(2A + n/16)}{d}$	$\frac{d(2A + n/16)}{d}$	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Hydrogen	< -200°	—	< 0°05	30	m = 1	H 1	1 = n	0.917	1.96	< -20
Lithium	150°	—	0.50	12	—	Li 7	1†	2.0	15	— 9
Beryllium	(900°)	—	1.64	9.5	—	Be 9	— 2	3.06	16.5	— 2.6
Boron	(1900°)	—	2.5	4.4	—	B 11	— 3	1.8	39	10
Carbon	> (3500°)	—	< 3.0	6	4	C 12	— 4	> 1.0	< 88	< 19
Nitrogen	-203°	—	< 0.7	20	3	N 14	1 - 3*	1.64	66	< 5
Oxygen	< -200°	—	< 1.0	16	2	O 16	—	—	—	—
Fluorine	—	—	—	—	1	F 19	—	—	—	—
Sodium	90°	0.71	0.28	23	—	Na 23	1†	Na ₂ O	2.6	24
Magnesium	500°	0.27	1.74	14	—	Mg 24	— 2†	3.6	22	— 5
Aluminium	600°	0.23	2.4	11	3	Al 27	— 3	4.0	26	+ 1.3
Silicon	(1200°)	0.08	2.3	12	4	Si 28	— 3 4	2.65	45	— 2.2
Phosphorus	44°	1.28	2.2	14	3	P 31	1 - 3*	3.20	59	— 6.2
Sulphur	114°	0.67	2.67	13	2	S 32	— 2 - 4* 5* 6*	1.96	62	— 8.7
Chlorine	-75°	—	1.3	37	1	Cl 35.5	1 - 3 - 5* - 7*	—	—	—
Potassium	58°	0.84	0.87	45	—	K 39	1†	2.7	55	— 5.5
Calcium	(800°)	—	1.6	25	—	Ca 40	— 2†	3.15	36	— 7
Scandium	—	—	—	—	—	Sc 44	— 3†	3.66	35	(0)
Titanium	(2500°)	—	—	—	—	Ti 48	— 3 4	4.2	38	(+ 5)
Vanadium	(3000°)	—	—	—	—	V 51	— 2 3 4 5	2.49	52	— 6.7
Chromium	(3000°)	—	—	—	—	Cr 52	— 2 3 - 6*	2.74	73	— 9.5
Manganese	(1300°)	—	—	—	—	Mn 55	— 2* 3 4 - 6* 7*	—	—	—
Iron	1400°	0.12	7.8	7.9	—	Fe 56	— 2* 3 4 - 6*	—	—	—
Cobalt	(1400°)	0.12	8.6	6.8	—	Co 58.5	— 2* 3 4	—	—	—
Nickel	1350°	0.17	8.7	6.8	—	Ni 59	— 2* 3 4	—	—	—
Copper	1084°	0.29	8.8	7.2	—	Cu 63	1† 2†	CaO	5.9	24
Zinc	425°	—	7.1	5.2	—	Zn 65	— 2†	—	—	—
Gallium	30°	—	5.96	12	3	Ga 70	— 3	Ga ₂ O ₃ (5.1)	(26)	(4.0)
Germanium	900°	—	8.47	13	4	Ge 72	— 2 3 4	4.7	44	4.5
Arsenic	500°	0.06	5.7	13	3	As 75	— 3 - 5*	4.1	56	6.0
Selenium	317°	—	4.8	16	2	Se 79	— 4 - 6*	—	—	—
Bromine	-7°	—	3.1	36	1	Br 80	— 5* - 7*	—	—	—
Rubidium	39°	—	1.5	57	—	Rb 85	1†	—	—	—
Strontium	(600°)	—	2.5	35	—	Sr 87	— 2†	4.3	49	- 11
Yttrium	—	—	—	—	—	Y 89	— 3†	5.05	45	(- 2)
Zirconium	(1500°)	—	4.1	22	—	Zr 90	— 4	5.7	43	- 0.2
Niobium	—	—	7.1	13	—	Nb 94	— 3 - 5*	4.7	57	+ 6.2
Molybdenum	—	—	8.6	12	—	Mo 96	— 2 3 4 - 6*	4.4	63	6.8
Ruthenium	(3000°)	0.10	12.2	8.4	—	Ru 103	— 2 3 4 - 6 - 8	—	—	—
Rhodium	(1900°)	0.08	12.1	8.6	—	Rh 104	— 2 3 4 - 6	—	—	—
Palladium	1500°	0.12	11.4	8.3	—	Pd 106	1† 2†	—	—	—
Silver	1550°	0.19	10.5	10	—	Ag 108	1†	Ag ₂ O	7.5	31
Cadmium	320°	0.51	8.0	13	3	Cd 112	— 2†	8.15	31	2.5
Iodine	176°	0.46	7.4	14	3	Ia 127	— 2 3	7.18	38	2.7
Tin	230°	0.23	7.2	16	4	Sn 118	— 2 3 4	6.93	43	2.8
Antimony	430°	0.12	6.7	18	3	Sb 120	— 3 4 5	6.5	49	2.6
Tellurium	455°	0.17	6.4	20	2	Te 125	— 4 - 6*	5.1	68	4.7
Iodine	114°	—	4.9	26	1	I 127	1 - 3 - 5* - 7*	—	—	—
Cesium	27°	—	1.88	71	—	Cs 133	1†	—	—	—
Barium	—	—	—	—	—	Ba 137	— 2†	5.1	69	- 6.0
Lanthanum	(600°)	—	6.1	28	—	La 138	— 3†	6.5	50	+ 1.3
Cerium	(700°)	—	6.6	21	—	Ce 140	— 3 4	6.74	56	2.0
Dysprosium	(800°)	—	6.5	22	—	Dy 142	— 2 3 - 5	—	—	—
Ytterbium	—	—	—	—	—	Yb 173	— 3	9.28	43	(- 2)
Tantalum	—	—	10.4	18	—	Ta 182	— 5	7.5	59	4.6
Tungsten	(1500°)	—	12.1	9.6	—	W 184	— 4 - 6	6.9	67	8
Osmium	(3500°)	0.07	22.5	8.2	—	Os 191	— 3 4 - 6 - 8	—	—	—
Iridium	2000°	0.07	22.4	8.6	—	Ir 193	— 3 4 - 6	—	—	—
Platinum	1773°	0.03	21.5	9.2	—	Pt 196	— 3 4	—	—	—
Gold	1045°	0.14	19.3	10	—	Au 198	1 - 3	Au ₂ O (12.5)	(33)	(15)
Mercury	-39°	—	13.6	15	2	Hg 200	1† 2†	11.1	39	4.5
Thallium	294°	0.31	11.8	17	3	Tl 204	— 3	Tl ₂ O ₃ (9.7)	(47)	(4.3)
Lead	328°	0.29	11.2	18	4	Pb 208	— 2 4	8.9	53	4.2
Bismuth	298°	0.14	9.8	21	3	Bi 208	— 3 - 5	—	—	—
Thorium	—	—	11.1	21	—	Th 232	— 4	9.86	54	2.0
Uranium	(800°)	—	18.7	13	—	U 240	— 4 - 6	(7.2)	(80)	(9)



Dmitry Mendeleev

He created the first periodic table based on the properties of the elements

ChemCatalyst: This document was created in 1889, when chemists only knew of 63 different elements. How do you think the elements are organized? What do you think the numbers represent?



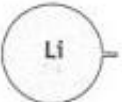







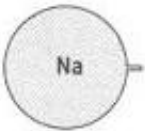
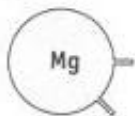
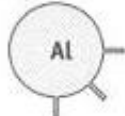
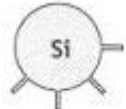
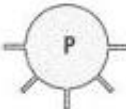
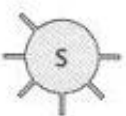

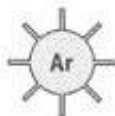
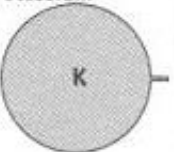
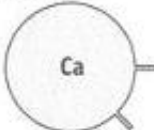
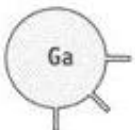
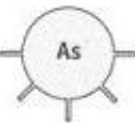
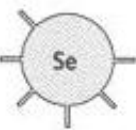
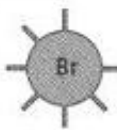
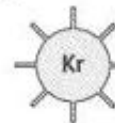
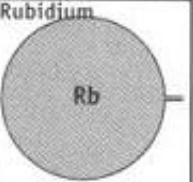
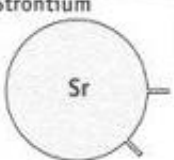
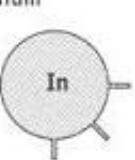
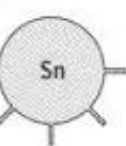
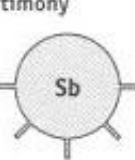
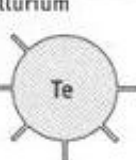
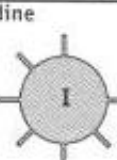
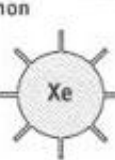


Mendeleyev's Table of the Elements - 1889

	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
1	H = 1							
2	Li = 7	Be = 9	B = 11	C = 12	N = 14	O = 16	F = 19	
3	Na = 23	Mg = 24	Al = 27	Si = 28	P = 31	S = 32	Cl = 35	
4	K = 39	Ca = 40	___ = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	Fe = 56 Co = 59 Ni = 59 Cu = 63
5	Cu = 63	Zn = 65	___ = 68	___ = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	Sr = 87	Yt = 88	Zr = 90	Nb = 94	Mo = 96	___ = 100	Ru = 104 Rh = 106 Pd = 106 Ag = 108
7	Ag = 108	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	I = 127	
8	Cs = 133	Ba = 137	Di = 138	Ce = 140	___	___	___	___
9	___	___	___	___	___	___	___	___
10	___	___	Er = 178	La = 180	Ta = 182	W = 184	___	Os = 195 Ir = 197 Pt = 198 Au = 199
11	Au = 199	Hg = 200	Tl = 204	Pb = 207	Bi = 208	___	___	___
12	___	___	___	Th = 231	___	U = 240	___	___

Note: Mendeleyev's symbol for iodine, "J", has been changed to "I" to match modern symbols.

Create a Periodic Table Activity

Hydrogen 							Helium 
Lithium 	Beryllium 	Boron 	Carbon 	Nitrogen 	Oxygen 	Fluorine 	Neon 
Sodium 	Magnesium 	Aluminum 	Silicon 	Phosphorus 	Sulfur 	Chlorine 	Argon 
Potassium 	Calcium 	Gallium 		Arsenic 	Selenium 	Bromine 	Krypton 
Rubidium 	Strontium 	Indium 	Tin 	Antimony 	Tellurium 	Iodine 	Xenon 

Activity Compared to Real Table

Hydrogen										Helium
Lithium	Beryllium									Neon
Sodium	Magnesium									Argon
Potassium	Calcium									Krypton
Rubidium	Strontium									Xenon

Transition metals missing!

Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon
Aluminum	Silicon	Phosphorus	Sulfur	Chlorine	Argon
Gallium		Arsenic	Selenium	Bromine	Krypton
Indium	Tin	Antimony	Tellurium	Iodine	Xenon

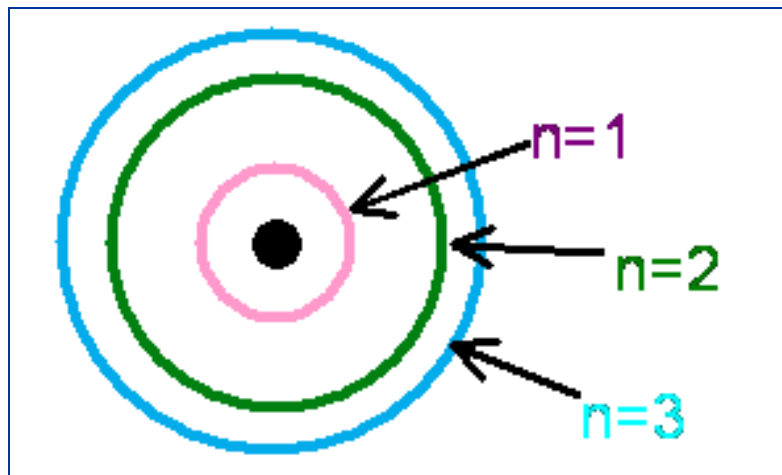
1A																8A	
1 H 1s ¹	2A											3A	4A	5A	6A	7A	2 He 1s ²
3 Li 2s ¹	4 Be 2s ²											5 B 2s ² 2p ¹	6 C 2s ² 2p ²	7 N 2s ² 2p ³	8 O 2s ² 2p ⁴	9 F 2s ² 2p ⁵	10 Ne 2s ² 2p ⁶
11 Na 3s ¹	12 Mg 3s ²	3B	4B	5B	6B	7B	8B		1B	2B	13 Al 3s ² 3p ¹	14 Si 3s ² 3p ²	15 P 3s ² 3p ³	16 S 3s ² 3p ⁴	17 Cl 3s ² 3p ⁵	18 Ar 3s ² 3p ⁶	
19 K 4s ¹	20 Ca 4s ²	21 Sc 3d ¹ 4s ²	22 Ti 3d ² 4s ²	23 V 3d ³ 4s ²	24 Cr 3d ⁵ 4s ¹	25 Mn 3d ⁵ 4s ²	26 Fe 3d ⁶ 4s ²	27 Co 3d ⁷ 4s ²	28 Ni 3d ⁸ 4s ²	29 Cu 3d ¹⁰ 4s ¹	30 Zn 3d ¹⁰ 4s ²	31 Ga 4s ² 4p ¹	32 Ge 4s ² 4p ²	33 As 4s ² 4p ³	34 Se 4s ² 4p ⁴	35 Br 4s ² 4p ⁵	36 Kr 4s ² 4p ⁶
37 Rb 5s ¹	38 Sr 5s ²	39 Y 4d ¹ 5s ²	40 Zr 4d ² 5s ²	41 Nb 4d ⁴ 5s ¹	42 Mo 4d ⁵ 5s ¹	43 Tc 4d ⁵ 5s ²	44 Ru 4d ⁷ 5s ¹	45 Rh 4d ⁸ 5s ¹	46 Pd 4d ¹⁰	47 Ag 4d ¹⁰ 5s ¹	48 Cd 4d ¹⁰ 5s ²	49 In 5s ² 5p ¹	50 Sn 5s ² 5p ²	51 Sb 5s ² 5p ³	52 Te 5s ² 5p ⁴	53 I 5s ² 5p ⁵	54 Xe 5s ² 5p ⁶
55 Cs 6s ¹	56 Ba 6s ²	57 *La 5d ¹ 6s ²	72 Hf 5d ² 6s ²	73 Ta 5d ³ 6s ²	74 W 5d ⁴ 6s ²	75 Re 5d ⁵ 6s ²	76 Os 5d ⁶ 6s ²	77 Ir 5d ⁷ 6s ²	78 Pt 5d ⁹ 6s ¹	79 Au 5d ¹⁰ 6s ¹	80 Hg 5d ¹⁰ 6s ²	81 Tl 6s ² 6p ¹	82 Pb 6s ² 6p ²	83 Bi 6s ² 6p ³	84 Po 6s ² 6p ⁴	85 At 6s ² 6p ⁵	86 Rn 6s ² 6p ⁶
87 Fr 7s ¹	88 Ra 7s ²	89 †Ac 6d ¹ 7s ²	104 Rf 6d ² 7s ²	105 Db 6d ³ 7s ²	106 Sg 6d ⁴ 7s ²	107 Bh	108 Hs	109 Mt	110	111	112	Unknown	114	Unknown	††116	Unknown	††118

* 58 Ce $4f^2 6s^2$	59 Pr $4f^3 6s^2$	60 Nd $4f^4 6s^2$	61 Pm $4f^5 6s^2$	62 Sm $4f^6 6s^2$	63 Eu $4f^7 6s^2$	64 Gd $4f^7 5d^1 6s^2$	65 Tb $4f^9 6s^2$	66 Dy $4f^{10} 6s^2$	67 Ho $4f^{11} 6s^2$	68 Er $4f^{12} 6s^2$	69 Tm $4f^{13} 6s^2$	70 Yb $4f^{14} 6s^2$	71 Lu $4f^{14} 5d^1 6s^2$
† 90 Th $6d^2 7s^2$	91 Pa $5f^2 6d^1 7s^2$	92 U $5f^3 6d^1 7s^2$	93 Np $5f^4 6d^1 7s^2$	94 Pu $5f^6 7s^2$	95 Am $5f^7 7s^2$	96 Cm $5f^7 6d^1 7s^2$	97 Bk $5f^9 7s^2$	98 Cf $5f^{10} 7s^2$	99 Es $5f^{11} 7s^2$	100 Fm $5f^{12} 7s^2$	101 Md $5f^{13} 7s^2$	102 No $5f^{14} 7s^2$	103 Lr $5f^{14} 6d^1 7s^2$

Electron Configuration

Electrons are found in energy levels

- Fill the lowest possible energy levels 1st and move outward as the energy levels fill up



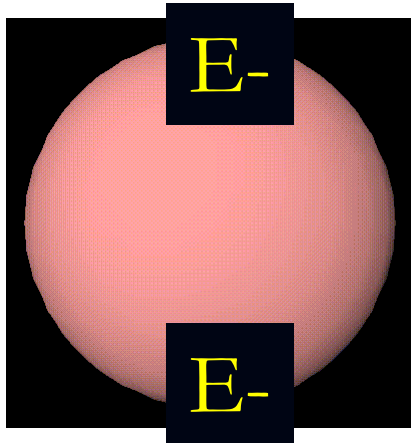
Energy levels
called "rings" in
lower level
classes

$n=1$ is lowest energy level
(closest to the nucleus)

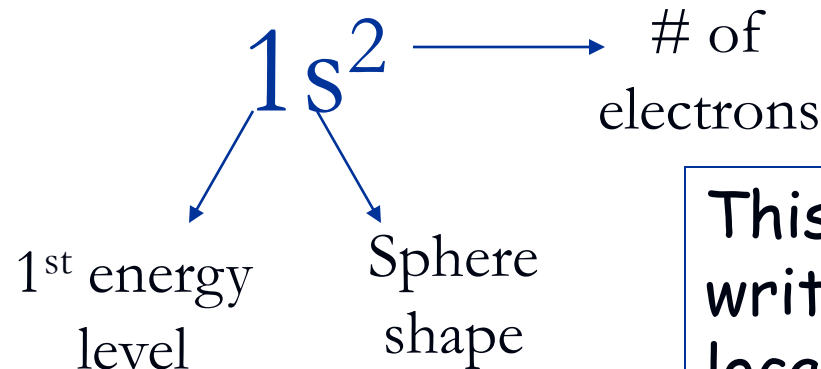
Each Energy Level is Different...

- Each energy level has specific orbitals (3-D pathways) where electrons can be found
- Each energy level can hold a specific # of electrons

1st Energy Level- can hold 2 electrons



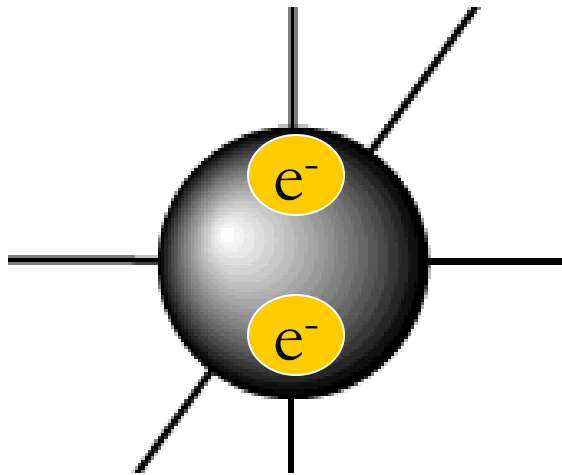
Puts them in "S" shaped orbital (always only hold 2 electrons).



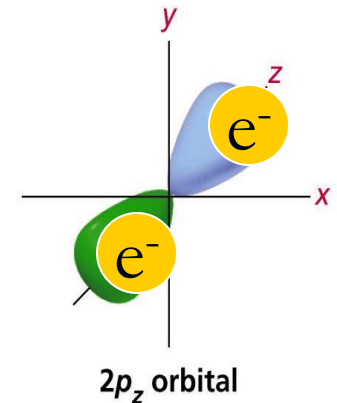
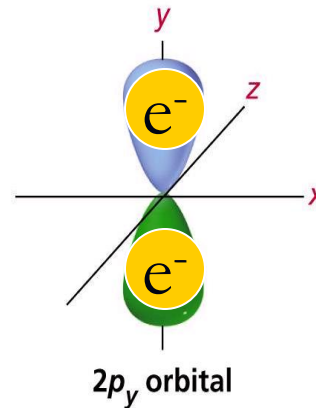
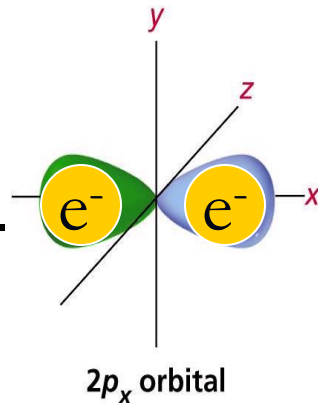
This is how you write out the location of the electrons

2nd Energy Level

- Can hold up to 8 electrons
- Has an s-shaped orbital & a p-shaped orbital
 - The s-orbital always fills up 1st!



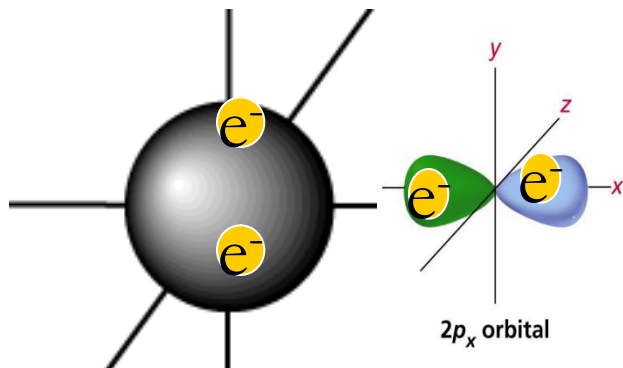
$2s^2$



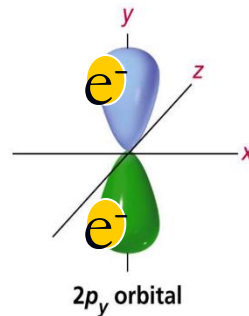
$2p^6$

3rd Energy Level

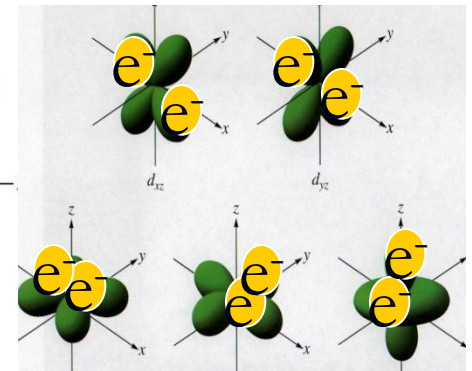
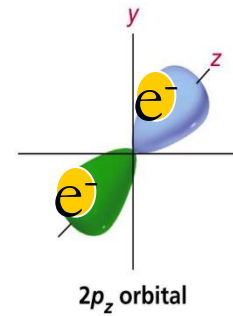
- Can hold up to 18 Electrons
- Has s, p and d orbitals



$3s^2$



$3p^6$

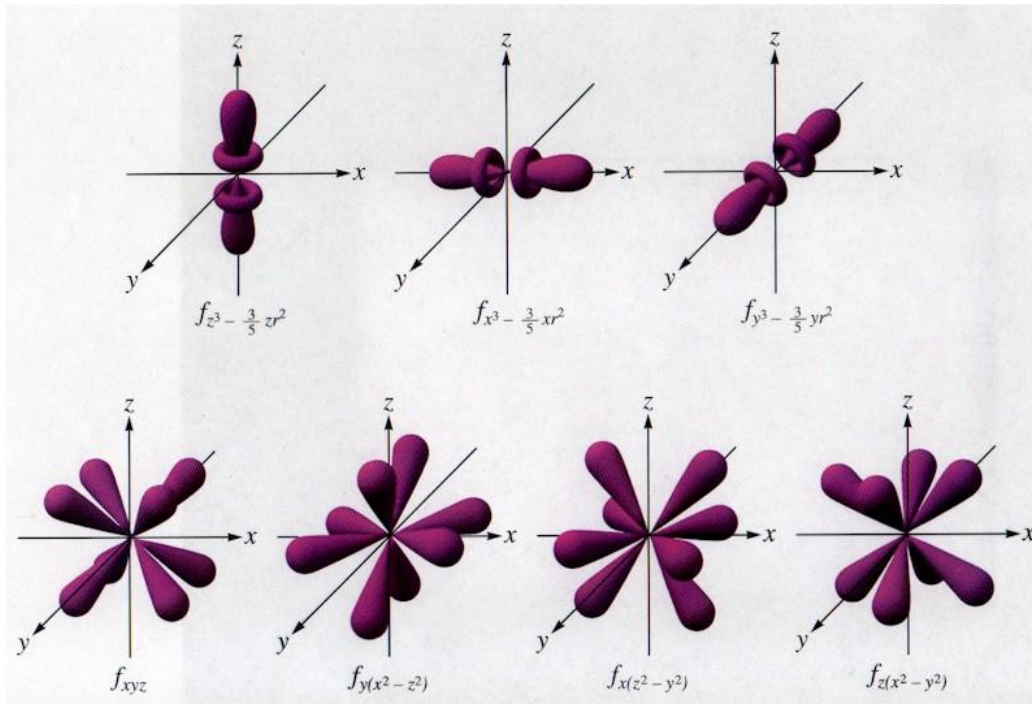


$3d^{10}$

- NOTE: The 4s orbital is actually at a lower energy, so electrons will fill it before the 3d orbital!

4th Energy Level-

- Has 4 different types of orbitals (s,p,d & f)

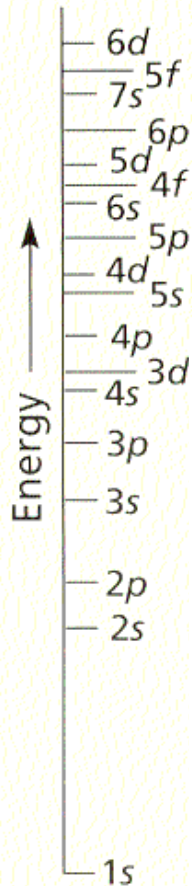


- f- orbitals are the most complicated

- 7 possible "f" orientations

- 14 electrons can fit in f orbitals (2 electrons x 7 orientations = 14)

One little trick...



- Here's the order that an atom will fill it's electrons

- Starts with the easiest, lowest energy level to put electrons and moves up.

Diagram on pg 150 of your text book

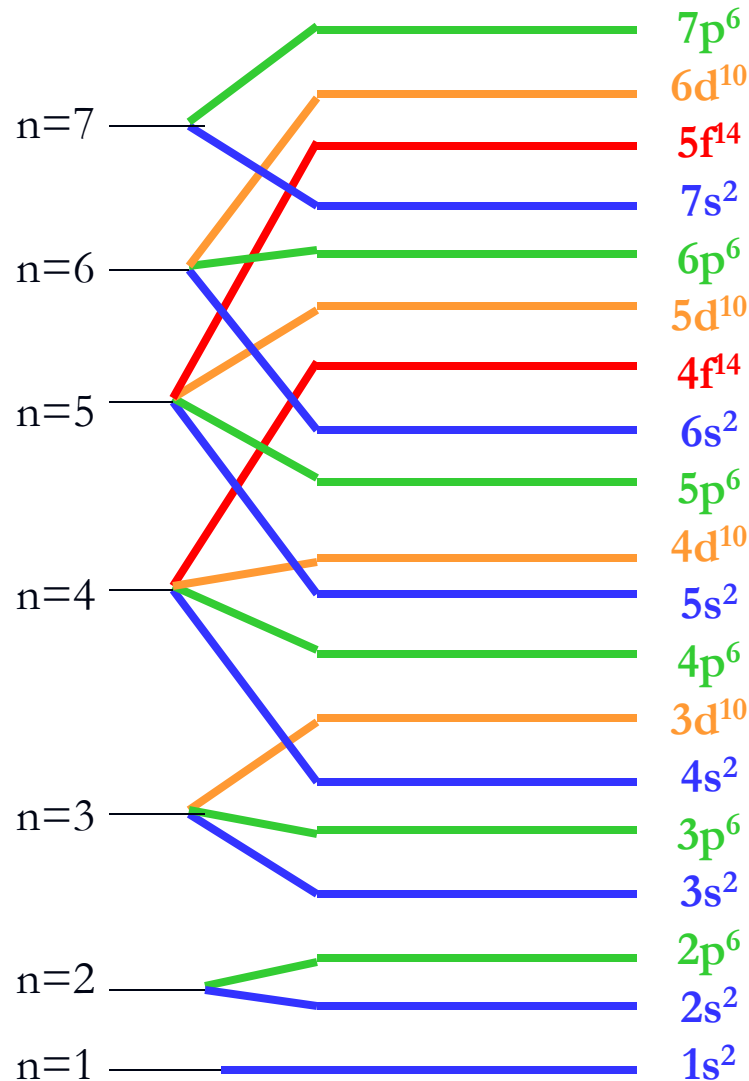
- Whoa... skips from 3p to 4s to 3d?

- Based on energy, it's easier to fill the "s" orbital on 4th energy level then the complicated "d" on the 3rd.

- Look further up the fill chart and you'll see more of this.

Order that Orbitals Fill Up... don't memorize!!

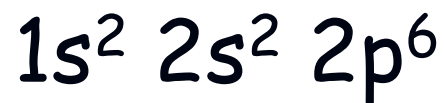
•You will
learn to use
your periodic
table to
figure this
out!



Writing Electron Configurations

Orbital Notation & Electron Configuration Notation

Ex: E. Config. for Fluorine (9 electrons)



- Write the order that they fill the electrons

More Practice (a harder one)

Ex: Titanium (22 electrons)

E. Configuration Notation

$1s^2 2s^2 2p^6 3s^2 3p^6$ $4s^2 3d^2$

Remember the fill order,
4s before 3d!

Using the Periodic Table for E. Config.

<u>S Block</u>		Group										<u>p Block</u>					8A
	1A											3A	4A	5A	6A	7A	1s
1	1s																
2	2s													2p			
3	3s													3p			
Period 4	4s					3d							4p				
5	5s					4d							5p				
6	6s	La				5d							6p				
7	7s	Ac				6d											

E. Configuration with Periodic Table

1A																	8A
1 H $1s^1$																	2 He $1s^2$
3 Li $2s^1$	4 Be $2s^2$																
11 Na $3s^1$	12 Mg $3s^2$																
		3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	
19 K $4s^1$	20 Ca $4s^2$	21 Sc $3d^1 4s^2$	22 Ti $3d^2 4s^2$	23 V $3d^3 4s^2$	24 Cr $3d^5 4s^1$	25 Mn $3d^5 4s^2$	26 Fe $3d^6 4s^2$	27 Co $3d^7 4s^2$	28 Ni $3d^8 4s^2$	29 Cu $3d^{10} 4s^1$	30 Zn $3d^{10} 4s^2$	31 Ga $4s^2 4p^1$	32 Ge $4s^2 4p^2$	33 As $4s^2 4p^3$	34 Se $4s^2 4p^4$	35 Br $4s^2 4p^5$	36 Kr $4s^2 4p^6$
37 Rb $5s^1$	38 Sr $5s^2$	39 Y $4d^1 5s^2$	40 Zr $4d^2 5s^2$	41 Nb $4d^4 5s^1$	42 Mo $4d^5 5s^1$	43 Tc $4d^5 5s^2$	44 Ru $4d^7 5s^1$	45 Rh $4d^8 5s^1$	46 Pd $4d^{10}$	47 Ag $4d^{10} 5s^1$	48 Cd $4d^{10} 5s^2$	49 In $5s^2 5p^1$	50 Sn $5s^2 5p^2$	51 Sb $5s^2 5p^3$	52 Te $5s^2 5p^4$	53 I $5s^2 5p^5$	54 Xe $5s^2 5p^6$
55 Cs $6s^1$	56 Ba $6s^2$	57 *La $5d^1 6s^2$	72 Hf $5d^2 6s^2$	73 Ta $5d^3 6s^2$	74 W $5d^4 6s^2$	75 Re $5d^5 6s^2$	76 Os $5d^6 6s^2$	77 Ir $5d^7 6s^2$	78 Pt $5d^9 6s^1$	79 Au $5d^{10} 6s^1$	80 Hg $5d^{10} 6s^2$	81 Tl $6s^2 6p^1$	82 Pb $6s^2 6p^2$	83 Bi $6s^2 6p^3$	84 Po $6s^2 6p^4$	85 At $6s^2 6p^5$	86 Rn $6s^2 6p^6$
87 Fr $7s^1$	88 Ra $7s^2$	89 †Ac $6d^1 7s^2$	104 Rf $6d^2 7s^2$	105 Db $6d^3 7s^2$	106 Sg $6d^4 7s^2$	107 Bh	108 Hs	109 Mt	110	111	112	Unknown	114	Unknown	††116	Unknown	††118

* 58 Ce $4f^2 6s^2$	59 Pr $4f^3 6s^2$	60 Nd $4f^4 6s^2$	61 Pm $4f^5 6s^2$	62 Sm $4f^6 6s^2$	63 Eu $4f^7 6s^2$	64 Gd $4f^7 5d^1 6s^2$	65 Tb $4f^9 6s^2$	66 Dy $4f^{10} 6s^2$	67 Ho $4f^{11} 6s^2$	68 Er $4f^{12} 6s^2$	69 Tm $4f^{13} 6s^2$	70 Yb $4f^{14} 6s^2$	71 Lu $4f^{14} 5d^1 6s^2$
† 90 Th $6d^2 7s^2$	91 Pa $5f^2 6d^1 7s^2$	92 U $5f^3 6d^1 7s^2$	93 Np $5f^4 6d^1 7s^2$	94 Pu $5f^6 7s^2$	95 Am $5f^7 7s^2$	96 Cm $5f^7 6d^1 7s^2$	97 Bk $5f^9 7s^2$	98 Cf $5f^{10} 7s^2$	99 Es $5f^{11} 7s^2$	100 Fm $5f^{12} 7s^2$	101 Md $5f^{13} 7s^2$	102 No $5f^{14} 7s^2$	103 Lr $5f^{14} 6d^1 7s^2$

Practice Writing E. Configs.

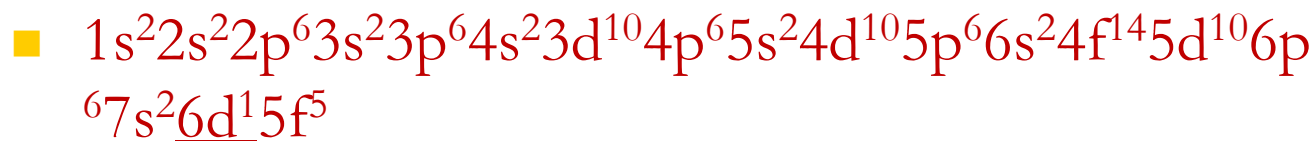
- Carbon
- Magnesium
- Iron
- Iodine

Challenging:

- Gold

Even more
challenging:

- Plutonium



Noble Gas Notation- the “short cut”

H 1s ¹											He 1s ²						
Li 2s ¹	Be 2s ²											B 2p ¹	C 2p ²	N 2p ³	O 2p ⁴	F 2p ⁵	Ne 2p ⁶
Na 3s ¹	Mg 3s ²											Al 3p ¹	Si 3p ²	P 3p ³	S 3p ⁴	Cl 3p ⁵	Ar 3p ⁶

For Na

E. config: 1s² 2s² 2p⁶ 3s¹

Noble Gas Not.: [Ne] 3s¹

For Cl

E. config: 1s² 2s² 2p⁶ 3s¹

Noble Gas Not.: [Ne] 3s² 3p⁵

*Start at the noble gas ABOVE the element and do the configuration from there.

Noble Gas Notations through the D and F Blocks

1A																	8A				
1 H 1s ¹	2A																2 He 1s ²				
3 Li 2s ¹	4 Be 2s ²															5 B 2s ² 2p ¹	6 C 2s ² 2p ²	7 N 2s ² 2p ³	8 O 2s ² 2p ⁴	9 F 2s ² 2p ⁵	10 Ne 2s ² 2p ⁶
11 Na 3s ¹	12 Mg 3s ²	3B	4B	5B	6B	7B	8B		1B	2B	3A 13 Al 3s ² 3p ¹	4A 14 Si 3s ² 3p ²	5A 15 P 3s ² 3p ³	6A 16 S 3s ² 3p ⁴	7A 17 Cl 3s ² 3p ⁵	18 Ar 3s ² 3p ⁶					
19 K 4s ¹	20 Ca 4s ²	21 Sc 3d ¹ 4s ²	22 Ti 3d ² 4s ²	23 V 3d ³ 4s ²	24 Cr 3d ⁵ 4s ¹	25 Mn 3d ⁵ 4s ²	26 Fe 3d ⁶ 4s ²	27 Co 3d ⁷ 4s ²	28 Ni 3d ⁸ 4s ²	29 Cu 3d ¹⁰ 4s ¹	30 Zn 3d ¹⁰ 4s ²	31 Ga 4s ² 4p ¹	32 Ge 4s ² 4p ²	33 As 4s ² 4p ³	34 Se 4s ² 4p ⁴	35 Br 4s ² 4p ⁵	36 Kr 4s ² 4p ⁶				
37 Rb 5s ¹	38 Sr 5s ²	39 Y 4d ¹ 5s ²	40 Zr 4d ² 5s ²	41 Nb 4d ⁴ 5s ¹	42 Mo 4d ⁵ 5s ¹	43 Tc 4d ⁵ 5s ²	44 Ru 4d ⁷ 5s ¹	45 Rh 4d ⁸ 5s ¹	46 Pd 4d ¹⁰	47 Ag 4d ¹⁰ 5s ¹	48 Cd 4d ¹⁰ 5s ²	49 In 5s ² 5p ¹	50 Sn 5s ² 5p ²	51 Sb 5s ² 5p ³	52 Te 5s ² 5p ⁴	53 I 5s ² 5p ⁵	54 Xe 5s ² 5p ⁶				
55 Cs 6s ¹	56 Ba 6s ²	57 La 5d ¹ 6s ²	72 Hf 5d ² 6s ²	73 Ta 5d ³ 6s ²	74 W 5d ⁴ 6s ²	75 Re 5d ⁵ 6s ²	76 Os 5d ⁶ 6s ²	77 Ir 5d ⁷ 6s ²	78 Pt 5d ⁹ 6s ¹	79 Au 5d ¹⁰ 6s ¹	80 Hg 5d ¹⁰ 6s ²	81 Tl 6s ² 6p ¹	82 Pb 6s ² 6p ²	83 Bi 6s ² 6p ³	84 Po 6s ² 6p ⁴	85 At 6s ² 6p ⁵	86 Rn 6s ² 6p ⁶				
87 Fr 7s ¹	88 Ra 7s ²	89 †Ac 6d ¹ 7s ²	104 Rf 6d ² 7s ²	105 Db 6d ³ 7s ²	106 Sg 6d ⁴ 7s ²	107 Bh	108 Hs	109 Mt	110	111	112	Unknown	114	Unknown	††116	Unknown	††118				
* †																					
58 Ce 4f ² 6s ²	59 Pr 4f ³ 6s ²	60 Nd 4f ⁴ 6s ²	61 Pm 4f ⁵ 6s ²	62 Sm 4f ⁶ 6s ²	63 Eu 4f ⁷ 6s ²	64 Gd 4f ⁷ 5d ¹ 6s ²	65 Tb 4f ⁹ 6s ²	66 Dy 4f ¹⁰ 6s ²	67 Ho 4f ¹¹ 6s ²	68 Er 4f ¹² 6s ²	69 Tm 4f ¹³ 6s ²	70 Yb 4f ¹⁴ 6s ²	71 Lu 4f ¹⁴ 5d ¹ 6s ²								
90 Th 6d ² 7s ²	91 Pa 5f ² 6d ¹ 7s ²	92 U 5f ³ 6d ¹ 7s ²	93 Np 5f ⁴ 6d ¹ 7s ²	94 Pu 5f ⁶ 7s ²	95 Am 5f ⁷ 7s ²	96 Cm 5f ⁷ 6d ¹ 7s ²	97 Bk 5f ⁹ 7s ²	98 Cf 5f ¹⁰ 7s ²	99 Es 5f ¹¹ 7s ²	100 Fm 5f ¹² 7s ²	101 Md 5f ¹³ 7s ²	102 No 5f ¹⁴ 7s ²	103 Lr 5f ¹⁴ 6d ¹ 7s ²								

Noble Gas Notation for Br



Remember d block is n-1
(row 4 -1 =3)

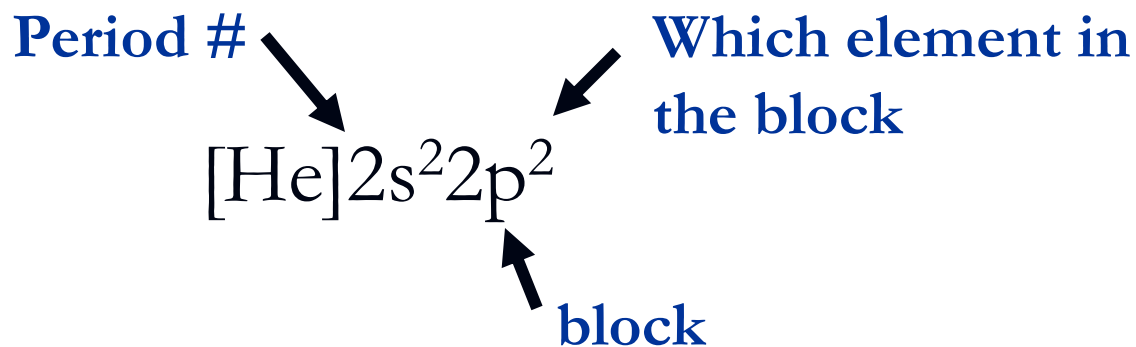
Noble Gas Notation for Pb



Remember f block is n-2 (row 6 -2 =4)

Using Noble Gas Notation

- The noble gas notation can tell you the identity of an element



Element identity = Carbon

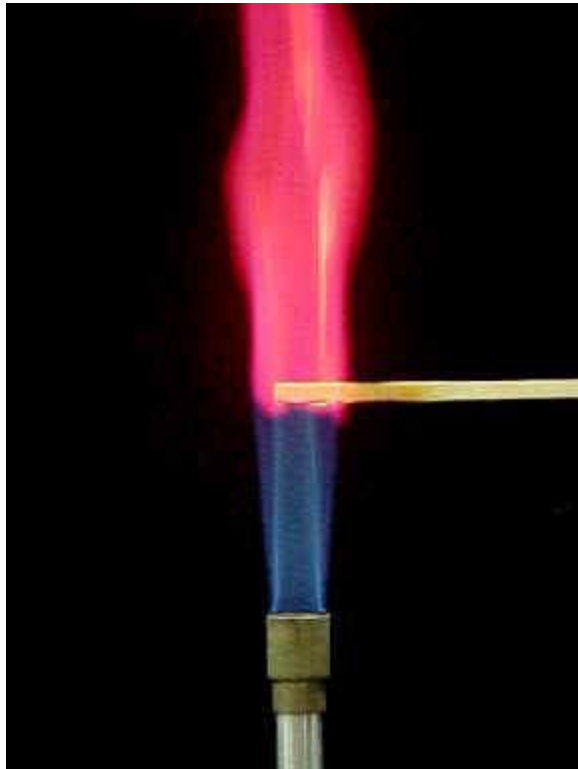
Decoding Noble Gas Notation

	Period 3	Block s	Group 2	Identity Mg
$[\text{Ne}]3s^2$	4	d	10	Ni
$[\text{Ar}]4s^23d^8$	6	p	14	Pb
$[\text{Xe}]6s^24f^{14}5d^{10}6p^2$				

Electrons

History Behind Electron Configuration

- Certain elements emit distinct, visible light when heated in a flame. But why?



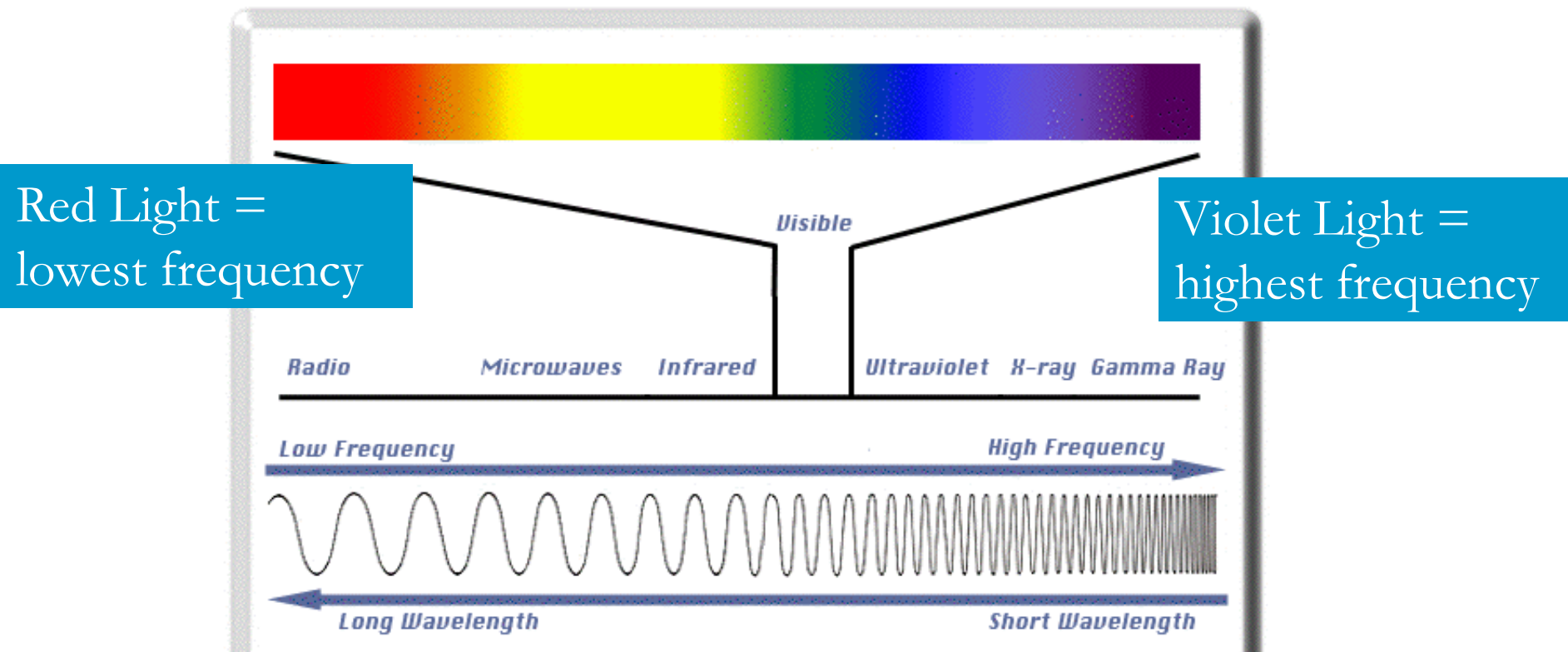
Strontium



Copper

What is light?

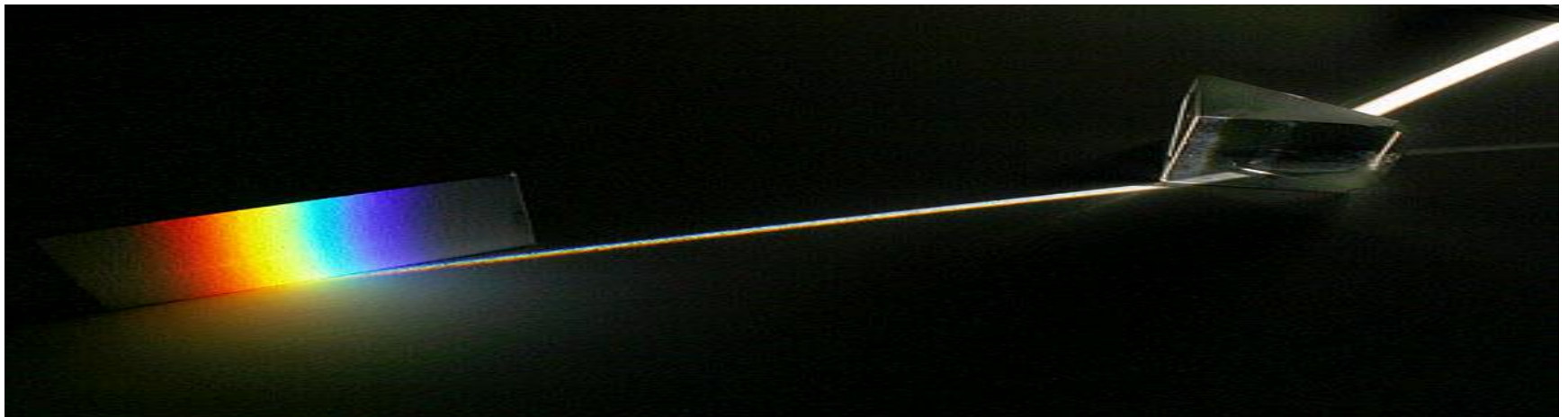
- It's a form of energy
- The Electromagnetic Spectrum (see image) shows other types of energy in our environment.



Visible light makes up only a small portion of the spectrum

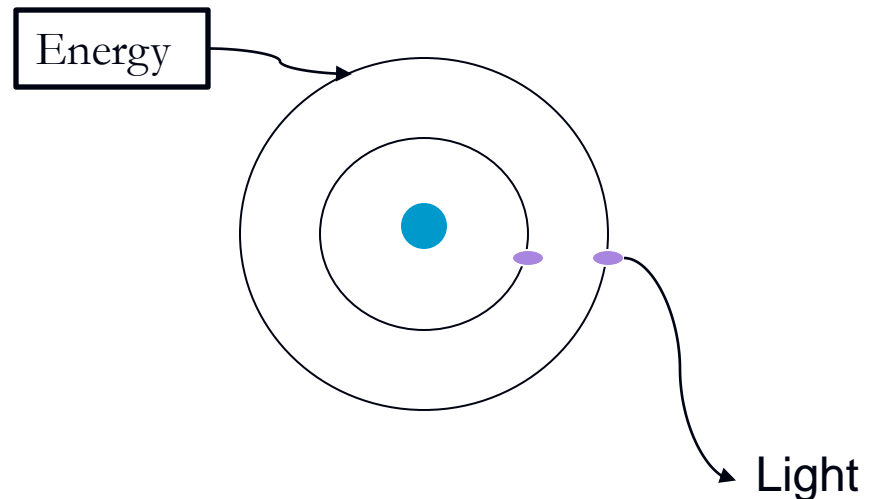
Spectroscopic Analysis

- When white light is scattered through a prism (or spectroscope), all of the colors of the visual spectrum can be seen.
 - This is seen as a “continuous spectrum” (without breaks)

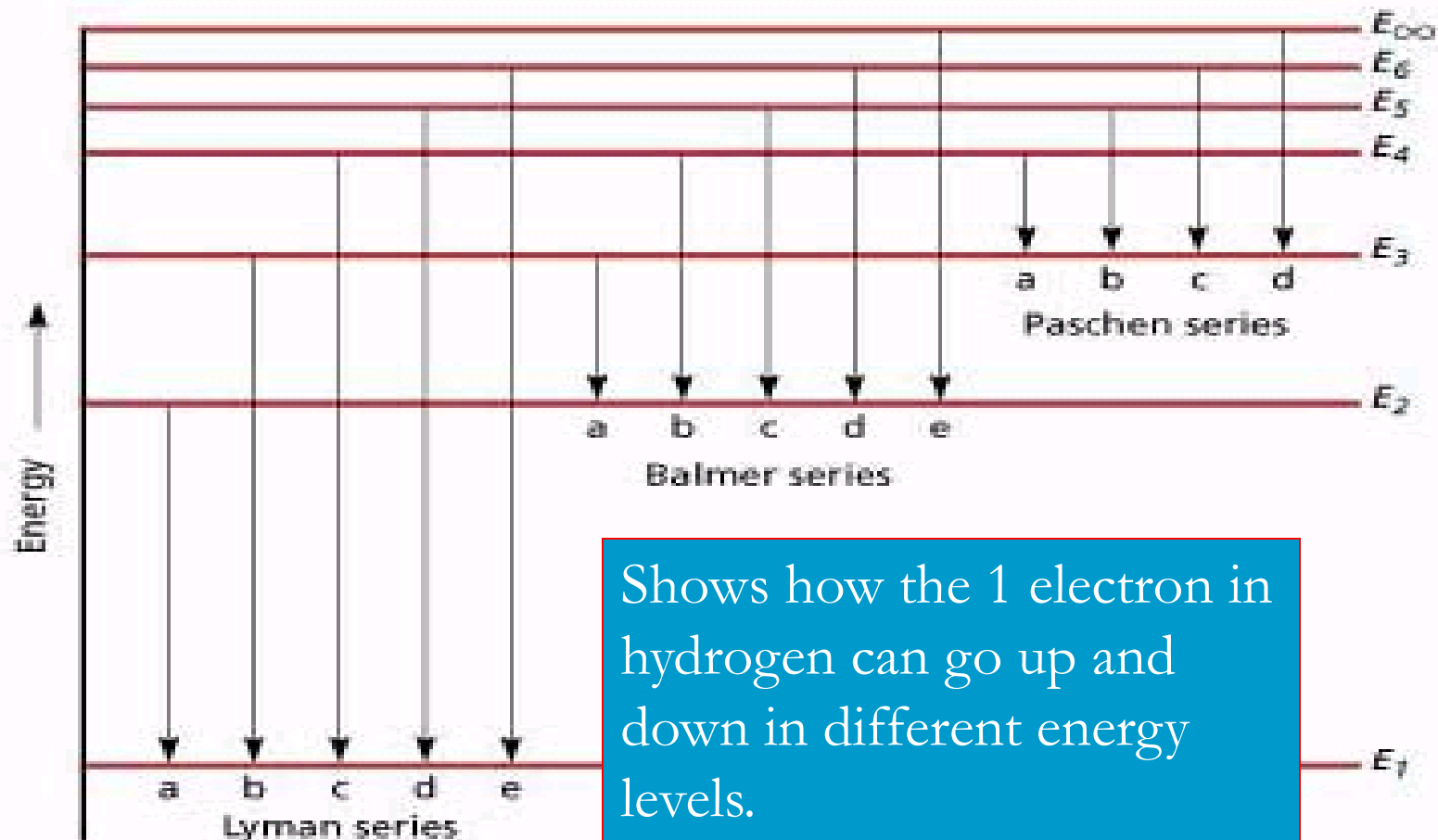


Electron Transitions

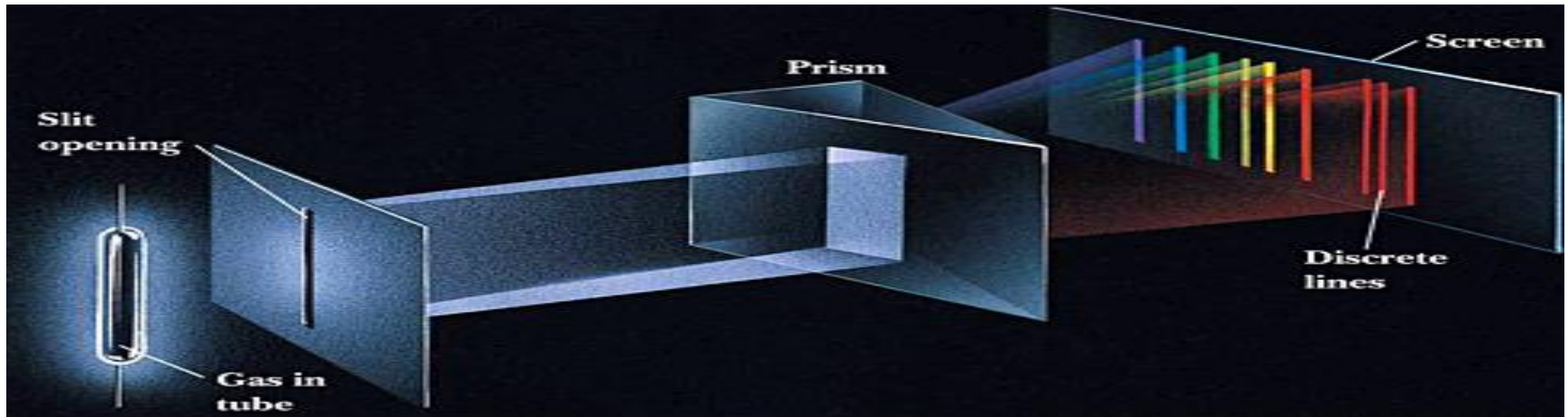
- Electrons can “jump” to higher energy levels when atoms are exposed to an energy source
 - This is known as the “excited state”
- When the electrons fall back down, they release that energy in the form of light
 - This is known as the “ground state”



Energy Transitions for Hydrogen



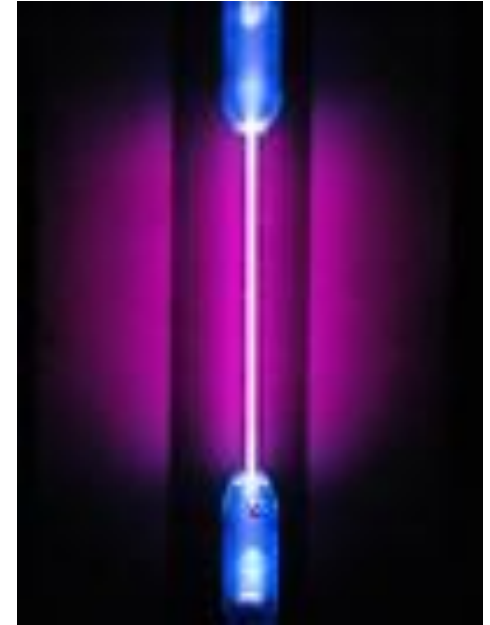
Emission Spectroscopy



- Because atoms have different numbers of electrons, different types of atoms emit specific wavelengths and have a different pattern of spectral lines
 - This is the "line-emission spectrum"

Spectroscopy

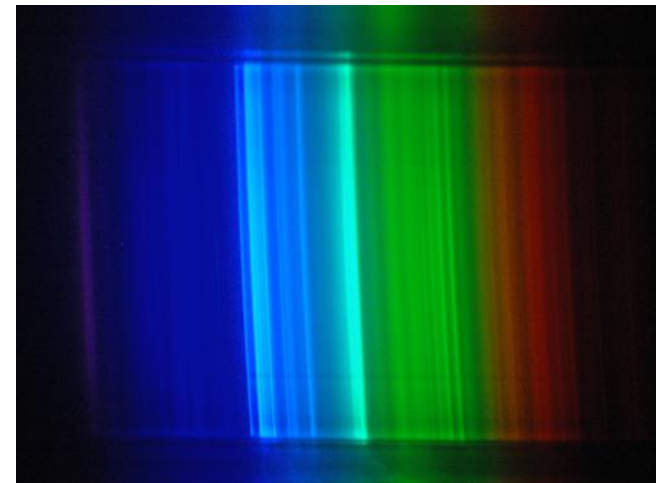
- Elements have a unique set of spectral lines that allows us to identify them



- This is how we know the sun contains H and He, even though we've never been there.



Argon



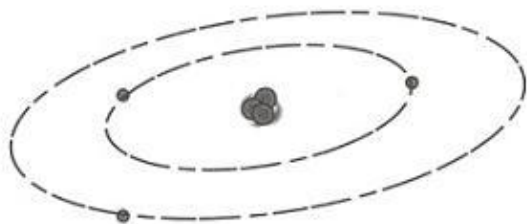
Hydrogen

Valence Electrons, Octet Rule, and Ions

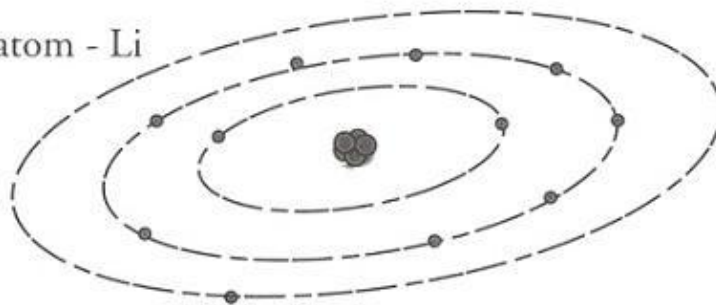
These 3 atoms have similar reactivity and chemical behavior.

A) where are they located on the periodic table?

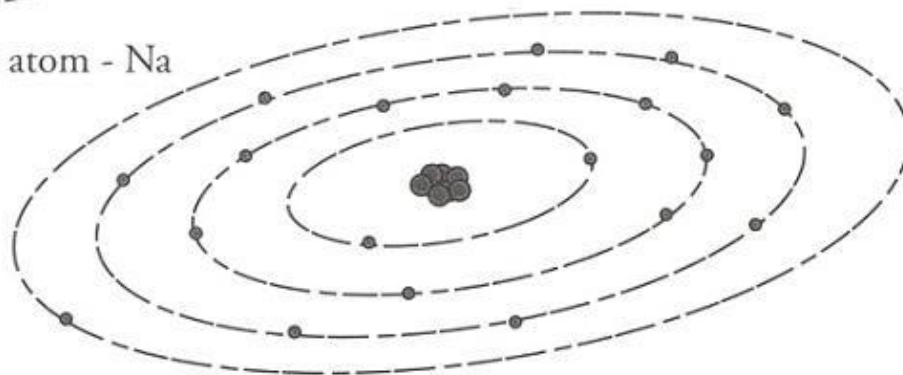
B. What do you think might be responsible for their similar properties?



Bohr model of lithium atom - Li



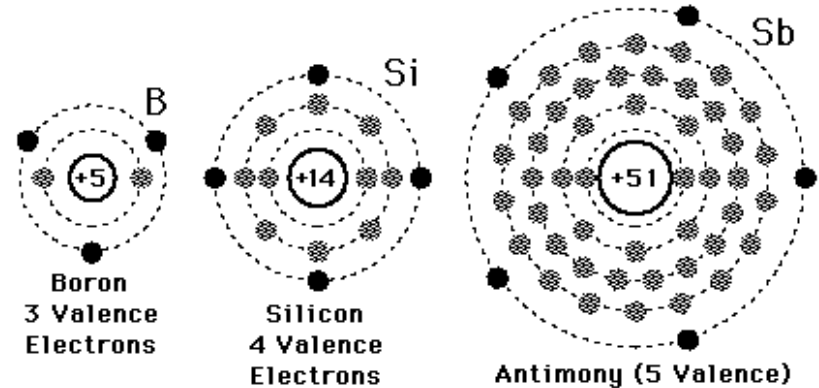
Bohr model of sodium atom - Na



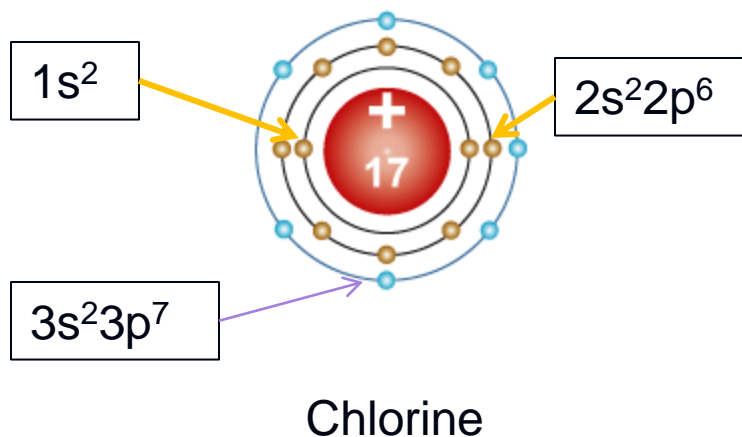
Bohr model of potassium atom - K

Valence Electrons

- Valence Electrons - electrons in the outermost energy level
- These are the electrons that interact with other atoms
 - They determine an atom's chemical reactivity




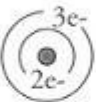
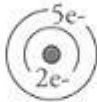
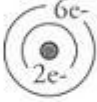


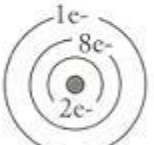
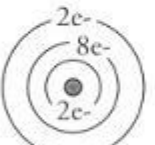
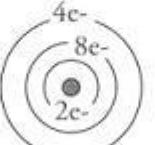
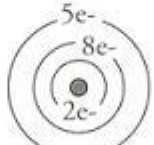
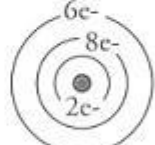
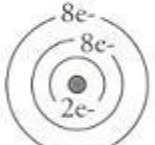
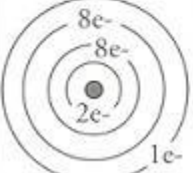
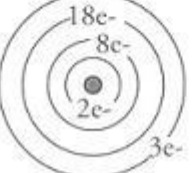
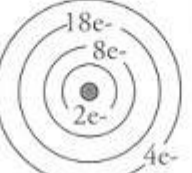
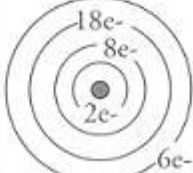
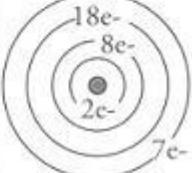
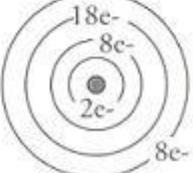


Valence Electrons & E. Congfig.



- In the electron configuration, the valence electrons are found in the s & p orbitals of the highest energy level.
- Examples:
 - Cl: [Ne]3s²3p⁵
 - Has 7 valence electrons
 - Fe: [Ar]4s²3d⁶
 - Has 2 valence electrons
 - Sn: [Kr]5s²4d¹⁰5p²
 - Has 4 valence electrons

Valence Electrons and the Periodic Table

IA							VIIIA
 1e- Hydrogen							 2e- Helium
	IIA	IIIA	IVA	VA	VIA	VIIA	
 1e- 2e- Lithium	Beryllium	 3e- 2e- Boron	Carbon	 5e- 2e- Nitrogen	 6e- 2e- Oxygen	 7e- 2e- Fluorine	 8e- 2e- Neon
 1e- 8e- 2e- Sodium	 2e- 8e- 2e- Magnesium	Aluminum	 4e- 8e- 2e- Silicon	 5e- 8e- 2e- Phosphorus	 6e- 8e- 2e- Sulfur		 8e- 8e- 2e- Argon
 8e- 8e- 2e- 1e- Potassium	Calcium	 18e- 8e- 2e- 3e- Gallium	 18e- 8e- 2e- 4e- Germanium		 18e- 8e- 2e- 6e- Selenium	 18e- 8e- 2e- 7e- Bromine	 18e- 8e- 2e- 8e- Krypton

Figuring out # of Valence Electrons

Using the Periodic Table (Short Cut)

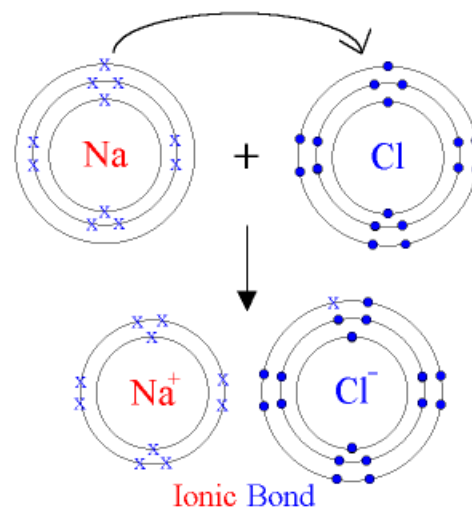
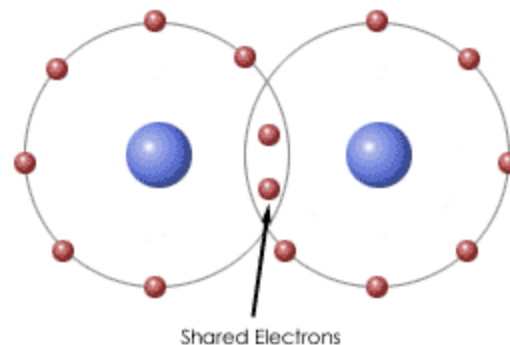
- The column that they are in is the number of valence electrons an atom has.

(EXCEPTION: This does not work for the D Block)

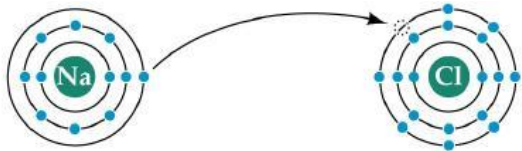
	1A	Group																8A				
1	1s																	1s				
2	2s	2A															3A	4A	5A	6A	7A	
3	3s																		2p			
4	4s						3d										4p					
5	5s						4d										5p					
6	6s	La					5d										6p					
7	7s	Ac					6d															
													4f									
													5f									

The Octet Rule

- Atoms tend to gain, lose, or share electrons to “fill” their valence shell.
- Exceptions: H & He abide by the “duet” rule.
 - They only need 2 electrons in their valence shell because the 1st energy level only holds 2 electrons



Ions

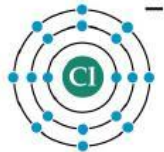


Sodium atom (Na)
(11 protons, 11 electrons)

Chlorine atom (Cl)
(17 protons, 17 electrons)



Sodium ion (Na⁺)
(11 protons, **10** electrons)



Chloride ion (Cl⁻)
(17 protons, **18** electrons)

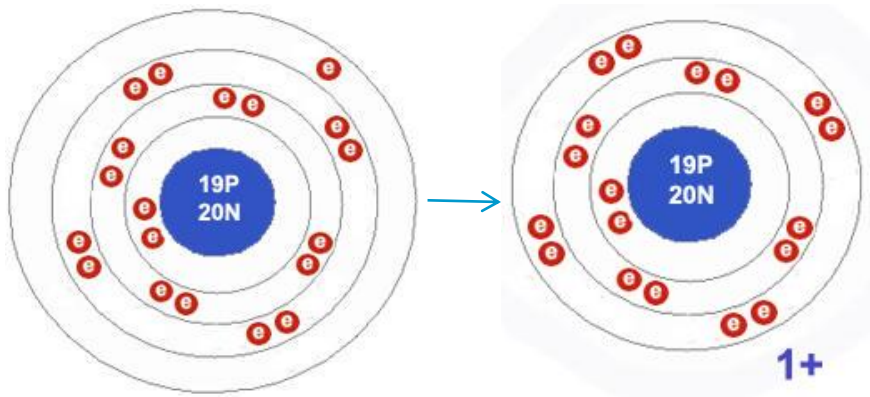
© 1998 Sinauer Associates, Inc.

- Ions are charged particles or atoms that have gained or lost electrons to “fill” their octet.
- Anions have a negative charge.
 - They have gained electrons & electrons are negative.
 - They have more electrons than protons.
- Cations have a positive charge.
 - They have lost electrons.
 - They have more protons than electrons

Ion Examples

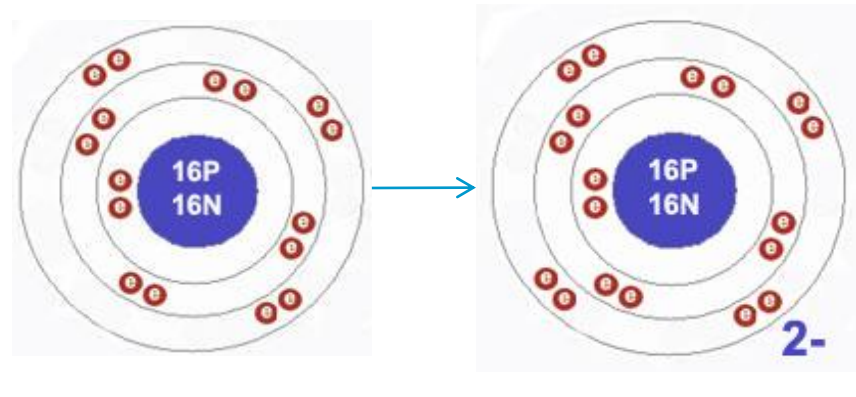
■ Potassium has 1 valence electron, what ion will it form?

■ It will lose 1 electron and form the ion K^+

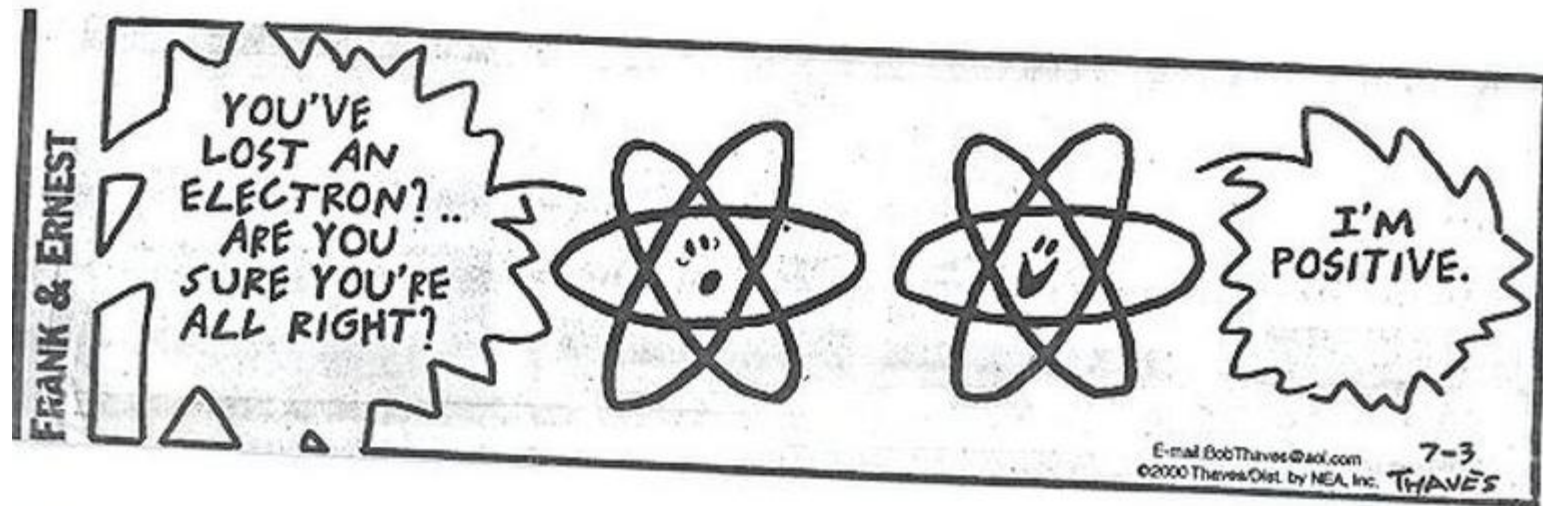


■ Sulfur has 6 valence electrons, what ion will it form?

■ It will gain 2 electrons and form S^{2-}



Joke



joke

- Two atoms walk into a bar.
One atom stops and says to the other,
"I think I just lost an electron."
- The second atom asks "Are you sure?"
- The first atom replies, "I'm positive!"

Organization of the Periodic Table

Characteristics of the Periodic Table

- Elements are arranged in order of increasing atomic number
- Elements with similar properties appear at regular intervals ("periods" or rows)
- Elements with similar properties fall in the same column ("group" or "family")

Periods (rows)

Families / groups

1

H

Hydrogen

1.007 94

3

Li

Lithium

6.941

11

Na

Sodium

22.989 769 28

19

K

Potassium

39.098 3

37

Rb

Rubidium

85.467 8

55

Cs

Cesium

132.905 451

87

Fr

Francium

(223)

4

Be

Beryllium

9.012 182

12

Mg

Magnesium

24.304

20

Ca

Calcium

40.078

28

Ni

Nickel

58.693 4

36

Ar

Argon

39.948

54

Xe

Xenon

131.29

86

Rn

Radon

(222)

21

Sc

Scandium

44.955 912 2

29

Cu

Copper

63.546

39

Y

Yttrium

88.905 848

47

Ag

Silver

107.868 2

57

La

Lanthanum

138.905 47

71

Lu

Lutetium

174.967

22

Ti

Titanium

47.867

30

Zn

Zinc

65.38

40

Zr

Zirconium

91.224

48

Cd

Cadmium

112.411

58

Ce

Cerium

140.12

72

Tm

Thulium

168.930 32

23

V

Vanadium

50.941 5

31

Ga

Gallium

69.723 1

41

Nb

Niobium

92.906 38

49

In

Indium

114.818

59

Pr

Praseodymium

140.907 65

73

Yb

Ytterbium

173.045

24

Cr

Chromium

51.996 1

32

Ge

Germanium

72.630

42

Mo

Molybdenum

95.94

50

Sn

Tin

118.710

60

Nd

Neodymium

144.24

74

Lu

Lutetium

174.967

25

Mn

Manganese

54.938 045

33

As

Arsenic

74.921 6

43

Tc

Technetium

(98)

51

Sb

Antimony

121.757

61

Pm

Promethium

(145)

75

Yb

Ytterbium

173.045

26

Fe

Iron

55.845

34

Se

Selenium

78.96

44

Ru

Ruthenium

101.07

52

Te

Tellurium

127.6

62

Sm

Samarium

150.36

76

Lu

Lutetium

174.967

27

Co

Cobalt

58.933 195

35

Br

Bromine

79.904

45

Rh

Rhodium

102.905 50

53

I

Iodine

126.905 47

63

Eu

Europium

151.964

77

Lu

Lutetium

174.967

28

Ni

Nickel

58.693 4

36

Kr

Krypton

83.798

46

Pd

Palladium

106.905 6

54

Xe

Xenon

131.29

64

Gd

Gadolinium

157.25

78

Er

Erbium

167.259

29

Cu

Copper

63.546

37

Sr

Strontium

87.62

47

Ag

Silver

107.868 2

55

Cs

Cesium

132.905 451

65

Tb

Terbium

158.925 32

79

Er

Erbium

167.259

30

Zn

Zinc

65.38

38

Y

Yttrium

88.905 848

48

Cd

Cadmium

112.411

56

La

Lanthanum

138.905 47

66

Dy

Dysprosium

162.500 15

80

Er

Erbium

167.259

31

Ga

Gallium

69.723 1

39

Zr

Zirconium

91.224

49

In

Indium

114.818

57

La

Lanthanum

138.905 47

67

Ho

Holmium

164.930 32

81

Er

Erbium

167.259

32

Ge

Germanium

72.630

40

Nb

Niobium

92.906 38

50

Sn

Tin

118.710

58

Ce

Cerium

140.12

68

Tm

Thulium

168.930 32

82

Er

Erbium

167.259

33

As

Arsenic

74.921 6

41

Tc

Technetium

(98)

51

Sb

Antimony

121.757

59

Pr

Praseodymium

140.907 65

69

Yb

Ytterbium

173.045

83

Bi

Bismuth

208.980 40

34

Se

Selenium

78.96

42

Mo

Molybdenum

95.94

52

Te

Tellurium

127.6

60

Nd

Neodymium

144.24

70

Yb

Ytterbium

173.045

84

Po

Polonium

(209)

35

Br

Bromine

79.904

43

Ru

Ruthenium

101.07

53

I

Iodine

126.905 47

61

Pm

Promethium

(145)

71

Lu

Lutetium

174.967

85

At

Astatine

(210)

36

Kr

Krypton

83.798

44

Rh

Rhodium

102.905 50

54

Xe

Xenon

131.29

62

Sm

Samarium

150.36

72

Lu

Lutetium

174.967

86

Lr

Lawrencium

(260)

37

Sr

Strontium

87.62

45

Rh

Rhodium

102.905 50

55

Cs

Cesium

132.905 451

63

Eu

Europium

151.964

73

Lu

Lutetium

174.967

87

Fr

Francium

(223)

38

Y

Yttrium

88.905 848

46

Pd

Palladium

106.905 6

56

La

Lanthanum

138.905 47

64

Gd

Gadolinium

157.25

74

Lu

Lutetium

174.967

88

Ra

Radium

(226)

39

Zr

Zirconium

91.224

47

Ag

Silver

107.868 2

57

La

Lanthanum

138.905 47

65

Tb

Terbium

158.925 32

75

Lu

Lutetium

174.967

89

Ac

Actinium

(227)

40

Nb

Niobium

92.906 38

48

In

Indium

114.818

58

Ce

Cerium

140.12

66

Dy

Dysprosium

162.500 15

76

Lu

Lutetium

174.967

90

Th

Thorium

(232)

41

Tc

Technetium

(98)

49

In

Indium

114.818

59

Pr

Praseodymium

140.907 65

67

Ho

Holmium

164.930 32

77

Lu

Lutetium

174.967

91

Pa

Protactinium

(231)

42

Mo

Molybdenum

95.94

50

Sn

Tin

118.710

60

Nd

Neodymium

144.24

68

Tm

Thulium

168.930 32

78

Lu

Lutetium

174.967

92

U

Uranium

(238)

43

Ru

Ruthenium

101.07

51

Sb

Antimony

121.757

61

Pm

Promethium

(145)

69

Yb

Ytterbium

173.045

79

Lu

Lutetium

174.967

93

Np

Neptunium

(237)

44

Rh

Rhodium

102.905 50

52

Te

Tellurium

127.6

62

Sm

Samarium

150.36

70

Yb

Ytterbium

173.045

80

Lu

Lutetium

174.967

94

Pu

Plutonium

(244)

45

Rh

Rhodium

102.905 50

53

I

Iodine

126.905 47

63

Eu

Europium

151.964

71

Lu

Lutetium

174.967

81

Lu

Lutetium

174.967

95

Am

Americium

(243)

46

Pd

Palladium

106.905 6

54

Xe

Xenon

131.29

64

Gd

Gadolinium

157.25

72

Lu

Lutetium

174.967

82

Lu

Lutetium

174.967

96

Cm

Curium

(247)

47

Ag

Silver

107.868 2

55

Cs

Cesium

132.905 451

65

Tb

Terbium

158.925 32

73

Lu

Lutetium

174.967

83

Lu

Lutetium

174.967

97

Bk

Berkelium

(247)

48

In

Indium

114.818

56

La

Lanthanum

138.905 47

66

Dy

Dysprosium

162.500 15

74

Lu

Lutetium

174.967

84

Lu

Lutetium

174.967

98

Cf

Californium

(251)

49

In

Indium

114.818

57

La

Lanthanum

138.905 47

67

Ho

Holmium

164.930 32

75

Lu

Lutetium

174.967

85

Lu

Lutetium

174.967

99

Es

Einsteinium

(252)

50

Sn

Tin

118.710

58

Ce

Cerium

140.12

68

Tm

Thulium

168.930 32

76

Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

100

Fm

Fermium

(257)

51

Sb

Antimony

121.757

59

Pr

Praseodymium

140.907 65

69

Yb

Ytterbium

173.045

77

Lu

Lutetium

174.967

87

Lu

Lutetium

174.967

101

No

Nobelium

(259)

52

Te

Tellurium

127.6

60

Nd

Neodymium

144.24

69

Yb

Ytterbium

173.045

78

Lu

Lutetium

174.967

88

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

53

I

Iodine

126.905 47

61

Pm

Promethium

(145)

69

Yb

Ytterbium

173.045

76

Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

54

Xe

Xenon

131.29

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Sm

Samarium

150.36

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Yb

Ytterbium

173.045

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Lu

Lutetium

174.967

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Lu

Lutetium

174.967

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Lr

Lawrencium

(260)

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Cs

Cesium

132.905 451

63

Eu

Europium

151.964

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Yb

Ytterbium

173.045

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Lutetium

174.967

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Lu

Lutetium

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Lr

Lawrencium

(260)

56

La

Lanthanum

138.905 47

64

Gd

Gadolinium

157.25

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Yb

Ytterbium

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Lutetium

174.967

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Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

57

La

Lanthanum

138.905 47

65

Tb

Terbium

158.925 32

69

Yb

Ytterbium

173.045

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Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

58

Ce

Cerium

140.12

66

Dy

Dysprosium

162.500 15

69

Yb

Ytterbium

173.045

76

Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

59

Pr

Praseodymium

140.907 65

67

Ho

Holmium

164.930 32

69

Yb

Ytterbium

173.045

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Lu

Lutetium

174.967

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Lutetium

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Lr

Lawrencium

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Nd

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144.24

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Tm

Thulium

168.930 32

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162.500 15

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Lutetium

174.967

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Lu

Lutetium

174.967

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Gadolinium

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Tb

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Ytterbium

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(260)

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Terbium

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Dysprosium

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Lu

Lutetium

174.967

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(260)

66

Dy

Dysprosium

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67

Ho

Holmium

164.930 32

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Yb

Ytterbium

173.045

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Lu

Lutetium

174.967

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Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

67

Ho

Holmium

164.930 32

68

Tm

Thulium

168.930 32

69

Yb

Ytterbium

173.045

76

Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

68

Tm

Thulium

168.930 32

69

Yb

Ytterbium

173.045

69

Yb

Ytterbium

173.045

76

Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

69

Yb

Ytterbium

173.045

69

Yb

Ytterbium

173.045

69

Yb

Ytterbium

173.045

76

Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

70

Lu

Lutetium

174.967

70

Lu

Lutetium

174.967

69

Yb

Ytterbium

173.045

76

Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

71

Lu

Lutetium

174.967

70

Lu

Lutetium

174.967

69

Yb

Ytterbium

173.045

76

Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

72

Lu

Lutetium

174.967

70

Lu

Lutetium

174.967

69

Yb

Ytterbium

173.045

76

Lu

Lutetium

174.967

86

Lu

Lutetium

174.967

102

Lr

Lawrencium

(260)

73

Lu

Lutetium

174.967

70

Lu

Lutetium

174.967

69

Yb

Ytterbium

173.045

76

Lu

Lutetium

174.967

86

Lu

Lutetium

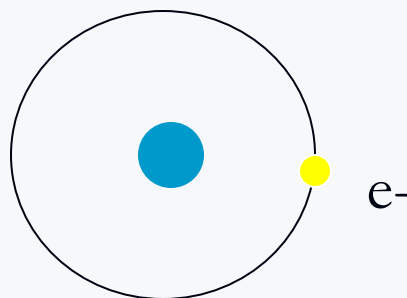
Organization of the Periodic Table

- **Metals - excellent conductors of heat & electricity**
 - Alkali metals - Group 1
 - Alkaline-earth metals - Group 2
 - Transition metals - Groups 3-12
- **Metalloids - properties of metals & non-metals (along zigzag)**
- **Non-Metals- poor conductors of heat & electricity. Usually brittle solids or gases.**
 - Halogens - Group 17
 - Noble gases - Group 18
 - Other solid non-metals - above metalloids

Alkali Metals

Group 1	
2	<div>3 Li Lithium 6.941</div>
3	<div>11 Na Sodium 22.989 770</div>
4	<div>19 K Potassium 39.0983</div>
5	<div>37 Rb Rubidium 85.4678</div>
6	<div>55 Cs Cesium 132.905 45</div>
7	<div>87 Fr Francium (223)</div>

- Group 1 of the Periodic Table
- All have 1 valence electron



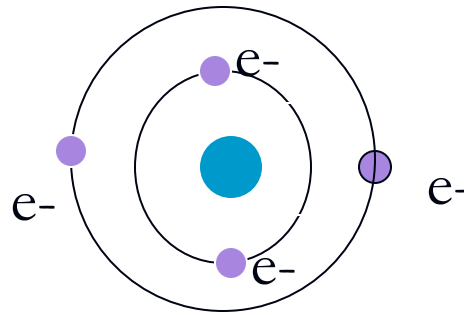
- Highly reactive (with water)
- Silvery in appearance
- Soft enough to be cut with a knife

Alkaline-Earth Metals

Group 2



- Group 2 of the Periodic Table
- All have 2 valence electrons

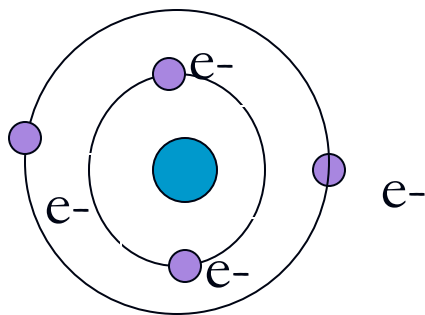


- Harder, denser, stronger the alkali metals
- Also reactive, but not as much as alkali metals

Transition Metals

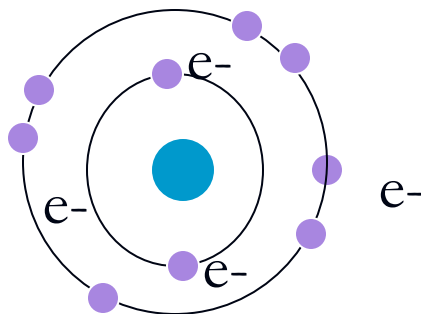
Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12
21 Sc Scandium 44.955 910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938 044	26 Fe Iron 55.845	27 Co Cobalt 58.933 195	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38
38 Y Yttrium 88.905 85	40 Zr Zirconium 91.224	41 Nb Niobium 92.906 38	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.905 50	46 Pd Palladium 106.42	47 Ag Silver 107.868 2	48 Cd Cadmium 112.411
57 La Lanthanum 138.905 5	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.222	78 Pt Platinum 195.078	79 Au Gold 196.966 55	80 Hg Mercury 200.59
89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (271)	111 Uuh* Ununhennium (272)	112 Uub* Unbibium (285)
<div> <div>do not fill data</div> <div></div> </div>							A team at Lawrence Berkeley National Lab used The same team rekindled the discovery in July		
							63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925 34
							66 Dy Dysprosium 162.500	67 Ho Holmium 164.930 32	68 Er Erbium 167.259
							69 Tm Thulium 168.934 21	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
							85 Am Americium (243)	86 Cm Curium (247)	87 Bk Berkelium (247)
							88 Cf Californium (251)	89 Es Einsteinium (252)	90 Fm Fermium (257)
							91 Md Mendelevium (258)	92 No Nobelium (259)	93 Lr Lawrencium (262)

- Groups 3-12 of the periodic table
- All have 2 valence electrons



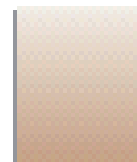
Halogens

- Group 17 of the Periodic Table
- All have 7 valence electrons



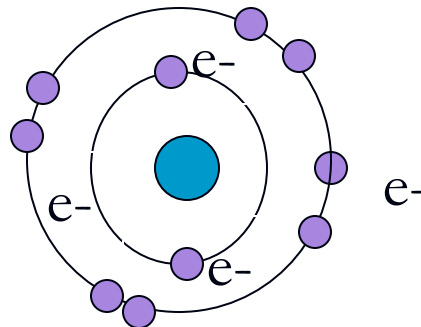
- Despite chemical similarities, some are solids, liquids, and gases
- Most reactive non-metals
- React with metals to make salts

Group 17



Noble Gases

- Group 18 of the Periodic Table
- All have 8 valence electrons, a complete octet



- Total lack of reactivity, inert
 - "too *noble* to react with anyone else"

Group 18



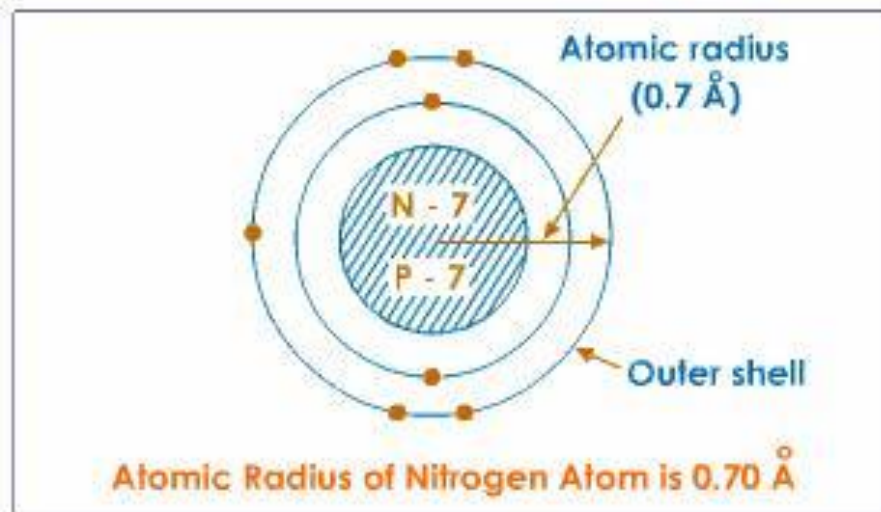
PERIODIC TRENDS

Periodic Trends

- Characteristics of elements are predictable based on their location on the Periodic Table.
- These characteristics are dependent on the structure of the atom and the location of its electrons.
- Periodic Trends include:
 - Reactivity
 - Atomic radius (size)
 - Ionization energy
 - Electronegativity

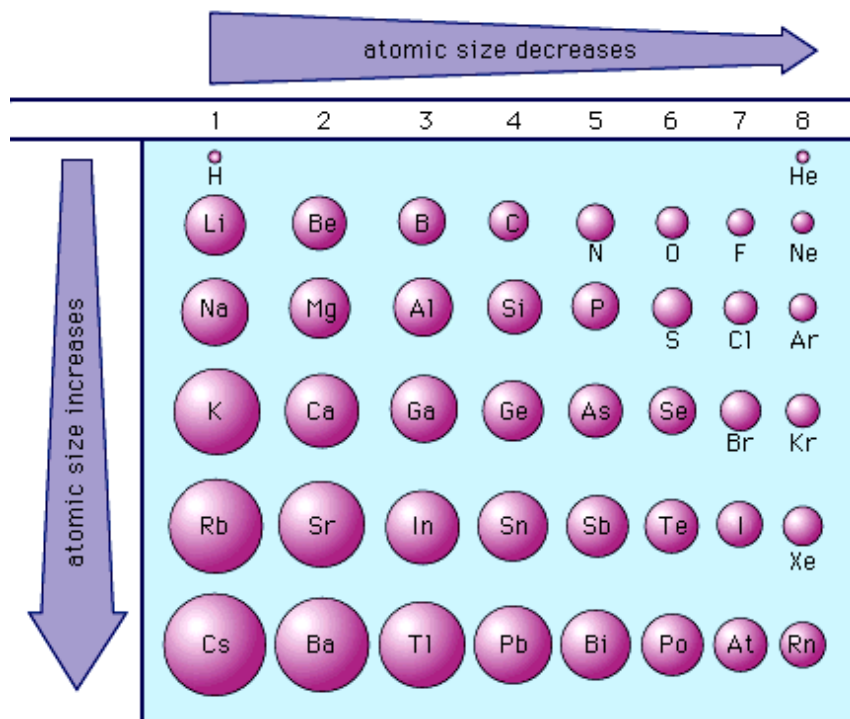
Atomic Radii

- Size of the atom – measured using half the distance between the nuclei of two identical atoms bonded together
- Trend – decreases across a period, increases down a group



- Largest atom = Francium
- Smallest atoms = Helium

Atomic Radii



- As you move across a period, you are adding electrons to the same energy level, but also adding more protons
 - These protons attract the electron cloud closer, decreasing the atomic radius.
- As you move down a group, you add energy levels.
 - Each energy level is farther away from the nucleus, increasing the atomic radius.

Ionization Energy (IE)

- The energy required to remove one electron from a neutral atom

Ex: Noble Gases require a ton of energy to lose an electron because they are "happy" with their full shells

Ex: Alkali Metals have low ionization energies because they want to lose their outer electron.

- Trend - increases across a period, decreases down a group

Ionization Energy

Periodic Table of Ionization Energies (kJ/mol)

Increase

Decrease

1 H 1.312																	2 He 2372	Group 18										
Group 1	3 Li 520	Group 2	4 Be 900													5 B 801	6 C 1086	7 N 1402	8 O 1314	9 F 1681	10 Ne 2081	2						
11 Na 496	12 Mg 738													13 Al 539	14 Si 787	15 P 1012	16 S 1000	17 Cl 1251	18 Ar 1321	3								
19 K 419	20 Ca 590	Group 3	21 Sc 831	Group 4	22 Ti 659	Group 5	23 V 651	Group 6	24 Cr 651	Group 7	25 Mn 711	Group 8	26 Fe 762	Group 9	27 Co 760	Group 10	28 Ni 737	Group 11	29 Cu 746	Group 12	30 Zn 900	31 Ga 579	32 Ge 762	33 As 947	34 Se 941	35 Br 1140	36 Kr 1351	4
37 Rb 403	38 Sr 550	39 Y 600	40 Zr 640	41 Nb 652	42 Mo 684	43 Tc 702	44 Ru 710	45 Rh 720	46 Pd 804	47 Ag 731	48 Cd 864	49 In 559	50 Sn 709	51 Sb 834	52 Te 869	53 I 1098	54 Xe 1170			5								
55 Cs 376	56 Ba 503	57 La 538	72 Hf 659	73 Ta 761	74 W 770	75 Re 760	76 Os 839	77 Ir 838	78 Pt 888	79 Au 890	80 Hg 1007	81 Tl 589	82 Pb 716	83 Bi 703	84 Po 812	85 At —	86 Rn 1038			6								
87 Fr —	88 Ra 509	89 Ac 490	104 Rf —	105 Db —	106 Sg —	107 Bh —	108 Hs —	109 Mt —	110 Uun —	111 Uuu —	112 Uub —	113 —	114 Uuq —	115 —	116 Uuh —	117 —	118 Uuo —			7								

6

C

1086

number

Symbol

First ionization energy

Lanthanide series													
58 Ce 534	59 Pr 527	60 Nd 533	61 Pm 536	62 Sm 545	63 Eu 547	64 Gd 592	65 Tb 586	66 Dy 573	67 Ho 581	68 Er 589	69 Tm 597	70 Yb 603	71 Lu 523
90 Th 587	91 Pa 570	92 U 598	93 Np 600	94 Pu 585	95 Am 578	96 Cm 581	97 Bk 601	98 Cf 608	99 Es 619	100 Fm 627	101 Md 635	102 No 642	103 Lr —
Actinide series													

Electronegativity

- The ability of an atom to attract electrons (how "greedy" it is)

Ex: Fluorine really wants another electron to get to the octet rule so it has a very high electronegativity. Anything close to Fluorine will have a high electronegativity

- Trend - increase across a period, decrease down a group

Electronegativity

Period

Increase

Decrease

1 H 2.1																	2 He —				
Group 1	Group 2															Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
3 Li 1.0	4 Be 1.5															5 B 2.0	6 C 2.5	7 N 3.0	8 O 3.5	9 F 4.0	10 Ne —
11 Na 0.9	12 Mg 1.2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	13 Al 1.5	14 Si 1.8	15 P 2.1	16 S 2.3	17 Cl 3.0	18 Ar —				
19 K 0.8	20 Ca 1.0	21 Sc 1.3	22 Ti 1.5	23 V 1.6	24 Cr 1.6	25 Mn 1.5	26 Fe 1.8	27 Co 1.8	28 Ni 1.8	29 Cu 1.9	30 Zn 1.8	31 Ga 1.8	32 Ge 1.8	33 As 2.0	34 Se 2.4	35 Br 2.8	36 Kr 3.0				
37 Rb 0.8	38 Sr 1.0	39 Y 1.2	40 Zr 1.4	41 Nb 1.6	42 Mo 1.8	43 Tc 1.9	44 Ru 2.2	45 Rh 2.2	46 Pd 2.2	47 Ag 1.9	48 Cd 1.7	49 In 1.7	50 Sn 1.8	51 Sb 1.9	52 Te 2.1	53 I 2.5	54 Xe 2.6				
55 Cs 0.7	56 Ba 0.9	57 La 1.1	72 Hf 1.3	73 Ta 1.5	74 W 1.7	75 Re 1.9	76 Os 2.2	77 Ir 2.2	78 Pt 2.2	79 Au 2.4	80 Hg 1.9	81 Tl 1.8	82 Pb 1.8	83 Bi 1.9	84 Po 2.0	85 At 2.2	86 Rn 2.4				
87 Fr 0.7	88 Ra 0.9	89 Ac 1.1	104 Rf —	105 Db —	106 Sg —	107 Bh —	108 Hs —	109 Mt —	110 Uun —	111 Uuu —	112 Uub —	113 —	114 Uuq —	115 —	116 Uuh —	117 —	118 Uuo —				

6

C

2.5

Atomic number

Symbol

Electronegativity

Lanthanide series

58 Ce 1.1	59 Pr 1.1	60 Nd 1.1	61 Pm 1.1	62 Sm 1.2	63 Eu 1.2	64 Gd 1.2	65 Tb 1.1	66 Dy 1.2	67 Ho 1.2	68 Er 1.2	69 Tm 1.2	70 Yb 1.1	71 Lu 1.3
90 Th 1.3	91 Pa 1.5	92 U 1.4	93 Np 1.4	94 Pu 1.3	95 Am 1.3	96 Cm 1.3	97 Bk 1.3	98 Cf 1.3	99 Es 1.1	100 Fm 1.3	101 Md 1.3	102 No 1.3	103 Lr —

Actinide series

Heavy metal (joke)

thinkgeek.com



Mental_Floss magazine

