**Reaction Stoichiometry: Balanced Equation give Mole – Mole Relationships**



Balanced equation gives mol – mol relationships (conversion factors):

CH3CH2OH + 3 O2 🡪 2 CO2 + 3 H2O

Pb(NO3)2(aq) + 2 NaCl(aq) --> PbCl2(s) + 2 NaNO3(aq)

If you have 5.00 moles of Pb(NO3)2, how many moles of PbCl2 can you make?

How many moles of NaNO3 can you make?

If we react 115 g of CH3CH2OH, what mass of H2O is formed?

**Theoretical Yield and Percent Yield**

Alum Synthesis Experiment:

2 Al(s) + 2 KOH(aq) + 4 H2SO4(aq) + 22 H2O(l) 🡪 2 KAl(SO4)2 ⋅12H2O(s) + 3 H2(g)

Calculation of Theoretical Yield: Map: grams reactant 🡪 moles reactant 🡪 moles product 🡪 grams product

If you react 1.083 g Al, what mass of alum (KAl(SO4)2 ⋅12H2O(s)) is theoretically possible to form?

$$1.083 g Al × \frac{1 mol Al}{26.98 g Al} = 0.04014 mol Al $$

$$0.04014 mol Al × \frac{1 mol alum}{1 mol Al} = 0.04014 mol alum $$

$$0.04014 mol alum × \frac{474.37 g alum}{1 mol alum} = 19.0 g KAl(SO\_{4})\_{2}°12H\_{2}O $$

This is the “theoretical yield.”

Calculation of Percent Yield:

If you do the reaction using 1.083 g Al and obtain 15.2 g KAl(SO4)2 ⋅12H2O(s), what is the percent yield?

$$Percent Yield = \frac{Actual Yield (g)}{Theoretical Yield (g)} × 100\%$$

**Using Amounts Tables:**



If we react 132 grams of CH3CH2OH, how many grams of H2O are formed, how many grams of O2 react?

 CH3CH2OH + 3 O2 🡪 2 CO2 + 3 H2O

**Limiting Reactants: When multiple reactants are used, one will run out and limit the reaction.**

A cake recipe calls for 3 eggs, 2 cups of flour, and 3 teaspoons of sugar. If you have:

* 9 eggs
* 8 cups of flour
* 12 teaspoons of sugar

How many cakes can you make?

 2 CO(g) + O2(g) 🡪 2 CO2(g)

If you start with 4 CO molecules and 3 O2 molecules, which mixture will result?



Determining the Limiting Reactant:

If you have 5 P4 molecules and 20 Cl2 molecules, which will run out first? How many PCl3 molecules can form?

 P4 + 6 Cl2 🡪 4 PCl3

Reaction to make iron (steel) from iron ore:

If you react 496 g Fe­2O3 with 122 g C, which is the limiting reactant? What mass of Fe can be produced? What mass of the reactant in excess remains?

molar mass Fe2O3 =159.69 g/mol

2 Fe2O3 + 3 C 🡪 4 Fe + 3 CO2

**Chemical Analysis:** Determining Chemical Formulas or Chemical Composition using Reactions

Example 1:



A **5.486** gram sample of a compound containing C, H and O is analyzed by combustion analysis and **9.136** grams of CO2 and **2.993** grams of H2O are produced. What is the empirical formula?

**Example 2:**

A **8.878** gram sample of **manganese** is heated in the presence of excess **sulfur**. A metal **sulfide** is formed with a mass of **14.06** g. Determine the empirical formula of the metal **sulfide**.

**Example 3:**

A sample of a substance with the empirical formula **XCl2** weighs **0.5539** g. When it is dissolved in water and reacted with AgNO3, all its **chlorine** is converted to insoluble **AgCl**. The mass of the resulting **AgCl** is found to be **1.1807** g. The chemical reaction is

 **XCl2 + 2 AgNO3 🡪 2 AgCl + X(NO3)2 X is an unknown element**

What is the molar mass of XCl2?

What is the molar mass of X?

What element is X?