

## *b) Indicators*

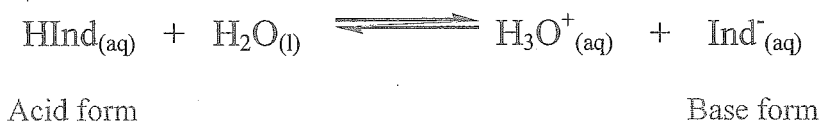
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i) What is an "Indicator"?

- purpose is to tell us when we are at the equivalence point
- it is a weak acid/base

ii) How Do They Work?

- since it is a weak acid/base, it is in equilibrium:



- if there is an excess of  $\text{H}_3\text{O}^+$  at the equivalence point, the equilibrium will shift to the acid form of the indicator.
- if there is an excess of base at the equivalence point, the equilibrium will shift to the base form of the indicator

- the key to indicators is that their acid and base forms have different colours!

Indicator Name	Acid Form	Base Form
Phenolphthalein	<i>Colourless</i>	<i>Pink</i>
Methyl Orange	<i>Red</i>	<i>Yellow</i>
Bromothymol Blue	<i>Yellow</i>	<i>Blue</i>
Bromocresol Green	<i>Yellow</i>	<i>Blue</i>
Thymol Blue	<i>Yellow</i>	<i>Blue</i>

- see p.335 Hebden and Data Booklet for others.

### iii) End Point

- the point at which an indicator is exactly halfway through its colour change and  $[HInd] = [Ind^-]$
- thus, for the equilibrium for an indicator at the End Point:

$$K_a = \frac{[H_3O^+][Ind^-]}{[HInd]} = [H_3O^+]$$

$$K_a \text{ for that indicator} = [H_3O^+] \text{ present}$$

$$- \log K_a = - \log [H_3O^+]$$

$$pK_a \text{ of that indicator} = \text{pH of the solution}$$

- the point is, you must choose an indicator that will have an End Point near the Equivalence Point of that acid/base titration.

Example: The pH at the equivalence point is 4.5

An appropriate indicator will change colour around 4.5  
Bromocresol green would be a good choice.

### iv) $K_a$ of Indicators

Example: What is the  $K_a$  value for Bromothymol blue indicator?

Bromothymol blue indicator has a pH range of 6.0 – 7.6

Midpoint of colour change =  $pK_a = \text{pH} = 6.8$

$$K_a = \text{antilog}(-6.8) = 1.6 \times 10^{-7} = 2 \times 10^{-7}$$

### v) Universal Indicators

- a mixture of several indicators that has several colour changes over a large pH range.
- useful to get an approximate pH of an unknown solution