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**
Reading: Hebden – page 183-186

Today's focus.

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.

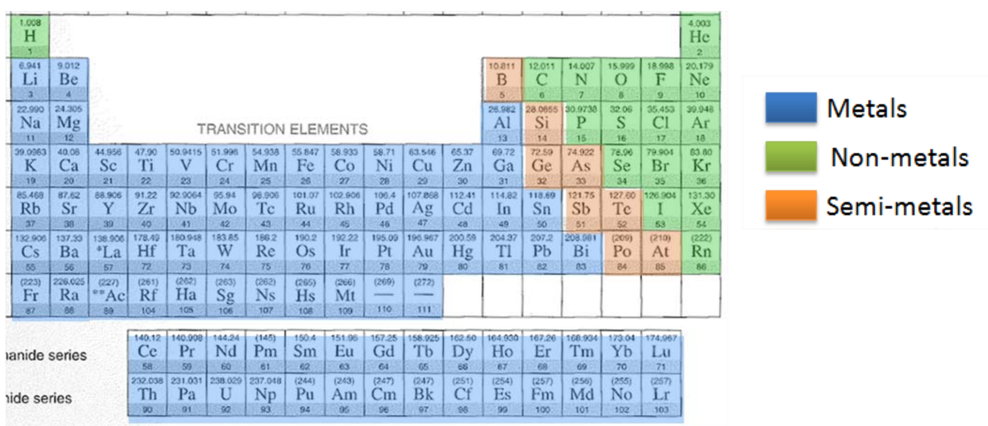
Ionic bonding

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.

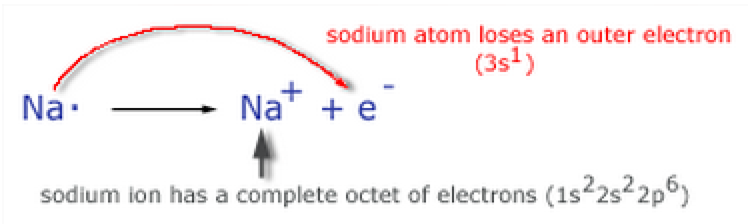
Lewis electron dot symbols can be used to describe ionic bonding in:

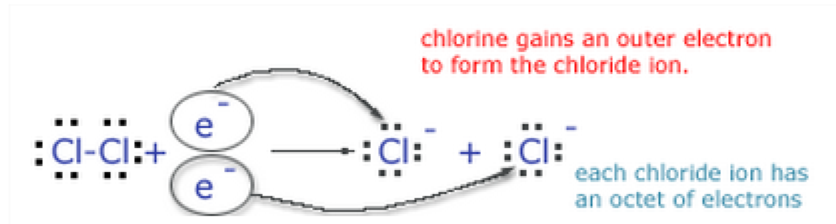
1. sodium chloride, NaCl
2. magneisum chloride, $MgCl_2$

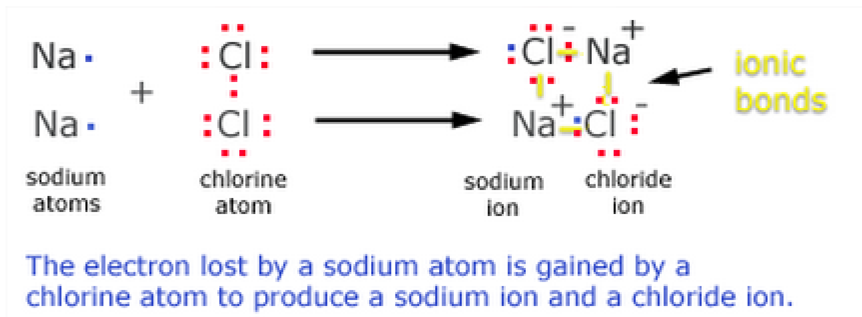


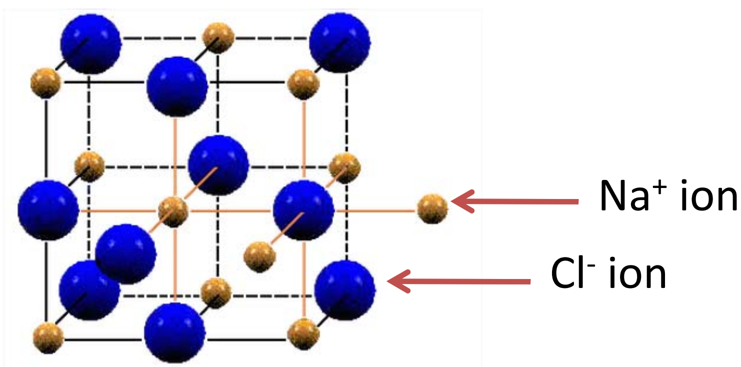
Ionic Bonding

Lewis electron dot symbol to describe ionic bonding in sodium chloride



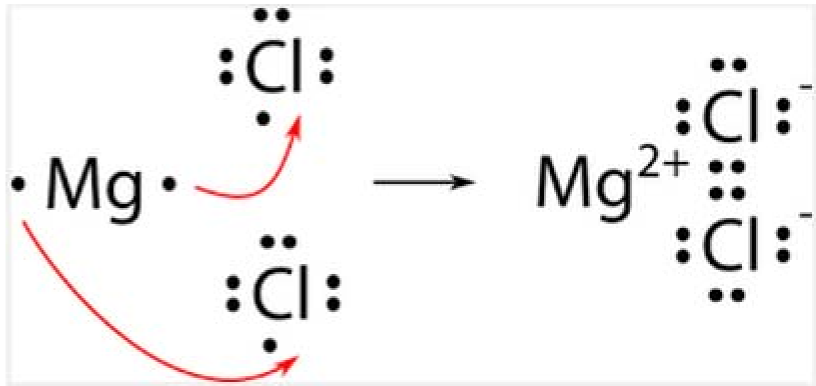


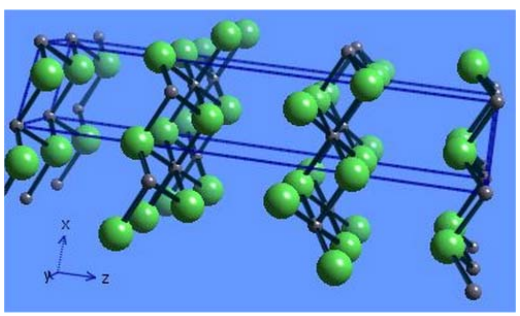


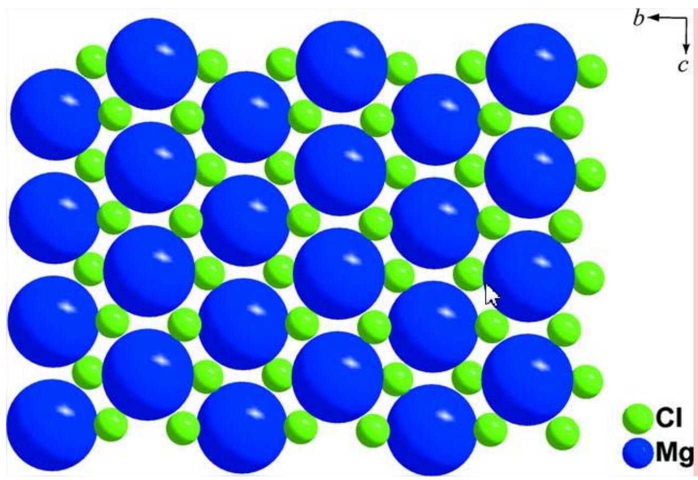


Ionic Bonding

Lewis electron dot symbol to describe ionic bonding in magnesium chloride





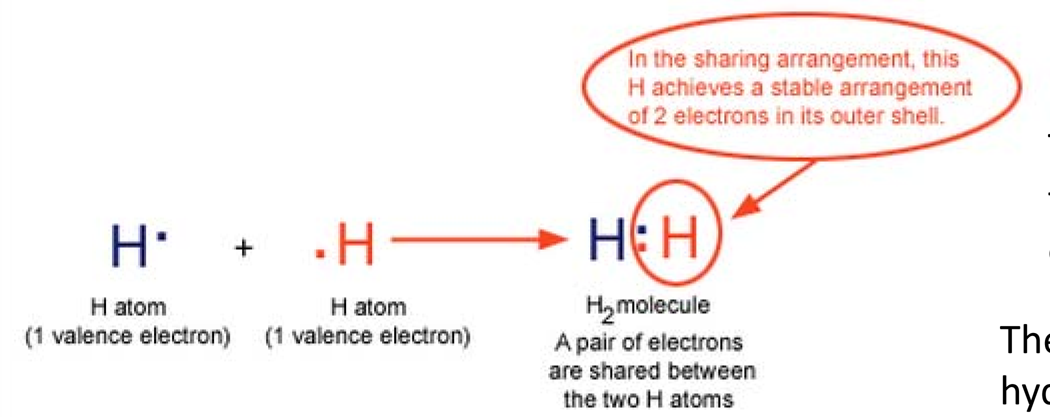


Covalent bonding

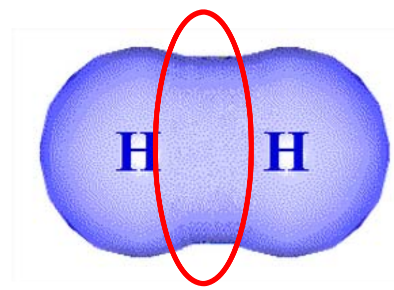
The chemical bonds formed by sharing of electrons between non-metallic elements are referred to as **covalent bonds**. When two or more atoms are joined together chemically by covalent bonds, a molecule is formed. The mass of a molecule is called the molecular mass.

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



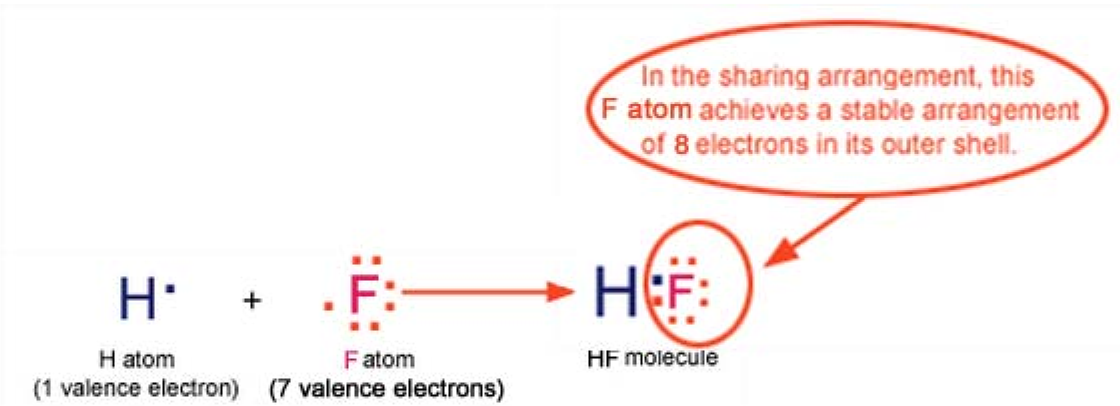
Nonpolar covalent bond

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

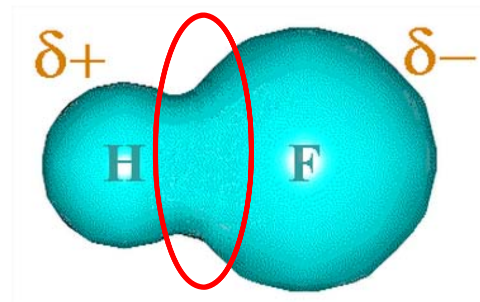
The identical electron clouds about each hydrogen atom indicate that in the hydrogen molecule, the electrons are **shared equally** between the two hydrogen nuclei.

Covalent Bonding

Covalent bond formed between dissimilar elements, HF



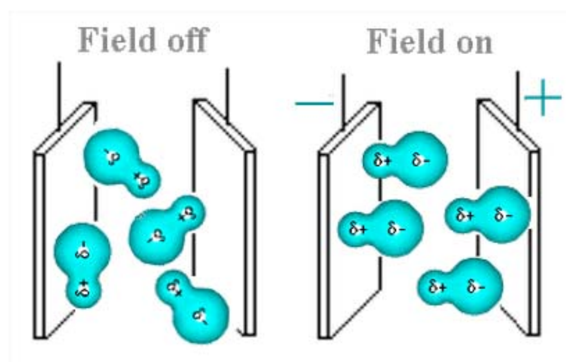
Overlap of electron cloud forms the bond



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

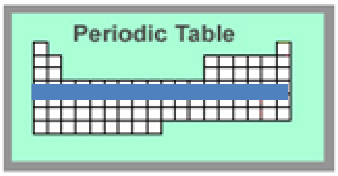
Periodic Trends

1.96Å ← 1.12Å

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.

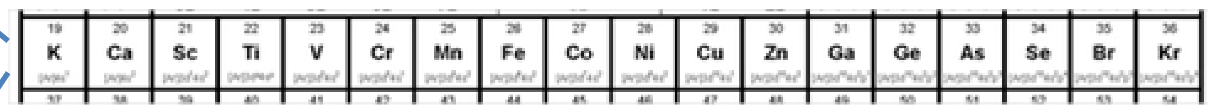
$1 Å = 10^{-10}$ meter



Example: Across Period 4

19 protons

36 protons



19 electrons

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

4s

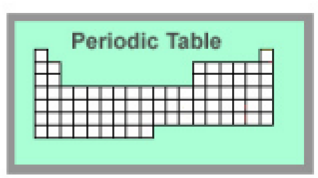
3d

4p

36 electrons

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$

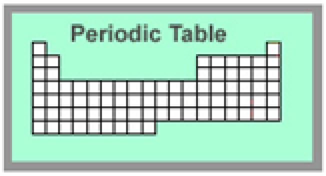
For Period 4 elements, the outermost shell that the electrons occupy is n=4. However, the number of proton within the period increases. The increased in positive nuclear charge from L→R enables the nucleus to draw the electron cloud closer to itself, and hence, decreasing the atomic size.



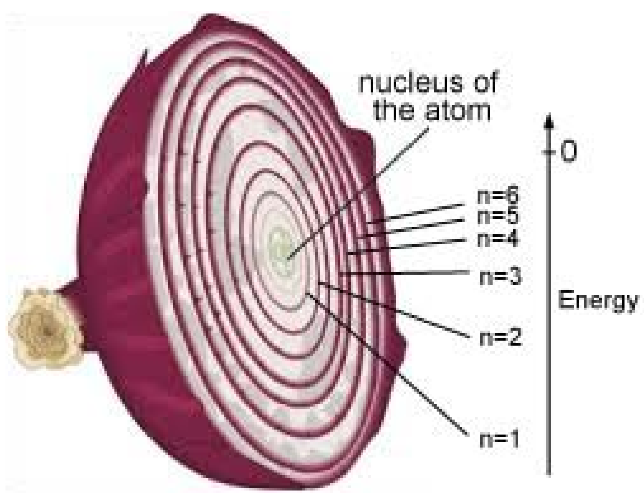
Atomic size increases R→L

Periodic Trends

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

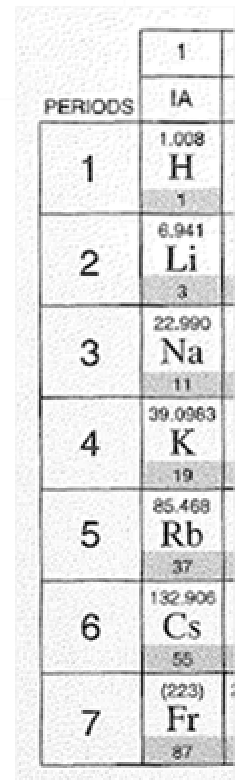


Atomic size increases as you move down a column



n=1

n=7



Periodic Trends

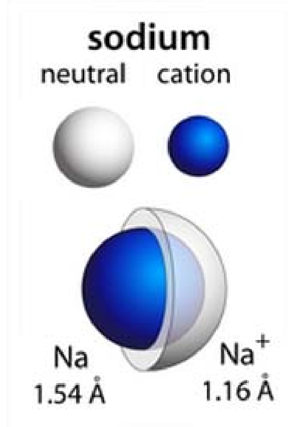
$1Å = 10^{-10}$ meter

II. Ionic size

Circle which is bigger.

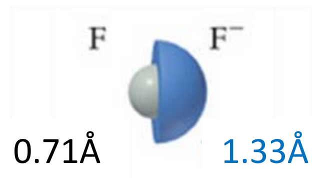
1. Na atom or Na^+ ion

# of protons	11	11
# of electrons	11	10
	$1s^2 2s^2 2p^6$ **$3s^1$**	$1s^2 2s^2 2p^6$



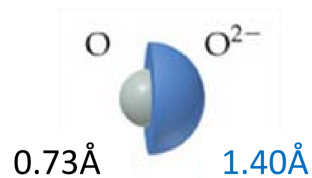
2. F atom or F^- ion

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

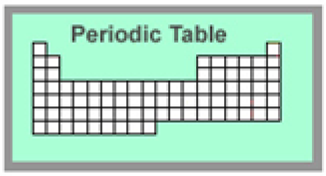


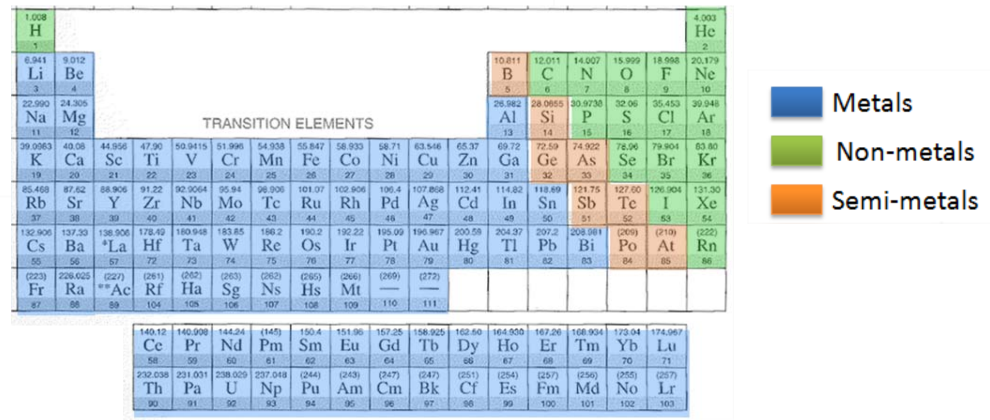
Isoelectronic series (i.e. these ions have the same number of electrons)

Periodic Trends

III. Metallic characteristic

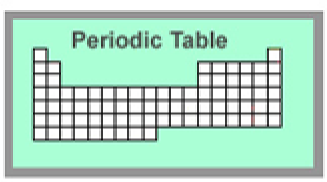
1. Draw in the direction of an arrow for metallic characteristics trend as you move ACROSS a row on the Periodic Table.





Metallic characteristics increases from R→L

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 colum for the halogens (Group VIIA).

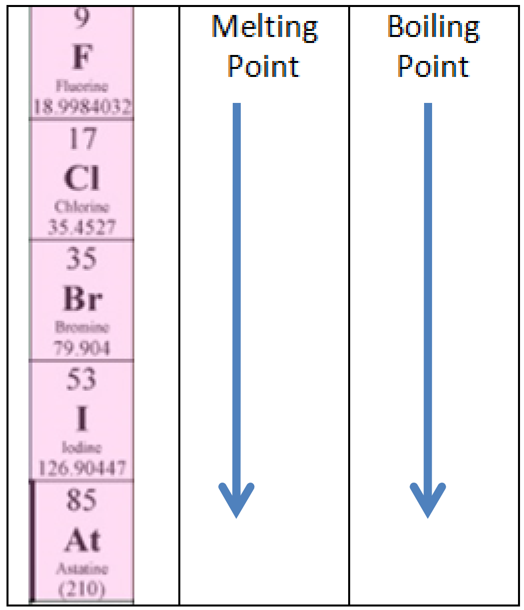
Room Temperature:

(g)

(g)

(l)

(s)



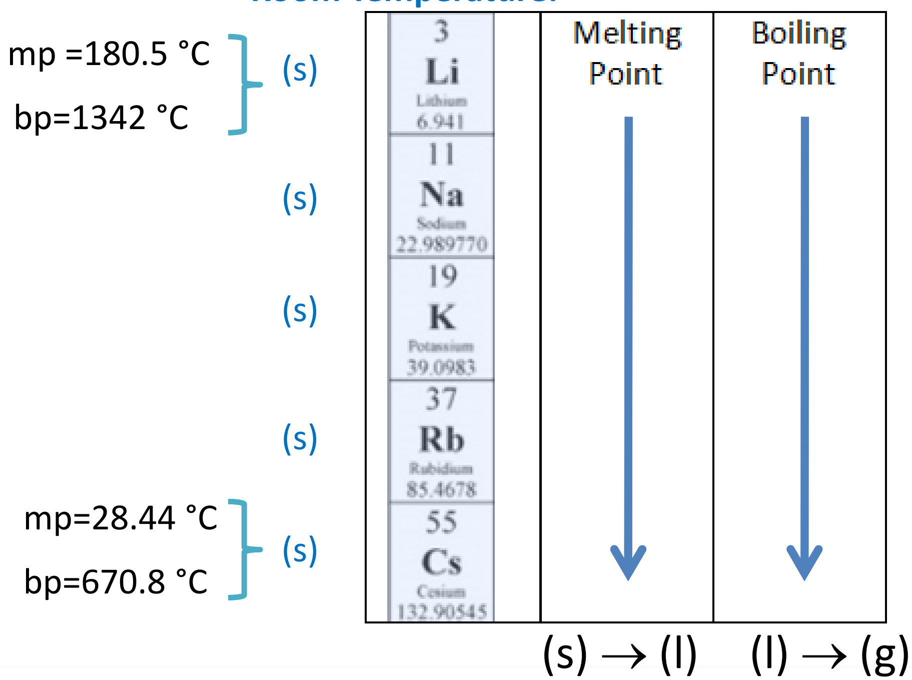
(s) → (l) (l) → (g)

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 colum for the alkali metals (Group IA).

Room Temperature:



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.

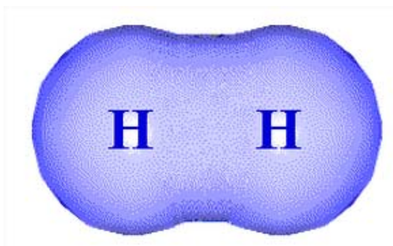
Periodic Trends

V. Electronegativity

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

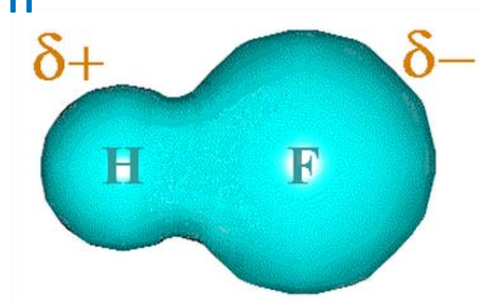
Electronegativity is a measure of the tendency of an atom to draw electrons to itself in a bond.

H_2



Nonpolar covalent bond

HF



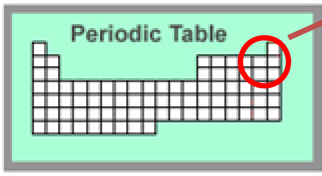
Polar covalent bond

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

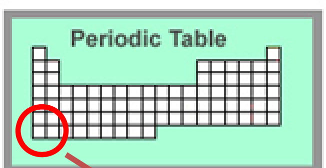
2. Draw in the direction of an arrow for electronegativity trend as you move ACROSS a row on the Periodic Table.



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.


THE
END