CHEMISTRY UNIT 3 NOTES

What are Ions?

Ions are atoms that contain an uneven number of protons and electrons which results in an overall positive or negative charge

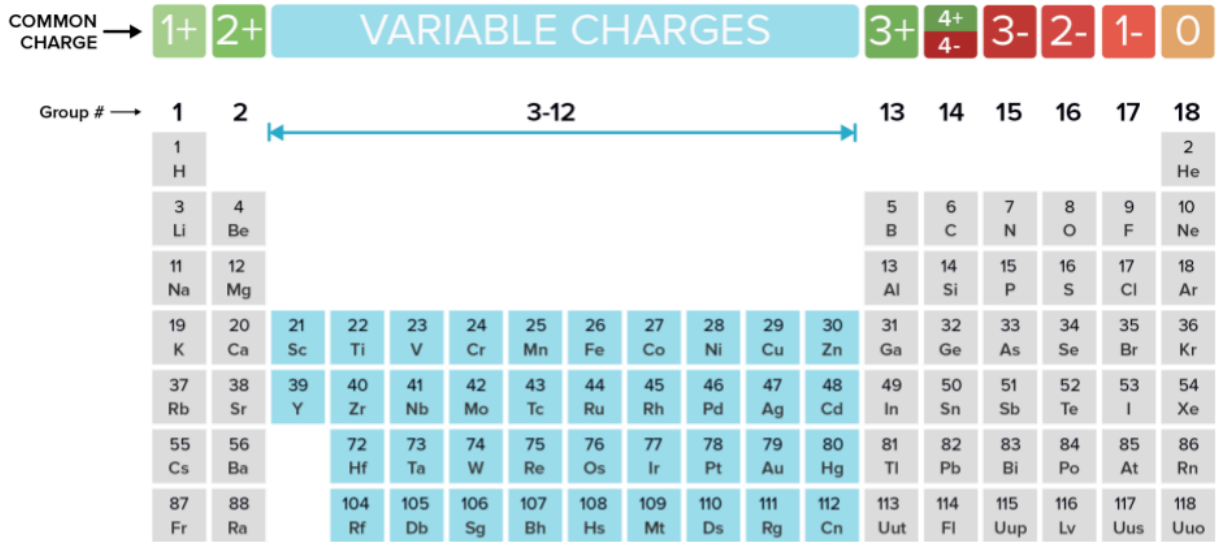
Cation

Cations are **atoms that contain a positive charge.** The positive charge is a result of the atom containing more protons than electrons

Anion

Anions are **atoms that contain a negative charge.** The negative charge is a result of the atom containing more electrons than protons

For an anion, the ending becomes "-ide"



VOCABULARY

_____ _____: the electrostatic force that holds oppositely charged particles together in an ionic compound.

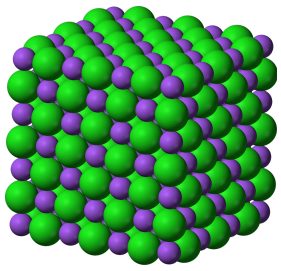
_____ _____: compounds that contain ionic bonds

_____: a special ionic bond that occurs between metals and oxygen

_____: what we call most other ionic compounds

_____ _____ _____: ionic compounds that contain only two different elements, a metallic cation and a nonmetallic anion

Properties of Ionic Compounds



- Ions are packed in a regular repeating pattern for balancing forces of attraction and repulsion called a _____ _____. Each positive ion is surrounded by negative, and each negative ion is surrounded by positive.

- Ionic solids do not conduct electricity, but melted or in solution they are excellent conductors. _____- an ionic compound whose aqueous solution conducts an electric current.

- Melting point, boiling point, and hardness depend on the strength of attraction between particles. Ionic crystals have high melting and boiling points, are _____, _____, and _____.

- Forming ionic bonds is _____, or energy is released, because it is forming something more stable

- _____ _____- the energy required to separate 1 mol of the ions in an ionic compound. The greater the lattice energy, the stronger the forces of attraction

Characteristic	Lattice Energy
Bigger Ion	Lower lattice energy
Bigger Charge	Higher lattice energy

Formulas for Ionic Compounds

_____ _____: the chemical formula for an ionic compound, representing the simplest ratio of the ions involved. Ex: $MgCl_2$

_____ _____: a one-atom ion such as Mg^{2+}

_____ _____: equal to the charge of a monatomic ion and the number of electrons transferred from the atom to form the ion

1. The symbol of the cation is written first
2. followed by the symbol of the anion.
3. Subscripts represent the number of each ion. If there is no subscript, it is assumed to be one.
4. Ionic compounds must have no charge.

Cross Over Method for Charges

Examples: NaF, KI, $MgCl_2$, $AlBr_3$

Table 9 Common Polyatomic Ions

Ion	Name	Ion	Name
NH_4^+	ammonium	IO_4^-	periodate
NO_2^-	nitrite	$C_2H_3O_2^-$	acetate
NO_3^-	nitrate	$H_2PO_4^-$	dihydrogen phosphate
OH^-	hydroxide	CO_3^{2-}	carbonate
CN^-	cyanide	SO_3^{2-}	sulfite
MnO_4^-	permanganate	SO_4^{2-}	sulfate
HCO_3^-	hydrogen carbonate	$S_2O_3^{2-}$	thiosulfate
ClO^-	hypochlorite	O_2^{2-}	peroxide
ClO_2^-	chlorite	CrO_4^{2-}	chromate
ClO_3^-	chlorate	$Cr_2O_7^{2-}$	dichromate
ClO_4^-	perchlorate	HPO_4^{2-}	hydrogen phosphate
BrO_3^-	bromate	PO_4^{3-}	phosphate
IO_3^-	iodate	AsO_4^{3-}	arsenate

Because a polyatomic ion exists as a unit, never change subscripts of the atoms within the ion. If more than one polyatomic ion is needed, place parentheses around the ion and write the subscript outside the parentheses.

OXYANIONS- POLYATOMIC ION COMPOSED OF AN ELEMENT BONDED TO ONE OR MORE OXYGEN ATOM

Oxyanion Nomenclature (Naming)

- Compare the sets of oxyanions below. Notice the pattern in their names.
  - NO_2^- (nitrite) and NO_3^- (nitrate)
  - SO_3^{2-} (sulfite) and SO_4^{2-} (sulfate)
  - ClO_2^- (chlorite) and ClO_3^- (chlorate)
- The one with fewer oxygens ends in *-ite*.
- The one with more oxygens ends in *-ate*.

NAMING IONIC COMPOUNDS

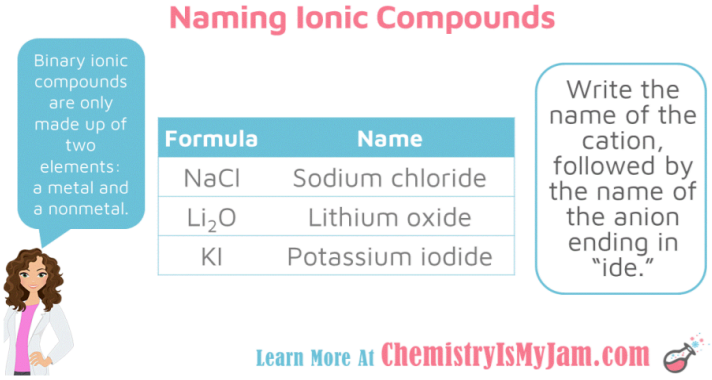
1. Name the cation followed by the anion.
2. For monatomic cations, use the element name.
3. For monatomic anions, use the root of the element name plus suffix "-ide"

   Ex: CsBr = cesium bromide

4. If something has more than one oxidation number, write the number in roman numeral in parentheses.

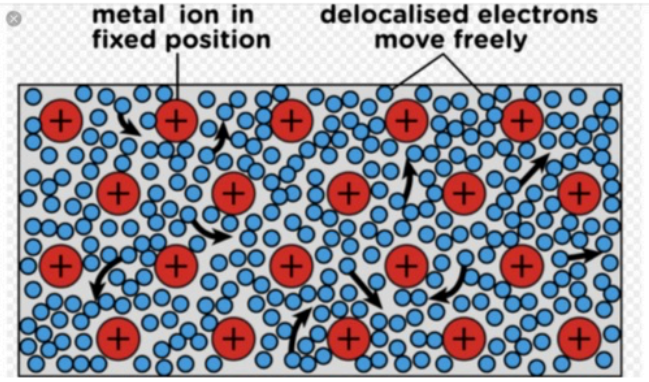
   Ex: FeO = iron(II) oxide

5. When it contains a polyatomic ion, use the name of the polyatomic ion in place of the cation or anion



Metallic bonds

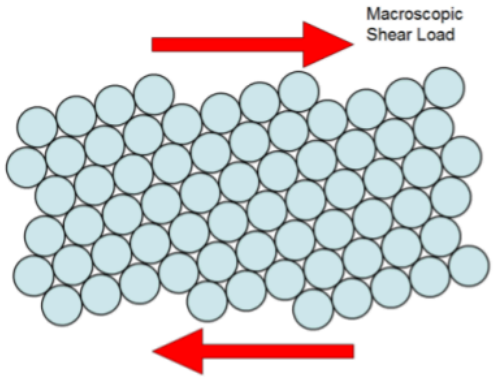
- Metallic bond- the attraction of a metallic cation for delocalized electrons



Properties of metals

Moderately high melting and boiling points

Malleable, ductile, durable, hard, and strong

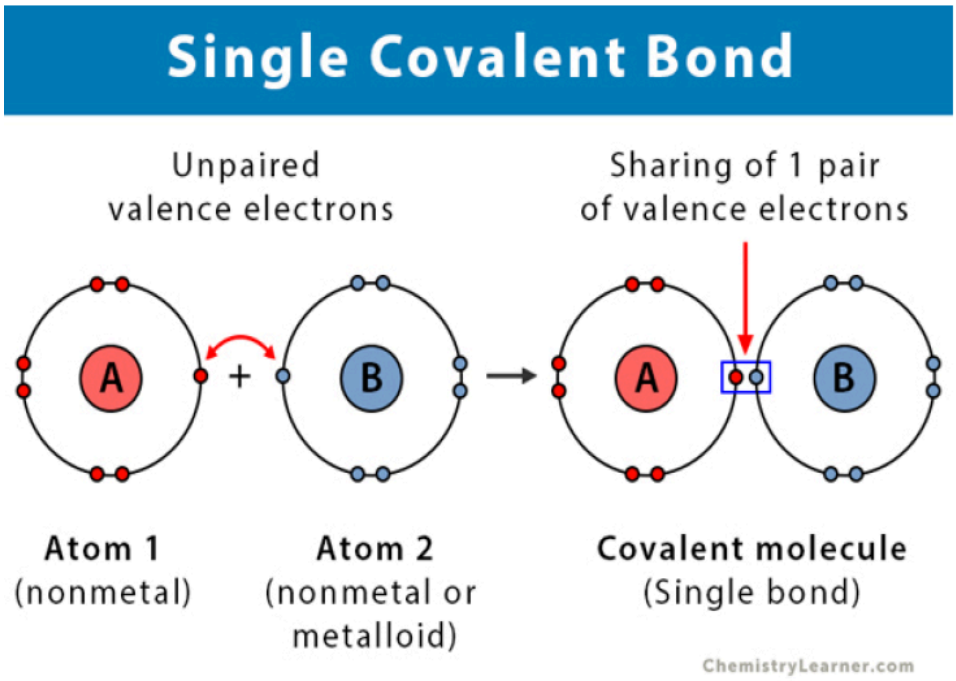


ALLOYS

_____- a mixture of elements that has metallic properties like stainless steel, brass, and cast iron

_____ _____- some of the original metallic solid are replaced by other metals of similar size

_____ _____- when small holes in metallic crystal are filled with smaller atoms



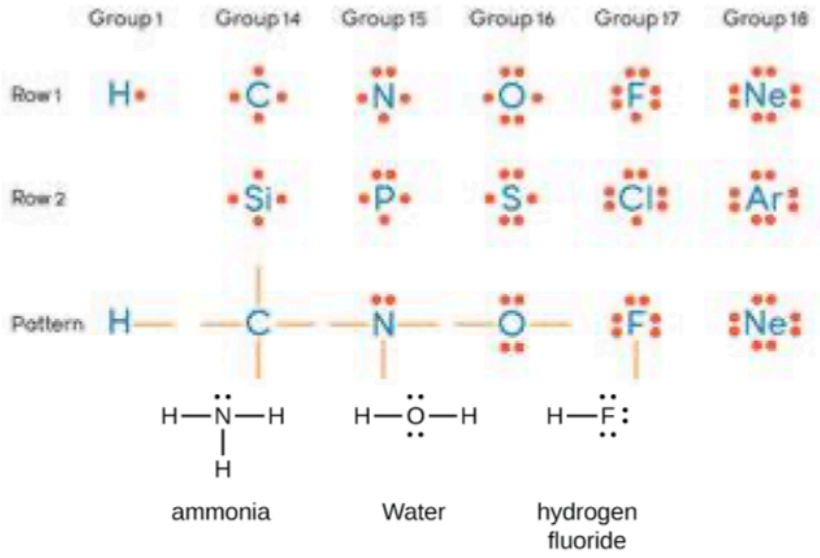
Molecule

Typically happen between

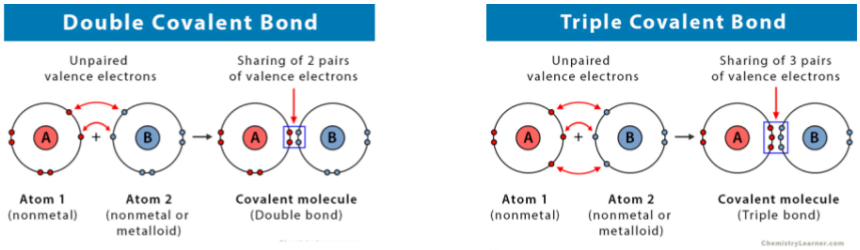
_____

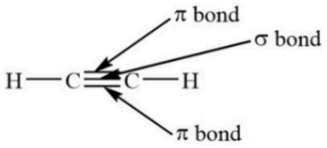
Forces of attraction and repulsion

Lewis structures



Multiple covalent bonds

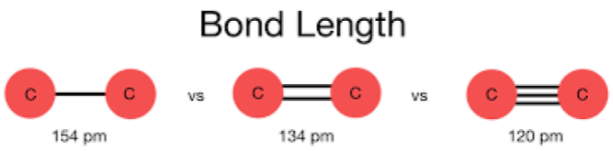




Bond strength

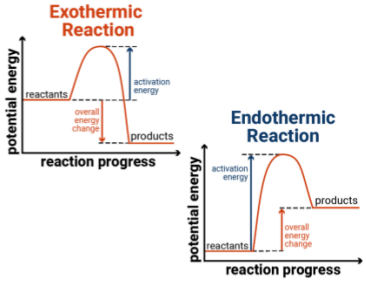
The more bonds there are, the shorter the bond length!

The shorter the bond length, the stronger the bond!



Bonds and energy

Energy is released when a bond forms, but is required for a bond to break. The energy required to break a covalent bond is called bond-dissociation energy.



Naming binary molecular compounds

1. The first element in the formula is always named first.
2. The second element is named using its root and adding the suffix -ide.
3. Prefixes indicate number of atoms.

   Ex. N_2O is dinitrogen monoxide

Prefixes - Number of Atoms	
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

Naming binary acids (which contain hydrogen and one other element)

1. The first word has the prefix hydro-. The rest of the first word is the form of the root of the second element with the suffix -ic
2. The second word is always acid.

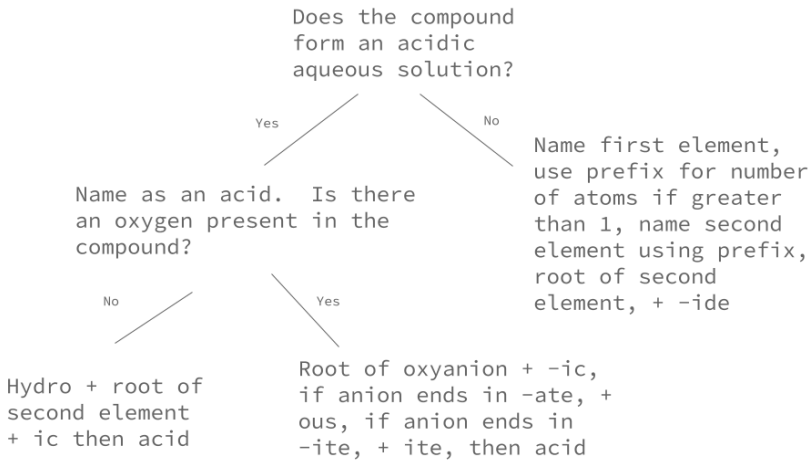
Ex. HCl is hydrochloric acid

Naming oxyacids (an acid that with hydrogen and oxyanion)

Oxyanion is a polyatomic ion that contains oxygen.

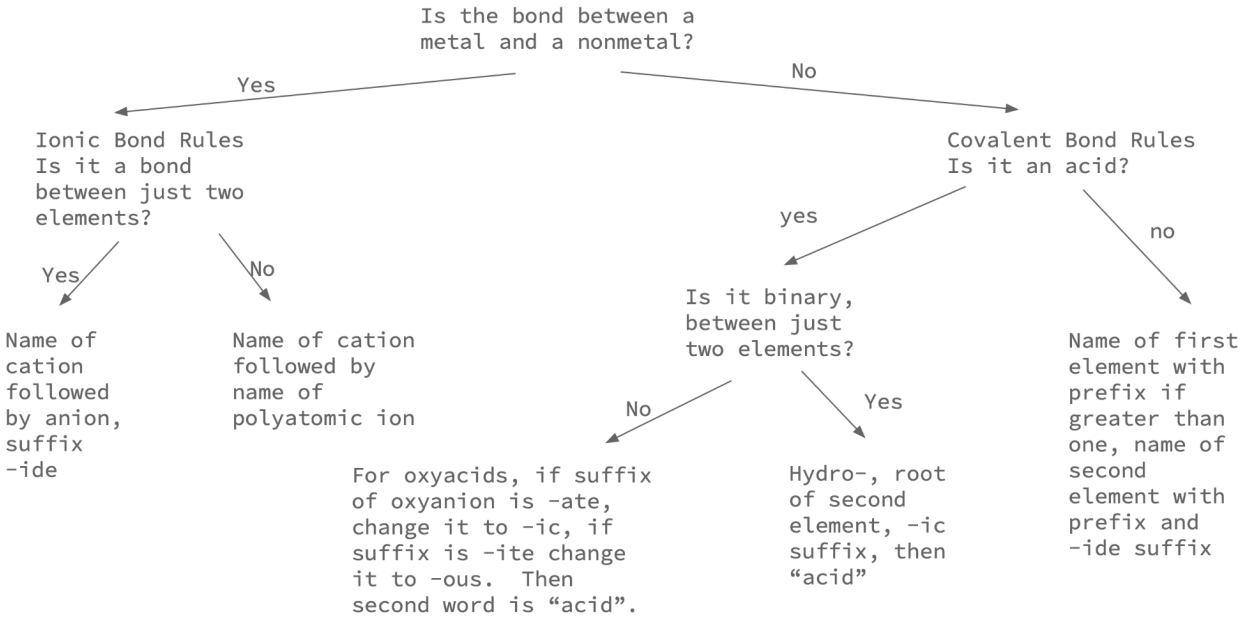
1. The first word is the root of the oxyanion. If there is a prefix, use the prefix. If it has the suffix -ate you replace it with -ic. If it ends with -ite, replace it with -ous.
2. The second word is acid.

Ex. HNO3 is nitric acid

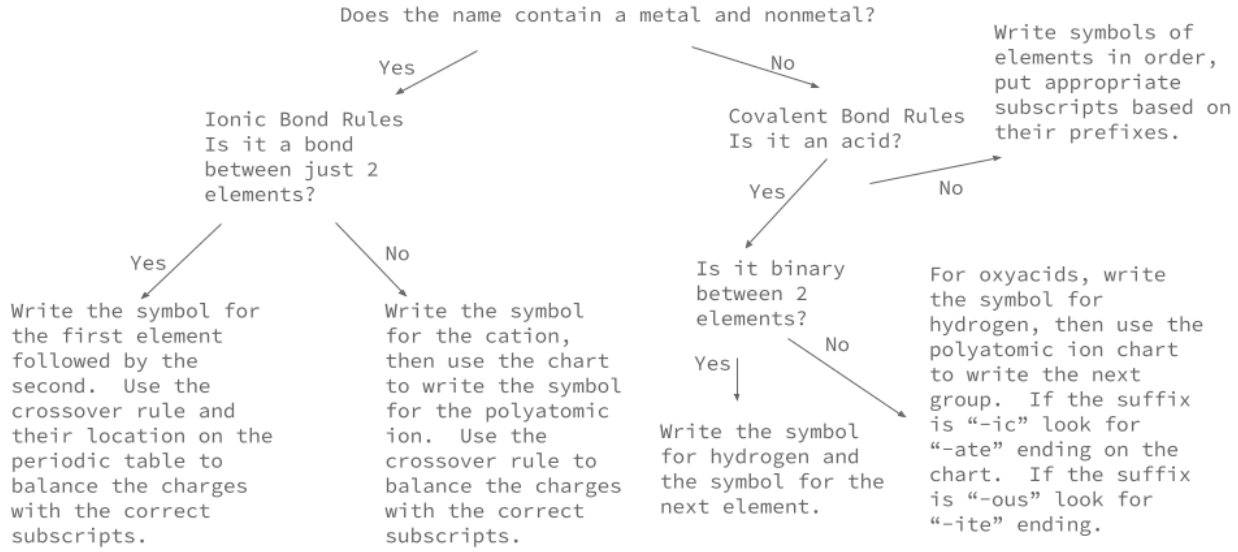


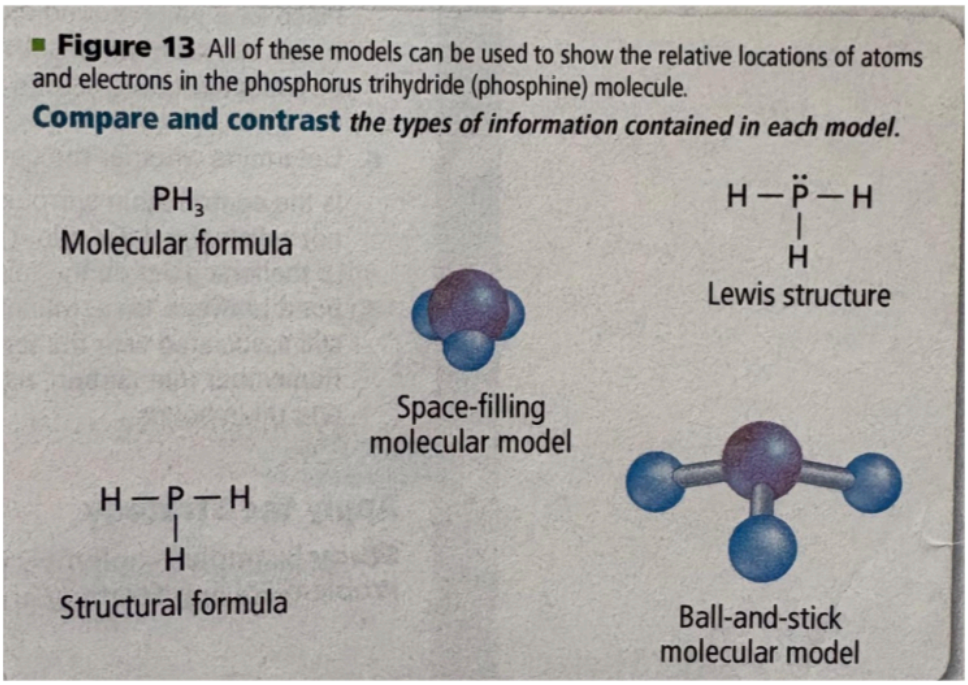
FLOWCHARTS FOR ALL COMPOUNDS

Naming compounds Flowchart



Name to compound flowchart





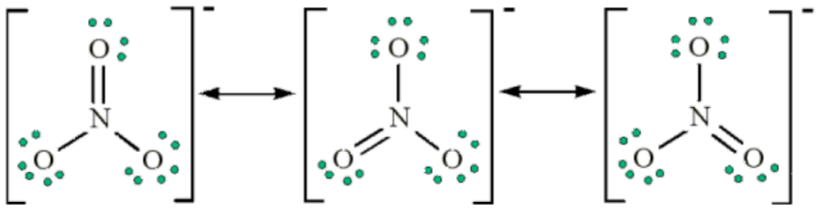
Steps for drawing Lewis structures

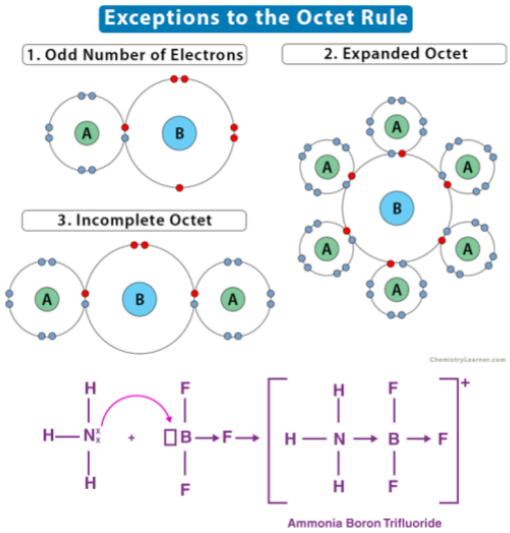
1. Atom farthest away from fluorine is center (hydrogen is never in center).
2. Total number of valence electrons.
3. Divide by 2 to find number of pairs.
4. Place bonds between atoms.
5. Place remaining pairs around atoms.
6. Is octet rule satisfied? May need to adjust for double and triple bonds.

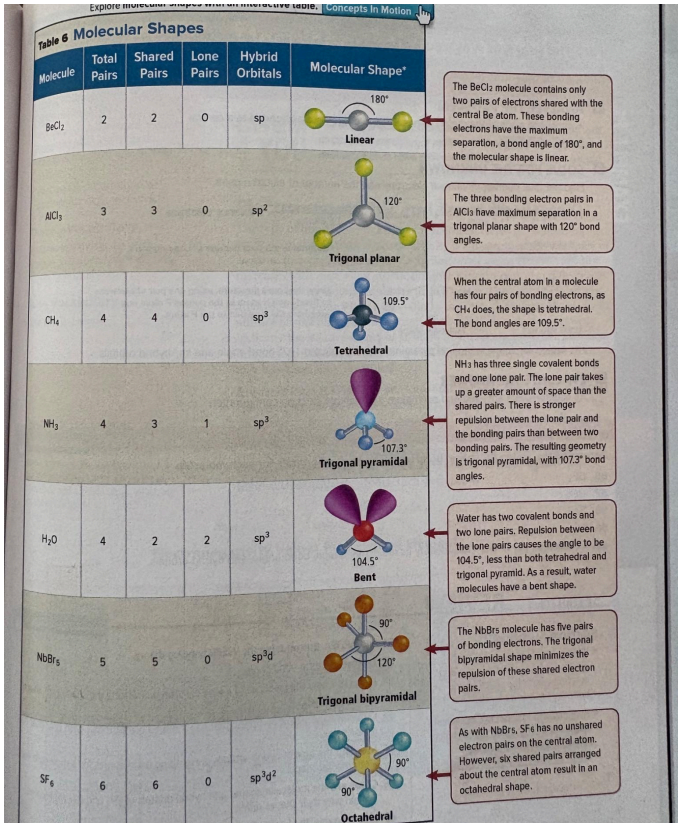
* If it is a polyatomic ion, make sure to consider the charge when totaling the electrons.

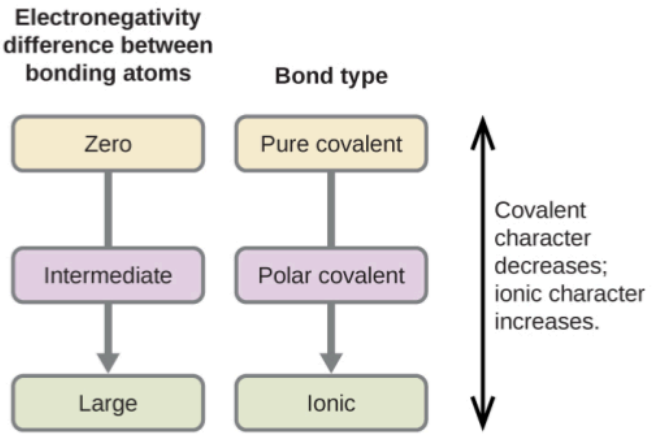
Resonance structures

When more than one valid Lewis structure can be written.





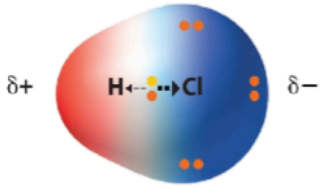




Bond Type	Electronegativity Difference
pure covalent	< 0.4
polar covalent	between 0.4 and 1.8
ionic	> 1.8

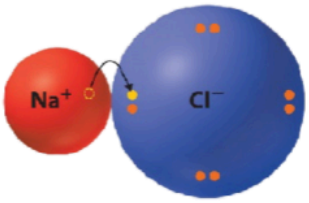
Non-Polar Covalent Bond

Bonding electrons ***shared equally*** between two atoms.
No charges on atoms.



Polar Covalent Bond

Bonding electrons ***shared unequally*** between two atoms.
Partial charges on atoms.



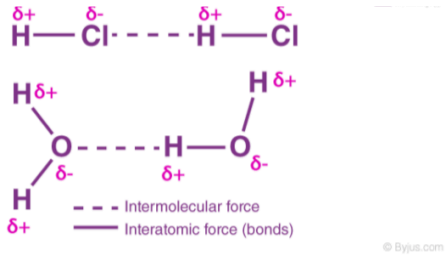
Ionic Bond

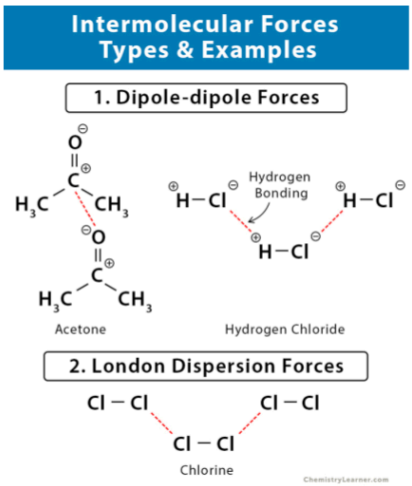
Complete ***transfer*** of one or more valence electrons.
Full charges on resulting ions.

POLARITY AND SOLUBILITY:

"Like dissolves like"

Intermolecular forces or van der waals forces





How strong?

Strongest:

Medium:

Weakest:

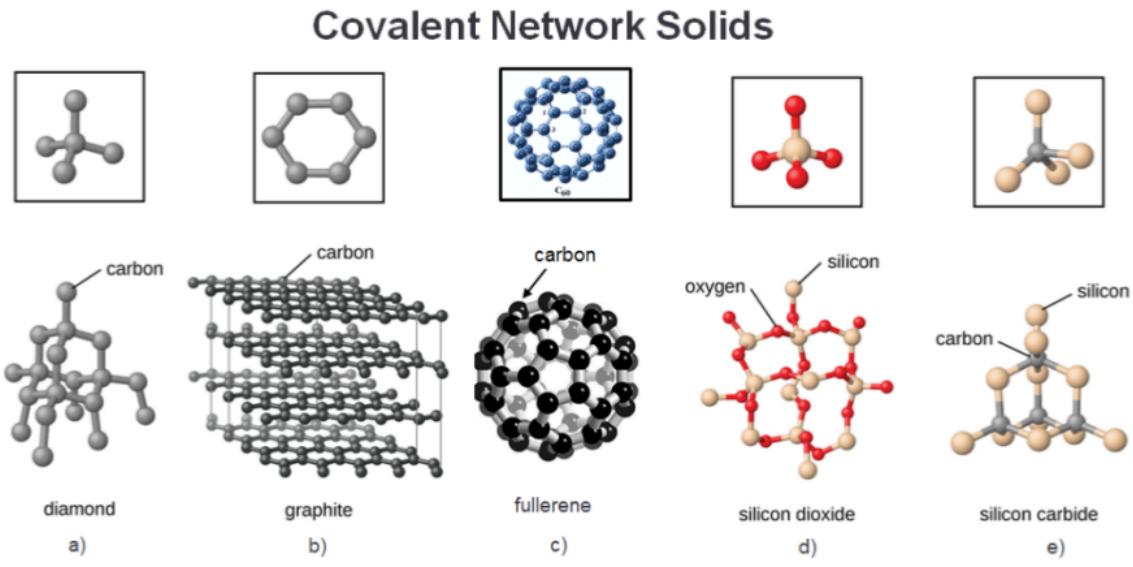


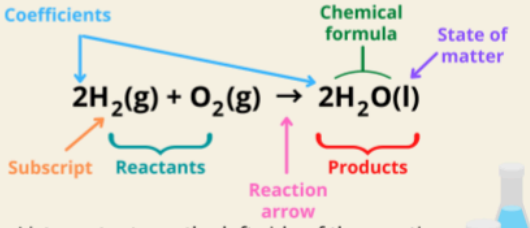
FIGURE 4 : *A covalent crystal contains a 3-dimensional network of covalent bonds, as illustrated by the structures of diamond, graphite, fullerene, silicon dioxide and silicon carbide*

EVIDENCE OF A CHEMICAL CHANGE/REACTION:

- COLOR CHANGES – (COLOR APPEARS OR DISAPPEARS)
- TEMPERATURE CHANGES
- GAS/GAS BUBBLES PRODUCED
- FIRE/EXPLOSION
- PRECIPITATE IS FORMED – A SOLID FORMS OUT OF 2 LIQUIDS

What Is a Chemical Equation?

A chemical equation is a written representation of a chemical reaction.



List reactants on the left side of the reaction arrow and products on the right side.

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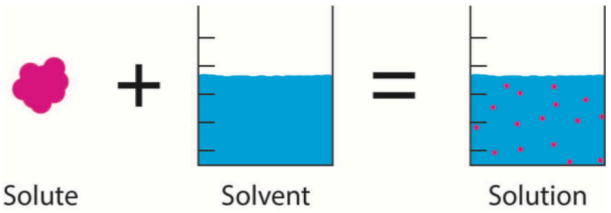
(g)	gas
(l)	liquid
(s)	solid
(aq)	aqueous

- **Word Equation:**
- hydrogen + oxygen → water
- **Skeleton Equation:**
- $H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(l)}$
- **Balanced Equation:**
- $\_\_\_H_{2(g)} + \_\_\_O_{2(g)} \rightarrow \_\_\_H_2O_{(l)}$
- $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$

Writing chemical equations

1. Write the skeleton equation.
2. Count atoms of reactants and products.
3. Add/Adjust coefficients.
4. Reduce coefficients to lowest possible ratio.
5. Check work.



In aqueous solutions, only double replacement reaction occurs. Three types of products that form in aqueous solutions are, a precipitate, water, or a gas.

1) Reactions that form precipitates:

   Example: $2\,NaOH(aq) + CuCl_2(aq) \longrightarrow 2\,NaCl\,(aq) + Cu(OH)_2(aq)$

2) Reactions that form water:

   Example: $HCl\,(aq) + NaOH\,(aq) \longrightarrow NaCl(aq) + H_2O\,(l)$

3) Reactions that form gases:

   Example: $2\,HI\,(aq) + (NH_4)_2S\,(aq) \longrightarrow H_2S\,(g) + 2\,NH_4I\,(aq)$

Net Ionic Equation and Complete Ionic Equation

Molecular Equation or Balanced Equation

$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

Complete Ionic Equation

$Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \rightarrow AgCl(s) + Na^+(aq) + NO_3^-(aq)$

Net Ionic Equation

$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

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Example #1: Create an overall balanced equation from the following elementary steps.

Elementary Step 1: $3Ag + Al(NO_3)_3 \rightarrow 3AgNO_3 + Al$
Elementary Step 2: $2AgNO_3 \rightarrow 2Ag + O_2 + 2NO_2$
Elementary Step 3: $2NO_2 \rightarrow 2NO + O_2$