Date : 23rd nov, 2020

Experiment No:- 08

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 :-

$$HA(aq) + NaOH(aq) \longrightarrow NaA(aq) + H_2O$$

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

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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)

$$HA_{(aq)} + NaOH(aq) \rightarrow NaA(aq) + H_2O$$

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 acid vs strong base). From the equivalence point, the concentration of an ~~unknown~~ unknown acid HA is found. In addition, the acid constant K_a can be determined.

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

$$pH = pK_a + \log \frac{[\text{salt form}]}{[\text{acid form}]}$$

Henderson-Hasselbalch equation

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

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Observations:-

Normality of standard NaOH = 0.1N

	Volume of NaOH added from the burette (mL)	pH
1.	0.4	2.85
2.	0.9	3.77
3.	1.4	3.96
4.	1.9	4.10
5.	2.4	4.24
6.	2.9	4.36
7.	3.4	4.4
8.	3.9	4.56
9.	4.4	4.65
10.	4.9	4.75
11.	5.4	4.85
12.	5.9	4.92
13.	6.4	5.05
14.	6.9	5.18
15.	7.4	5.31
16.	7.9	5.46
17.	8.4	5.62
18.	8.9	5.97
19.	9.4	9.36
20.	9.9	12.01
21.	10.4	12.16
22.	10.9	12.52
23.	11.4	12.64
24.	11.9	12.70

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→ Procedure :-

Titration of ~~HAKON~~ unknown HA with standard NaOH :-

1) Calibrate the pH meter with the standard buffer solution of pH = 4 or 9, then rinse the glass electrode and immerse it in the beaker. Position the burrette so that the titrant can be easily added.
2) Pipette out 50ml of acetic acid into a clean beaker, dip the glass electrode. Record the pH.
3) Initially, add 0.5 ml of 0.1N NaOH solution at a time, record the pH (after each titration) until the pH change is more than 0.2 - 0.3 units, then start add 0.2ml of NaOH 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 yield 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 0.5mL per addition. Make atleast 10 more additions after the equivalence point so that the region with the plateau can be plotted.
5) pK_a is determined by examining the titration curve. The negative log of K_a is pK_a and is same as the pH at half the volume of equivalence point. (pH = pK_a when logarithm term is = zero which in ~~term~~ turn is zero once [salt] = [acid]. This is true at half equivalence point) cf. Henderson - Hasselbalch

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Volume of NaOH added from the burette (mL)		pH
25.	12.4	12.76
26.	12.9	12.82
27.	13.4	12.87
28.	13.9	12.90
29.	14.4	12.94
30.	14.9	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) = pKa
9.9	4.4	4.65

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equation.

→ Result :-

The pK_a of acetic acid is 4.65.

→ Precautions :-

(i) Rinse the pipette / burette with the solution to be transferred to the titration flask / burette

(ii) Do not rinse the titration flask.

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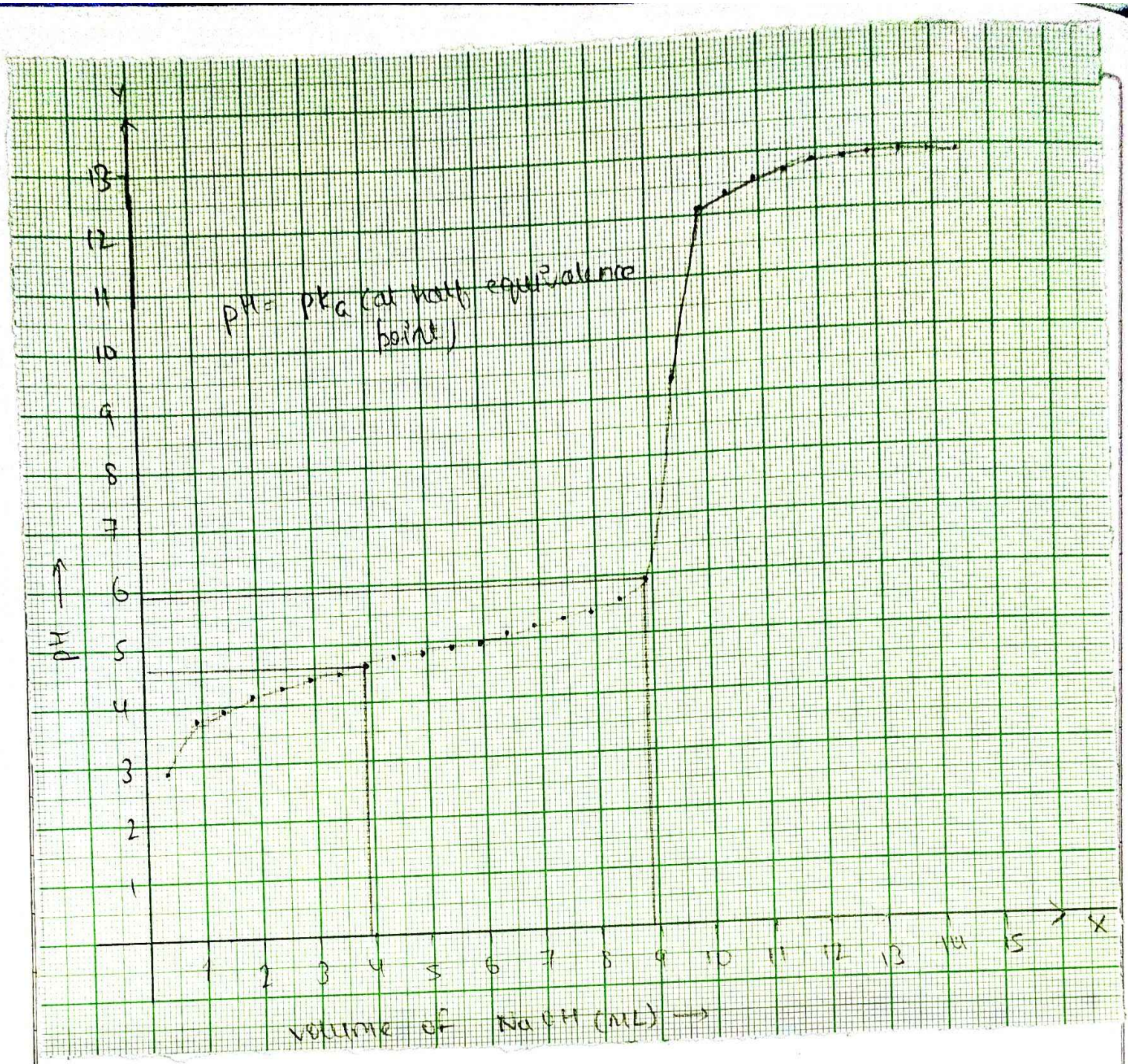

Result :-

The pKa of acetic acid is 4.65.

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