Student Name: _____ **Pd.** ____ **Date:** _____

Stoichiometry Word Problems 2 SOLUTIONS

1. Cellular respiration occurs in animal cells, a reaction that is essentially the combustion of a sugar called glucose, $C_6H_{12}O_6$. If the average human uses 550 liters of oxygen when breathing, how many grams of glucose are used by this process?

Balanced Equation: $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$

$$\left(\frac{550\ L\ O_2}{1}\right)\left(\frac{1\ mol\ O_2}{22.4\ L\ O_2}\right)\left(\frac{1\ mol\ C_6H_{12}O_6}{6\ mol\ O_2}\right)\left(\frac{180\ g\ C_6H_{12}O_6}{1\ mol\ C_6H_{12}O_{62}}\right) = 736.61\ g\ C_6H_{12}O_6$$

2. Nitroglycerin, $C_3H_5(ONO_2)_3$, was invented in 1846 by an Italian chemist named Ascanio Sobrero. Nitroglycerine contains both an oxidant and a fuel. When it detonates, it decomposes to form carbon dioxide, water, nitrogen, and oxygen, all in a gaseous state. Every mole of the explosive that decomposes in this way generates a tremendous amount of energy – approximately 1.5 MJ (1 MJ = 1 megajoule = 1 x 10^6 J = 1 MJ).
    a. If 1.135 kilograms of nitroglycerin detonates, how many total liters of gas (assuming STP) are produced?

Balanced Equations: $4\ C_3H_5(ONO_2)_3 \rightarrow 10\ H_2O + 12\ CO_2 + 6\ N_2 + O_2$

$$\left(\frac{1.135\ kg\ nitro}{1}\right)\left(\frac{1000\ g\ nitro}{1\ kg\ nitro}\right)\left(\frac{1\ mol\ nitro}{227\ g\ nitro}\right)\left(\frac{29\ mol\ gas}{4\ mol\ nitro}\right)\left(\frac{22.4\ L\ gas}{1\ mol\ gas}\right) = 812\ L\ C_3H_5(ONO_2)_3$$

    b. How much energy is produced by the explosion?

$$\left(\frac{1.135\ kg\ nitro}{1}\right)\left(\frac{1000\ g\ nitro}{1\ kg\ nitro}\right)\left(\frac{1\ mol\ nitro}{227\ g\ nitro}\right)\left(\frac{1\ MJ\ energy}{1\ mol\ nitro}\right) = 7.5\ MJ$$

3. Sodium hydroxide is a strong, inexpensive base used commonly in many industrial chemical processes. It is manufactured by creating a strong aqueous brine (NaCl) solution and applying an intense electrical current. The sodium ions react with the water to generate sodium hydroxide, hydrogen gas, and chlorine gas. If 2345 g of salt is mixed with 4562 g of water:
    a. Which reactant is limiting?

Balanced Equation: $2\ NaCl + 2\ H_2O \rightarrow 2\ NaOH + H_2 + Cl_2$

$$\left(\frac{2345\ g\ NaCl}{1}\right)\left(\frac{1\ mol\ NaCl}{58.5\ g\ NaCl}\right)\left(\frac{2\ mol\ H_2O}{2\ mol\ NaCl}\right)\left(\frac{18\ g\ H_2O}{1\ mol\ H_2O}\right) = 721.54\ g\ H_2O$$

Since the amount of H_2O required is less than the amount provided (4562 g), it is in excess, so NaCl is the limiting reagent.

b. How much base is produced?

Use the limiting reactant (NaCl):

$$\left(\frac{2345\ g\ NaCl}{1}\right)\left(\frac{1\ mol\ NaCl}{58.5\ g\ NaCl}\right)\left(\frac{2\ mol\ NaOH}{2\ mol\ NaCl}\right)\left(\frac{40\ g\ NaOH}{1\ mol\ NaOH}\right)=1603.42\ g\ NaOH$$

c. How much of the excess reactant is left over?

From part (a), 721.54 g of water were consumed. Subtract this from the given (4562 – 721.54 = 3840 g H_2O are left over.

4. Prior to World War II, ammonia was produced by a process called dry distillation, by which ammonium chloride and quicklime (calcium oxide) react to form calcium chloride, calcium hydroxide, and ammonia. The reaction looks like this:

$$2\ NH_4Cl + 2\ CaO \rightarrow CaCl_2 + Ca(OH)_2 + 2\ NH_3$$

If 75.6 g of ammonium chloride is allowed to react with 52.8 g of quicklime:

a. How many grams of the excess reactant are left over?

$$\left(\frac{75.6\ g\ NH_4Cl}{1}\right)\left(\frac{1\ mol\ NH_4Cl}{43.5\ g\ NH_4Cl}\right)\left(\frac{2\ mol\ CaO}{2\ mol\ NH_4Cl}\right)\left(\frac{56.1\ g\ CaO}{1\ mol\ CaO}\right)=97.50\ g\ CaO$$

Since more quicklime is needed than is provided, quicklime is the limiting reactant. Therefore:

$$\left(\frac{52.8\ g\ CaO}{1}\right)\left(\frac{1\ mol\ CaO}{56.1\ g\ CaO}\right)\left(\frac{2\ mol\ NH_4Cl}{2\ mol\ CaO}\right)\left(\frac{43.5\ g\ NH_4Cl}{1\ mol\ NH_4Cl}\right)=40.94\ g\ NH_4Cl$$

75.6 – 40.4 = 35.2 grams of NH_4Cl are left over.

b. How many grams of ammonia are formed?

Use the limiting reactant:

$$\left(\frac{52.8\ g\ CaO}{1}\right)\left(\frac{1\ mol\ CaO}{56.1\ g\ CaO}\right)\left(\frac{2\ mol\ NH_3}{2\ mol\ CaO}\right)\left(\frac{17.0\ g\ NH_4Cl}{1\ mol\ NH_3}\right)=16.0\ g\ NH_3$$

5. Hydrochloric acid reacts with zinc metal to form zinc chloride and hydrogen gas. If 345.2 g of zinc metal reacts with 231.6 grams of acid. How many liters of hydrogen gas are produced? How many moles of zinc chloride are produced?

Balanced Equation: $2\ HCl + Zn \rightarrow ZnCl_2 + H_2$

$$\left(\frac{231.6\ g\ HCl}{1}\right)\left(\frac{1\ mol\ HCl}{36.5\ g\ HCl}\right)\left(\frac{1\ mol\ Zn}{2\ mol\ HCl}\right)\left(\frac{65.4\ g\ Zn}{1\ mol\ Zn}\right) = 207.49\ g\ Zn$$

HCl is limiting,

$$\left(\frac{231.6\ g\ HCl}{1}\right)\left(\frac{1\ mol\ HCl}{36.5\ g\ HCl}\right)\left(\frac{1\ mol\ H_2}{2\ mol\ HCl}\right)\left(\frac{2.0\ g\ H_2}{1\ mol\ H_2}\right) = 6.35\ g\ H_2$$

$$\left(\frac{231.6\ g\ HCl}{1}\right)\left(\frac{1\ mol\ HCl}{36.5\ g\ HCl}\right)\left(\frac{1\ mol\ ZnCl}{2\ mol\ HCl}\right)\left(\frac{100.9\ g\ ZnCl}{1\ mol\ ZnCl}\right) = 320.12\ g\ ZnCl$$

6. Dappolonium gas (Dp_2 mw=5 g/mol) and Rockthehousium (Rk, mw=7 g/mol) combine to form Dapphousium ($RkDp_2$), an amazingly hard material with transdimensional properties. If 17 grams of Dp_2 and 32 grams of Rk combine, which is the limiting reactant? How many grams of Dapphousium is formed?

Balanced Equation: $2\ Rk + Dp_2 \rightarrow RkDp_2$

$$\left(\frac{17\ g\ Dp_2}{1}\right)\left(\frac{1\ mol\ Dp_2}{5\ g\ Dp_2}\right)\left(\frac{2\ mol\ Rk}{1\ mol\ Dp_2}\right)\left(\frac{7\ g\ Rk}{1\ mol\ Rk}\right) = 47.6\ g\ Rk$$

Rockthehousium is limiting.

$$\left(\frac{32\ g\ Rk}{1}\right)\left(\frac{1\ mol\ Rk}{7\ g\ Rk}\right)\left(\frac{1\ mol\ RkDp_2}{2\ mol\ Rk}\right)\left(\frac{12\ g\ RkDp_2}{1\ mol\ RkDp_2}\right) = 27.43\ g\ RkDp_2$$