Chemistry Packet

Day 1

Complete the "Balancing and Stoichiometry Review" worksheet

Day 2

Review the "Limiting Reagents, Theoretical, Actual and Percent Yields" notes

*email me if you have questions, nicole.hoover@k12.wv.us

Day 3

Complete the "Stoichiometry and Limiting Reactants" worksheet

Day 4

Review the "Excess Reactant" notes

*email me if you have questions

Day 5

Complete all parts of number 1 on the "Limiting Reactants" worksheet

Day 6

Complete all parts of number 2 on the "Limiting Reactants" worksheet

Day 7

Complete all parts of number 1 on the "Limiting Reactants, Theoretical Yield and Percent Yield" worksheet

Day 8

Complete all parts of number 2 on the "Limiting Reactants, Theoretical Yield and Percent Yield" worksheet

Day 9

Complete all parts of number 3 on the "Limiting Reactants, Theoretical Yield and Percent Yield" worksheet

Day 10

Complete all parts of number 4 on the "Limiting Reactants, Theoretical Yield and Percent Yield" worksheet

Name _____ Period _____

Balancing and Stoichiometry Review

a. _____H_2 + _____Cl_2 → _____HCl

How many grams of HCl can be produced if 7.25 g of Cl_2 is reacted with an unlimited supply of H_2?

b. _____Al + _____Fe_2O_3 → _____Al_2O_3 + _____Fe

How many grams of Fe can be produced when 10.0g of Al is reacted with an excess (unlimited) supply of Fe_2O_3?

c. _____$Pb(C_2H_3O_2)_2$ + _____H_2S → _____PbS + _____$HC_2H_3O_2$

How many grams of PbS is produced when 5.00g of H_2S is reacted with an excess (unlimited) supply of $Pb(C_2H_3O_2)_2$?

LIMITING REAGENTS, THEORETICAL , ACTUAL AND PERCENT YIELDS

A limiting reagent is a chemical *reactant* that limits the amount of product that is formed. The limiting reagent gives the smallest yield of product calculated from the reagents (reactants) available. This smallest yield of product is called the theoretical yield.

To find the limiting reagent and theoretical yield, carry out the following procedure:

1. Find the moles of each reactant present.

2. Calculate the moles of a product formed from each mole of reactant.

3. Identify the reactant giving the smaller number of moles of product. This reactant is the Limiting Reagent:

4. Calculate the grams of product produced by the Limiting Reagent. This is the theoretical yield.

THEORETICAL YIELD

The theoretical yield is the amount of the product in g formed from the limiting reagent. From the moles of limiting reagent available, calculate the grams of product that is theoretically possible (same as Step 4 above).

ACTUAL YIELD

The actual yield is the amount of the product in g actually formed in the laboratory.

PERCENT YIELD

The percent yield is the percent of the product formed based upon the theoretical yield.

$$\frac{\text{actual yield in g}}{\text{theoretical yield in g}} \times 100\ \% = \text{Percent Yield}$$

LIMITING REAGENTS, THEORETICAL , ACTUAL AND PERCENT YIELDS

EXAMPLE OF A LIMITING REAGENT PROBLEM

How many grams of NH_3 can be be produced (theoretically) from the reaction of 5.0 g of N_2 and 5.0 H_2? What is the limiting reagent? If 8.52 g are actually formed, what is the percent yield of NH_3?

Balance: $3\ H_2 + N_2 \rightarrow 2\ NH_3$

Find:

1 mole H_2:
2 x 1.01 g H = 2.01 g

1 mole N_2:
2 x 14.01 g = 28.02 g

1 mole NH_3:
3 x 1.01 g = 3.03 g H
1 x 14.01 g = 14.01 g N

17.04 g NH_3

To answer this type of question, carry out EACH step of the following procedure:

1. Find the g of product produced from each of the given amounts of reactants.

For H_2: $5.0\ g\ H_2 \times \frac{1\ mole\ H_2}{2.02\ g\ H_2} \times \frac{2\ mole\ NH_3}{3\ mol\ H_2} \times \frac{17.04\ g\ NH_3}{1\ mol\ NH_3} = 28.12\ g\ NH_3$

For N_2: $5.0\ g\ N_2 \times \frac{1\ mole\ N_2}{140.01\ g\ N_2} \times \frac{2\ mole\ NH_3}{1\ mol\ N_2} \times \frac{17.04\ g\ NH_3}{1\ mol\ NH_3} = 12.16\ g\ NH_3$

(carry 1 or 2 additional significant figures here)

2. Identify the smaller amount of calculated product:

This is the maximum amount of product that can be formed. The larger amount cannot be formed because there is not enough of the limiting reagent present.

12.16 g is the smaller amount calculated.

3. Identity the reactant that gives the smallest amount of product.
The limiting reagent determines the amount of product formed.

The limiting reagent is N_2.

4. Identify the **THEORETICAL YIELD**:
The theoretical yield is the amount of the product (in g) formed from the limiting reagent.

12 g is the theoretical yield

5. Identify the **ACTUAL YIELD**:
The actual yield is the amount of the product (in g or mol) actually formed in the laboratory.

8.25 g is the actual yield.

6. Calculate the **PERCENT YIELD**: The percent yield is based upon the theoretical yield.

$$\frac{\text{actual yield (g)}}{\text{theoretical yield (g)}} \times 100\ \% = \text{Percent Yield} = \frac{8.25\ g}{12.16\ g} \times 100\ \% = 68\%$$

(For theoretical yield, carry more sig. figs. in this calculation)

Final sig. figs. limited by the given amounts of reactants.

Stoichiometry and Limiting Reactants

1. Balance the following equation:

$$\_\_\_\_\_\ Mg(OH)_2 + \_\_\_\_\_\ HCl \rightarrow \_\_\_\_\_\ MgCl_2 + \_\_\_\_\_\ H_2O$$

2. How many grams of magnesium hydroxide would be required to produce 250 grams of water?

3. If you performed the reaction in problem 1 using 100 grams of hydrochloric acid and 55 grams of magnesium hydroxide, how many grams of magnesium chloride would you expect to make (theoretical yield)?

4. What is the limiting reactant in this reaction?

Excess Reactants

Given the chemical equation and the masses of reactants, determine the mass of excess reactant.

Example:

A 2.00 g sample of ammonia reacts with 4.00 g of oxygen according to the equation $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$.

How much excess reactant remains after the reaction has stopped?

Strategy

1. Balance the equation
2. Calculate the moles of product from the first reactant
3. Calculate the moles of product from the second reactant
4. Identify the limiting reactant (the one that produces less product)
5. Calculate the mass of the excess reactant used
6. Calculate the mass of the unused excess reactant

Moles of NO from NH_3

Convert grams of NH_3 to moles of NH_3, and then use the molar ratio from the equation to get moles of NO.

The molar mass of NH_3 is 17.03 g/mol.

Moles of NH_3 = 2.00g NH_3 × 1 mol NH_3 /17.03g NH_3 = 0.1174 mol NH_3

0.1174mol NH_3× 4 mol NO / 4mol NH_3= 0.1174 mol NO

3. Moles of NO from O_2

The molar mass of O_2 is 32.00 g/mol.

Moles of O_2 = 4.00g O_2 ×1 mol O_2 / 32.00g O_2 = 0.1250 mol O_2

0.1250mol O_2 × 4 mol NO / 5mol O_2 = 0.1000 mol NO

4. Identify limiting and excess reactants

O_2 is the limiting reactant, since it gives the smaller amount of NO.

NH_3 is the only other reactant, so it is the excess reactant.

5. Calculate the mass of excess reactant used up.

Use the molar ratio from the equation to convert moles of O_2 (from Step 3) to moles of NH_3, and then convert moles of NH_3 to grams of NH_3.

0.1250mol O_2 × 4 mol NH_3 / 5mol O_2 = 0.1000 mol NH_3

0.1000mol NH_3 × 17.03 g NH_3 / 1mol NH_3 = 1.703 g NH_3

6. Calculate the mass of unused excess reactant.

We started with 2.00 g of NH_3 and used up 1.703 g, so

Mass of excess NH_3 = 2.00 g – 1.703 g = 0.30 g NH_3

Limiting Reactants

1. Take the reaction: $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$. In an experiment, 3.25 g of NH_3 are allowed to react with 3.50 g of O_2.

   a. What is the theoretical yield?

   b. Which reactant is the limiting reagent?

   c. How much of the excess reactant remains after the reaction?

2. Consider the reaction of _____ C_6H_6 + _____ $Br_2 \rightarrow$ _____ C_6H_5Br + _____ HBr. In an experiment, 42.1 g of C_6H_6 react with 73.0 g of Br_2.

   a. What is the theoretical yield?

   b. What is the limiting reagent?

   c. How much of the excess reactant remains after the reaction?

Name _____ Period _____

Limiting Reactants, Theoretical Yield and Percent Yield

1. Consider the following reaction: $2\ Al + 6\ HBr \rightarrow 2\ AlBr_3 + 3\ H_2$

   a. When 3.22 moles of Al react with 4.96 moles of HBr, how many grams of H_2 are formed (theoretical yield)?

   b. What is the limiting reactant?

   c. For the reactant in excess, how many grams are left over at the end of the reaction?

   d. If the experimental yield of the reaction was 3.78 grams of H_2, what was the percent yield?

2. Consider the following reaction: $3\ Si + 2\ N_2 \rightarrow Si_3N_4$

   a. When 21.44 moles of Si react with 17.62 moles of N_2, how many grams of Si_3N_4 are formed (theoretical yield)?

   b. What is the limiting reactant?

   c. For the reactant in excess, how many grams are left over at the end of the reaction?

   d. If the experimental yield of the reaction was 992.6 grams of Si_3N_4, what was the percent yield?

3. Consider the following reaction: $2\ CuCl_2 + 4\ KI \rightarrow 2\ CuI + 4\ KCl + I_2$

   a. When 0.56 moles of $CuCl_2$ react with 0.64 moles of KI, how many grams of I_2 are formed (theoretical yield)?

   b. What is the limiting reactant?

   c. For the reactant in excess, how many grams are left over at the end of the reaction?

   d. If the experimental yield of the reaction was 38.6 grams of I_2, what was the percent yield?

4. Consider the following reaction: $4\ FeS_2 + 11\ O_2 \rightarrow 2\ Fe_2O_3 + 8\ SO_2$

   a. When 26.62 moles of FeS_2 react with 5.44 moles of O_2, how many grams of SO_2 are formed (theoretical yield)?

   b. What is the limiting reactant?

   c. For the reactant in excess, how many grams are left over at the end of the reaction?

   d. If the experimental yield of the reaction was 234.7 grams of I_2, what was the percent yield?