Solutions and Solution Stoichiometry

What is a Solution?

In simplest terms, a solution is a solute dissolved in a solvent. The solvent is the component in greatest excess.

Solutions can be liquid-liquid (e.g. Rum and Coke; Coke is the solvent, depending on your preference), solid-liquid (e.g. sugar in water; water is the solvent), gas-liquid (e.g. carbonated water, made by dissolving CO_2 in water), gas-gas (e.g. air, a solution of oxygen and other trace gases dissolved in nitrogen), and solid-solid (e.g. sterling silver – a small amount of Cu dissolved in the solvent Ag)

Terms

A saturated solution is one that has the maximum amount of solution dissolved for a given amount of solvent

An unsaturated solution has less than the maximum amount of solution dissolved for a given amount of solvent

A supersaturated solution has more than the maximum amount of solution dissolved for a given amount of solvent

Temperature Effects -- a) most solids become more soluble as solvent temperature increases
b) gases become less soluble at solvent temperature increases

Pressure Effects -- gases are less soluble in liquid solvents as pressure is decreased

Specifying Solution Concentration: Mass Percent

$$\text{Mass percent} = \frac{\text{mass solute}}{\text{total mass solution}} \times 100$$

(*** The total mass of solution is the sum of the masses of all solutes plus the solvent ***)

Example: A solution is formed by dissolving 2.51 g of NaCl and 1.28 of $AgNO_3$ in 100.0 g of water. What is the mass percent of $AgNO_3$ in the solution?

Solution Stoichiometry

Remember that the key to stoichiometry is to find moles! In solutions, we can find moles by using the **molarity** (M), the most common expression for solution concentration. **Molarity** is defined as follows:

$$\text{Molarity} = \frac{\text{moles solute}}{\text{Liters of solution}}$$ (in words "molarity equals moles per liter")

For solutions, then → **moles solute = Molarity × Liters** (i.e. mol = M x L)

Example Questions (to be done in class)

1) If 3.75 g of $SrCl_2$ (158.52 g/mol) is dissolved in enough water to make 250.0 mL of solution, what is $[SrCl_2]$?

2) What is the $[Cl^{-1}]$ in the solution in Question 1?

3) What mass of $SrCl_2$ is required to make 500.0 mL of a solution with $[Cl^-] = 0.0255$ M?

4) What volume of 0.250 M HCl is required to react completely with 1.50 g of Zn?

5) Calculate $[H_3PO_4]$ if 27.12 mL of 0.250 M KOH are required to react completely with 25.00 mL of H_3PO_4.

6) Try this one your own: What would be the theoretical yield of hydrogen gas if you added 5.52 g of Al to 100.0 mL of 3.00 M HNO_3?

7) What would be the new $[Cl^-]$ if you added 75.0 mL of water to the solution in Question 2?

8) What volume of water would you evaporate from the solution in Question 2 to get a solution with $[Cl^-] = 0.500$ M?