

# Periodic Table & Trends

**Regions of the Periodic Table**

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

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

# History of the Periodic Table

- 1871 – **Mendeleev** arranged the elements according to:
  1. **Increasing atomic mass**
  2. Elements w/ **similar properties** were put in the **same row**
- 1913 – **Moseley** arranged the elements according to:
  1. **Increasing atomic number**
  2. Elements w/ **similar properties** were put in the **same column**

# Group Names

Alkali +1	Alkaline Earth Metals +2		+3		-3	-2	Halogen -1	Noble Gases 0
H 1								He 2
Li 3	Be 4		B 5	C 6	N 7	O 8	F 9	Ne 10
Na 11	Mg 12		Al 13	Si 14	P 15	S 16	Cl 17	Ar 18

# METALS

Regions of the Periodic Table

# NONMETALS

## TRANSITION METALS

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

S & P block – Representative Elements

Metalloids (Semimetals, Semiconductors) – B, Si, Ge, As, Sb, Te (properties of both metals & nonmetals)

Columns – groups or families

Rows - periods

# Periodic Groups

- Elements in the same column have similar chemical and physical properties
- These similarities are observed because elements in a column have similar  $e^-$  configurations (same amount of electrons in outermost shell)

# Periodic Trends

- Periodic Trends – patterns (don't always hold true) can be seen with our current arrangement of the elements (Moseley)
- Trends we'll be looking at:
  1. Atomic Radius
  2. Ionization Energy
  3. Electronegativity

# Atomic Radius

**TABLE 11-7**

Atomic radius decreases →

	1A	2A	3A	4A	5A	6A	7A
H 37							
Li 152	Be 111	B 88	C 77	N 70	O 66	F 64	
Na 186	Mg 160	Al 143	Si 117	P 110	S 104	Cl 99	
K 231	Ca 197	Ga 135	Ge 122	As 121	Se 117	Br 114	
Rb 244	Sr 215	In 162	Sn 140	Sb 141	Te 137	I 133	
Cs 262	Ba 217	Tl 171	Pb 175	Bi 146	Po 150	At 140	

Atomic radius increases ↓

- **Atomic Radius** — size of an atom (distance from nucleus to outermost  $e^-$ )

# Atomic Radius Trend

- Group Trend – As you go **down a column**, **atomic radius increases**

As you go down,  $e^-$  are filled into orbitals that are farther away from the nucleus (attraction not as strong)

- Periodic Trend – As you go **across a period** (L to R), **atomic radius decreases**

As you go L to R,  $e^-$  are put into the same orbital, but more  $p^+$  and  $e^-$  total (more attraction = smaller size)



# Ionic Radius

**TABLE 11-8**

Ionic Radii of Representative Elements (pm)					
Li <sup>+</sup> 60	Be <sup>2+</sup> 31		N <sup>3-</sup> 171	O <sup>2-</sup> 140	F <sup>-</sup> 136
Na <sup>+</sup> 95	Mg <sup>2+</sup> 65	Al <sup>3+</sup> 50	P <sup>3-</sup> 212	S <sup>2-</sup> 184	Cl <sup>-</sup> 181
K <sup>+</sup> 133	Ca <sup>2+</sup> 99	Ga <sup>3+</sup> 62	As <sup>3-</sup> 222	Se <sup>2-</sup> 198	Br <sup>-</sup> 195
Rb <sup>+</sup> 148	Sr <sup>2+</sup> 113	In <sup>3+</sup> 81			
Cs <sup>+</sup> 169	Ba <sup>2+</sup> 135	Tl <sup>3+</sup> 95	Te <sup>2-</sup> 221	I <sup>-</sup> 216	

Cations larger (left side, downward arrow)  
 Anions larger (right side, downward arrow)  
 Cations larger (bottom left, leftward arrow)  
 Anions larger (bottom right, leftward arrow)

- Ionic Radius – size of an atom when it is an ion

# Ionic Radius Trend

**Metals** – lose  $e^-$ , which means more  $p^+$  than  $e^-$  (more attraction) SO...

**Cation Radius  $<$  Neutral Atomic Radius**

**Nonmetals** – gain  $e^-$ , which means more  $e^-$  than  $p^+$  (not as much attraction) SO...

**Anion Radius  $>$  Neutral Atomic Radius**

# Ionic Radius Trend

- Group Trend – As you go down a column, ionic radius increases
- Periodic Trend – As you go across a period (L to R), cation radius decreases, anion radius decreases, too.

As you go L to R, cations have more attraction (smaller size because more  $p^+$  than  $e^-$ ). The anions have a larger size than the cations, but also decrease L to R because of less attraction (more  $e^-$  than  $p^+$ )

# Ionic Radius



## Ionic radii

S.K. Lower

Ions are colored red and blue; parent atoms brown.  
Radii are in picometers.

# Ionic Radius

How do I remember this?????

*The more electrons that are lost, the greater the reduction in size.*

**Li<sup>+1</sup>**

protons 3

electrons 2

**Be<sup>+2</sup>**

protons 4

electrons 2

**Which ion is smaller?**

# Ionic Radius

How do I remember this???

*The more electrons that are gained, the greater the increase in size.*



protons 15

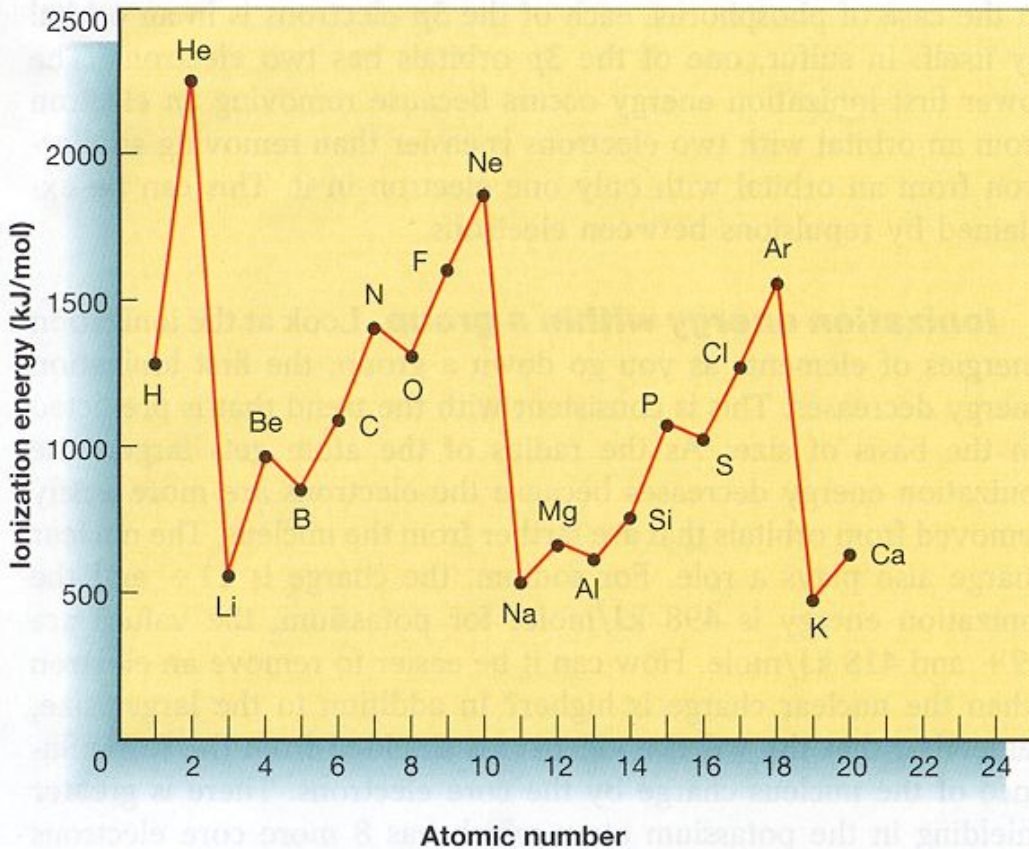
protons 16

electrons 18

electrons 18

**Which ion is smaller?**

# Ionization Energy



- Ionization Energy – energy needed to remove outermost  $e^-$

# Ionization Energy

- Group Trend – As you go **down a column**, **ionization energy decreases**

As you go down, atomic size is increasing (less attraction), so easier to remove an  $e^-$

- Periodic Trend – As you go **across a period** (L to R), **ionization energy increases**

As you go L to R, atomic size is decreasing (more attraction), so more difficult to remove an  $e^-$

(also, metals want to lose  $e^-$ , but nonmetals do not)



# Electronegativity

Table 14.2

Electronegativity Values for Atoms of Selected Elements						
H 2.1						
Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8	Ca 1.0	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
Rb 0.8	Sr 1.0	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5
Cs 0.7	Ba 0.9	Tl 1.8	Pb 1.9	Bi 1.9		

- Electronegativity-  
tendency of an  
atom to attract  $e^-$

# Electronegativity Trend

- Group Trend – As you go **down a column**, **electronegativity decreases**

As you go down, atomic size is increasing, so less attraction to its own  $e^-$  and other atom's  $e^-$

- Periodic Trend – As you go **across a period** (L to R), **electronegativity increases**

As you go L to R, atomic size is decreasing, so there is more attraction to its own  $e^-$  and other atom's  $e^-$

# Reactivity

- Reactivity – tendency of an atom to react
- **Metals** – lose  $e^-$  when they react, so metals' reactivity is based on lowest Ionization Energy (bottom/left corner) Low I.E = High Reactivity
- **Nonmetals** – gain  $e^-$  when they react, so nonmetals' reactivity is based on high electronegativity (upper/right corner)

High electronegativity = High reactivity

# Metallic Character

- Properties of a Metal – 1. Easy to shape  
2. Conduct electricity 3. Shiny
- Group Trend – As you go **down a column**, **metallic character increases**
- Periodic Trend – As you go **across a period** (L to R), **metallic character decreases** (L to R, you are going from metals to non-metals)