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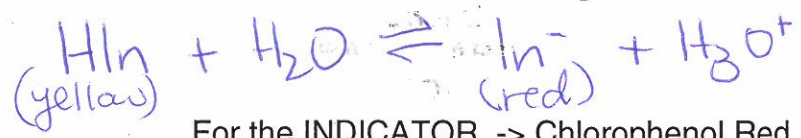
Chemistry 12
ACID BASE PART II Lesson # 17
INDICATORS

An INDICATOR is a mixture of a Weak organic acid and its 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:



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 (the OH⁻ will react with 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 the indicator changes.

EQUIVALENCE POINT - the STOICHIOMETRIC point of a
titration where.

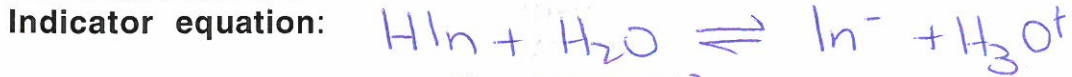
If the indicator is chosen correctly, the indicator should change colour at (or very close
to) the equivalence point.

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 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 $-\log(K_a) = -\log[H_3O^+]$
 $pK_a = pH$

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

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? *what is it's colour?*

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

2. $K_a = \text{antilog}(-4.1)$
 $= 8 \times 10^{-5}$, 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

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

Example 3. Alizarin Yellow R changes from yellow to red at $pH = 11.0$. If Aliz⁻ ion is RED, what colour is Alizarin Yellow R in 1.0×10^{-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 : 01-05

