Name: Key
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Chemistry 12
ACID BASE PART II Lesson # 17
INDICATORS

An INDICATOR is a mixture of a weak organic acid and it's conjugate BASE.

To simplify matters we will use the FORMULA HIn to represent the acid and In^- to represent the base.

For a list of INDICATORS refer to page 7 in your DATA BOOKLET or pg 335 in your HEBDEN text book.

Because an indicator is a weak acid in water the generic chemical reaction is:

$$\underset{\text{(yellow)}}{HIn} + H_2O \rightleftharpoons \underset{\text{(red)}}{In^-} + H_3O^+$$

For the INDICATOR -> Chlorophenol Red
The colour of **HIn** is Yellow while the colour of **In-** is Red.

In the presence of an ACID ($\uparrow H_3O^+$) the above reaction is going to shift to the Reactants and the colour that predominates will be yellow.

In the presence of a BASE (the OH^- will react with H_3O^+) the above reaction is going to shift to the Products and the colour that predominates will be RED.

Some important terminology:
END POINT/ TRANSITION POINT- The pH where the colour of the indicator changes.

EQUIVALENCE POINT - the STOICHIOMETRIC point of a titration ~~where~~.

If the indicator is chosen correctly, the indicator should change colour at (or very close to) the equivalence point.

Example 1. Calculate the END POINT for the indicator Chlorophenol Red.

The End Point is determined by calculating the MIDPOINT of the colour change

$$\therefore \frac{5.2 + 6.8}{2} = \frac{12.0}{2} = 6.0$$

At the END POINT of an indicator the [HIn] = [In-]. Therefore we can use this relationship to calcalate the indicator's **Ka** using the MIDPOINT of the indicator's COLOUR CHANGE.

Indicator equation: $HIn + H_2O \rightleftharpoons In^- + H_3O^+$

Ka expression: $Ka = \frac{[In^-][H_3O^+]}{[HIn]}$; if $[HIn] = [In^-]$

Conclusion: $\boxed{Ka = [H_3O^+]}$

If Ka = $[H_3O^+]$

then -log (Ka) = - log $[H_3O^+]$

pKa = pH

Conclusion: An indicator is at the MIDPOINT of its colour change when the pH of the solution equals the pKa of the indicator

Example 2. Ethyl Orange is RED at pH < 3.4 and YELLOW at pH > 4.8. What is the approxmate value of the K_a for Ethyl Orange? what is it's colour?

1. MIDPOINT = $\frac{3.4 + 4.8}{2} = \frac{8.2}{2} = 4.1$

2. $Ka =$ antilog (-4.1)

$= 8 \times 10^{-5}$; ORANGE

Example 3. Given that an indicator has a K_a value of 2.5×10^{-5} , what is the transition point of the indicator? Identify the indicator.

1. $pH = -\log(2.5 \times 10^{-5})$

$= 4.60$

2. Indicator is Bromocresol green

$\frac{3.8 + 5.4}{2} = \frac{9.2}{2} = 4.6$

3,8
5,4
2|5.2
6
12

Example 4. Alzarin Yellow R changes from yellow to red at pH = 11.0. If $Aliz^-$ ion is RED, what colour is Alzarin Yellow R in 1.0×10^{-5} M NaOH?

pH of 1.0×10^{-5} M NaOH $\Rightarrow$ $pOH = -\log(1.0 \times 10^{-5}) = 5.00$

$[HIn] > [In^-] \rightarrow pH < 11.0 \Rightarrow$ yellow

$[HIn] = [In^-] \rightarrow pH = 11.0$

$[HIn] < [In^-] \rightarrow pH > 11.0 \rightarrow$ Red

$pH = 14.000 - 5.00$

$= 9.00$

$\therefore$ The colour is Yellow !

SEATWORK/HOMEWORK: Exercises 108-114 pgs 162-163 in HEBDEN

PLO's : O1-O5

$HAliz + H_2O \rightleftharpoons Aliz^- + H_3O^+$

(YELLOW) (RED)