Education in Chemistry 16–18 years

Acid-base indicators

Learning objectives

1 To understand that indicators are weak acids in which the colour of the aqueous solution of the acid is distinctly different from that of its conjugate base.

2 To know that the pH range over which a colour change occurs can be estimated by $\mathrm{pH} = -\mathrm{p}K_{In} \pm 1$.

3 To be able to sketch the pH curves for different acid-base titrations and suggest suitable indicators based on data given.

Introduction

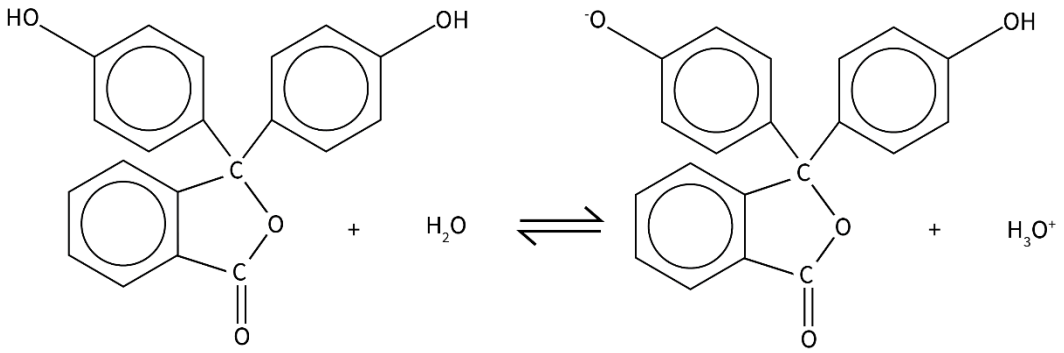
You will need to apply your understanding of equilibria and acid-base chemistry to answer some questions about indicators.

Questions

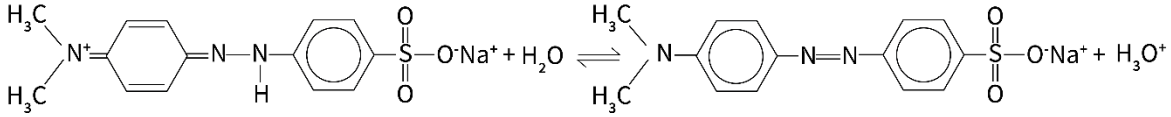
1. Phenolphthalein and methyl orange are weak acid indicators. When dissolved in water they dissociate slightly to form the conjugate base. For each of the equilibria:

(a) identify the weak acid and the conjugate base;
(b) on the structure of the weak acid, circle the proton that is released during dissociation.

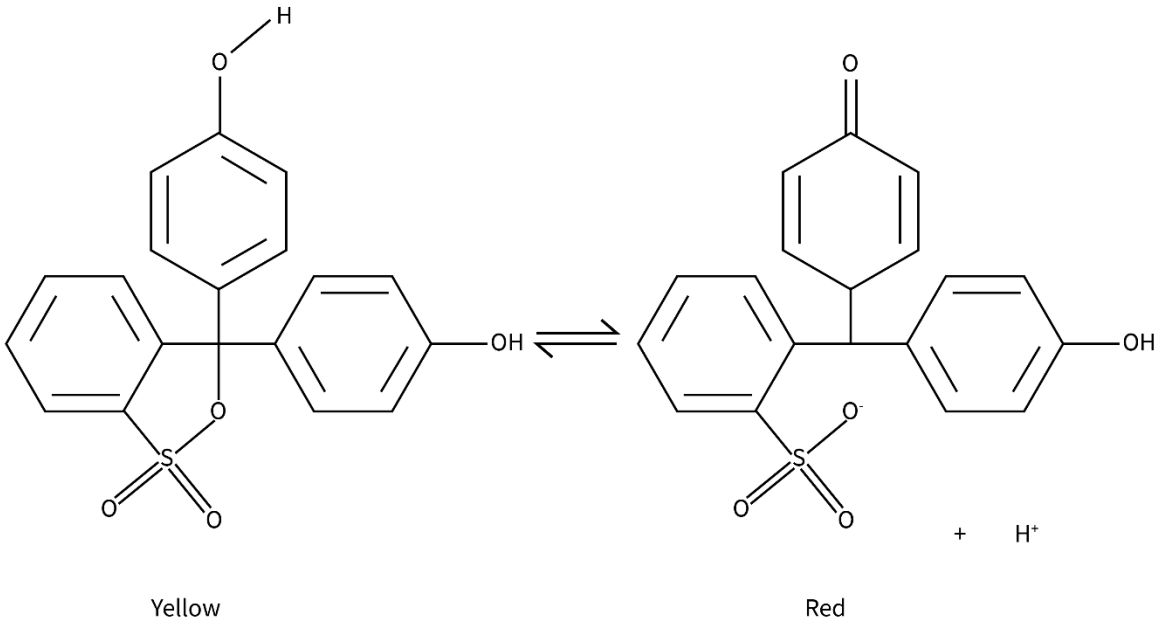
phenolphthalein:



methyl orange:



2. Phenol red is another weak acid indicator. When dissolved in water the following equilibrium is established.



Yellow Red

(a) Explain why phenol red turns red when you add it to an alkaline solution.
(b) Explain why phenol red turns yellow when you add it to an acidic solution.
(c) The K_{In} for this equilibrium is 1.26×10^{-8} mol dm^{-3}. Estimate the pH range over which phenol red changes colour.

3. The names of different acid-base indicators and the range over which they change colour is given in the table below.

Indicator	Colour in acidic solution	Colour in basic solution	pH range
Methyl orange	red	yellow	3.1–4.4
Phenolphthalein	colourless	pink	8.3–10.0
4-Nitrophenol	colourless	yellow	5.6–7.0

Sketch pH curves for each of the titrations below and choose a suitable indicator for the titration from those listed in the table

(a) Addition of ammonia solution to hydrochloric acid.
(b) Addition of ethanoic acid to sodium hydroxide.