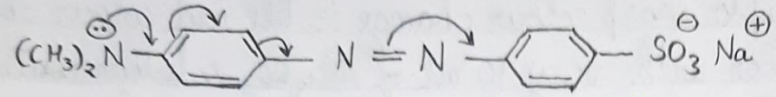
Indicators and their end points:

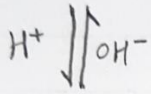
(i) Phenolphthalein (pink to colourless)

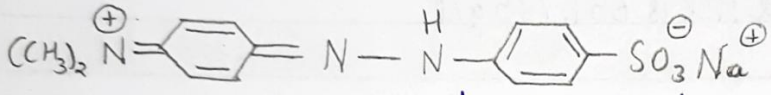
(ii) Methyl orange (yellow to pink)

Resonance structure of Methyl orange:



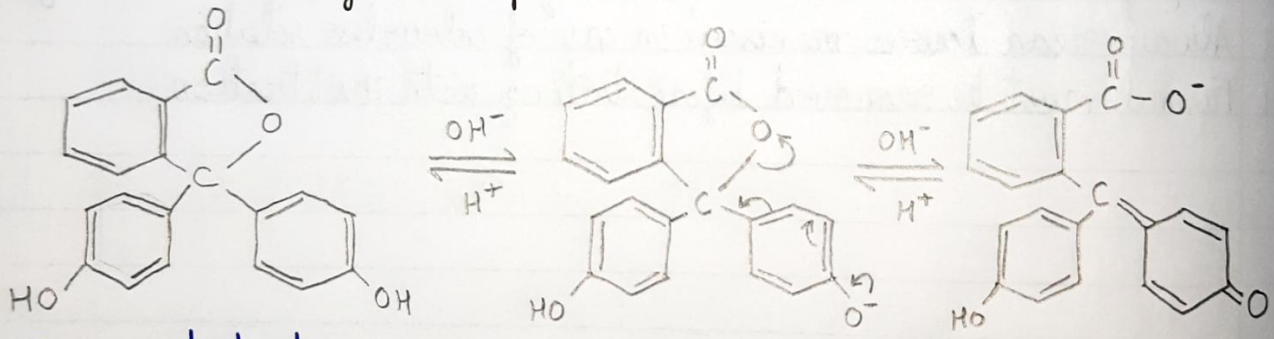
Benzenoid structure, yellow





Quinonoid structure, pink

Resonance structure of Phenolphthalein:



Benzenoid structure
colourless

Quininoid structure
pink colour

Date 24/12/2030

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Experiment 2.

Aim:

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 given HCl solution.

Apparatus required:

Pipette, Burette, Stand, Conical flask, Measuring cylinder, White paper.

Reagents required:

Sodium Carbonate (Na_2CO_3), Hydrochloric acid (HCl), Distilled water, Water sample containing $NaOH$ and Na_2CO_3 mixture.

Theory:

The titration is based upon the specific pH range for each indicator. The phenolphthalein indicator gives pink colour in pH range 8.2 - 10.0 while methyl orange gives pink colour in pH range 4.4 - 3.0. It has been observed that the presence of sodium hydroxide and sodium carbonate always provide the pH higher than 8.2 to the solution.

Initially when standard hydrochloric acid is added, the OH^- ions are first converted to H_2O and then CO_3^{2-} ions are converted to HCO_3^-.

When first two steps completed the pH of solution becomes less than 8.2 and the pink colour of phenolphthalein disappears. At this point, methyl orange is added as indicator to find the complete neutralization. On addition of further acid, the HCO_3^- ions are converted to CO_2 and H_2O. It means step 3 is completed.

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Chemical reactions:

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

Ionic reactions:

$$OH^- + H^+ \rightarrow H_2O$$
$$CO_3^{2-} + H^+ \rightarrow HCO_3^-$$
$$HCO_3^- + H^+ \rightarrow H_2O + CO_2$$

Observations:

S.no.	Volume of Na_2CO_3 taken (ml)	Burette readings		Volume of HCl used (ml)	Concordant reading (V_0) (ml)
		Initial	final		
1.	10 ml	0.0	7.7	7.7	7.7 ml
2.	10 ml	7.7	15.4	7.7	
3.	10 ml	15.4	23.1	7.7	

S.no.	Volume of water sample taken (ml)	Burette readings			Vol^m of HCl used (ml)		Concordant reading (V_0) (ml)
		Initial (V_1)	Final		P	M	
			P(V_2)	M(V_3)	$V_4 = V_2 - V_1$	$V_5 = V_3 - V_2$	
1.	10 ml	0.0	7.0	12.3	7.0	5.3	P = 7.0 ml M = 5.3 ml
2.	10 ml	12.3	19.3	24.6	7.0	5.3	
3.	10 ml	24.6	31.6	36.9	7.0	5.3	

When all HCO_3^- ions are used up the pH of the solution becomes less than 4.4 instantaneously. At this point methyl orange gives pink colour.

Procedure:

1. Standardization of given HCl solution

(i) Take 10ml of standard Na_2CO_3 with the help of pipette into a conical flask. Added 1-2 drops of methyl orange.

(ii) Ran the acid solution from the burette into conical flask drop wise with constant shaking of solution. Find the end point when light yellow colour solution turns pink. Noted volume of acid used. Repeated this step 4-5 times till you got atleast two concordant readings.

2. Titration of given water sample with HCl solution

(i) Pipetted out 10ml of given water sample into a conical flask. Added 1-2 drops of phenolphthalein indicator. The solution turned pink.

(ii) Added HCl solution from burette into the conical flask with constantly shaking till the pink colour disappears. Noted the readings on the given burette (V_2).

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

(iv) Titrated then again with acid till yellow coloured solution turned pink again. Noted the volume of acid used (V_3). Repeated the steps to get concordant readings.

Result:

Strength of NaOH in given solution = $0.22\ g\ L^{-1}$

Strength of Na_2CO_3 in given solution = $1.82\ g\ L^{-1}$

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Calculations:

To calculate Normality of given HCl solution, apply normality equation:

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

$N_{HCl} = \frac{N_{Na_2CO_3} \times 10}{V_{HCl}} = \frac{1}{40} \times \frac{10}{7.7} = \frac{10}{308} N = 0.03246 N$

To calculate Normality of NaOH and Na_2CO_3 from given water sample:

V_4 = Vol^m of HCl when whole of NaOH & half of Na_2CO_3 is neutralized

$= [OH^-] + \frac{1}{2}[CO_3^{2-}]$

V_5 = Vol^m of HCl when rest half of Na_2CO_3 is neutralized

$= \frac{1}{2}[CO_3^{2-}]$

Hence,

Vol^m of HCl req. for neutralization of NaOH = $V_4 - V_5 = 1.7$ ml

Vol^m of HCl req. for neutralization of $Na_2CO_3 = 2V_5 = 10.6$ ml

Normality of NaOH, $N_{NaOH} = \frac{(N_{HCl} \times V_4 - V_5)}{10} = \frac{0.03246 \times 1.7}{10} = 0.0055N$

Normality of Na_2CO_3, $N_{Na_2CO_3} = \frac{(N_{HCl} \times 2V_5)}{10} = \frac{0.03246 \times 10.6}{10} = 0.0344N$

Strength of NaOH = N_{NaOH} × equivalent wt. of NaOH

$= 0.0055 \times 40$

$= 0.22\ gL^{-1}$

Strength of Na_2CO_3 = $N_{Na_2CO_3}$ × equivalent wt. of Na_2CO_3

$= 0.0344 \times 53$

$= 1.82\ gL^{-1}$

Precautions:

(i) Before starting the experiment, the glass apparatus must be perfectly cleaned.

(ii) For each titration, the initial reading of burette should always be same.

(iii) Always read lower meniscus of solution level in burette.

(iv) Near the end point, add acid solution dropwise and after addition of each drop, see the colour against white background.

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