CHEM 210 – Titrations 1

(1) In a titration, 21.05 mL of a 0.175 M NaOH is required to fully titrate a 30.0 mL sample of phosphoric acid, H_3PO_4.

A) Write the balanced equation for the reaction that takes place.

$$H_3PO_{4(aq)} + 3\,NaOH_{(aq)} \rightarrow 3\,H_2O_{(l)} + Na_3PO_{4(aq)}$$

B) Is there a limiting reagent? Explain.

No - In a titration, just enough of the titrating solution is added to fully react with the titrant

C) Calculate the molarity of the phosphoric acid solution.

$$21.05\,mL \left| \frac{0.175\,mol\,NaOH}{1000\,mL\,NaOH} \right| \frac{1\,mol\,H_3PO_4}{3\,mol\,NaOH} = 0.001228\,mol\,H_3PO_4$$

$$\frac{0.001228\,mol}{0.0300\,L} = \boxed{0.0409\,M}$$

(2) A student masses out 1.3009-g of potassium hydrogen phthalate (KHP). KHP has the formula $KHC_8H_4O_4$, where only the first hydrogen is acidic. The student dissolves the sample in about 25-mL of water and titrates the acid with sodium hydroxide solution. If 41.20 mL of NaOH solution are required:

A) Write a balanced equation for the reaction.

$$NaOH_{(aq)} + KHC_8H_4O_{4(aq)} \rightarrow HOH_{(l)} + K^+ + Na^+ + C_8H_4O_4^{2-}$$

B) Calculate the moles of base reacted.

$$1.3009\,g\,KHP \left| \frac{1\,mol\,KHP}{204.22\,g\,KHP} \right| \frac{1\,mol\,NaOH}{1\,mol\,KHP} = 0.0063701\,mol$$

C) Calculate the [NaOH].

$$[NaOH] = \frac{0.0063701\,mol\,NaOH}{0.04120\,L\,soln} = 0.1546\,M$$

(3) The student then uses this standardized NaOH solution to determine the molar mass of an unknown diprotic acid. If a 1.015-g sample dissolved in (25-mL water) requires 22.62 mL of the NaOH solution to fully react with it:

A) Write a balanced equation for the reaction.

$$H_2A + 2\,NaOH \rightarrow Na_2A + 2\,HOH$$

B) Calculate the moles of acid reacted.

$$0.02262\,L\,NaOH \left| \frac{0.1546\,mol\,NaOH}{1\,L\,soln} \right| \frac{1\,mol\,H_2A}{2\,mol\,NaOH} = 0.001749\,mol$$

C) Calculate the molar mass of the acid.

$$\text{Molar mass} = \frac{1.015\,g}{0.001749\,mol} = 580.4\,g/mol$$