Practice Sheets

STOICHIOMETRY: MOLE-MOLE PROBLEMS

Name Key

1. $N_2 + 3H_2 \rightarrow 2NH_3$

How many moles of hydrogen are needed to completely react with two moles of nitrogen?

$$2 \text{ mol } N_2 \times \frac{3 \text{ mol } H_2}{1 \text{ mol } N_2}$$

6 mol H_2

2. $2KClO_3 \rightarrow 2KCl + 3O_2$

How many moles of oxygen are produced by the decomposition of six moles of potassium chlorate?

$$6 \text{ mol } KClO_3 \times \frac{3 \text{ mol } O_2}{2 \text{ mol } KClO_3}$$

9 mol O_2

3. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

How many moles of hydrogen are produced from the reaction of three moles of zinc with an excess of hydrochloric acid?

ignore

$$3 \text{ mol } Zn \times \frac{1 \text{ mol } H_2}{1 \text{ mol } Zn}$$

3 mol H_2

4. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

How many moles of oxygen are necessary to react completely with four moles of propane (C_3H_8)?

$$4 \text{ mole } C_3H_8 \times \frac{5 \text{ mol } O_2}{1 \text{ mol } C_3H_8}$$

20 mol O_2

5. $K_3PO_4 + Al(NO_3)_3 \rightarrow 3KNO_3 + AlPO_4$

How many moles of potassium nitrate are produced when two moles of potassium phosphate react with two moles of aluminum nitrate?

pick one to start with

$$2 \text{ mol } K_3PO_4 \times \frac{3 \text{ mol } KNO_3}{1 \text{ mol } K_3PO_4}$$

OR

$$2 \text{ mol } Al(NO_3)_3 \times \frac{3 \text{ mol } KNO_3}{1 \text{ mol } Al(NO_3)_3}$$

6 mol KNO_3

STOICHIOMETRY: MASS-MASS PROBLEMS

Name _____

1. $2KClO_3 \rightarrow 2KCl + 3O_2$

How many grams of potassium chloride are produced if 25 g of potassium chlora decompose?

$$25\text{g } KClO_3 \times \frac{1 \text{ mol } KClO_3}{122.5492\text{g } KClO_3} \times \frac{2 \text{ mol } KCl}{2 \text{ mol } KClO_3} \times \frac{74.551\text{g } KCl}{1 \text{ mol } KCl}$$

$= 15.2\text{g } KCl$

2. $N_2 + 3H_2 \rightarrow 2NH_3$

How many grams of hydrogen are necessary to react completely with 50.0 g of nitrogen in the above reaction?

$$50.0\text{g } N_2 \times \frac{1 \text{ mol } N_2}{28.0134\text{g } N_2} \times \frac{3 \text{ mol } H_2}{1 \text{ mol } N_2} \times \frac{2.014\text{g } H_2}{1 \text{ mol } H_2}$$

$10.8\text{g } H_2$

3. How many grams of ammonia are produced in the reaction in Problem 2?

$$50.0\text{g } N_2 \times \frac{1 \text{ mol } N_2}{28.0134\text{g } N_2} \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} \times \frac{17.027\text{g } NH_3}{1 \text{ mol } NH_3}$$

~~84.2~~ $60.7\text{g } NH_3$

4. $2AgNO_3 + BaCl_2 \rightarrow 2AgCl + Ba(NO_3)_2$

How many grams of silver chloride are produced from 5.0 g of silver nitrate reactin with an excess of barium chloride?

$$5.0\text{g } AgNO_3 \times \frac{1 \text{ mol } AgNO_3}{169.9049\text{g } AgNO_3} \times \frac{2 \text{ mol } AgCl}{2 \text{ mol } AgNO_3} \times \frac{143.353\text{g } AgCl}{1 \text{ mol } AgCl}$$

$4.22\text{g } AgCl$

5. How much barium chloride is necessary to react with the silver nitrate in Problem 4

$$5.0\text{g } AgNO_3 \times \frac{1 \text{ mol } AgNO_3}{169.9049\text{g } AgNO_3} \times \frac{1 \text{ mol } BaCl_2}{2 \text{ mol } AgNO_3} \times \frac{208.206\text{g } BaCl_2}{1 \text{ mol } BaCl_2}$$

$3.06\text{g } BaCl_2$

STOICHIOMETRY: VOLUME-VOLUME PROBLEMS

Name _____

1. $N_2 + 3H_2 \rightarrow 2NH_3$

What volume of hydrogen is necessary to react with five liters of nitrogen to produce ammonia? (Assume constant temperature and pressure.)

$$5\text{ L } N_2 \times \frac{1\text{ mol } N_2}{22.4\text{ L } N_2} \times \frac{3\text{ mol } H_2}{1\text{ mol } N_2} \times \frac{22.4\text{ L } H_2}{1\text{ mol } H_2}$$

15 L H_2

2. What volume of ammonia is produced in the reaction in Problem 1?

$$5\text{ L } N_2 \times \frac{1\text{ mol } N_2}{22.4\text{ L } N_2} \times \frac{2\text{ mol } NH_3}{1\text{ mol } N_2} \times \frac{22.4\text{ L } NH_3}{1\text{ mol } NH_3}$$

10 L NH_3

3. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

If 20 liters of oxygen are consumed in the above reaction, how many liters of carbon dioxide are produced?

$$20\text{ L } O_2 \times \frac{1\text{ mol } O_2}{22.4\text{ L } O_2} \times \frac{3\text{ mol } CO_2}{5\text{ mol } O_2} \times \frac{22.4\text{ L } CO_2}{1\text{ mol } CO_2}$$

12 L CO_2

4. $2H_2O \rightarrow 2H_2 + O_2$

If 30 mL of hydrogen are produced in the above reaction, how many milliliters of oxygen are produced?

$$0.030\text{ L } H_2 \times \frac{1\text{ mol } H_2}{22.4\text{ L } H_2} \times \frac{1\text{ mol } O_2}{2\text{ mol } H_2} \times \frac{22.4\text{ L } O_2}{1\text{ mol } O_2}$$

15 mL O_2

5. $2CO + O_2 \rightarrow 2CO_2$

How many liters of carbon dioxide are produced if 75 liters of carbon monoxide are burned in oxygen? How many liters of oxygen are necessary?

$$75\text{ L CO} \times \frac{1\text{ mol CO}}{22.4\text{ L CO}} \times \frac{2\text{ mol } CO_2}{2\text{ mol CO}} \times \frac{22.4\text{ L } CO_2}{1\text{ mol } CO_2}$$

75 L CO_2

$$75\text{ L CO} \times \frac{1\text{ mol CO}}{22.4\text{ L CO}} \times \frac{1\text{ mol } O_2}{2\text{ mol CO}} \times \frac{22.4\text{ L } O_2}{1\text{ mol } O_2}$$

37.5 L O_2

STOICHIOMETRY: MIXED PROBLEMS

Name _____

1. $N_2 + 3H_2 \rightarrow 2NH_3$

What volume of NH_3 at STP is produced if 25.0 g of N_2 is reacted with an excess of H_2?

$$25.0\text{ g } N_2 \times \frac{1\text{ mol } N_2}{28.0134\text{ g } N_2} \times \frac{2\text{ mol } NH_3}{1\text{ mol } N_2} \times \frac{22.4\text{ L } NH_3}{1\text{ mol } NH_3}$$

39.98 L NH_3

2. $2KClO_3 \rightarrow 2KCl + 3O_2$

If 5.0 g of $KClO_3$ is decomposed, what volume of O_2 is produced at STP?

$$5.0\text{ g } KClO_3 \times \frac{1\text{ mol } KClO_3}{122.5492\text{ g } KClO_3} \times \frac{3\text{ mol } O_2}{2\text{ mol } KClO_3} \times \frac{22.4\text{ L } O_2}{1\text{ mol } O_2}$$

1.37 L O_2

3. How many grams of KCl are produced in Problem 2?

$$5.0\text{ g } KClO_3 \times \frac{1\text{ mol } KClO_3}{122.5492\text{ g } KClO_3} \times \frac{2\text{ mol } KCl}{2\text{ mol } KClO_3} \times \frac{74.551\text{ g } KCl}{1\text{ mol}}$$

3.04 g KCl

4. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

What volume of hydrogen at STP is produced when 2.5 g of zinc react with an excess of hydrochloric acid?

$$2.5\text{ g } Zn \times \frac{1\text{ mol } Zn}{63.546\text{ g } Zn} \times \frac{1\text{ mol } H_2}{1\text{ mol } Zn} \times \frac{22.4\text{ L } H_2}{1\text{ mol } H_2}$$

0.881 L H_2

5. $H_2SO_4 + 2NaOH \rightarrow 2H_2O + Na_2SO_4$

How many molecules of water are produced if 2.0 g of sodium sulfate are produced in the above reaction?

$$2.0\text{ g } Na_2SO_4 \times \frac{1\text{ mol } Na_2SO_4}{142.0428\text{ g } Na_2SO_4} \times \frac{2\text{ mol } H_2O}{1\text{ mol } Na_2SO_4} \times \frac{6.02\times10^{23}\text{ part. } H_2O}{1\text{ mol } H_2O}$$

1.70×10^{22} part.

6. $2AlCl_3 \rightarrow 2Al + 3Cl_2$

If 10.0 g of aluminum chloride are decomposed, how many molecules of Cl_2 are produced?

$$10.0\text{ g } AlCl_3 \times \frac{1\text{ mol } AlCl_3}{133.3405\text{ g } AlCl_3} \times \frac{3\text{ mol } Cl_2}{2\text{ mol } AlCl_3} \times \frac{6.02\times10^{23}\text{ particles}}{1\text{ mol } Cl_2}$$

6.77×10^{22}

Theoretical Yield Worksheet

1/ If you start the reaction with 500mL of 6.0M NH_3, what is the theoretical yield of N_2F_4? If we actually get 150g of N_2F_4 is our lab synthesis, what is our percent yield?

$$2NH_3 + 5F_2 \rightarrow N_2F_4 + 6HF$$

$M = \frac{mol}{V_L}$

$mol = 6.0M(0.500L)$

$= 3\,mol\ NH_3 \times \frac{1\ mol\ N_2F_4}{2\ mol\ NH_3} \times \frac{104.0054g\ N_2F_4}{1\ mol\ N_2F_4} = \boxed{156.0081g\ N_2F_4}$

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

$= \frac{150g}{156.0081} \times 100 = \boxed{96.1\%}$

2/ Some solid Calcium oxide reacts with 30 grams of water in order to produce Calcium hydroxide. What is the theoretical yield of Calcium hydroxide? If, in the lab, we obtain 120 grams of Calcium hydroxide, what is our percent yield?

$$CaO_{(s)} + H_2O \rightarrow Ca(OH)_2$$

$30g\ H_2O \times \frac{1\ mol\ H_2O}{18.0134g\ H_2O} \times \frac{1\ mol\ Ca(OH)_2}{1\ mol\ H_2O} \times \frac{74.0932g\ Ca(OH)_2}{1\ mol\ Ca(OH)_2}$

$\boxed{\text{theoretical yield} = 123.4g\ Ca(OH)_2}$

$\%\ yield = \frac{actual}{theoretical} \times 100 = \frac{120g}{123.4g} \times 100 = \boxed{97.2\%}$

3/ Disulphur dichloride is used to galvanize rubber. It is made by reacting Sulphur with chlorine gas. If we were to start out with 45 grams of Sulphur and we get 94 grams of disulphur dichloride after the reaction, what is the theoretical and percent yields?

$S_8 + 4Cl_2 \rightarrow 4S_2Cl_2$

$45g\ S_8 \times \frac{1\ mol\ S_8}{256.48g\ S_8} \times \frac{4\ mol\ S_2Cl_2}{1\ mol\ S_8} \times \frac{135.02g\ S_2Cl_2}{1\ mol\ S_2Cl_2}$

$\boxed{= 94.8g\ S_2Cl_2}$

$\%\ = \frac{actual}{theoretical} \times 100 \quad \frac{94g}{94.8g} \times 100 = \boxed{99.1\%}$

STOICHIOMETRY: LIMITING REAGENT

Name _____

1. $N_2 + 3H_2 \rightarrow 2NH_3$

How many grams of NH_3 can be produced from the reaction of 28 g of N_2 and 25 g of H_2?

$28\text{g } N_2 \times \frac{1 \text{ mol } N_2}{28.0134\text{g } N_2} = 0.9995 \text{ mol } N_2$ * limiting — HAVE

$25\text{g } H_2 \times \frac{1 \text{ mol } H_2}{2.014 \text{ g } H_2} = 12.413 \text{ mol } H_2$ * excess

N_2: $12.413 \text{ mol } H_2 \times \frac{1 \text{ mol } N_2}{3 \text{ mol } H_2} = 4.138 \text{ mol } N_2$ — NEED

H_2: $0.9995 \text{ mol } N_2 \times \frac{3 \text{ mol } H_2}{1 \text{ mol } N_2} = 2.999 \text{ mol } H_2$

$0.9995 \text{ mol } N_2 \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} \times \frac{17.0277 \text{ g}}{\text{mol } NH_3} = 34.04\text{g } NH_3$

34.04 g NH_3

2. How much of the excess reagent in Problem 1 is left over?

$12.413 \text{ mol } H_2 - 2.999 \text{ mol } H_2$

$= 9.414 \text{ mol } H_2 \times \frac{2.014 \text{ g}}{1 \text{ mol}} = 18.96 \text{ g } H_2$

18.96 g H_2

3. $Mg + 2HCl \rightarrow MgCl_2 + H_2$

What volume of hydrogen at STP is produced from the reaction of 50.0 g of Mg and the equivalent of 75 g of HCl?

$50\text{g Mg} \times \frac{1 \text{ mol Mg}}{24.305\text{g Mg}} = 2.057 \text{ mol Mg}$ * excess — HAVE

$25\text{g HCl} \times \frac{1 \text{ mol HCl}}{36.461\text{g HCl}} = 0.686 \text{ mol HCl}$ * limiting

HCl: $2.057 \text{ mol Mg} \times \frac{2 \text{ mol HCl}}{1 \text{ mol Mg}} = 4.114 \text{ mol HCl}$ — NEED

Mg: $0.686 \text{ mol HCl} \times \frac{1 \text{ mol Mg}}{2 \text{ mol HCl}} = 0.342 \text{ mol Mg}$

7.68 L H_2

4. How much of the excess reagent in Problem 3 is left over?

$2.057 \text{ mol Mg} - 0.342 \text{ mol Mg}$

$= 1.715 \text{ mol Mg} \times \frac{24.305 \text{ g Mg}}{1 \text{ mol Mg}} = 41.68\text{g}$

$0.686 \text{ mol HCl} \times \frac{1 \text{ mol } H_2}{2 \text{ mol HCl}} \times \frac{22.4 \text{ L } H_2}{1 \text{ mol } H_2} = 7.68\text{L}$

41.68 g Mg

5. $3AgNO_3 + Na_3PO_4 \rightarrow Ag_3PO_4 + 3NaNO_3$

Silver nitrate and sodium phosphate are reacted in equal amounts of 200. g each. How many grams of silver phosphate are produced?

$200\text{g } AgNO_3 \times \frac{1 \text{ mol } AgNO_3}{169.8729\text{g } AgNO_3} = 1.178 \text{ mol } AgNO_3$ * limiting — HAVE

$200\text{g } Na_3PO_4 \times \frac{1 \text{ mol}}{163.94\text{g } Na_3PO_4} = 1.22 \text{ mol } Na_3PO_4$ * excess

Na_3PO_4 — NEED: $1.178 \text{ mol } AgNO_3 \times \frac{1 \text{ mol } Na_3PO_4}{3 \text{ mol } AgNO_3} = 0.393 \text{ mol } Na_3PO_4$

$AgNO_3$: $1.22 \text{ mol } Na_3PO_4 \times \frac{3 \text{ mol } AgNO_3}{1 \text{ mol } Na_3PO_4} = 3.66 \text{ mol } AgNO_3$

164.36 g Ag_3PO_4

6. How much of the excess reagent in Problem 5 is left?

Excess (Na_3PO_4)

$1.22 \text{ mol } Na_3PO_4 - 0.393 \text{ mol } Na_3PO_4 = 0.827 \text{ mol } Na_3PO_4 \times \frac{163.94 \text{ g } Na_3PO_4}{1 \text{ mol}}$

$1.178 \text{ mol } AgNO_3 \times \frac{1 \text{ mol } Ag_3PO_4}{3 \text{ mol } AgNO_3} \times \frac{418.5746 \text{ g}}{1 \text{ mol } Ag_3PO_4}$

135.58 g Na_3PO_4