

Unit 8

On completion of the unit you should be able to:

1. state the mass, charge and location of protons, electrons and neutrons.
2. given the atomic number of an element, draw diagrams showing the protons in the nucleus and the electrons in shells (or energy levels) around the nucleus.
3. write the electron dot symbols for the elements in groups 1 to 8 in the periodic table.
4. define isotopes, mass number and atomic mass.
5. given the relative abundance and isotopic masses for an element, calculate the atomic mass of that element.
6. given the atomic number and mass number of an element, calculate the number of electrons.

ATOMS AND THE PERIODIC TABLE

8.7 Periodic trends

- Atomic size
- Ionic size
- Metallic characteristic
- Melting point and boiling point
- Electronegativity

8.8 Bonding

- Ionic bonding
- Covalent bonding

 Today's focus.

Reading: Hebden – page 183-186

Unit 9

On completion of the unit you should be able to:

1. define solutions
2. define solute and solvent
3. describe the dissolving process for ionic and molecular compounds
4. define the term "solubility"
5. define saturated and unsaturated solutions
6. predict the solubility of molecular compounds in water
7. use the solubility rules to predict the solubility of ionic compounds in water

SOLUTION CHEMISTRY

9.1 Terminology

Reading: Hebden – page 193

9.2 Polarity of molecules

Reading: Hebden – page 204

9.3 Solubility rules of ionic compounds in water

 Today's focus.

Ionic bonding




When a substance contains atoms of both metals and nonmetals, the electrons are naturally more attracted to the nonmetals. The nonmetals become negatively charged ions and the metals naturally become positively charged ions. (NOTE: The number of electrons that is gained or lost by the nonmetal and the metal is determined by the **Octet rule**.) An attractive force exists between the oppositely charged ions. The force that keeps the ions held together is the chemical bond called the ionic bond.

Ionic bonding requires a transfer of electrons from a metal to a nonmetal, a process that forms ions. Once these ions are formed, they arrange themselves into a 3-dimensional crystal in the solid state.

Lewis electron dot symbols can be used to describe ionic bonding in:

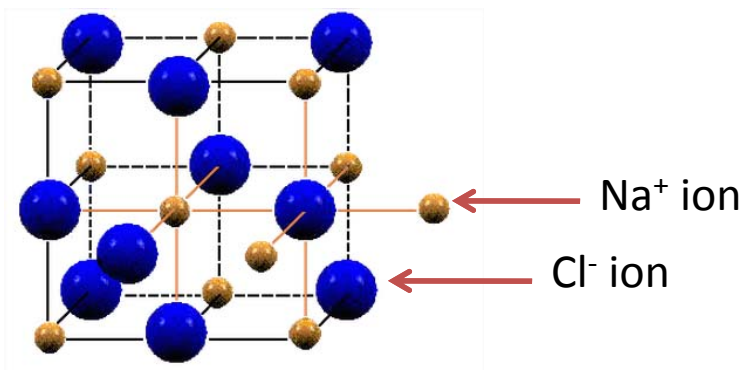
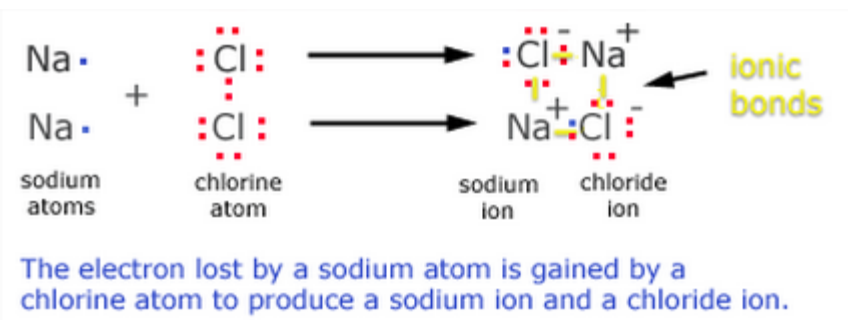
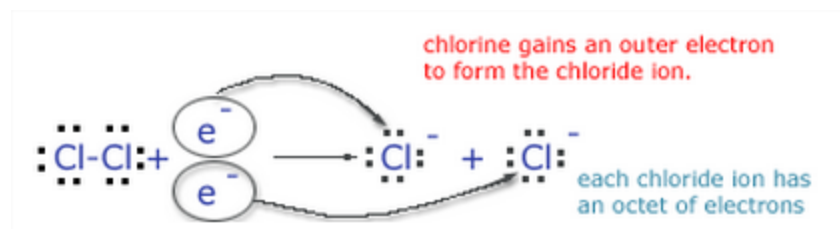
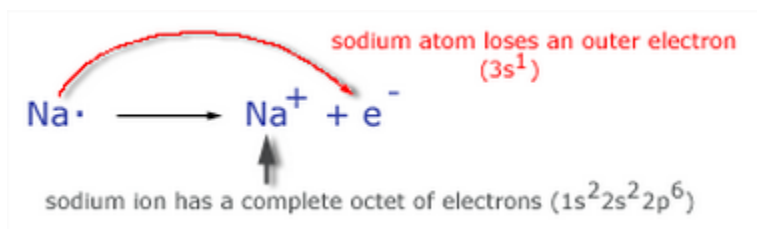
1. sodium chloride, NaCl
2. magnesium chloride, MgCl_2

1.008 H 1																	4.003 He 2	
6.941 Li 3	Be 4																	
22.990 Na 11	Mg 12																	
TRANSITION ELEMENTS																		
39.0983 K 19	Ca 20	44.956 Sc 21	47.90 Ti 22	50.9415 V 23	51.996 Cr 24	54.938 Mn 25	55.847 Fe 26	58.933 Co 27	58.71 Ni 28	63.546 Cu 29	65.37 Zn 30	69.72 Ga 31	72.64 Ge 32	74.922 As 33	78.96 Se 34	79.904 Br 35	83.80 Kr 36	
85.468 Rb 37	87.62 Sr 38	88.906 Y 39	91.224 Zr 40	92.9064 Nb 41	95.94 Mo 42	98.906 Tc 43	101.07 Ru 44	101.07 Rh 45	102.905 Pd 46	106.42 Ag 47	107.868 Cd 48	114.82 In 49	118.710 Sn 50	121.757 Sb 51	127.60 Te 52	126.905 I 53	131.29 Xe 54	
132.905 Cs 55	137.33 Ba 56	138.905 *La 57	138.905 Hf 72	180.948 Ta 73	183.85 W 74	186.2 Re 75	190.2 Os 76	192.22 Ir 77	195.09 Pt 78	196.967 Au 79	200.59 Hg 80	204.37 Tl 81	207.2 Pb 82	208.981 Bi 83	209 Po 84	210 At 85	222 Rn 86	
(223) Fr 87	(226) Ra 88	(227) **Ac 89	(261) Rf 104	(262) Db 105	(263) Sg 106	(265) Ns 107	(266) Hs 108	(269) Mt 109	(272) — 110	(277) — 111								

 Metals
  Non-metals
  Semi-metals

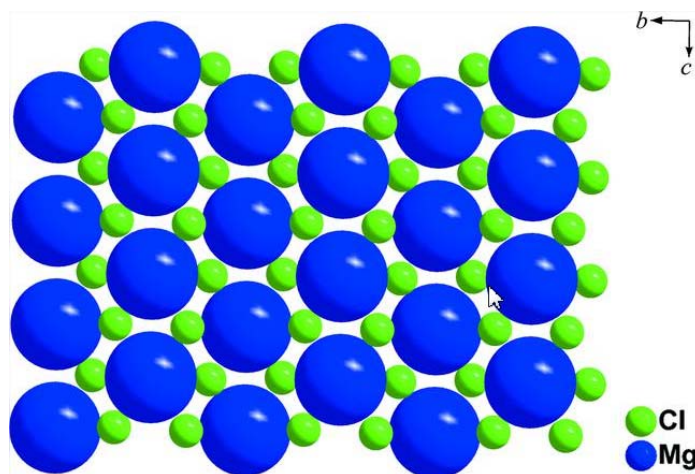
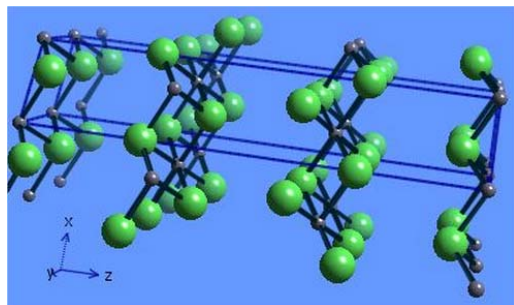
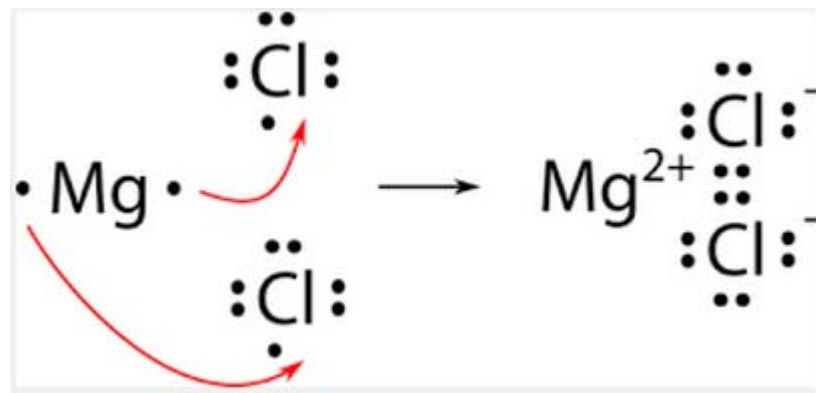
Ionic Bonding

Lewis electron dot symbol to describe ionic bonding in sodium chloride



Ionic Bonding

Lewis electron dot symbol to describe ionic bonding in magnesium chloride

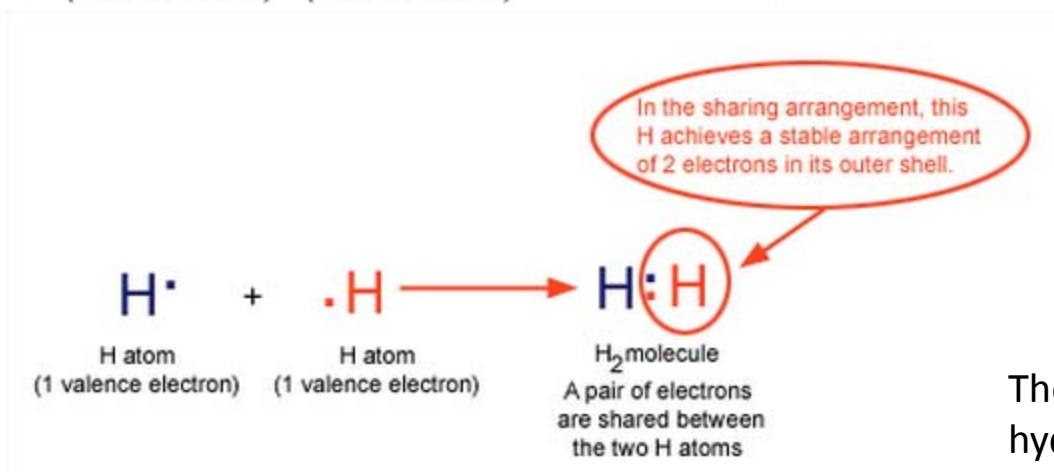
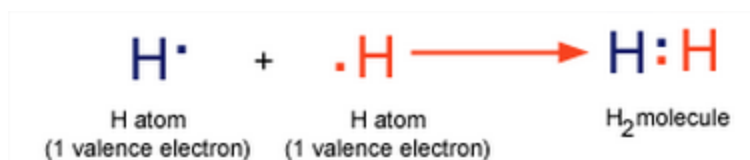


Covalent bonding

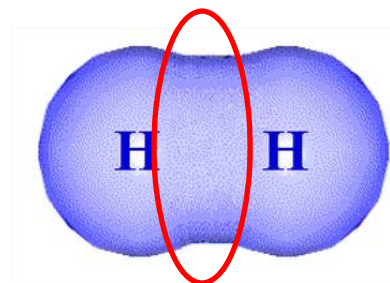
The chemical bonds formed by sharing of electrons between non-metallic elements are referred to as **covalent bonds**. When two or more atoms are joined together chemically by covalent bonds, a molecule is formed. The mass of a molecule is called the molecular mass.

Covalent bonds may either be polar or nonpolar. When electrons in a bond are shared equally, the bond is called nonpolar bond. When electrons in a bond are shared unequally, the bond is called polar covalent bond or polar bond.

Covalent bond formed between similar elements, H_2



Overlap of electron cloud forms the bond



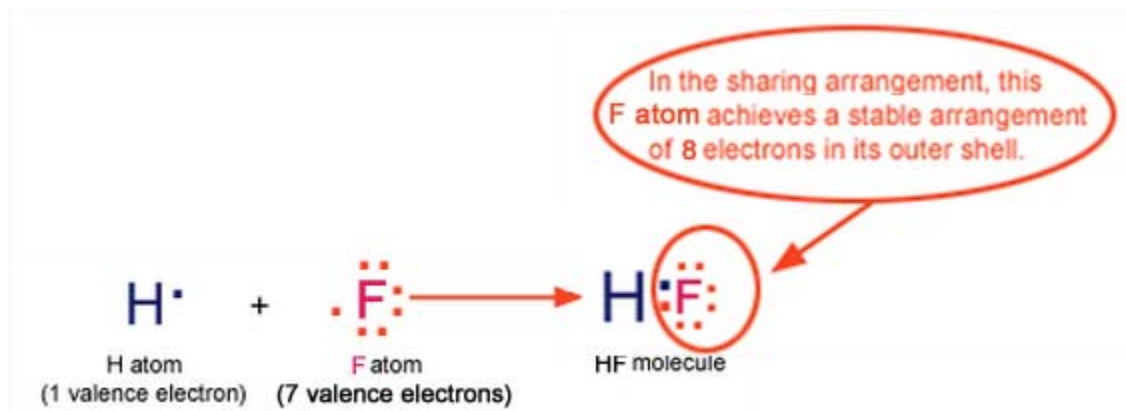
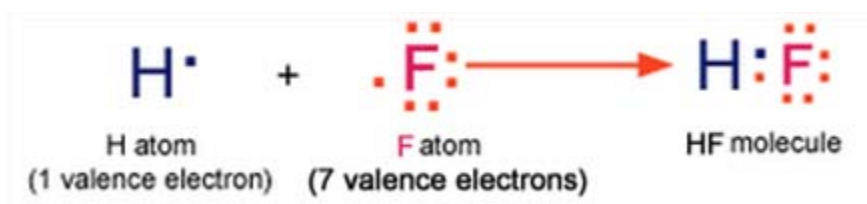
Nonpolar covalent bond

The above image is a representation of the electron cloud (residing in the atomic orbital $1s^1$) about the hydrogen atoms.

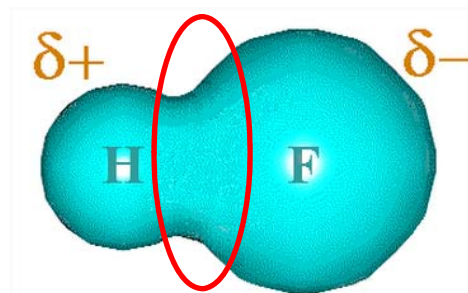
The identical electron clouds about each hydrogen atom indicate that in the hydrogen molecule, the electrons are **shared equally** between the two hydrogen nuclei.

Covalent Bonding

Covalent bond formed between dissimilar elements, HF



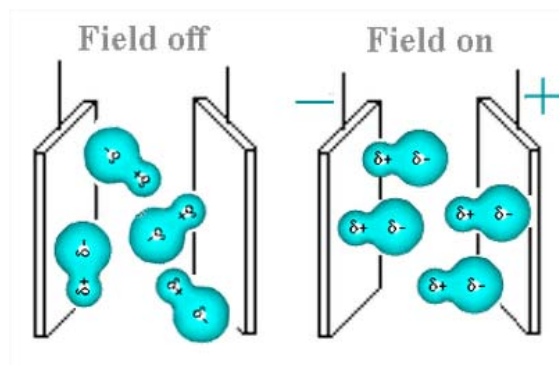
Overlap of electron cloud forms the bond



Polar covalent bond

The electron clouds about each atom in this molecule are not identical. The electrons are **not shared equally** between the two nuclei because the H atom and the F atom do not attract electrons towards their nuclei equally.

The separation of charge in a polar covalent bond creates an electric dipole.

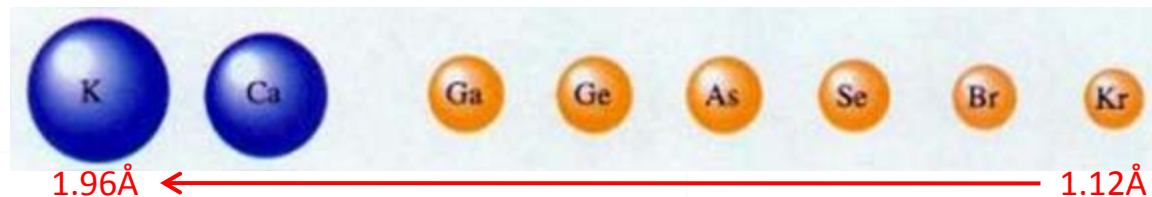


Periodic Trends

Periodic trends are the tendencies of certain elemental characteristics to increase or decrease as one moves across a row or column of the periodic table of elements.

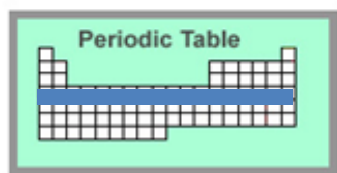
- Atomic size
- Ionic size
- Metallic characteristic
- Melting point and boiling point
- Electronegativity

Periodic Trends



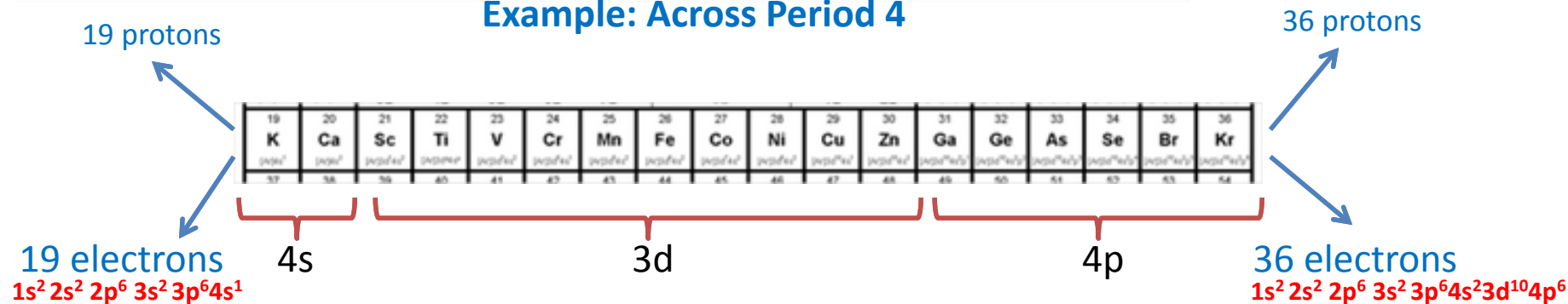
I. Atomic size

1. Draw in the direction of an arrow for atomic size trend as you move ACROSS a row on the Periodic Table.

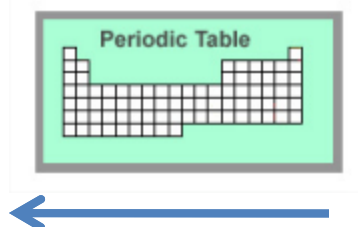


$$1\text{\AA} = 10^{-10} \text{ meter}$$

Example: Across Period 4



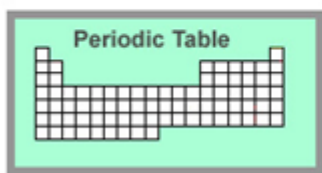
For Period 4 elements, the outermost shell that the electrons occupy is $n=4$. However, the number of proton within the period increases. The increased in positive nuclear charge from L→R enables the nucleus to draw the electron cloud closer to itself. and hence. decreasing the atomic size.



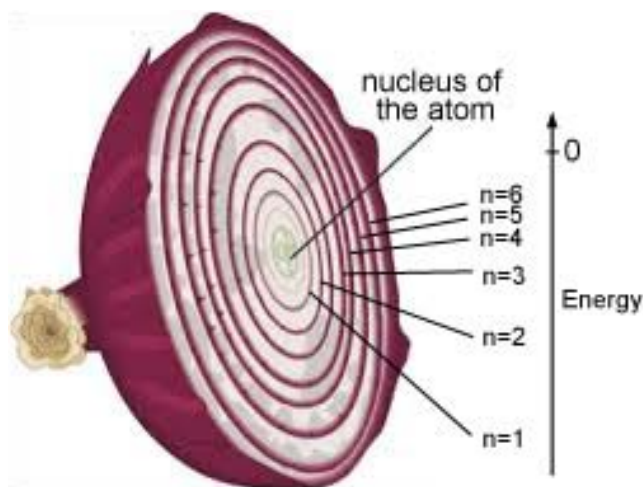
**Atomic size
increases
R→L**

Periodic Trends

2. Draw in the direction of an arrow for atomic size trend as you move DOWN a column on the Periodic Table.



**Atomic size
increases
as you move
down a column**



n=1



n=7

PERIODS		1
		IA
1	1.008	H
2	6.941	Li
3	22.990	Na
4	39.0983	K
5	85.468	Rb
6	132.906	Cs
7	(223)	Fr

Periodic Trends

$$1\text{\AA} = 10^{-10} \text{ meter}$$

II. Ionic size

Circle which is bigger.

1. **Na atom** or Na^+ ion

of protons 11 11

of electrons 11 10

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

$1s^2 2s^2 2p^6$

2. F atom or **F^- ion**

of protons 9 9

of electrons 9 10

$1s^2 2s^2 2p^5$

$1s^2 2s^2 2p^6$

3. Na^+ ion or F^- ion or **O^{2-} ion**

of protons 11 9 8

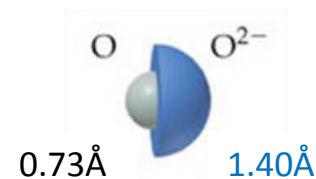
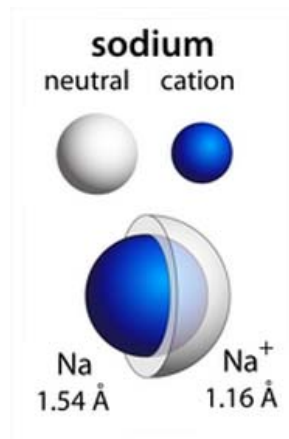
of electrons 10 10 10

$1s^2 2s^2 2p^6$

$1s^2 2s^2 2p^6$

$1s^2 2s^2 2p^6$

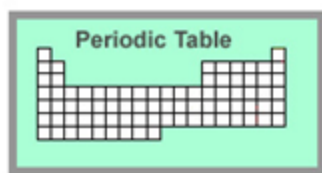
Isoelectronic series
(i.e. these ions have
the same number of
electrons)



Periodic Trends

III. Metallic characteristic

1. Draw in the direction of an arrow for metallic characteristics trend as you move **ACROSS** a row on the Periodic Table.

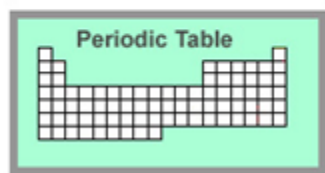


**Metallic
characteristics
increases from R→L**

1.008 H 1																	4.003 He 2
6.941 Li 3	9.012 Be 4											10.811 B 5	12.011 C 6	14.007 N 7	15.999 O 8	18.998 F 9	20.179 Ne 10
22.990 Na 11	24.305 Mg 12	TRANSITION ELEMENTS										26.982 Al 13	28.086 Si 14	30.974 P 15	32.06 S 16	35.453 Cl 17	39.948 Ar 18
39.0983 K 19	40.08 Ca 20	44.956 Sc 21	47.90 Ti 22	50.9415 V 23	51.996 Cr 24	54.938 Mn 25	55.847 Fe 26	58.933 Co 27	58.71 Ni 28	63.546 Cu 29	65.37 Zn 30	69.72 Ga 31	72.59 Ge 32	74.922 As 33	78.96 Se 34	79.904 Br 35	83.80 Kr 36
85.468 Rb 37	87.62 Sr 38	88.906 Y 39	91.22 Zr 40	92.9064 Nb 41	95.94 Mo 42	98.906 Tc 43	101.07 Ru 44	102.906 Rh 45	106.4 Pd 46	107.868 Ag 47	112.41 Cd 48	114.82 In 49	118.69 Sn 50	121.75 Sb 51	127.60 Te 52	126.904 I 53	131.30 Xe 54
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(223) Fr 87	(226) Ra 88	(227) **Ac 89	(261) Rf 104	(261) Ha 105	(263) Sg 106	(263) Ns 107	(269) Hs 108	(269) Mt 109	(272) — 110	(277) — 111							
140.12 Ce 58	140.908 Pr 59	144.24 Nd 60	(145) Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.925 Tb 65	162.50 Dy 66	164.930 Ho 67	167.26 Er 68	168.934 Tm 69	173.04 Yb 70	173.04 Lu 71				
232.0377 Th 90	231.0361 Pa 91	238.0289 U 92	237.0481 Np 93	(244) Pu 94	(247) Am 95	(247) Cm 96	(247) Bk 97	(251) Cf 98	(252) Es 99	(257) Fm 100	(257) Md 101	(258) No 102	(259) Lr 103				

- Metals
- Non-metals
- Semi-metals

2. Draw in the direction of an arrow for metallic characteristics trend as you move **DOWN** a column on the Periodic Table.



**Metallic
characteristics
increases as you
move down a column**

Periodic Trends

1. Draw in the direction of an arrow for melting point and boiling point trend as you move DOWN the column for the halogens (Group VIIA).



Room Temperature:

(g)

(g)

(l)

(s)

		Melting Point	Boiling Point
9	F Fluorine 18.9984032		
17	Cl Chlorine 35.4527		
35	Br Bromine 79.904		
53	I Iodine 126.90447		
85	At Astatine (210)		

(s) → (l) (l) → (g)

Melting point and
boiling point
increase as you move
down a column

Periodic Trends

2. Draw in the direction of an arrow for melting point and boiling point trend as you move DOWN the column for the alkali metals (Group IA).

Room Temperature:

mp = 180.5 °C } (s)
bp = 1342 °C }



(s)

(s)

(s)

mp = 28.44 °C } (s)
bp = 670.8 °C }

(s)

	Melting Point	Boiling Point
3 Li Lithium 6.941		
11 Na Sodium 22.989770		
19 K Potassium 39.0983		
37 Rb Rubidium 85.4678		
55 Cs Cesium 132.90545		

(s) → (l) (l) → (g)

**Melting point and
boiling point
decrease as you move
down a column**

With an increase in atomic number, you have an increase in electron shells. As the radius of atoms get larger down the group, you could say that the force holding them together is spread over the greater area and hence, the metal cations are more weakly bonded. When the bonding is weaker, the metal's melting point will decrease.

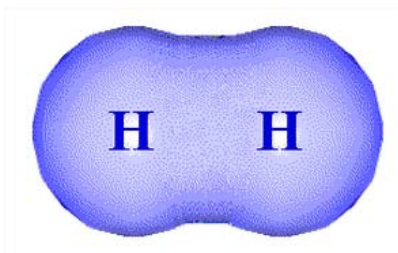
Periodic Trends

V. Electronegativity

1. In your own words, what is it and what is it used for?

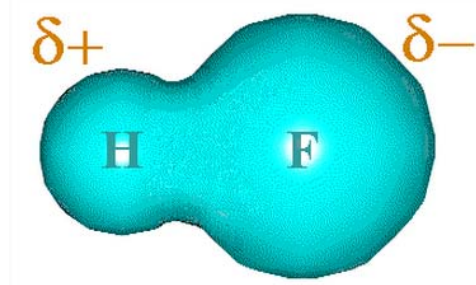
Electronegativity is a measure of the tendency of an atom to draw electrons to itself in a bond.

H₂



Nonpolar covalent bond

HF



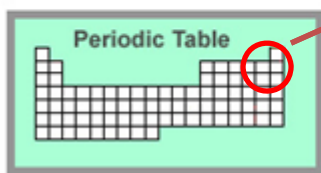
Polar covalent bond

It is a scale where **Fluorine** (the **most electronegative** element) is assigned a value of 4.0.
Cesium is the **least electronegative** with a value of 0.79.

This scale is used to determine how polar the bond is.

Periodic Trends

2. Draw in the direction of an arrow for electronegativity trend as you move ACROSS a row on the Periodic Table.

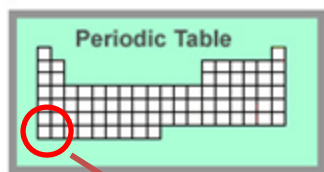


Fluorine is the *most* electronegative element.

**Electronegativity
increases from L→R**



3. Draw in the direction of an arrow for electronegativity trend as you move DOWN a column on the Periodic Table.



**Electronegativity
decreases as you go
down a column.**

Cesium is the *least* electronegative element.

