Session 10: LECTURE OUTLINE (SECTION L3 pp F83- F84)

I. Volumetric Analysis
   a. Acid-Base titration
   b. Redox titration
   c. Analyte
   d. Titrant
   e. Stoichiometric point (Equivalence point)
   f. Indicators

II. Stoichiometry in solutions problems

Suggested problems: p F85 L.3A
p F87 L.9, L.10, L.11, L.12, L.13, L.16, L20

VOLUMETRIC ANALYLIS/TITRATION

- We use volumetric analysis to determine the concentration of an unknown solution.
- The procedure is called titration. In an acid-base titration, an acid is titrated with a base or a base with an acid. In a redox titration, an oxidizing agent is titrated with a reducing agent or a reducing agent with an oxidizing agent.
- The solution with the unknown concentration is called the analyte. The solution with the known concentration is called the titrant.

So, how do we perform a titration?

- To a specific volume of the analyte we use a buret to slowly add the titrant until all the analyte has reacted.
- At this point, stoichiometric amounts of both analyte and titrant have reacted. This is called the stoichiometric point or the equivalence point.
- An indicator is used to help us detect the equivalence point of the titration.

How is the data obtained from a titration experiment used to determine the concentration of the analyte?

- Since both the volume and the concentration of the titrant are known, its number of moles can be calculated.
- The stoichiometric relationship between the analyte and the titrant is used (from the balanced corresponding chemical equation) to figure out the number of moles of the analyte.
- Once the number of moles of the analyte is calculated, and since the volume is already known, one can calculate the concentration of the analyte, $M = n/V$.

Example

We use 15.4 mL of a 0.200M $Ba(OH)_2$ solution to titrate 25.0 mL of an HCl solution. What is the molarity of the acid solution?

We first have to write the corresponding chemical equation and balance it.
$Ba(OH)_2$ (aq) + 2HCl (aq) --------→ $BaCl_2$ (aq) + $2H_2O$ (l)

We know the volume of the acid solution. We still need to calculate its number of moles so that we can calculate its molarity.

We have the molarity and the volume of the barium hydroxide solution. This allows us to directly calculate the number of moles of barium hydroxide that reacted:

$$\frac{.0154 \text{ L } Ba(OH)_2 \text{ solution}}{} \left| \frac{0.200 \text{ mols } Ba(OH)_2}{1 \text{ L } Ba(OH)_2 \text{ solution}} \right. = .00308 \text{ mols of } Ba(OH)_2$$

We use the ratio from the chemical equation to calculate the number of moles of HCl:

$$\frac{0.00308 \text{ mols } Ba(OH)_2}{} \left| \frac{2 \text{ mols HCl}}{1 \text{ mol } Ba(OH)_2} \right. = 0.00616 \text{ mols of HCl.}$$

Molarity of the HCl solution:

$$M_{HCl} = \frac{0.00616 \text{ mols HCl}}{0.0250 \text{ L solution}} = 0.246 \text{ M}$$

MORE STOICHIOMETRY PROBLEMS WHEN USING SOLUTIONS IN CHEMICAL REACTIONS!

Example 1 (answer and solution will be provided by TA)
How many grams of silver nitrate, $AgNO_3$, must we use to react completely with 75.0 mL of 0.450 M potassium chromate, K_2CrO_4?

Example 2 (answer and solution will be provided by TA)
Find the volume in liters of a 0.685 M $AgNO_3$ solution required to react with 16.50 mL of 0.0325 M K_2CrO_4 solution?