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Experiment No: 2

1.) **Objective:-** To determine the Strength of Sodium hydroxide (NaOH) and Sodium carbonate (Na_2CO_3) from given water sample. Given Standard N/40 Sodium carbonate to standardize N/40 given HCl solution.

2.) **Apparatus required:-** Burette, Stand, Pipette, Conical flask, Measuring Cylinder, White paper

3.) **Chemicals Involved**

→ **Reagents:**

- Sodium carbonate (Na_2CO_3)
- Hydrochloric acid (HCl)
- Distilled water
- Water sample containing NaOH and Na_2CO_3 mixture.

→ **Indicators and their End Points**

- Phenolphthalein (Pink to Colourless)
- Methyl Orange (Yellow to Pink)

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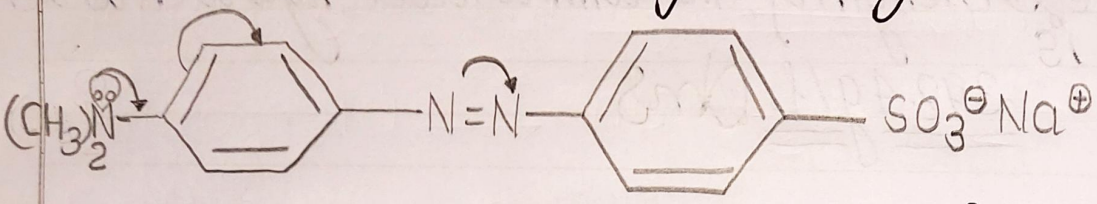
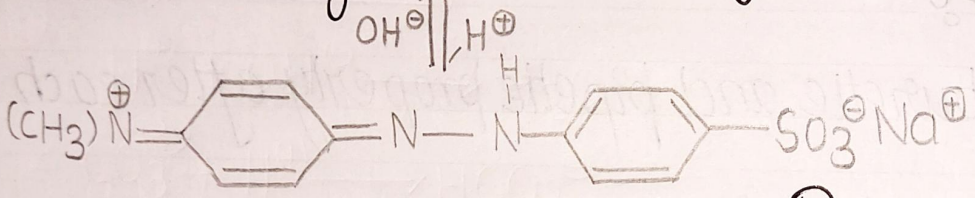
Experiment No: 2

Resonance Structure of Methyl Orange

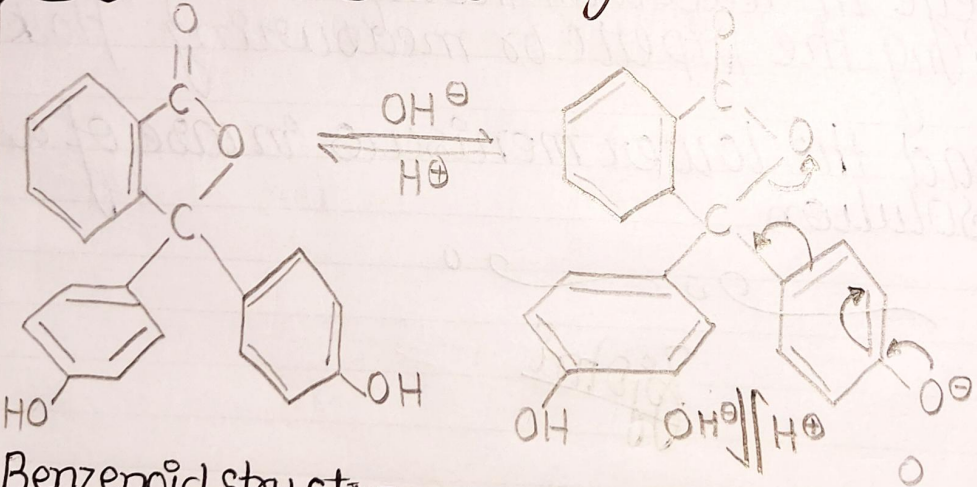


Benzenoid structure, yellow in colour

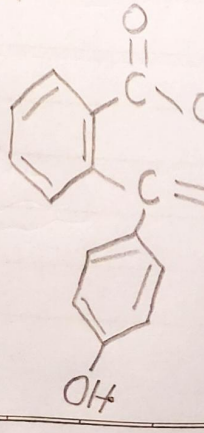


Quinonoid Structure, Pink in colour

Resonance Structure of Phenopthalein.



Benzenoid structure
colourless
exists predominantely in
Acidic medium



Exists Predominantely in Basic Medium

Quinonoid Structure, Pink in colour

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4) Theory:

The titration is based upon the specific pH range for each indicator.

The phenopthalein indicator gives pink colour in pH range 8.2-10.0, while methyl orange gives pink colour in pH range 4.4 - 03.0.

It has been observed that the presence of sodium hydroxide and sodium carbonate always provide a pH higher than 8.2 to the solution. Initially, when standard hydrochloric acid is added, the $OH^{\ominus}$ ions are first converted to H_2O and then CO_3^{2-} ions are converted to $HCO_3^{\ominus}$ when first two steps (i) and (ii) completed the pH of the solution becomes less than 8.2, and the pink colour of phenolpthalein disappears. At this point, methyl orange is added as an Indicator to find the complete neutralisation, on addition of further acid, the $HCO_3^{\ominus}$ ions are converted to CO_2 and H_2O. It means step (iii) is completed. When all $HCO_3^{\ominus}$ ions are used up, the pH of solution becomes less than 4.4 instantaneously, At this point methyl orange gives pink colour.

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5) Procedure

1) Standardization of given HCl solution

(i) 10 mL of Na_2CO_3 was taken into a conical flask with the help of pipette. Methyl orange was added to it (1-2 drops)

(ii) Acidic solution was added to the conical flask from the buguette while constant stirring of conical flask was done. End point was noticed when colour changed from yellow to pink, volume of Acid used was noted down.

The same procedure was noted down till 2-3 concordant readings were obtained.

2) Titration of given water sample with HCl solution

(i) 10 mL of given water sample was pipetted out into a conical flask. 1-2 drops of phenolpthalein were added as an indicator. The solution turned pink.

(ii) HCl solution was added from burette into the conical flask with constant shaking till the

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colour disappeared. The readings were noted down as V_2 on the ~~buret~~ burette.

(iii.) After discolouration, 1-2 drops of methyl orange were added into the solution

(iv.) Titration was done again till the yellow colour solution turned to pink. Volume on burette was noted to be V_3 same steps were repeated to get three concordant readings

Siphon

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CHEMICAL REACTIONS

$HCl + NaOH \longrightarrow NaCl + H_2O$

$HCl + Na_2CO_3 \longrightarrow NaHCO_3 + HCl + NaCl$ } Phenolphthalein

$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$ → Methyl Orange

IONIC REACTIONS

$H^{\oplus} + OH^{\ominus} \longrightarrow H_2O$

$CO_3^{(2-)} + H^{\oplus} \longrightarrow HCO_3^{\ominus}$ } Phenolphthalein

$HCO_3^{\ominus} + H^{\oplus} \longrightarrow H_2O + CO_2$ → Methyl Orange

OBSERVATIONS

Table No 1

Sr. No	Volume of Na_2CO_3 taken (in mL)	Buerette reading		Vol. of acid used in mL
		Initial (mL)	final (in mL)	
1.	10	0	7.7	7.7
2.	10	7.7	15.4	7.7
3.	10	15.4	23.1	7.7

Concordant Readings = 7.7mL

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Table No 2.

Sr. No	Volume of water sample taken (in ml)	Burette Readings			Volume of HCl used (ml)	
		Initial	final			
		V_1	P (V_2)	M V_3	P ($V_4 = V_2 - V_1$)	M ($V_5 = V_3 - V_2$)
1	10	0.0	7.0	12.3	7.0	5.3
2	10	12.3	19.3	24.6	7.0	5.3
3	10	24.6	31.6	36.9	7.0	5.3

Concordant Readings = P = 7.0 mL
M = 5.3 mL

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Calculations.

1. Normality of given HCl solution

$$N_{HCl} \times V_{HCl} = N_{Na_2CO_3} \times V_{Na_2CO_3}$$

$$N_{HCl} = \frac{N_{Na_2CO_3} \times V_{Na_2CO_3}}{V_{HCl}}$$

$$N_{HCl} = \left(\frac{N}{40}\right) \times \frac{10}{V_{HCl}}$$

$$N_{HCl} = \frac{N}{40} \times \frac{10}{7.7} = \frac{N}{30.8}$$

$$N_{HCl} = \underline{0.0324N}$$

2. Normality of given NaOH and Na_2CO_3 in given water sample

V_4 = Volume of HCl when whole NaOH and half of carbonate is neutralised = $[OH^{\ominus}] + 1/2 [CO_3^{2-}]$

V_5 = Volume of HCl when rest of carbonate is neutralized = $1/2 [CO_3^{2-}]$

Hence, volume of HCl required for neutralization of NaOH = $V_4 - V_5 = \underline{1.7 mL}$

Volume of HCl required for neutralization of Na_2CO_3 = $2V_5 = \underline{10.6 mL}$

Normality of NaOH:

$$N_{NaOH} = \frac{N_{HCl} \times (V_4 - V_5)}{10} = \frac{0.0324 \times 1.7}{10}$$

$$N_{NaOH} = 0.0055195\ N$$

Normality of Na_2CO_3:

$$N_{Na_2CO_3} = \frac{N_{HCl} \times 2V_5}{10} = \frac{0.0324 \times 10.6}{10}$$

$$N_{Na_2CO_3} = 0.034344\ N$$

Strength of NaOH in given solution = N_{NaOH} × Equivalent Weight

$= 0.0055195 \times 40$

$= 0.22\ g/L$

Strength of Na_2CO_3 in given solution = $N_{Na_2CO_3}$ × Equivalent Weight

$= 0.034344 \times 53$

$= 1.822\ g/L$

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6) Result :->

(i) Strength of NaOH in given solution = 0.22 g/L

(ii) Strength of Na_2CO_3 in given solution = 1.822 g/L

Ans

7) Precautions.

1.) Before Starting experiment, the glass apparatus must be cleaned

2.) For each titration, the initial reading of burette should be same.

3) Always read lower meniscus of solution in burette

4.) Near end point, add acid dropwise, and observe in white background.

5.) Do not blow last drop of solution from pipette flask. Just tap the tip of pipette to the walls of flask

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