and the equilibrium concentration of hydroxide ion is

$[OH^-] = C_{NaOH} = 1.33 \times 10^{-4}\ M$

$pOH = -\log(1.33 \times 10^{-4}) = 3.88$

$pH = pK_w - pOH$

$= 14 - 3.88 = 10.12$

After addition of 30 ml of Reagent

$$C_{NaOH} = \frac{\text{no. mmol NaOH added} - \text{original no. mmol HCl}}{\text{total Volume Soln}}$$

$$= \frac{30 \times 0.1 - 50 \times 0.05}{80}$$

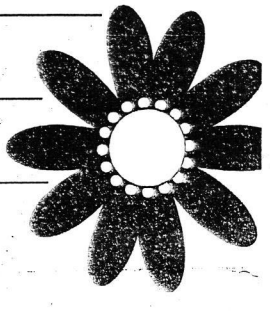
$$= 6.25 \times 10^{-3}\ M$$

and the equilibrium concentration of hydroxide ion is

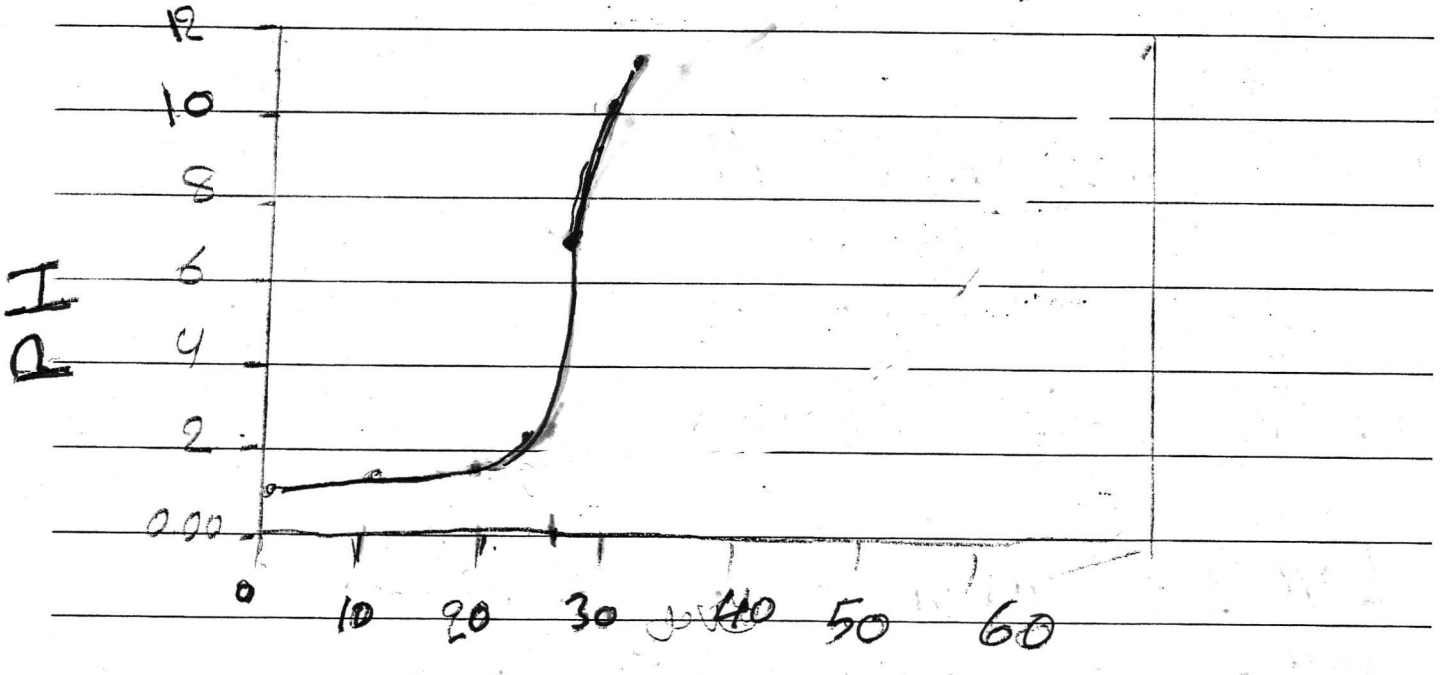
$[OH^-] = C_{NaOH} = 6.25 \times 10^{-3}\ M$

$pOH = -\log(6.25 \times 10^{-3}) = 2.2$

$pH = 14 - 2.2 = 11.8$



Volume of NaOH, ml	pH 50 ml of 0.05 M HCl with 1 M NaOH
0.00	1.3
10.00	1.30
20.00	1.60
25.00	2.15
25.1	7.00
30.00	10.12
	11.8



Titration Curve for weak acid with strong Base

Ex: Generate a curve for the titration of 50 ml of 0.1 M acetic acid (CH_3COOH) with 0.1 M Sodium hydroxide.

$K_a = 1.75 \times 10^{-5}$

$C_1V_1 = C_2V_2$

$0.1 \times 50 = 0.1 \times V_2$

$V_2 = 50$ ml

Initial pH

First, we must calculate the pH of a 0.1 M Solution of HOAC using Equation

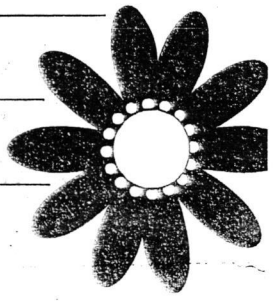
$$[H_3O^+] = \sqrt{K_a C_{HOAc}} = \sqrt{1.75 \times 10^{-5} \times 0.1}$$

$$= 1.32 \times 10^{-3} \text{ M}$$

$$pH = -\log(1.32 \times 10^{-3}) = 2.88$$

Acetic acid → CH_3COOH = HOAc

sodium acetate → CH_3COONa = NaOAc



pH after addition of 5ml of Reagent.

A Buffer Solution Consisting of NaOAC and HOAC has now been produced. The analytical concentrations of the two constituents are

$$C_{HOAC} = \frac{\text{original no. mmol HOAC} - \text{no. mmol NaOH added}}{\text{total Volume Soln}}$$

$$= \frac{50\ ml \times 0.1\ M - 5.0\ ml \times 0.1\ M}{55.00\ ml} = 0.081\ M$$

$$C_{NaOAC} = \frac{5ml \times 0.1}{55\ mL} = 0.009\ M$$

Now for the 5ml volume, we substitute the concentration of HOAC and OAC^- into the equation of the pH of acidic buffer

$$pH = pKa + \log \frac{[salt]}{[acid]}$$

$$pH = -\log (1.75 \times 10^{-5}) + \log \frac{(0.009)}{(0.081)}$$

$$pH = 3.67$$

pH after Addition of 25 ml of Reagent.

As in the previous calculation, the analytical concentrations of the two constituents are

$$C_{HOAC} = \frac{\text{original no. mmol HOAC} - \text{no. mmol NaOH added}}{\text{total Volume Soln}}$$

$$= \frac{50\ ml \times 0.1\ M - 25\ ml \times 0.1\ M}{75\ ml} = 0.033\ M$$

$$C_{NaOAc} = \frac{25\ ml \times 0.1\ M}{75\ ml} = 0.033\ M$$

Now for the 25 ml volume, we substitute the concentrations of HOAC and OAc^- into the equation of the pH of acidic buffer and obtain

$$pH = pKa + \log \frac{[salt]}{[acid]}$$

$$pH = -\log (1.75 \times 10^{-5}) + \log \frac{[0.033]}{[0.033]}$$

$$pH = pK_a = 4.76$$

Equivalence point pH.

At the equivalence point, all the acetic acid been converted to Sodium acetate

The Solution is therefore similar to one formed by dissolving that salt in water, the NaOAc concentration is **0.05 M**. Thus,

$$\underbrace{OAC^-}_{\text{base}} + H_2O \rightleftharpoons \underbrace{HOAC}_{\text{acid}} + OH^-$$

$$[OH^-] = [HOAC]$$

$$[OAc^-] = 0.05 - [OH^-] \approx 0.05$$

$$K_b = \frac{K_w}{K_a} = \frac{[OH^-]^2}{[OAc^-]}$$

$$\frac{[OH^-]^2}{0.05} = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{1.75 \times 10^{-5}} = 5.71 \times 10^{-10}$$

$$[OH^-] = \sqrt{0.05 \times 5.71 \times 10^{-10}} = 5.34 \times 10^{-6} M$$

$$pOH = -\log [OH^-] = -\log (5.34 \times 10^{-6}) = 5.27$$

$$pH = pK_w - pOH = 14 - 5.27 = 8.73$$