**Unit 4 Review – Chemical Reactions, Moles, and Stoichiometry**

We will start with the easiest topic and work our way to the most complex.

**Evidence of a Chemical Reaction –** There are 6 pieces of evidence that can occur to let you know a reaction has occurred.

* Gas bubbles form
* A solid precipitate forms
* A change in energy to the system, it’s endothermic or exothermic
* A permanent color change
* A permanent odor change
* Formation of water

**Types of Reactions** – You will need to be able to identify the 5 different types of chemical reactions on sight: synthesis, decomposition, combustion, single-replacement, and double-replacement. It’s fairly easy if you know what to look for within each type of reaction.

Try to identify these reactions. They are not balanced.

1. AlCl3 + Na2SO4 🡪 Al2(SO4)3 + NaCl
2. Zn + S8 🡪 ZnS
3. H2SO4 + Fe 🡪 H2 + FeSO4
4. C5H12 + O2 🡪 H2O + CO2
5. Al2S3 🡪 Al + S8
6. Li2CO3 + MgCl2 🡪 LiCl + MgCO3
7. Fe + O2 🡪 FeO
8. Zn + HBr 🡪 H2 + ZnBr2
9. C5H10O4 + O2 🡪 CO2 + H2O
10. MgO 🡪 Mg + O2

**Law of Conservation of Mass -**

1. What is the definition?

**Balancing Chemical Equations** –

Balance these equations below:

1. AlCl3 (aq) + Na2SO4 (aq) 🡪 Al2(SO4)3 (s) + NaCl (aq)
2. Zn (s) + S8 (s) 🡪 ZnS (s)
3. H2SO4 (aq) + Fe (s) 🡪 H2 (g) + FeSO4 (aq)
4. C5H12 (l) + O2 (g) 🡪 H2O (g) + CO2 (g)
5. Al2S3 (s) 🡪 Al (s) + S8 (s)
6. Li2CO3 (aq) + MgCl2 (s) 🡪 LiCl (aq) + MgCO3 (aq)
7. Fe (s)+ O2 (g) 🡪 FeO (s)
8. Zn (s)+ HBr (aq) 🡪 H2 (g) + ZnBr2 (aq)
9. C5H10O4 (l) + O2 (g)🡪 CO2 (g) + H2O (g

**Skeleton Equation**

**CaCO3 (s) + HC2H3O2 (aq) 🡪 Ca(C2H3O2)2 (aq) + CO2 (g) + H2O (l)**

Try writing skeleton equations for these reactions.

1. Aqueous ammonium chloride reacts with a solution of sodium hydroxide to produce water, ammonia (nitrogen trihydride) gas, and a solution of sodium chloride.
2. Solid sodium hydroxide reacts with a phosphoric acid solution to form water and a solution of sodium phosphate.
3. Solid copper in the Statue of Liberty reacted with oxygen gas in the air to create a green copper (II) oxide coating.

**Predicting Products** – based on the type of reaction and the reactants, predict the products for the reaction, write the skeleton equation and balance.

Single – Replacement

1. Ag (s) + CuSO4 (aq) 🡪
2. AlCl3 (aq) + Cs (s) 🡪
3. Sn (s) + Fe(CN)2 (aq) 🡪

Double – Replacement

1. KCl (s) + Mg(OH)2 (aq) 🡪
2. LiBr (s) + Co2(SO3)3 (aq) 🡪

Synthesis

1. H2 (g) + S (s) 🡪
2. Be (s) + Cl2 🡪

Decomposition

1. Na2O (s) 🡪
2. AlCl3 (s) 🡪

Combustion

1. C5H12 (l) + O2 (g) 🡪
2. CH3OH (aq) + O2 (g) 🡪

**Moles**

1. How many hydrogen atoms are in a molecule of each substance?
   1. Al(OH)3 c. (NH4)2HPO4
   2. H2C2O4 d. C4H10O
2. Which contains more molecules: 1.00mol of H2O2, 1.00mol C2H6, or 1.00mol CO?
3. Calculate the molar mass of each substance.
   1. H3PO4 c. C4H9O2
   2. N2O3 d. (NH4)2SO4
4. How many moles is in each of the following?
   1. 15.5g SiO2
   2. 0.0688g AgCl
5. Find the mass, in g, of each substance.
   1. 0.780 mol Ca(CN)2
   2. 7.00 mol H2O2
6. Calculate the volume of each of the following gases at STP.
   1. 7.6 mol Ar
   2. 0.44 mol C2H6
7. How many moles is in each of the following gases at STP?
   1. 14.4 L F2
   2. 3.21 × 102 L CO2
8. Find the number of molecules in each substance.
   1. 3.00 mol Sn
   2. 0.400 mol KCl
9. How many moles are in each substance?
   1. 4.80 × 1020 molecules of NaI
   2. 7.50 × 1024 molecules of SO2
10. Find each of the quantities below:
    1. The volume, in liters, if 835g of SO3 gas at STP
    2. The mass, in grams, of a molecule of aspirin, C9 H8O4
    3. The number of molecules in 146 L of O3 gas at STP.
11. Find the % of each element in the substances:
    1. H2S
    2. Mg(OH)2
12. Classify each as an empirical formula (E.F.) or as a molecular formula M.F.).
    1. S2Cl2 d. C5H10O5
    2. C6H10O4 e. C17H19NO3
    3. Na2SO3 f. (NH4)2CO3
13. Calculate the empirical formula for the following substances:
    1. A compound containing 79.8% C and 20.2% H
    2. A compound, called 1,6-diaminohexane, is used to make nylon. Its composed of 62.1% C, 13.8% H, ad 24.1% N.
14. What is the molecular formula for each compound? Each compound’s empirical formula and the molecular mass formula are given.
    1. CH2O, 90g/mol
    2. HgCl, 472.2g/mol
15. Determine the molecular formula for a compound called methyl butanoate, which smells like apples. Its percent composition is 58.8% C, 9.8% H, and 31.4% O. Methyl butanoate’s molecular mass is 102g/mol.
16. The scent of cinnamon comes from the organic molecule cinnamaldehyde. Cinamaldehyde has the following composition: 81.78% carbon, 6.1133% hydrogen, ad 12.1056% oxygen. The molecular mass is about 132 g/mol. Determine the molecular formula.

**Stoichiometry**

1. **2 Al (OH)3 (s) + 3 H2SO4 (aq)** 🡪 **Al2(SO4)3 (aq) + 6 H2O (l)**
   1. How many moles of water are produced from -.88 moles of aluminum hydroxide?
   2. How many moles of aluminum sulfate are produced from 0.88 g of aluminum hydroxide?
   3. How many grams of aluminum sulfate are produced along with 0.88g of water?
2. **8 H2S (g) + 4 O2 (g) 🡪 S8 (l) + 8 H2O (l)**
   1. Determine the limiting reactant when 102.27 g of hydrosulfuric acid reacts with 64.00g of oxygen. What is the theoretical yield of sulfur, S8?
   2. If 84.78 g of sulfur, S8, is actually produced in the lab, what is the % yield for the reaction?
3. **Fe2O3 (s) + 3 CO (g) 🡪 3 CO2 (g) + 2 Fe (s)**
   1. Calculate the number of grams of carbon monoxide that can react with 150.0 g of iron (III) oxide.
   2. What mass of iron is produced from the reaction of 2.50 moles of carbon monoxide with excess iron (III) oxide?
   3. 100.0 g of iron (III) oxide reacts with 100.0 g of carbon monoxide, determine the limiting reactant. What is the theoretical yield of carbon dioxide?
   4. If 60.5 g of carbon dioxide is actually produced, what is the % yield?