Name: Key
Blk: ____ Date: ____

Chemistry 11
STOICHIOMETRY
AND PERCENT YIELD

Sometimes 100% of the expected amount of products can not be obtained from a chemical reaction.

The term Percent Yield **is used to describe the amount of products that are actually obtained as a percentage of the expected amount.**

Reasons for less than 100% yield:
1. all of the reactant may not react (impure)
2. some of the product is lost (in filter etc).

$$\text{PERCENT YIELD} = \frac{\text{mass of product obtained}}{\text{mass of product expected}} = \frac{\text{actual}}{\text{expected}} \times 100\%$$

Example 1: When 15.0 g of CH_4 is reacted with an excess of Cl_2 according to the reaction:

$$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$$

a total of 29.7 g of CH_3Cl is formed. What is the percent yield of the reaction?

Step 1: Write out the balanced equation

$$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$$

Step 2: Write out the PERCENT YIELD FORMULA and identify what you are looking for

$$P.Y = \frac{\text{ACTUAL}}{\text{Expected}} \times 100\% \; ; \; \frac{29.7\text{ g}}{?} = ?$$

Step 3: Identify the ACTUAL amount produced:

29.7 g CH_3Cl

Step 4: Calculate the EXPECTED amount using STOICHIOMETRY

$$15.0\text{ g } CH_4 \times \frac{1\text{ mol } CH_4}{16.0\text{ g } CH_4} \times \frac{1\text{ mol } CH_3Cl}{1\text{ mol } CH_4} \times \frac{50.5\text{ g } CH_3Cl}{1\text{ mol } CH_3Cl} = 47.3\text{ g } CH_3Cl$$

Step 5: Plug the ACTUAL and EXPECTED into the formula

$$P.Y = \frac{29.7\text{ g } CH_3Cl}{47.3\text{ g } CH_3Cl} \times 100\% = \boxed{62.8\%}$$

Example 2: What mass of K_2CO_3 is produced when 1.50 g of KO_2 is reacted with an excess of CO_2 according to the reaction:

$4\ KO_2\ (s) + 2\ CO_2\ (g) \rightarrow 2\ K_2CO_3\ (s) + 3\ O_2\ (g)$

If the reaction has a 76.0 % yield?

Step 1: Write out the balanced equation

$$4\ KO_2 + 2\ CO_2 \longrightarrow 2\ K_2CO_3 + 3\ O_2$$

Step 2: Write out the PERCENT YIELD FORMULA and identify what you are looking for

$$P.Y = \frac{\text{actual}}{\text{expected}} \times 100\% = 76.0\% = \frac{?}{\text{expected}}$$

Step 3: Calculate the EXPECTED amount using STOICHIOMETRY

$$1.50\text{ g } KO_2 \times \frac{1\text{ mol } KO_2}{71.1\text{ g } KO_2} \times \frac{2\text{ mol } K_2CO_3}{4\text{ mol } KO_2} \times \frac{138.2\text{ g}}{1\text{ mol } K_2CO_3} = 1.46\text{ g } K_2CO_3$$

Step 4: Now use the Percent Yield Formula + expected to solve for ACTUAL

$$76.0\% = \frac{x}{1.46\text{ g}} \rightarrow 0.760 \times 1.46\text{ g} = x$$

$1.11\text{ g } K_2CO_3$ is actually produced

Example 3: What mass of CuO is required to make 10.0 g of Cu according to the reaction: $2\ NH_3 + 3\ CuO \rightarrow N_2 + 3\ Cu + 3\ H_2O$

IF the reaction has a 58.0 % yield?

Step 1: Write out the balanced equation

$$2\ NH_3 + 3\ CuO \longrightarrow N_2 + 3\ Cu + 3\ H_2O$$

Step 2: Write out the PERCENT YIELD FORMULA and identify what you are looking for

$$58.0\% = \frac{10.0\text{ g Cu}}{x} \rightarrow \frac{10.0\text{ g Cu}}{0.580} = x \Rightarrow 17.2\text{ g Cu}$$

Step 3: Re-arrange the FORMULA to solve for EXPECTED Cu

$$0.580 \cdot x = \left(\frac{10.0\text{ g Cu}}{x}\right) x \rightarrow \frac{0.580\,x}{0.580} = \frac{10.0\text{ g Cu}}{0.580} \Rightarrow 17.2\text{ g Cu}$$

Step 4:Use the Expected Cu to solve for the required amount of CuO (STOICH)

$$17.2\text{ g Cu} \times \frac{1\text{ mol Cu}}{63.5\text{ g Cu}} \times \frac{3\text{ mol CuO}}{3\text{ mol Cu}} \times \frac{79.5\text{ g CuO}}{1\text{ mol CuO}} = 21.6\text{ g CuO}$$