

## Chapter 4

## Chemical Reactions

Formula Weight - The sum of the atomic weights of all of the atoms in the chemical formula

### The Mole

A mole is a count numbering  $6.02 \times 10^{23}$  of an item.

A mole of a substance is its formula weight expressed in grams.

The number,  $6.02 \times 10^{23}$  is called Avagadro's number.

So, 12 g of carbon contains  $6.02 \times 10^{23}$  carbon atoms and 18 g of water contains  $6.02 \times 10^{23}$  water molecules.

Moles = mass of the substance / formula weight of the substance.

You must calculate number of moles from mass or mass from number of moles or the number of formula units from moles or mass.

### Chemical Equations

You must write balanced chemical equations for simple reactions.

Chemicals on the left of the yields sign are reactants and to the right are products.

Atoms are not created or destroyed in a chemical change but simply redistributed.

The number of each atom before a chemical reaction must equal the number after, or the number of moles of given atoms must be the same before and after a chemical reaction.

Coefficients are use in front of the formula units in the reaction to achieve equal numbers of each atom before and after a reaction.

A balanced chemical reaction is required for quantitative chemical determinations.

## Mass Relationships in Chemical Reactions – Stoichiometry

For the reaction,  $aA + bB \rightarrow cC + dD$

All of the following equivalent ratios can be written:

$$\text{Moles A/a} = \text{Moles B/b} = \text{Moles C/c} = \text{moles D/d}$$

$$\text{or } a/b = \text{moles A/moles B}, \quad b/c = \text{moles B/moles C}, \text{ etc.,}$$

These ratios form the basis for quantitative chemical determinations.

Calculate mass or moles of any product from moles or mass of any reactant.

Calculate mass or moles of any reactant from moles or mass of any other reactant.

Calculate mass or moles of any reactant from moles or mass of any product.

Calculate mass or moles of any product from moles or mass of any other product.

## Percentage Yield

The actual yield, the amount measured as produced from a chemical reaction in the laboratory or industrial process, is often less than the theoretical yield calculated to be possible from stoichiometry.

$$\% \text{ yield} = \text{actual yield} \times 100 / \text{theoretical yield}$$

## Reactions Between Ions in Aqueous Solution

Ionic compounds dissociate into ions when dissolved in water.

When solutions of different ionic compounds are mixed, new compounds that are not soluble in water may form and a solid precipitate. The ions not involved in this new combination are called spectator ions and can be left out of the chemical reaction because they undergo no change.

The sum of the ion charges on reactants in a balanced equation must equal the sum of the charges on the products.

The solubility of many compounds is indicated by the simple solubility rules. Recall of most of the rules can be prompted by reference to the periodic table.

## Oxidation-Reduction

Oxidation is the loss of electrons by a reactant in a chemical reaction.

Reduction is the gain of electrons by a reactant in a chemical reaction.

The electron loss and gain occurs together and the chemical change is called an oxidation–reduction reaction or redox reaction.

The oxidized substance gives electrons to cause reduction of another substance so is called the reducing agent.

The reduced substance takes electrons to cause oxidation of another substance so is called the oxidizing agent.

You must identify redox reactions and determine the oxidizing agent and reducing agent.

Some important categories of redox reactions:

- Combustion
- Respiration
- Rusting
- Bleaching
- Batteries

# Heat of Reaction

The heat lost or gained in a chemical reaction is called the heat of reaction.

A reaction that gives off heat is said to be exothermic.

A reaction that requires heat is endothermic.

The amount of heat involved is directly proportional to the amount of material reacted.

The amount of heat per mole of a given reactant is a constant called the molar heat of reaction.

The reverse of an exothermic reaction is endothermic by exactly the same amount of heat.