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EXPERIMENT: To determine the amount of NaOH and Na_2CO_3 present in the same solution.

THEORY: When a mixture of NaOH and Na_2CO_3 is titrated against a standard HCl solution, colour of solution changes from yellow to pink (using methyl orange as an indicator) due to complete neutralization of both the alkalis at pH ≈ 4. However, when the mixture is titrated using phenolphthalein as an indicator, the colour of the solution changes from pink to colorless due to complete neutralization of NaOH and half neutralization of Na_2CO_3 (i.e. upto the conversion of Na_2CO_3 to $NaHCO_3$) at pH ≈ 8. The difference of two titre values gives the amount of HCl required for half neutralization of Na_2CO_3 while the diff. of first titre value and twice the second titre value gives the amount of HCl required for NaOH neutralization.

PROCEDURE:

(i) **Standardization of HCl**

1. Transfer 10 mL of standard 0.1N Na_2CO_3 sol^n in a clean conical flask using a pipette.
2. Add 2 drops of methyl orange indicator. Titrate the solution against HCl from the burette.
3. The colour of the sol^n changes from yellow to pink (end point).
4. Note the volume of the solution used and repeat the titration at least 4 times and take the mean of closely related readings (V_0).

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EXPERIMENT: To determine the amount of NaOH and Na_2CO_3 present in the same solution.

APPARATUS: Pipette, burette, beakers, conical flask, funnel, burette stand and clamp.

CHEMICALS: Sodium carbonate (Na_2CO_3), sodium hydroxide (NaOH), hydrochloric acid (HCl), methyl orange and phenolphthalein.

CHEMICAL REACTIONS:

$$NaOH + HCl \longrightarrow NaCl + H_2O$$
$$Na_2CO_3 + HCl \longrightarrow NaHCO_3 + NaCl$$
$$NaHCO_3 + HCl \longrightarrow NaCl + CO_2 + H_2O$$

CHEMICAL STRUCTURES:

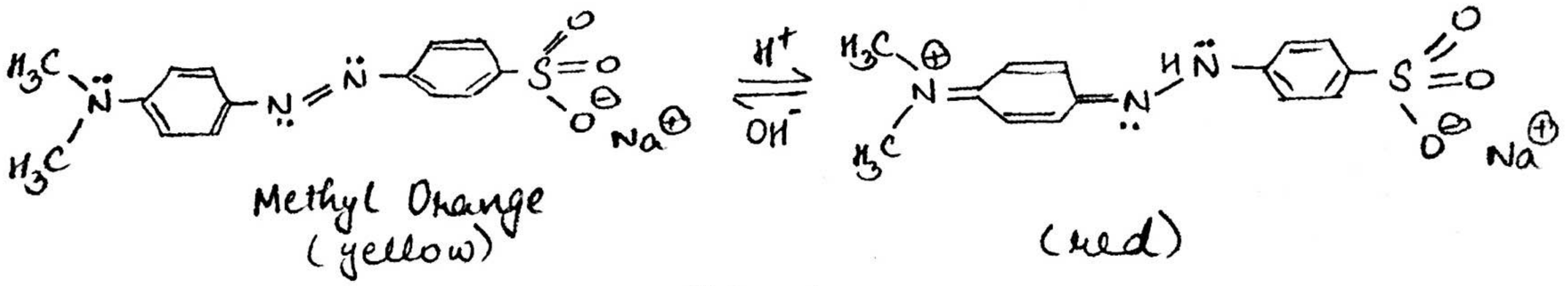

Fig. 1

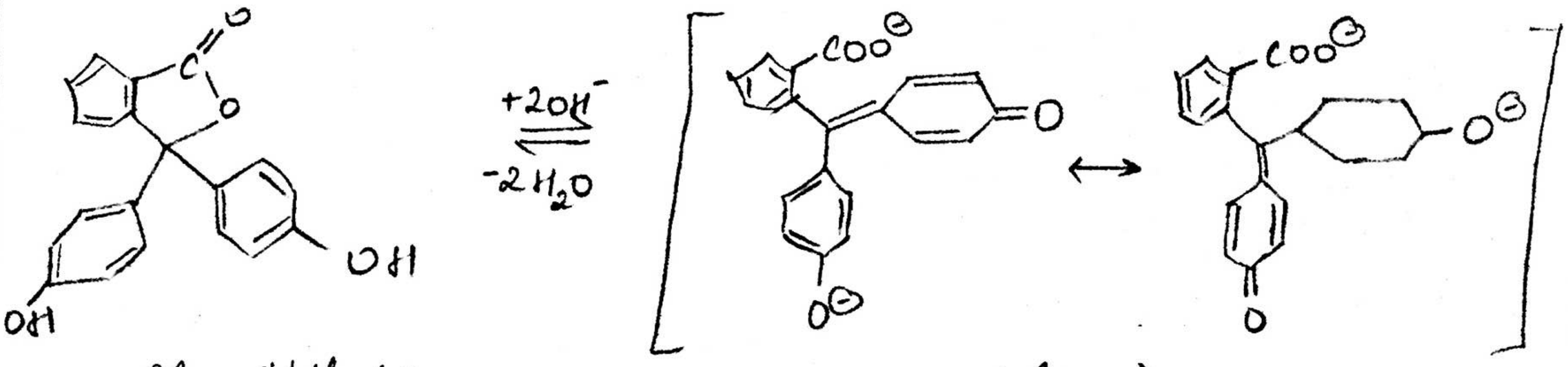

Fig. 2

INDICATOR: Methyl Orange and Phenolphthalein

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ii) Determination of NaOH and Na_2CO_3 content

1. Transfer 10ml of mixture of alkali sol^n into a conical flask.
2. Add 2-3 drops of phenolphthalein indicator. The solution becomes pink in colour.
3. Note the initial reading of HCl from the burette (A). Titrate the sol^n with standard HCl while the sol^n becomes colorless (B).
4. Note the titre value and this is the phenolphthalein end point, P. To the same sol^n, add 2-3 drops of methyl orange indicator and continue the titration with HCl, until a sharp colour change occurs from yellow to red at the end point (C).
5. This titre value i.e., the total volume of HCl run down from the beginning of the experiment to the methyl orange end point is noted and this is the methyl orange end point, M.

GENERAL CALCULATIONS:

Standardisation of HCl

Volume of alkali solution (Na_2CO_3) taken = 10 ml

Normality of $Na_2CO_3 = N_2$; Volume of HCl used = V_0

Using the normality equation -

$$N_1 \times V_0 = N_2 \times 10$$

$$N_1 = N_2 \times (10/V_0)$$

Determination of Na_2CO_3 and NaOH

(i) Determination of NaOH

Equivalent weight of NaOH = 40

Hence 1L of 1N HCl = 40g of NaOH

Normality of HCl used = N_1

V_2 ml of N_1 HCl = $40 \times (V_2/1000) \times N_1 = y$ gm of NaOH

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OBSERVATIONS:

(i) Standardization of HCl solution

Volume of 0.1 N Na_2CO_3 solution taken for each titration = 10 ml

Sr. No.	Burette Reading (mL)		Volume of HCl used (mL)
	Initial	Final	
1.	0.1	10.0	9.9
2.	0.1	10.0	9.9
3.	0.1	10.0	9.9

Mean Value of HCl used (V_0) = 9.9 mL

(ii) Determination of NaOH and Na_2CO_3 in the mixture

Volume of mixture of NaOH and Na_2CO_3 solution taken for each titration = 10 ml

Sr. No.	Burette Reading (mL)			Volume of HCl used (ml)	
	Initial Reading (A)	Colorless with phenolphthalein (B)	Reddish color with methyl orange (C)	P = B - A	M = C - A
1.	0.1	14.0	16.5	13.9	16.4
2.	0.1	14.0	16.5	13.9	16.4
3.	0.1	14.0	16.5	13.9	16.4

Mean volume of HCl used for P = 13.9 mL

Mean volume of HCl used for M = 16.4 mL

As P corresponds to 1/2 neutralization of Na_2CO_3 and complete neutralization of NaOH, ∴ Half of Na_2CO_3 = M - P = 16.4 - 13.9 = 2.5 ml

So, Volume of HCl required for neutralization of Na_2CO_3 = 2(M-P) = V_1 = 5 ml

Volume of HCl required for neutralization of NaOH = M - 2(M-P) = 2P - M = V_2 = 11.4 ml

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This is the amount of NaOH present in 10ml of the given alkali mixture solution.

Strength of NaOH = $y_1 \times (1000/10) = 100 \times y_1$ gm/L.

(ii) Determination of Na_2CO_3

Equivalent weight of $Na_2CO_3 = 53$

Hence 1L of 1N HCl = 53 gm of Na_2CO_3

Normality of HCl used = N_1

V_1 ml of N_1 HCl = $53 \times (V_1 \times 1000) \times N_1 = y_2$ gm of Na_2CO_3.

This is the amount of Na_2CO_3 present in 10ml of the given alkali mixture solution.

Strength of $Na_2CO_3 = y_2 \times (1000/10) = 100 \times y_2$ gm/L.

RESULTS: The given alkali mixture contains NaOH = $100 \times y_1$ gm/L
= 4.6 gm/L

The given alkali mixture contains $Na_2CO_3 = 100 \times y_2$ gm/L
= 3 gm/L

PRECAUTIONS: 1. Rinse the pipette with the solution to be transferred to titration flask.

2. Rinse the burette with the solution to be taken/filled in the burette.

3. Upper meniscus to be read for colored solutions.

4. Lower meniscus to be read for colourless solutions.

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CALCULATIONS:

Standardization of HCl

Using normality equation,

$$N_1 \times V_0 = N_2 \times 10$$

$$N_1 = \frac{0.1 \times 10}{9.9} = 0.101\ N$$

Determination of Na_2CO_3 and NaOH

(i) Determination of NaOH

$$\text{Y}_1 \text{ gm of NaOH} = 40 \times \frac{11.4}{1000} \times 0.101 = 0.046 \text{ gm}$$

Strength of NaOH = $0.046 \times 100 = 4.6$ gm/L

(ii) Determination of Na_2CO_3

$$Y_2 \text{ gm of } Na_2CO_3 = 53 \times \frac{5}{1000} \times 0.101 = 0.03 \text{ gm}$$

Strength of $Na_2CO_3 = 0.03 \times 100 = 3$ gm/L

RESULT:

Amount of NaOH present in 1L of alkali mixture = 4.6 gm/L
Amount of Na_2CO_3 present in 1L of alkali mixture = 3 gm/L

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