Stoichiometry

Stoichiometric Ratios: (similar to a recipe)
Coefficients in a balanced chemical equation represent relative number of:
Moles, molecules, ions, atoms, particles, and gases (at same T and P), etc.

Ex. $N_{2(g)}$ + 3 $H_{2(g)}$ → 2 $NH_{3(g)}$

Complete table for any amount given:

	N_2	3 H_2	2 NH_3
Moles			
Molecules			
Volume (liters)			
Mass			

Which is conserved? (atoms /molecules / moles / volume/ mass)

Ex. 1: Silver oxide decomposes into silver metal and oxygen as: $2Ag_2O$ → 4 Ag + O2
What mass of silver can be produced from the decomposition of __ g of Ag_2O?

Ex. 2: The combustion of propane: $C_3H_{8(g)}$ + 5 $O_{2(g)}$ → 3 $CO_{2(g)}$ + 4 $H_2O_{(g)}$, What volume at STP of CO_2 is produced when 100. grams of propane is combusted?

Stoichiometry involves 3 steps:

1.) Converting given amount to moles (division)
2.) Using coefficients for mole ratio
3.) Convert moles back to asked for quantity (multiplication)

Practice Worksheet

Calculations Involving a Limiting Reactant:

Introduction:

To introduce the amounts in a chemical reaction describe as analogous to:

1. 50 boys and 35 girls at a dance, how many couples could be formed?
2. If 1800 pounds boys and 1800 pounds of girls, how many couples?
3. Recipe requires 2 eggs, 3 tsp. Salt, 4 cups flour, 3 pints of water, if you mixed 5 eggs and 10 pints of water which ingredient is limiting?

Limiting Reactant: **Limiting reactant: the reactant that is completely consumed in the reaction.**

The reactant that is consumed first in a chemical reaction thus limiting the amount of product that can be formed.
The limiting reactant is not present in sufficient quantity to react with all other reactants.
The reaction stops when the limiting reactant is completely consumed.
Any remaining reactants are considered "excess reactants".
The amount of product formed is determined by the "limiting reactant".
Not necessarily the reactant with fewest moles or mass.

Steps Involved for Solving a Limiting Reactant Problem:

- **1.** Write a balanced equation for the reaction.
- **2.** Convert both reactant quantities to moles.
- **3.** Compare the moles by ratio to determine how many moles each needs.
- **4.** The reactant that is in excess.
- **5.** Use that number of moles of product to determine the mass produced.

Example:

#1: $2\ Mg_{(s)} + O_{2(g)} \rightarrow 2\ MgO_{(s)}$

What mass of magnesium oxide could be produced when 5.00 grams of Mg is reacted with 8.00 grams of oxygen?

#2: $Zn + AuCl_3 \rightarrow ZnCl_2 + Au$

How many grams of gold would produced when 10.0 grams of zinc is reacted with 50.0 grams of gold(III) chloride

Percent Yield:

$$\textbf{Percent Yield} = \frac{Actual\ Yield}{Theoretical\ Yield} x100 =$$

Actual Yield: Amount Actually produced in a chemical reaction.
Theoretical Yield: Amount of product to be formed as calculation.

#3: $3\ (NH_4)_2S + 2\ CoCl_3 \rightarrow Co_2S_3 + 6\ NH_4Cl$

12.0 grams $(NH_4)_2S$ reacts with 30.0 grams $CoCl_3$:

a.) What mass of Co_2S_3 will theoretically be produced?
b.) If __g of Co2S3 is produced, what is the percent yield?
c.) What mass of excess reactant is in excess?
d.) How many grams of ammonium chloride could also be produced?

Prove that the above supports the law of conservation of mass.

Practice Worksheet

Enthalpy and Heats of Reaction:

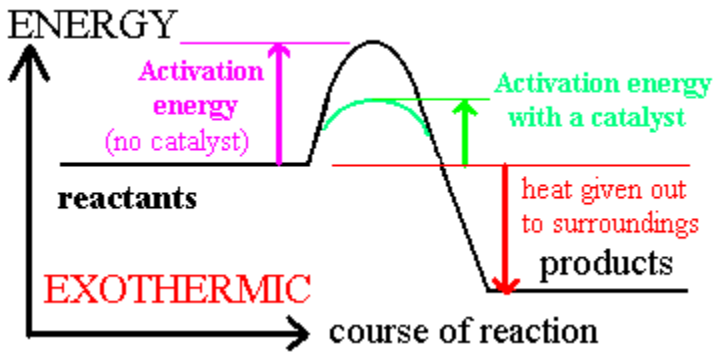
Energy is an extensive property which can be determined in much the same way as amounts of substances are used and produced.

Energy is conserved in a reaction, but changes form. Ex. Heat (kinetic) ←> Potential

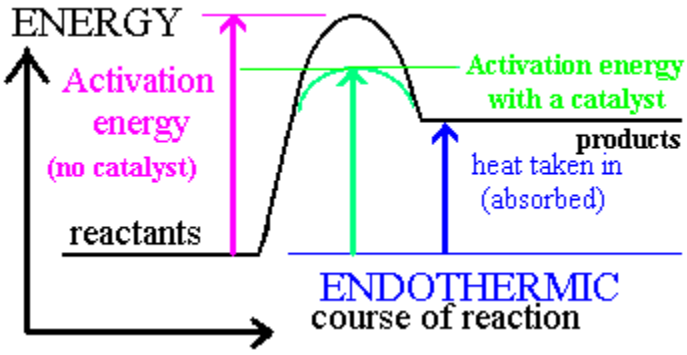
- When chemical reactions occur, as well as the formation of the products, there is also a heat energy change. This means the products have a different energy content than the original reactants (see the reaction profile diagrams below).
- If the products contain less energy than the reactants, heat is **given out** to the surroundings and the change is called **exothermic.** The temperature of the system will be observed to rise in an exothermic change.
- If the products contain more energy than the reactants, heat is **taken in (absorbed)** from the surroundings and the change is called **endothermic**. If the change can take place spontaneously, the temperature of the reacting system will fall but in some cases the reactants must be heated to speed up the reaction and provide the absorbed heat.
- The difference between the energy levels of the reactants and products gives the overall energy change for the reaction.

Energy Profile:

Exothermic **Energy is released** $\Delta H = {}^{-}$ **kJ**



Endothermic **Energy is absorbed.** $\Delta H = {}^{+}$**kJ**



Calculations Involving Heat Change in a Chemical Reaction:

Ex. $2\,HCl_{(aq)} + Ba(OH)_{2(aq)} \rightarrow BaCl_{2(aq)} + 2H_2O_{(l)}$ $\Delta H = -118$ kJ

How much energy is (released/absorbed) when 10.0 grams of HCl is reacted with an excess of $Ba(OH)_2$?

Solution:

$$\left(\frac{10.0gHCl}{1}\right)\left(\frac{1mol\ HCl}{36.5g\ HCl}\right)\left(\frac{-118kJ}{2mol\ HCl}\right) = -16.2kJ$$

Practice Worksheet