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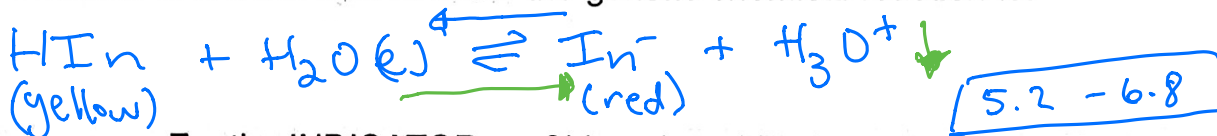
Chemistry 12
ACID BASE PART II Lesson # 17
INDICATORS

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

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:



For the INDICATOR -> Chlorophenol Red

The colour of HIn is yellow while the colour of In⁻ is red.

In the presence of an ACID (H₃O⁺) the above reaction is going to shift to the reactants and the colour that predominates will be yellow.

In the presence of a BASE (OH⁻ react with H₃O⁺ ∴ ↓ [H₃O⁺]) 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 an indicator changes.

EQUIVALENCE POINT - (stoichiometric point) where moles acid equals moles of base.

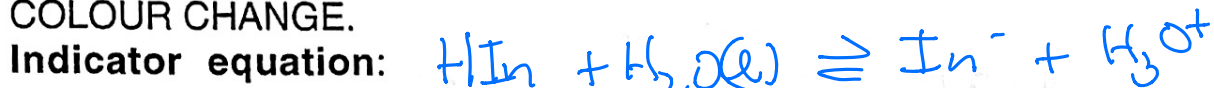
If the indicator is chosen correctly, the indicator should change colour at (or very close to) the equivalence point.

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

(mid point) is determined by adding the 2 values for the pH range together, then divide that value by 2.

$$\underline{5.2} + \underline{6.8} = 12.0 \div \underline{2} = \underline{6.0}$$

At the END POINT of an indicator the $[HIn] = [In^-]$. Therefore we can use this relationship to calculate the indicator's K_a using the MIDPOINT of the indicator's COLOUR CHANGE.



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

Conclusion: $K_a = [H_3O^+]$
 If $K_a = [H_3O^+]$

then $-\log(K_a) = -\log[H_3O^+]$ an indicator's
 $pK_a = pH$

Conclusion:

\therefore
 $K_a = \text{antilog}(-6.0)$
 (c.r.) $K_a = 1 \cdot 10^{-6}$

} midpoint value can be used to calculate its K_a value
 $K_a = \text{antilog}(-\text{midpoint})$

Example 2. Ethyl Orange is RED at $pH < 3.4$ and YELLOW at $pH > 4.8$. What is the approximate value of the K_a for Ethyl Orange?

midpoint = $3.4 + 4.8 = 8.2 \div 2 = 4.1$

$K_a = \text{antilog}(-\text{midpoint})$
 $= \text{antilog}(-4.1) \rightarrow 8 \cdot 10^{-5}$

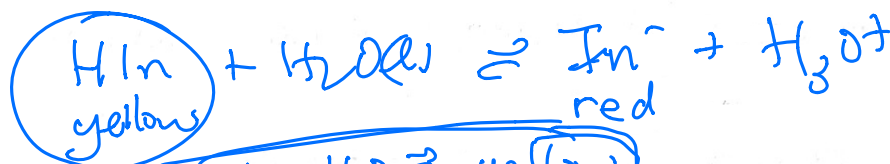
Example 3. Given that an indicator has a K_a value of 2.5×10^{-5} , what is the transition point of the indicator? Identify the indicator.

(midpoint) $pH = -\log(K_a)$
 $= -\log(2.5 \cdot 10^{-5})$
 $= 4.60$

B.G = $[3.8 + 5.4] = 9.2 \div 2 = 4.6$

indicator is Bromocresol green

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



$1 - 11.0 \Rightarrow$ yellow
 $11.0 - 14.0$ red

pH of $1.0 \cdot 10^{-5} M NaOH$

$[OH^-] = 1.0 \cdot 10^{-5} M$ pH = 14.000 - 5.000
 $pOH = -\log(1.0 \cdot 10^{-5}) = 5.00$
 $pH = 9.00$

\therefore basic indicator

\therefore will be yellow!