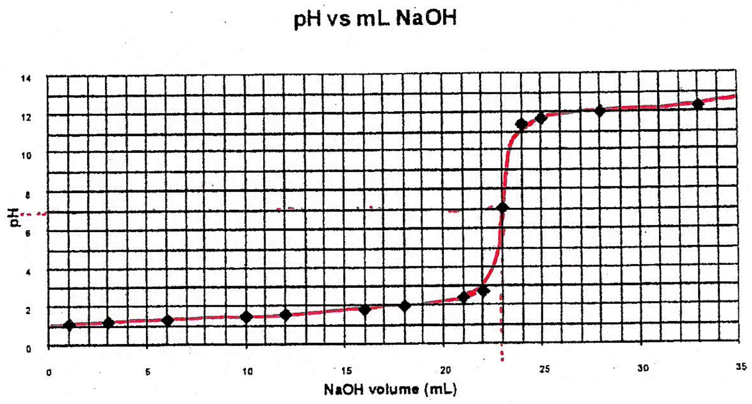
ANSWER KEY

EXTRA PRACTICE: Titration Problems Practice Name:______________________

Titration Problems

1) You have a solution of HBr of unknown concentration. To figure out the concentration, you measure out 25 mL of the acid solution. You then begin adding 0.100M NaOH solution and measuring the pH after each addition. The graph of pH vs mL NaOH looks like this:



a) At what volume of NaOH solution was the HBr consumed? (This is called the equivalence point)

Equivalence Point → $\boxed{pH = 7 \text{ @ } 23\,mL\ NaOH}$

b) Write a balanced equation for the reaction.

$1\,HBr + 1\,NaOH \rightarrow 1\,NaBr + 1\,H_2O$

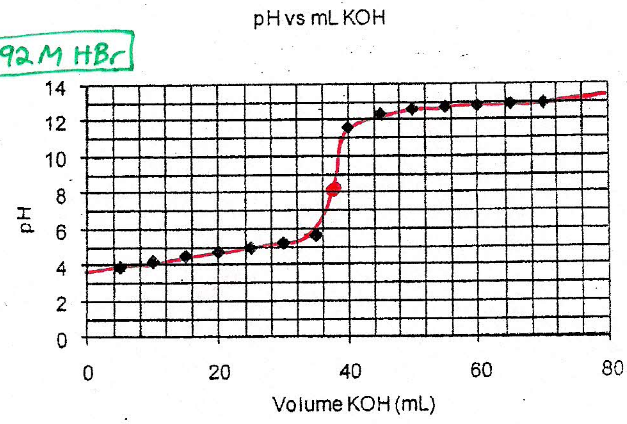
c) Calculate the moles of acid that must have been in the original 25 mL of acid.

1:1 Ratio ∴ mol $[H^+]$ = mol $[OH^-]$ → mol $[NaOH] = (0.100\,M)(0.023\,L)$ → $\boxed{0.0023\ mol\ [OH^-] = mol\ [H^+]}$

d) Calculate the concentration of the original acid solution.

$M_A = \frac{mol\ solute}{L\ soln} \rightarrow M_A = \frac{0.0023\ mol\ HBr}{0.025\,L} \rightarrow \boxed{0.092\,M\ HBr}$

2) You have a solution of KOH of unknown concentration. You measure out 25 mL of 0.50M acetic acid. You then begin adding the KOH solution and measure the pH after each addition. The graph of the titration is shown here:



a) At what volume of KOH solution was the acetic acid consumed?

Equivalence Point → $\boxed{pH = 8 \text{ @ } 37\,mL}$

b) Write a balanced equation for the reaction.

$1\,HC_2H_3O_2 + 1\,KOH \rightarrow 1\,KC_2H_3O_2 + 1\,H_2O$

c) Calculate the moles of base being added to the acetic acid at the equivalence point.

1:1 Ratio ∴ mol $[H^+]$ = mol $[OH^-]$ → mol $[HC_2H_3O_2] = (0.50\,M)(0.025\,L)$ → $\boxed{0.0125\ mol\ [H^+] = mol\ [OH^-]}$

d) Calculate the concentration of the original KOH solution.

$M_B = \frac{mol\ solute}{L\ soln} \rightarrow M_B = \frac{0.0125\ mol\ KOH}{0.037\,L} \rightarrow \boxed{0.338\,M\ KOH}$

3) You have 20.0 mL of a solution of hydroiodic acid of unknown concentration. You add a few drops of phenolphthalein indicator to it and titrate it with 37.5 mL of 0.15M NaOH, when it turns pink. Calculate the moles of base used, the moles of acid used and the concentration of the original acid solution. $1\,HCl + 1\,NaOH \rightarrow 1\,NaCl + 1\,H_2O$

① mol $[NaOH] = (0.15\,M)(0.0375\,L)$ → $\boxed{5.63\,E{-3}\ mol\ [OH^-] = mol\ [H^+]}$

② $M_A = \frac{mol\ solute}{L\ soln} \rightarrow M_A = \frac{5.63\,E{-3}\ mol\ HCl}{0.0200\,L} \rightarrow \boxed{0.281\,M\ HCl}$

4) You titrate 35 mL of nitrous acid solution with 0.050M KOH solution using bromothymol blue as your indicator. You add 12.2 mL of KOH solution when the color of the mixture changes from yellow to blue. What is the concentration of the original acid solution?

$1\,HNO_2 + 1\,KOH \rightarrow 1\,KNO_2 + 1\,H_2O$

① mol $[KOH] = (0.050\,M)(0.0122\,L) \rightarrow 6.10\,E{-4}$ mol $[OH^-]$ = mol $[H^+]$

② $M_A = \frac{mol\ solute}{L\ soln} \rightarrow M_A = \frac{6.10\,E{-4}\ mol\ HNO_2}{0.0350\,L} \rightarrow \boxed{0.0174\,M\ HNO_2}$