

## Types of Chemical Reactions

Chemical reactions can be classified on the basis of what processes occur during the reaction. You will be required to be able to identify what type of reaction has occurred and to predict the products of the reaction. There are four basic types of reactions as listed below.

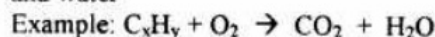
- 1) **Direct Combination** (synthesis)  $A + B \rightarrow AB$ 
  - a) Two elements  $\rightarrow$  a binary compound
  - b) Two compounds (with a common ion)  $\rightarrow$  one compoundExample:  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}$
  
- 2) **Single Replacement**  $A + \text{BX} \rightarrow \text{AX} + \text{B}$ 
  - a) Element + compound  $\rightarrow$  different element + different compound
  - b) Strong metals (Groups I & IIA) + Water  $\rightarrow$  metallic hydroxide + hydrogenExample:  $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$
  
- 3) **Double Replacement**  $\text{AX} + \text{BY} \rightarrow \text{AY} + \text{BX}$ 
  - a) Two compounds  $\rightarrow$  two different compoundsExample:  $\text{NaCl} + \text{AgNO}_3 \rightarrow \text{NaNO}_3 + \text{AgCl}$ 
  - b) Special : combustion of hydrocarbons  $\text{C}_x\text{H}_y + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
  
- 4) **Decomposition**  $\text{AB} \xrightarrow{\Delta} \text{A} + \text{B}$ 
  - a) One compound  $\xrightarrow{\Delta}$  two or more products
  - b) Rules for Decomposition Rxns.
    - i) Binary compounds ( with heat or electricity)  $\rightarrow$  free elements  
Example:  $\text{H}_2\text{O} \xrightarrow{\Delta} \text{H}_2 + \text{O}_2$
    - ii) Some oxides (when heated)  $\rightarrow$  free elements  
Example:  $2\text{HgO} \xrightarrow{\Delta} 2\text{Hg} + \text{O}_2$
    - iii) Metallic carbonates (when heated)  $\rightarrow$  metallic oxides +  $\text{CO}_2$   
Example:  $\text{CaCO}_3 \xrightarrow{\Delta} \text{CaO} + \text{CO}_2$
    - iv) Metallic chlorates (when heated)  $\rightarrow$  metallic chlorides +  $\text{O}_2$   
Example:  $2\text{KClO}_3 \xrightarrow{\Delta} 2\text{KCl} + 3\text{O}_2$
    - v) Metallic hydroxides (when heated)  $\rightarrow$  metallic oxides +  $\text{H}_2\text{O}$   
Example:  $\text{Ca}(\text{OH})_2 \xrightarrow{\Delta} \text{CaO} + \text{H}_2\text{O}$
    - vi) Oxyacids (when heated)  $\rightarrow$  nonmetallic oxides +  $\text{H}_2\text{O}$   
Example:  $\text{H}_2\text{SO}_4(\text{aq}) \xrightarrow{\Delta} \text{H}_2\text{O} + \text{SO}_3$
  - c) MEMORIZE:  $\text{NH}_4\text{OH} \xrightarrow{\Delta} \text{NH}_3 + \text{H}_2\text{O}$

\* Reminders: The physical state of the substance is often indicated by a letter following the formula. (s) = solid, (l) = liquid, (g) = gas, (aq) = aqueous, and (ppt) = precipitate. A precipitate is the solid formed when two liquid compounds combine and one of the resulting compounds is insoluble in the newly formed liquid.

## SPECIAL REACTIONS

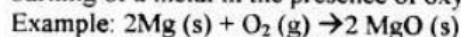
### 1) Combustion Reactions:

- a) combustion of a hydrocarbon (organic compound):  
hydrocarbon burning in the presence of oxygen gas yields carbon dioxide and water



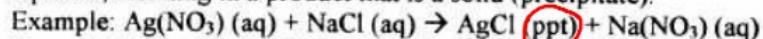
- b) combustion of a metal:

burning of a metal in the presence of oxygen gas yields a metal oxide



### 2) Precipitation Reactions: *Double Replacement Rxn : evaluate products*

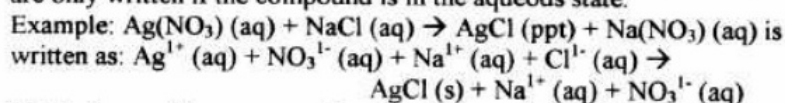
- a) single and double replacement reactions involving reactants that are aqueous, resulting in a product that is a solid (precipitate).



- b) Use solubility rules to help determine which product is insoluble in water and will result in a precipitate.

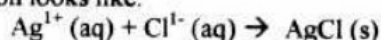
### 3) Ionic and Net ionic Equations:

- a) Ionic equations write a chemical reaction by showing what ions are present on both the reactant and product sides. \*Please keep in mind ions are only written if the compound is in the aqueous state.



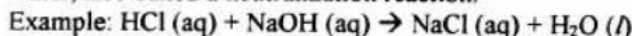
- b) Net Ionic equations express the chemical reaction with spectator ions removed. \*Spectator ions are those ions that remain in the same form before and after the reaction.

Example: Using the equation from above the  $Na^{1+}$  and the  $NO_3^{1-}$  are spectator ions and will be removed from the equation. The resulting equation looks like:



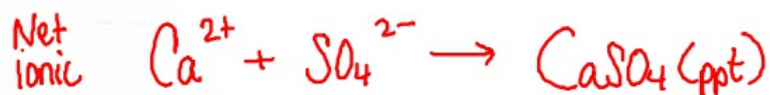
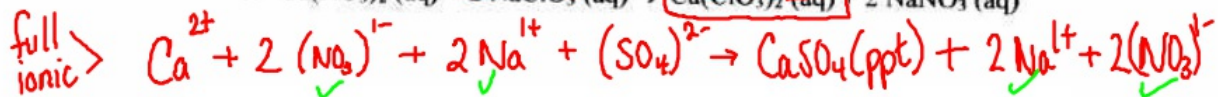
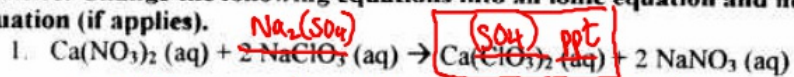
### 4) Acid – Base Reactions:

- a) The reaction between a strong acid and a strong base will form a salt and water, also called a neutralization reaction.

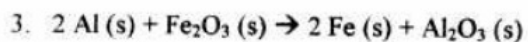
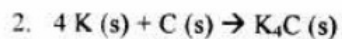
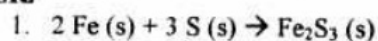


- b) The reactants and products can be divided into acid-base pairs. An acid-base pair can be identified by examining the movement of the hydrogen throughout the reaction. The compound that donates the hydrogen (proton) is considered the acid. The compound that accepts the hydrogen (proton) is considered the base. Also referred to as the Brønsted-Lowry model.

Practice: Change the following equations into an ionic equation and net ionic equation (if applies).



Practice: Complete redox equations for the following. Remember to label LEO and GER.



Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

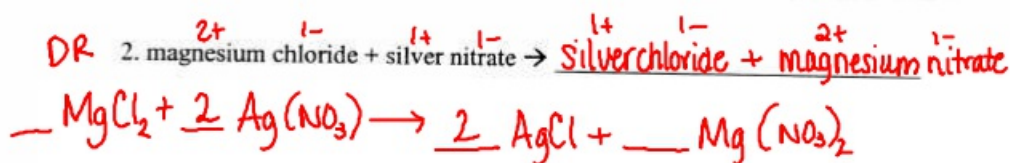
**Homework: Types of Reactions**

Identify the type of reactions.

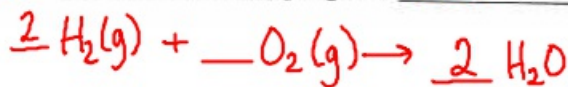
- |  |                  |
|--|------------------|
| 1. $3 \text{CaBr}_2 + 2\text{Na}_3\text{P} \rightarrow \text{Ca}_3\text{P}_2 + 6 \text{NaBr}$    | DR               |
| 2. $2 \text{KI} + \text{Br}_2 (\text{g}) \rightarrow 2 \text{KBr} + \text{I}_2 (\text{g})$       | SR               |
| 3. $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 6 \text{C} + 6 \text{H}_2\text{O}$             | DEC              |
| 4. $2 \text{NaF} \rightarrow 2 \text{Na} + \text{F}_2 (\text{g})$                                | DEC              |
| 5. $\text{Si} + \text{O}_2 (\text{g}) \rightarrow \text{SiO}_2$                                  | DC or Combustion |
| 6. $2 \text{NaI} + \text{Pb}(\text{NO}_3)_2 \rightarrow 2 \text{NaNO}_3 + \text{PbI}_2$          | DR               |
| 7. $\text{NaI} + \text{Cs} \rightarrow \text{CsI} + \text{Na}$                                   | SR               |
| 8. $\text{H}_2 (\text{g}) + \text{CO} + \text{O}_2 (\text{g}) \rightarrow \text{H}_2\text{CO}_3$ | DC               |
| 9. $\text{Li}_3\text{PO}_4 \rightarrow 3 \text{Li} + \text{P} + 2 \text{O}_2 (\text{g})$         | DEC              |
| 10. $\text{CS}_2 + 2 \text{F}_2 (\text{g}) \rightarrow \text{CF}_4 + 2 \text{S}$                 | SR               |

Predict the products for the following reactions, and write a balanced equation.

1. aluminum sulfate + calcium phosphate  $\rightarrow$  \_\_\_\_\_



DC 4. hydrogen gas + oxygen gas  $\rightarrow$  water



Diatomic molecules  
 $\text{H}_2$      $\text{N}_2$   $\text{O}_2$   $\text{F}_2$   
 $\text{Cl}_2$   
 $\text{I}_2$   
 $\text{Br}_2$

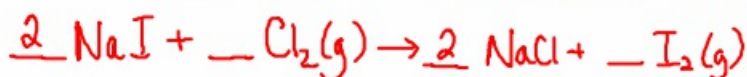
DEC 6.  $\overset{2+}{\text{Cu}}(\overset{1-}{\text{OH}})_2 \xrightarrow{\Delta} \overset{2+}{\text{Cu}}(\overset{2-}{\text{O}}) + \text{water}$



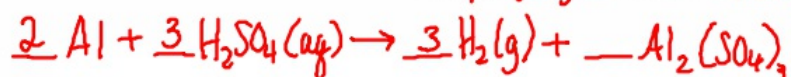
DC 8.  $\overset{3-}{\text{N}_2} + \overset{1+}{\text{H}_2} \rightarrow$  ammonia



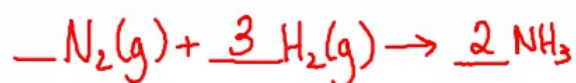
SR 10.  $\overset{1+}{\text{Na}}\overset{1-}{\text{I}} + \text{chlorine gas} \rightarrow$  sodium chloride + iodine gas



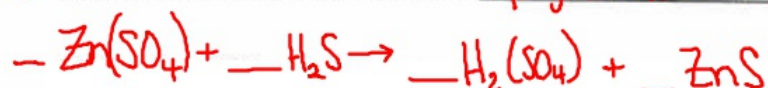
SR 12. aluminum + sulfuric acid → hydrogen gas + aluminum sulfate



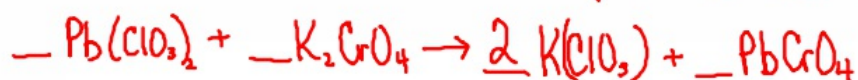
DC 14. synthesis of ammonia: (from front side)



DR 16.  $\overset{2+}{\text{Zn}}\overset{2-}{\text{SO}_4}$  +  $\overset{1+}{\text{H}}\overset{2-}{\text{S}}$  →  $\overset{1+}{\text{H}}\overset{2-}{\text{SO}_4}$  +  $\overset{2+}{\text{Zn}}\overset{2-}{\text{S}}$



DR 18.  $\overset{2+}{\text{Pb}}(\overset{1-}{\text{ClO}_3})_2$  +  $\overset{1+}{\text{K}}\overset{2-}{\text{CrO}_4}$  → potassium chlorate + lead (II) chromate



DR 20.  $\overset{1+}{\text{K}}\overset{1-}{\text{I}}$  +  $\overset{\text{H}}{\text{O}}\overset{1-}{\text{H}}$  →  $\overset{1+}{\text{H}}\overset{1-}{\text{I}}$  +  $\overset{1+}{\text{K}}\overset{1-}{\text{OH}}$

