Name _____

Class _____ Date _____

Calculations Involving Reactions

Solve each of the following problems. Show your work in the space provided and include a balanced equation for each problem. Write your final answer on the blank line.

Part A

1. How many moles of hydrogen are required to react with 2.5 moles of oxygen to produce water?

$2H_2 + O_2 \rightarrow 2H_2O$

$2.5 \text{ mol } O_2 \times \frac{2 \text{ mol } H_2}{1 \text{ mol } O_2}$

5.0 mol H_2

2. How many moles of hydrochloric acid, HCl, will be required to produce 0.4 mole of hydrogen gas by reaction with zinc?

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

$0.4 \text{ mol } H_2 \times \frac{2 \text{ mol } HCl}{1 \text{ mol } H_2}$

0.8 mol HCl

3. How many moles of nitrogen and of hydrogen will be required to produce 1.70 moles of ammonia, NH_3?

$N_2 + 3H_2 \rightarrow 2NH_3$

$1.70 \text{ mol } NH_3 \times \frac{1 \text{ mol } N_2}{2 \text{ mol } NH_3} =$ 0.850 mol N_2

$1.70 \text{ mol } NH_3 \times \frac{3 \text{ mol } H_2}{2 \text{ mol } NH_3} =$ 2.55 mol H_2

Part B

4. How many moles of fluorine will be needed to produce 5.6 g of hydrogen fluoride by reaction with hydrogen?

$H_2 + F_2 \rightarrow 2HF$

$5.6 \text{ g HF} \times \frac{1 \text{ mol HF}}{20.01 \text{ g HF}} \times \frac{1 \text{ mol } F_2}{2 \text{ mol HF}} = 0.13993 \text{ mol } F_2$

0.14 mol F_2

CHAPTER 6 PROBLEMS

5. How many grams of carbon will react with 0.25 mole of oxygen to produce carbon dioxide?

$$C + O_2 \rightarrow CO_2$$

$$0.25\ mol\ O_2 \times \frac{1\ mol\ C}{1\ mol\ O_2} \times \frac{12.01\ g\ C}{1\ mol\ C} = 3.0025\ g\ C$$

3.0 g C

6. How many grams of oxygen can be produced when 15.6 g of sulfur trioxide, SO_3, are decomposed?

$$2SO_3 \rightarrow 2S + 3O_2$$

$$15.6\ g\ SO_3 \times \frac{1\ mol\ SO_3}{80.07\ g\ SO_3} \times \frac{3\ mol\ O_2}{2\ mol\ SO_3} \times \frac{32.00\ g\ O_2}{1\ mol\ O_2}$$

$$= 9.351817169\ g\ O_2$$

9.35 g O_2

7. How many grams of chlorine are required to produce 355 g of carbon tetrachloride, CCl_4, by reaction with carbon?

$$C + 2Cl_2 \rightarrow CCl_4$$

$$355\ g\ CCl_4 \times \frac{1\ mol\ CCl_4}{153.81\ g\ CCl_4} \times \frac{2\ mol\ Cl_2}{1\ mol\ CCl_4} \times \frac{70.90\ g\ Cl_2}{1\ mol\ Cl_2}$$

$$= 327.2804109\ g\ Cl_2$$

327 g Cl_2

8. How many grams of magnesium are required to react with 1.62 g bromine to produce magnesium bromide, $MgBr_2$?

$$Mg + Br_2 \rightarrow MgBr_2$$

$$1.62\ g\ Br_2 \times \frac{1\ mol\ Br_2}{159.80\ g\ Br_2} \times \frac{1\ mol\ Mg}{1\ mol\ Br_2} \times \frac{24.31\ g\ Mg}{1\ mol\ Mg}$$

$$= 0.2464468\ g\ Mg$$

0.246 g Mg

Part C

9. Assume that 2.40 moles of oxygen are reacted with 2.46 moles of magnesium to produce magnesium oxide, MgO. Determine which reactant is in excess and by what amount, and calculate the number of moles of product formed.

$2Mg + O_2 \rightarrow 2MgO$

Limiting Reagent ?

$\frac{2.40\ mol\ O_2}{1\ mol\ O_2} = 2.40$

$\frac{2.46\ mol\ Mg}{2\ mol\ Mg} = 1.23$ Limiting reagent.

O_2 is in excess.

$2.40\ mol\ O_2 - 1.23\ mol\ O_2 = 1.17\ mol\ O_2$ in excess

$2.46\ mol\ Mg \left(\frac{2\ mol\ MgO}{2\ mol\ Mg}\right) = 2.46\ mol\ MgO$

10. Assume that 13.1 g of potassium are reacted with 18.0 g of oxygen to produce potassium oxide, K_2O. Determine which reactant is in excess and by what amount, in moles, and calculate the number of grams of products formed.

$4K + O_2 \rightarrow 2K_2O$

Limiting reagent : K.

- mol O_2 used

$13.1g\ K \left(\frac{1\ mol\ K}{39.10g\ K}\right)\left(\frac{1\ mol\ O_2}{4\ mol\ K}\right) = 0.0838\ mol\ O_2$

- mol O_2 in excess

$18.0g\ O_2 \left(\frac{1\ mol\ O_2}{32.00g\ O_2}\right) = 0.563\ mol\ O_2$

$0.563\ mol\ O_2 - 0.0838\ mol\ O_2 = 0.479\ mol\ O_2$

0.479 mol O_2 in excess.

- g K_2O produced

$13.1g\ K \left(\frac{1\ mol\ K}{39.10g\ K}\right)\left(\frac{2\ mol\ K_2O}{4\ mol\ K}\right)\left(\frac{94.20g\ K_2O}{1\ mol\ K_2O}\right) = 15.6598g\ K_2O$

15.7 g K_2O

Part D

11. When 21.8 g of silver nitrate, $AgNO_3$, are reacted with an excess of sodium chloride, 17.8 g of silver chloride, AgCl, are formed. Calculate the percent yield of silver chloride.

$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

- Theoretical yield of the AgCl

$21.8g\ AgNO_3 \left(\frac{1\ mol\ AgNO_3}{169.88g\ AgNO_3}\right)\left(\frac{1\ mol\ AgCl}{1\ mol\ AgNO_3}\right)\left(\frac{143.32g\ AgCl}{1\ mol\ AgCl}\right) = 18.4g\ AgCl$

$\%\ yield = \frac{17.8g\ AgCl}{18.4g\ AgCl} \times 100 = 96.7\%$

96.7%

12. When 5.44 g of copper are reacted with an excess of oxygen, 5.10 g of copper(II) oxide, CuO, are formed. Calculate the percent yield of copper(II) oxide.

$2Cu + O_2 \rightarrow 2CuO$

- Theoretical yield of the product, CuO

$$5.44\,g\,Cu\left(\frac{1\,mol\,Cu}{63.55\,g\,Cu}\right)\left(\frac{2\,mol\,CuO}{2\,mol\,Cu}\right)\left(\frac{79.55\,g\,CuO}{1\,mol\,CuO}\right) = 6.81\,g\,CuO$$

$$\%\ yield = \frac{actual\ yield}{theoretical\ yield} \times 100$$

$$= \frac{5.10\,g}{6.81\,g} \times 100 = 74.9\,\%$$

74.9%