Experiment - Determine pK_a value of acetic acid by pH metric titration.

Apparatus - pipette, burette, beakers, funnel, burette stand, clamp, pH meter and glass electrode.

Chemicals Required - Sodium hydroxide (NaOH) and acetic acid (CH_3COOH)

Chemical Equations - $HA_{(aq)} + NaOH_{(aq)} \rightarrow NaA_{(aq)} + H_2O$

$$HA + H_2O \rightarrow H_3O^+ + A^-$$

Observations - Normality of standard NaOH = 0.1N

	Vol. of NaOH added from the burette (mL)	pH
1	0.5	2.85
2	0.7	3.79
3	1.2	3.96
4	1.7	4.10
5	2.2	4.24
6	2.7	4.36
7	3.2	4.44
8	3.7	4.56
9	4.2	4.65
10	4.7	4.75
11	5.2	4.85
12	5.7	4.92

Experiment-8

Aim- Determine pK_a value of acetic acid by pH metric titration.

Theory- A pH meter will be used to follow the titration of an unknown weak acid, $HA(aq)$ with Sodium hydroxide, $NaOH(aq)$

$$HA_{(aq)} + NaOH_{(aq)} \longrightarrow NaA_{(aq)} + H_2O$$

The weak acid has a concentration around 0.1 M. The result of the pH versus volume of NaOH plot is "S" shaped curve which is not as steep as the one arising from the titration of strong acid. The equivalence point (this time) will be at alkaline pH (not 7 as in strong vs strong base). From the equivalence point, the concentration of an unknown acid HA is found. In addition, the acid constant K_a can be determined.

$$HA + H_2O \longrightarrow H_3O^+ + A^-$$

{ $pH = pK_a + \log$ [salt form][acid fo
Henderson - Hasselbalch eq

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

Procedure- A). Titration of unknown HA with standard NaOH:

1. Calibrate the pH meter with standard buffer solⁿ of pH=4

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13.	6.2	5.05
14	6.7	5.18
15.	7.2	5.31
16.	7.7	5.46
17.	8.2	5.62
18	8.7	5.97
19.	9.2	9.36
20.	9.7	12.01
21.	10.2	12.36
22.	10.7	12.52
23.	11.2	12.64
24.	11.7	12.70
25.	12.2	12.76
26.	12.7	12.82
27.	13.2	12.87
28.	13.7	12.90
29.	14.2	12.94
30.	14.7	12.95

Draw a graph pH vs volumes of NaOH (sample graph is as shown). Find out pKa value of CH_3COOH from the graph as under :-

NaOH (ml) at equivalence point	NaOH (ml) at half equivalence point	pH at half equivalence point
x (along x-axis)	$\frac{x}{2}$ (along (x-axis))	pH at $\frac{x}{2}$. A along y
9.1	$\frac{9.1}{2}$ = 4.55	4.8

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of 9, then rinse the glass electrode and immerse it in the beaker. Position the burette so that the titrant can be easily added.

2. Pipette out 50 ml of acetic acid into a clean beaker, dip the glass electrode. Record the pH.

3. Initially, add 0.5 ml of 0.1 NaOH solution at a time, record the pH change is more than 0.2-0.3 units, then start add 0.2 ml of NaOH ~~each~~ each time (i.e near to the equivalence point, decrease the volume of NaOH added) so that the change in pH is small enough to yeild a good shape of plot.

4. After the rapid change in pH (after the equivalent point), the volume of NaOH may again be increased to 0.5 ml per addition. Make at least 10 more additions after the equivalence point so that the region with the plateau can be plotted.

5. pKa is determined by examining the titration curve. The negative log of Ka is pKa and is same as the pH at half the volume of equivalence point. (pH = pKa when logarithm term is zero which in turn is zero once [salt] = [acid]. This is true at half equivalence point i.e. Henderson Hasselbalch equation.

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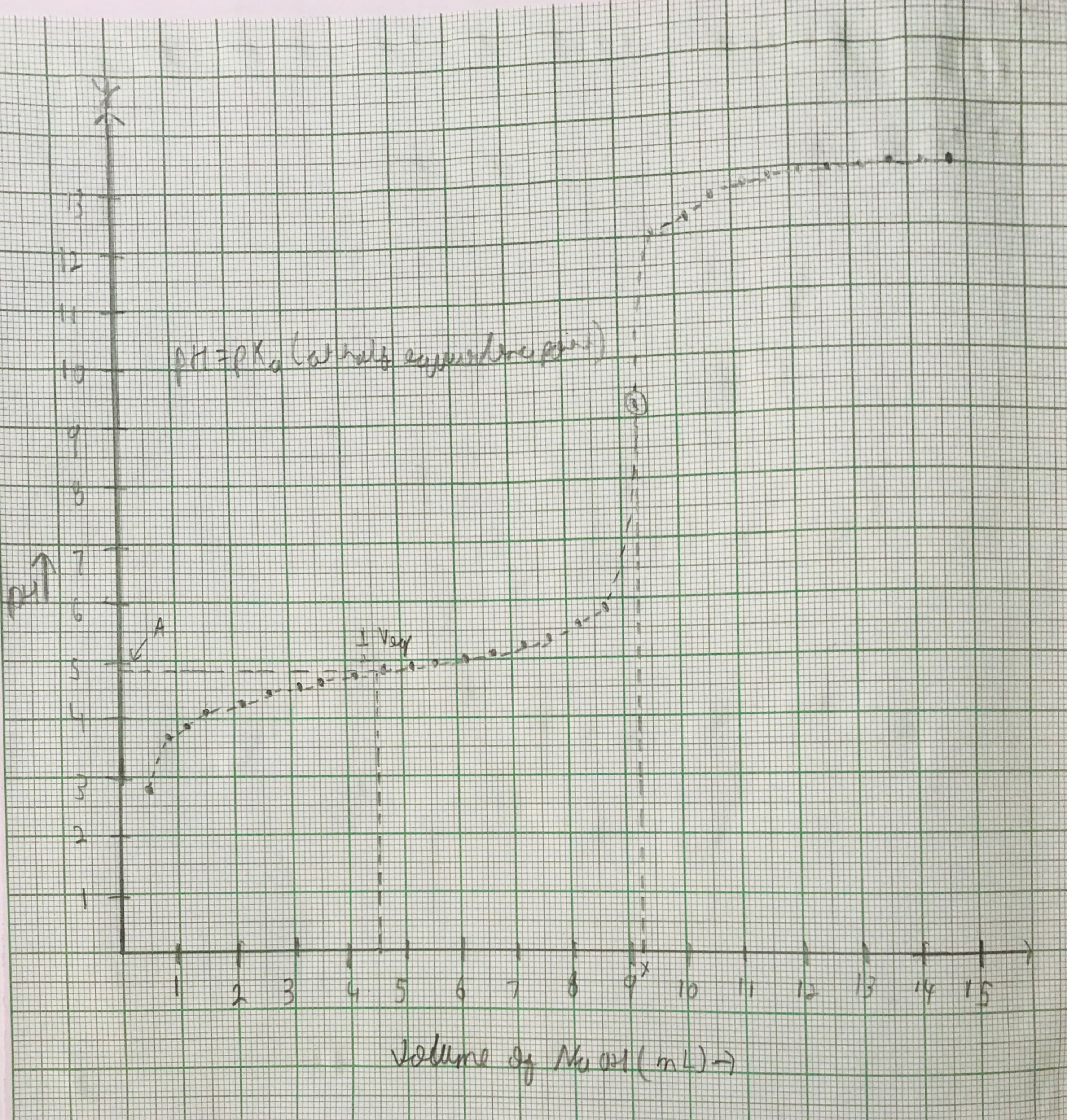

Result- The pKa of acetic acid is 4.8

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<u>Result</u> - The pKa of acetic acid is <u>4.8.</u>

<u>Precautions</u> - (i) Rinse the pipette / burette with the Soln to be transferred to the titration flask / burette

(ii) Do not rinse the titration flask.

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