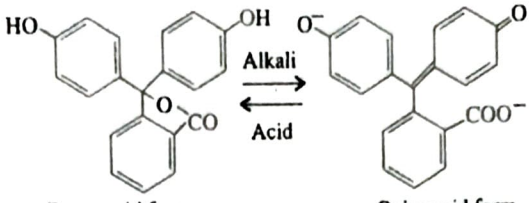
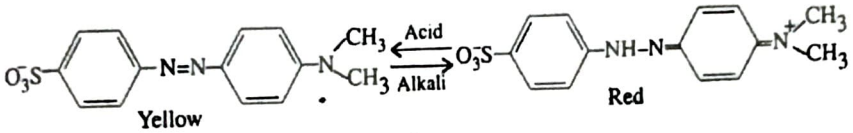


Benzenoid form (colourless) Quinonoid form (pink)

Methyl orange has quinonoid form in acidic solution and has red colour, while benzenoid form in alkaline solution has yellow in colour.



Yellow Red

Phenolphthalein is weak acid. The dissociation of phenolphthalein (HIn) represented as

$$\underset{\text{Colourless}}{HIn} \rightleftharpoons \underset{\text{Pink}}{H^+ + In^-}$$

(In Acid solution) (In Basic Solution)

When acid taken in a conical flask, phenolphthalein remain in a non-dissociated form due to presence of more concentration of H^+ ion. So solution is colourless. At end point, colour changes from colourless to pink. When basic solution taken in a conical flask, phenolphthalein undergo dissociation and solution become pink in colour. At end point, colour changes from pink to colourless due to consumption of all OH^- ion.

In Similar manner, methyl orange (InOH) shows different colour in dissociated and non-dissociated form.

$$\underset{\text{Yellow}}{InOH} \rightleftharpoons \underset{\text{Pink}}{In^+ + {}^-OH}$$

(In basic solution) (In acidic solution)

Hence when acid taken in a conical flask, colour changes from pink to yellow, and in case of alkali colour changes from yellow to pink.

2.13 Choice of suitable indicator for different acid base titration

The acid-base (neutralization)/titration has following four types.

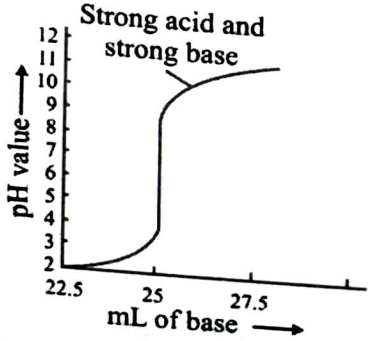
i) A strong acid versus a strong base
ii) A weak acid versus a strong base.
iii) A strong acid versus a weak base.
iv) A weak acid versus a weak base.

In the acid-base titration, the curve obtained by plotting pH against the volume of alkali added is known as neutralization or titration curve. In every acid base titration, titration curve becomes almost vertical for some distance and then bends away. This region indicates

the change in pH at equivalence point. The color change of acid-base indicator takes place within a small range of pH value. This range is called the pH range of indicator. The selection of indicator depends on pH range of indicator matches with pH range of indicator matches with pH range near the equivalent point of concern acid-base titration.

1) Strong acid versus strong base. (e.g. HCl + NaOH)

The pH curve (titration curve) of strong acid (HCl) and strong base (NaOH) is almost vertical over the pH range 3.3-10.5. The titration curve indicates that up to neutralization, pH slightly increases up to 3.3. After addition excess of NaOH, concentration of HO^- increases and pH suddenly rises to 10.5. The indicator pH range matches with selected strong acid and strong base titration pH range 3.3 – 10.5. So phenolphthalein, Methyl orange, methyl red, etc. are suitable for such titration.

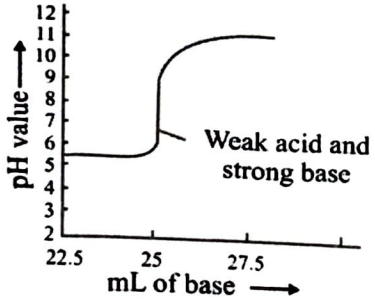


Suitable Indicator	pH range
Methyl Orange	3.2 – 4.5
Methyl Red	4.4 – 6.5
Litmus	5.5 – 7.5
Phenolphthalein	8.4 – 10.5

Fig. 2.2: Neutralization curve for strong acid and strong base titration.

2) Weak acid versus Strong base (e.g. CH_3COOH and NaOH)

The titration curve of weak acid (CH_3COOH) and strong base (NaOH) is vertical over the approximate pH range 6.5 to 10.5. Due to weak strength of acid, solution is alkaline at end point. The phenolphthalein is suitable indicator available for the titration between weak acid and weak base.

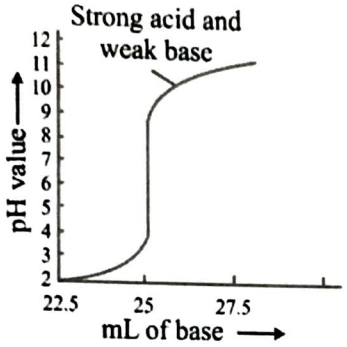


Suitable Indicator	pH range
Phenolphthalein	8.4 – 10.5
Bromothymol blue	6.0 – 7.6

Fig. 2.3: Neutralization curve for weak acid and strong base titration.

3) Strong acid versus weak base (e.g. HCl and NH_4OH)

The titration curve of strong acid (HCl) with a weak base (NH_4OH) is vertical over the pH range 3.5 to 7.0. After the neutralization, the pH varies from 3.5 to 7.0, so methyl red and methyl orange are suitable for such a titration.



Suitable Indicator	pH range
Methyl orange	3.2 – 4.5
Methyl Red	4.4 – 6.5

Fig. 2.4: Neutralization curve for strong acid and weak base titration.

4) Weak acid versus weak base e.g. (CH_3COOH and NH_4OH)

In weak acid versus weak base titration, pH varies in very narrow pH range as the curved is not vertical. Hence, no suitable indicator available for the titration between weak acid and weak base.

Suitable Indicator: No suitable indicator

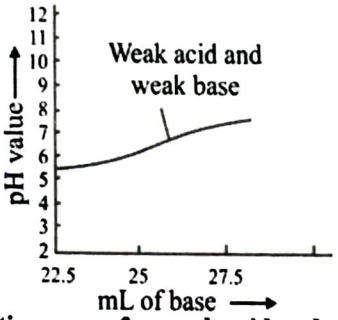


Fig. 2.5: Neutralization curve for weak acid and weak base titration.

2.14 Redox titration

The titration in which one reactant is oxidized and the other is reduced is known as redox titration. The titration reaction involves a transfer of electron from one substance to another.

The process of releasing electron is oxidation and the process of gaining electron is known as reduction. In redox titration, both oxidation and reduction process takes place simultaneously.

The reagent which oxidizes to other substance and itself reduces; this substance is called as oxidizing agent (oxidant) i.e. oxidizing agent gain electrons and reduced itself to lower valency state. The reagent which reduces to other substance and itself oxidizes this