b) Indicators

IV.17

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:

$$HInd_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Ind^-_{(aq)}$$

Acid form Base form

- if there is an excess of H_3O^+ 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	*Colourless*	*Pink*
Methyl Orange	*Red*	*Yellow*
Bromothymol Blue	*Yellow*	*Blue*
Bromocresol Green	*Yellow*	*Blue*
Thymol Blue	*Yellow*	*Blue*

- 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:

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

Ka for that indicator = $[H_3O^+]$ present

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

pKa of that indicator = 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) Ka of Indicators

Example: What is the Ka value for Bromothymol blue indicator?

Bromothymol blue indicator has a pH range of 6.0 – 7.6

Midpoint of colour change = pka = pH = 6.8

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

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