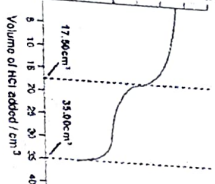
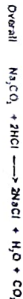
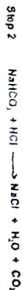
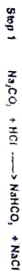


Double Indicator Titration

- certain indicators change color at different stages of a neutralization (used in volumetric work to determine the proportions of the components of certain mixtures by observing two end points in a single titration)

A. Titration of sodium carbonate (Na_2CO_3) with a Strong Acid

Sodium carbonate reacts with hydrochloric acid in two steps:-



There are two sharp pH changes
The second addition of HCl is exactly the same as the first because the NaHCO_3 formed in the first reaction reacts with the HCl to form the same products as the Na_2CO_3 reacting with the HCl.

Step 1 phenolphthalein indicator (pH 8-10)

Step 2 methyl orange indicator (pH 3-4)

$V_{\text{ph}} = V_{\text{mo}}$

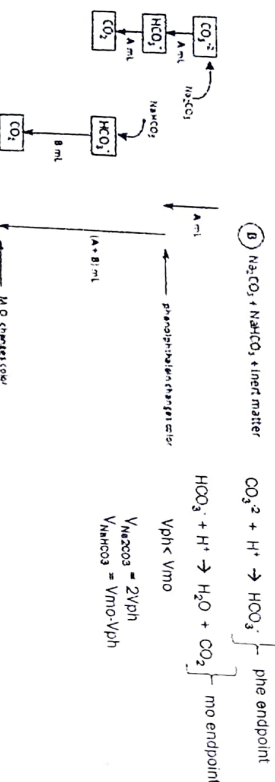
$V_{\text{Na}_2\text{CO}_3} = V_{\text{ph}} + V_{\text{mo}} = 2V_{\text{ph}}$

where V_{ph} = volume required to reach pH endpoint

V_{mo} = volume required to reach the mo endpoint

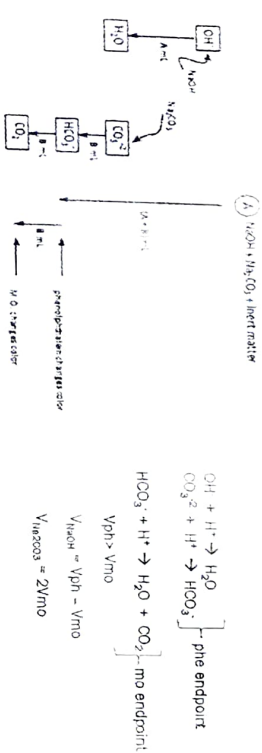
V_{mo} = volume required to reach the mo endpoint

C. Titration of a Mixture containing Na_2CO_3 and NaHCO_3 with a Strong Acid



- End point using phenolphthalein is reached when Na_2CO_3 has been converted to NaHCO_3
- End point using methyl orange is reached when complete reaction with NaHCO_3 formed from Na_2CO_3 plus the original NaHCO_3 occurs
- Volume acid methyl orange end point $>$ volume acid for the phenolphthalein end point

B. Titration of a Mixture containing Na_2CO_3 and NaOH with a Strong Acid



- End point using phenolphthalein is reached when NaOH is neutralized and Na_2CO_3 has been half-neutralized (i.e. converted to NaHCO_3)
- End point using methyl orange is reached when complete reaction of NaHCO_3 with an acid occurs
- Volume acid methyl orange end point $<$ volume acid for the phenolphthalein end point

D. Titration of Na_2CO_3 with a Strong Acid using Bromocresol green (bcg) indicator

- at the start of the titration, addition of the strong acid using bromocresol green indicator directly completes the neutralization reaction with Na_2CO_3 (conversion of CO_3^{2-} to CO_2)
- Volume of the strong acid added to reach the bcg endpoint is the total volume for the 2 end points using phe and methyl orange
- If only Na_2CO_3 is present $V_{\text{ph}} + V_{\text{mo}} = V_{\text{bcg}}$ or $V_{\text{ph}} = 1/2 V_{\text{bcg}}$

E. Titration of Na_2CO_3 and NaHCO_3 Mixture with a Strong Acid using Bromocresol green (bcg) indicator

- at the start of the titration, addition of the strong acid using bromocresol green indicator directly completes the neutralization reaction with Na_2CO_3 (conversion of CO_3^{2-} to CO_2) and with NaHCO_3 (HCO_3^- to CO_2)
- In a separate titration, addition of the strong acid using phe indicator converts only the CO_3^{2-} of Na_2CO_3 to HCO_3^-
- with NaHCO_3 present in the mixture $V_{\text{mo}} = V_{\text{bcg}} - V_{\text{ph}}$ thus $V_{\text{mo}} > V_{\text{ph}}$