Acid/Base Titrations Practice

1.) A $0.025\ L$ solution of NaOH having an unknown concentration is titrated using $0.125\ M\ HCl$. $15.3\ mL\ HCl$ is needed to reach the equivalence point. What is the [NaOH]? $HCl + NaOH \leftrightarrow NaCl + H_2O$ $1:1\ ratio$

Answer - $\frac{0.125\ mol\ HCl}{1\ L} \times 0.0153\ L =$ $0.0019125\ mol\ HCl$ $0.00191\ mol\ HCl \times \frac{1\ mol\ NaOH}{1\ mol\ HCl} =$ $0.00191\ mol\ NaOH$

$0.00191\ mol\ NaOH \times \frac{1}{0.025\ L} =$ $[NaOH] = 0.0765\ M$ $[NaOH] = 0.077\ M$

2.) The following titration reaction occurred: $H_2SO_4 + LiOH \rightarrow Li_2SO_4 + 2\ H_2O$

$0.0282\ L$ of $0.0635\ LiOH$ was used to titrate $0.0250\ L\ H_2SO_4$. What is the $[H_2SO_4]$? $1:1\ ratio$

Answer - $\frac{0.0635\ mol\ LiOH}{1\ L} \times 0.0282\ L = 0.0017907\ mol\ LiOH$ $0.00179\ mol\ LiOH \times \frac{1\ mol\ H_2SO_4}{1\ mol\ LiOH} = 0.00179\ mol\ H_2SO_4$

$0.00179\ mol\ H_2SO_4 \times \frac{1}{0.025\ L} =$ $[H_2SO_4] = 0.071628\ M$ $[H_2SO_4] = 0.0716\ M$

3.) $0.0500\ L\ of\ 0.0275\ M\ HCl$ was fully titrated using $0.0350\ M\ NH_3$. What volume of NH_3 was needed?

Answer - $HCl + NH_3 \leftrightarrow NH_4^+ + Cl^-$ $1:1\ ratio$

$\frac{0.0275\ mol\ HCl}{1\ L} \times 0.0500\ L =$ $0.001375\ mol\ HCl$ $0.001375\ mol\ HCl \times \frac{1\ mol\ NH_3}{1\ mol\ HCl} =$ $0.001375\ mol\ NH_3$

$0.001375\ mol\ NH_3 \times \frac{1\ L}{0.0350\ mol} =$ $volume\ NH_3 = 0.0392857\ L$ $NH_3 = 39.3\ mL$

4.) $0.0287\ L$ of $0.0136\ M\ H_4P_2O_7$, pyrophosphoric acid, is fully titrated using $0.0403\ L$ of $0.0387\ M\ KOH$. How many protons are removed from the acid, and what is the formula of the acid if the water is removed?

$H_4P_2O_7 + KOH \leftrightarrow H_3P_2O_7^- + H_2O$ $1:1\ ratio\ if\ this\ is\ true!$

Answer - $\frac{0.0387\ mol\ KOH}{1\ L} \times 0.0403\ L =$ $0.0015596\ mol\ KOH$ $\frac{0.0136\ mol\ H_4P_2O_7}{1\ L} \times 0.0287\ L = 0.00039032\ mol\ H_4P_2O_7$

$\frac{0.0015596\ mol\ KOH}{0.00039032\ mol\ H_4P_2O_7} = 4$ $\therefore 4\ protons\ removed$

$H_4P_2O_7 + 4\ KOH \leftrightarrow K_4P_2O_7 + 4\ H_2O$ once the water is removed only $K_4P_2O_7$ salt will remain.

5.) A $5.00\ g$ sample of solid, impure C_6H_5COOH, is dissolved in $0.250\ L$ water. A $25.00\ mL$ sample is titrated using $31.84\ mL$ of $0.1236\ M\ NaOH$. What is the % purity of the acid? $C_6H_5COOH + NaOH \leftrightarrow NaC_6H_5COO + H_2O$

Answer - $\frac{0.1236\ mol\ NaOH}{1\ L} \times 0.03184\ L = 0.0039354\ mol\ NaOH$ $0.00394\ mol\ NaOH \times \frac{1\ mol\ C_6H_5COOH}{1\ mol\ NaOH} \times \frac{1}{0.02500\ L} =$

$[C_6H_5COOH] = 0.157417\ M$ $5.00\ g\ C_6H_5COOH \times \frac{1\ mol}{122.13\ g} \times \frac{1}{0.250\ L} =$ $[C_6H_5COOH] = 0.1637599\ M$

$\frac{0.0157\ mol\ C_6H_5COOH}{0.164\ mol\ C_6H_5COOH} \times 100 =$ $\%\ purity = 96.126$ $\%\ purity = 96.1\ \%$