Chapter 14 Solutions

14.1 Solubility

Definitions:

Solution: a homogeneous mixture
Solvent: substance present in the largest amount (the other stuff is dissolved into this)
Solute: substance(s) dissolved into the solvent (present in a lesser amount)
Aqueous solutions: water is the solvent

Solutions can be solids, liquids or gases- see examples in text page 423

Like dissolves like- Water is polar and therefore polar and ionic molecules will dissolve in water. Non polar covalent bond such as oil, do not dissolve in water.

14.2 Solution Composition- Introduction

Saturated: a solution that contains the maximum amount of solute that will dissolve at that temperature

Unsaturated: a solution that contains less than the maximum amount of solute that will dissolve at that temperature

Supersaturated: a solution that has been forced to have more solute dissolved into solution than should be possible at that temperature

Concentrated: relatively large amount of dissolved solute

Dilute: relatively small amount of dissolved solute

These are qualitative terms, they do not tell us the exact amount of solute or solvent in the solution.

14.3 Solution Composition- Mass Percent

Mass Percent is a method of describing a solutions composition. It describes the mass of solute present in a given mass of solution.

$$\text{Mass Percent} = \frac{\text{Mass of Solute}}{\text{Mass of Solution}} \times 100\%$$

$$\text{Mass Percent} = \frac{\text{Mass of Solute}}{\text{Mass of Solute} + \text{Mass of Solvent}} \times 100\ \%$$

14.4 Solution Composition: Molarity

Most common expression of concentration is Molarity.

Molarity (M, must be capital) = number of moles of solute per volume of solution in liters.

M = moles / liter

Example:

A 1.0 M solution contains 1 mole of solute per liter of solution.

Mass of solute → Moles of Solute → Molarity
Use Molar Mass Moles/Liters

Example: If I dissolve 11.5 grams of NaOH in 1.5 Liters of solution, what is the molarity of my solution?

$$11.5 \text{ g NaOH} \times \frac{1 \text{ mole NaOH}}{40.0 \text{ grams NaOH}} = 0.288 \text{ moles of NaOH}$$

$$\frac{0.288 \text{ moles of NaOH}}{1.50 \text{ liters of solution}} = 0.192 \text{ M NaOH}$$

Example:

A 1.0 M solution of $FeCl_3$ contains what concentration of Fe^{+3} ions and what concentration of Cl^{-1} ions?

$FeCl_3 \rightarrow Fe^{+3} + 3\ Cl^{-1}$

Therefore for every 1 mole of $FeCl_3$ that dissolves, 1 mole of Fe^{+3} ions are produced and 3 moles of Cl^{-1} ions are produced. So the solution actually contains 1.0 M Fe^{+3} ions and 3.0 M Cl^{-1} ions.

Example:

How many moles of Ag^{+1} ion are in 25 ml of a 0.75 M solution of $AgNO_3$?

25 ml → liters = .025 liters

$$0.025 \text{ liters} \times \frac{0.075 \text{ moles}}{1 \text{ liter of solution}} = .019 \text{ moles } Ag^{+1} \text{ ion}$$

Once you have moles you can go back to mass using the molar mass of the substance.

Standard solution- a solution whose concentration is accurately known.

Volumetric Flasks are used to create Standard solutions.

- weigh out a sample of solute (specific # of moles needed)
- place in volumetric flask (accurately known volume)
- add solvent to bring volume to mark on neck of flask

See example on page 433 of Text.

Chapter 14 Section 5

Dilution

Standard Solution: a solution whose concentration is accurately known

Dilution: the process of adding more solvent to a solution.

Dilution does not change the amount of solute present!!!

SO,

MOLES OF SOLUTE BEFORE DILUTION = MOLES OF SOLUTE AFTER DILUTION!

$M_1 \times V_1 = M_2 \times V_2$

Where M = molarity and V = volume in liters

Example:

If I want to make 500 ml of a 1.00 M acetic acid solution from a standard stock solution that is 17.5 M, What volume of stock solution must I have?

$17.5\ M \times V_1 = 1.00\ M \times .5L$

$V_1 = .5/17.5 = .0286$ L or 28.6 mL

Note: Most common dilutions in a chemistry lab are diluting concentrated stock solutions of acids to more dilute concentrations for use in experiments. When doing this you ALWAYS ADD ACID TO WATER NOT WATER TO ACID!