Name: SOLUTIONS
Hour: _____ Date: _____

Chem B Unit 7, Day 4 Homework: Gases and LR

Stoichiometry with gases

1.) How many liters of ammonia could form if 24.2 liters of hydrogen gas were reacted with excess nitrogen gas?

a. Write the balanced chemical equation: $N_2 + 3H_2 \rightarrow 2NH_3$

b. Use the road map to go from volume of one substance to volume of another:

$V_{H_2} \rightarrow mol_{H_2} \rightarrow mol_{NH_3} \rightarrow V_{NH_3}$

$$\frac{24.2\ L\ H_2}{1} \left| \frac{1\ mol\ H_2}{22.4\ L\ H_2} \right| \frac{2\ mol\ NH_3}{3\ mol\ H_2} \left| \frac{22.4\ L\ NH_3}{1\ mol\ NH_3} \right. = 16.1\ L\ NH_3$$

2.) How many molecules of carbon dioxide are formed when 6.35 liters of propane, C_3H_8, burn in the presence of excess oxygen?

a. Write the balanced chemical equation: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

b. Use the road map to go from volume of one substance to volume of another:

$V_{C_3H_8} \rightarrow mol_{C_3H_8} \rightarrow mol_{CO_2} \rightarrow A_{CO_2}$

$$\frac{6.35\ L\ C_3H_8}{1} \left| \frac{1\ mol\ C_3H_8}{22.4\ L\ C_3H_8} \right| \frac{3\ mol\ CO_2}{1\ mol\ C_3H_8} \left| \frac{6.02\times10^{23}\ molecules\ CO_2}{1\ mol\ CO_2} \right. = 5.11\times10^{23}\ molecules\ CO_2$$

3.) How many molecules of oxygen are produced by the decomposition of 6.54 g of potassium chlorate ($KClO_3$)?

$$2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$$

$G_{KClO_3} \rightarrow mol_{KClO_3} \rightarrow mol_{O_2} \rightarrow A_{O_2}$

$$\frac{6.54\ g\ KClO_3}{1} \left| \frac{1\ mol\ KClO_3}{122.55\ g\ KClO_3} \right| \frac{3\ mol\ O_2}{2\ mol\ KClO_3} \left| \frac{6.02\times10^{23}\ molecules\ O_2}{1\ mol\ O_2} \right. = 1.93\times10^{22}\ molecules\ O_2\ gas\ will\ be\ formed$$

4.) Calculate the volume of sulfur dioxide, in milliliters, produced when 27.9 mL O_2 reacts with carbon disulfide. (Recall that 1000 mL = 1 L).

$$CS_{2(l)} + 3O_{2(g)} \rightarrow CO_{2(g)} + 2SO_{2(g)}$$

$mL_{O_2} \rightarrow V_{O_2} \rightarrow mol_{O_2} \rightarrow mol_{SO_2} \rightarrow V_{SO_2} \rightarrow mL_{SO_2}$

$$\frac{27.9\ mL\ O_2}{1} \left| \frac{1\ L\ O_2}{1000\ mL\ O_2} \right| \frac{1\ mol\ O_2}{22.4\ L\ O_2} \left| \frac{2\ mol\ SO_2}{3\ mol\ O_2} \right| \frac{22.4\ L\ SO_2}{1\ mol\ SO_2} \left| \frac{1000\ mL\ SO_2}{1\ L\ SO_2} \right. = 18.6\ mL\ SO_2$$

Part II: Limiting reagents

5.) The equation below shows the incomplete combustion of ethane:

$$C_2H_{4(g)} + 2O_{2(g)} \rightarrow 2CO_{(g)} + 2H_2O_{(g)}$$

If 2.70 mol C_2H_4 is reacted with 6.30 mol O_2,

a. Calculate the moles of water produced given the amounts of *each* reactant present (DO TWO CALCULATIONS!). (1) $mol_{C_2H_2} \rightarrow mol_{H_2O}$

$$2.70 \text{ mol } C_2H_4 \left| \frac{2 \text{ mol } H_2O}{1 \text{ mol } C_2H_4} \right. = \boxed{5.40 \text{ mol } H_2O}$$

(2) $mol_{O_2} \rightarrow mol_{H_2O}$

$$6.30 \text{ mol } O_2 \left| \frac{2 \text{ mol } H_2O}{2 \text{ mol } O_2} \right. = 6.30 \text{ mol } H_2O$$

b. Identify the limiting reagent based on your calculations in a.

Only 5.40 mol H_2O can be produced b/c C_2H_4 will run out after that ∴ C_2H_4 is the limiting reagent.

6.) Hydrogen gas can be produced by the reaction of magnesium metal with hydrochloric acid.

$$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$$

Identify the limiting reagent when 6.00 g HCl reacts with 5.00 g Mg
(*Hint*: Calculate the amount of one of the products that will be produced if you had 6.00 g HCl and plenty of Mg and then repeat the calculation for the amount of Mg given assuming you have plenty of HCl).

(1) Pick either product to calculate for if one isn't assigned: I'll pick H_2 (g)

(2) $G_{HCl} \rightarrow mol_{HCl} \rightarrow mol_{H_2}$

$$6.00 \text{ g HCl} \left| \frac{1 \text{ mol HCl}}{36.46 \text{ g HCl}} \right| \frac{1 \text{ mol } H_2}{2 \text{ mol HCl}} = \boxed{0.0823 \text{ mol } H_2}$$

HCl is the limiting reagent b/c it will make less product.

(3) $G_{Mg} \rightarrow mol_{Mg} \rightarrow mol_{H_2}$

$$6.00 \text{ g Mg} \left| \frac{1 \text{ mol Mg}}{24.3 \text{ g Mg}} \right| \frac{1 \text{ mol } H_2}{1 \text{ mol Mg}} = 0.247 \text{ mol } H_2$$

7.) The heat from an acetylene torch is produced by burning acetylene (C_2H_2) in oxygen:

$$2C_2H_{2(g)} + 5O_{2(g)} \rightarrow 4CO_{2(g)} + 2H_2O_{(g)}$$

How many grams of water can be produced by the reaction of 2.40 mol C_2H_2 with 7.40 mol O_2?

(1) $mol_{C_2H_2} \rightarrow mol_{H_2O} \rightarrow G_{H_2O}$

$$2.40 \text{ mol } C_2H_4 \left| \frac{2 \text{ mol } H_2O}{2 \text{ mol } C_2H_2} \right| \frac{18.0152 \text{ g } H_2O}{1 \text{ mol } H_2O} = \boxed{43.2 \text{ g } H_2O}$$

C_2H_2 is the limiting reagent.

(2) $mol_{O_2} \rightarrow mol_{O_2} \rightarrow G_{O_2}$

$$7.40 \text{ mol } O_2 \left| \frac{2 \text{ mol } H_2O}{5 \text{ mol } O_2} \right| \frac{18.0152 \text{ g } H_2O}{1 \text{ mol } H_2O} = 53.3 \text{ g } H_2O$$