Date: _____

IV.17 Indicators

You will be able to:

- Describe an indicator as a mixture of a weak acid and its conjugate base, each with distinguishing colours
- Describe the term transition point of an indicator, including the conditions that exist in an equilibrium system
- Describe the shift in equilibrium and resulting colour changes as an acid or base is added to an indicator
- Predict the approximate pH at the transition point using the Ka value of an indicator
- Predict the approximate Ka value for an indicator given the approximate pH range of the colour change

We have used indicators in many labs to identify acidic or basic solutions, or even to signify the equivalence point of a titration.
So, what is an indicator anyway?

DEFINE: An **INDICATOR** is _____
_____

- HIn is the _____
- In^- is the _____

Ex: An indicator HInd has a yellow acid form (**HIn**) and a red base form (In^-).

_____

ACCORDING TO LE CHATELIER'S PRINCIPLE:

- If **excess H_3O^+** is added, equilibrium shifts _____; Favours _____
  - **[HIn] > [In^-]**
  - Colour will be _____

Therefore, _____

- If **excess OH^-** is added, equilibrium shifts _____; Favours _____
  - **[HIn] < [In^-]**
  - Colour will be _____

Therefore, _____

- If acid/base solution has **[HIn] = [In^-]**
  - Colour will be _____

Therefore, _____

Using the A-B Indicator chart in Data Book:

ACID-BASE INDICATORS

Indicator	pH Range in Which Colour Change Occurs	Colour Change as pH Increases
Methyl violet	0.0 – 1.6	yellow to blue
Thymol blue	1.2 – 2.8	red to yellow
Orange IV	1.4 – 2.8	red to yellow
Methyl orange	3.2 – 4.4	red to yellow
Bromcresol green	3.8 – 5.4	yellow to blue

Example 30: When a drop of 0.1M HCl is added to the indicator bromcresol green, the colour is yellow. When a drop of 0.10M NaOH is added to the indicator, the colour is blue.

- What colour is the acid form of bromcresol green (HIn)? _____
- What colour is the base form of bromcresol green (In^-)? _____
- What would the colour be if [HIn] = [In^-] for bromcresol green? _____

DEFINE: The **TRANSITION POINT** is _____
_____

AT TRANSITION POINT (or END POINT):

[HIn] = [In^-]	
Colour is 50/50 mix of acid/base colours.	
$K_{a\ (indicator)}$ = [ ]	*Reasoning:* $K_a = \frac{[\ \ ][\ \ ]}{[\ \ ]} = [\ \ ]$
pKa = pH	*Reasoning:* **pKa** = _____ So, _____ _____ Then, _____

Finding the transition point and K_a of an Indicator

Example 31: Find the K_a of Alizarin Yellow

Step 1: Look on the Indicator table. Find the midpoint of the pH range.	
Step 2: Remember at transition point, pKa = pH. Solve for K_a.	

Thymol Blue (a diprotic indicator)

You'll notice that Thymol Blue appears twice on the Indicator Table:

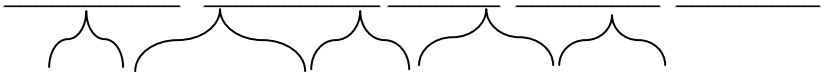
Indicator	pH Range in Which Colour Change Occurs	Colour Change as pH Increases
Thymol blue	1.2 – 2.8	red to yellow
Thymol blue	8.0 – 9.6	yellow to blue

First ionization

Second ionization

pH	Form(s) which predominate(s) (H_2Tb, HTb^- or Tb^{2-})	Approximate Colour
1.0		
2.0	& are equal	
3.0		
7.0		
8.8	& are equal	
10.0		

Colours of Thymol Blue:



pH < 1.2 | | 2.8 - 8.0 | | > 9.6

Example 32: What is the colour of indigo carmine indicator in 0.01 M $Ca(OH)_2$?

Step 1: Look on the Indicator table. Find the midpoint of the pH range.	
Step 2: Determine [OH-] in solution, convert to $[H_3O^+]$ to calculate pH	
Step 3: Locate pH of solution on pH range of indicator to determine colour	

Example 33: Indicator X ($K_a = 1.7 \times 10^{-4}$) is orange in acid and green in base form. What colour is it in 0.0001 M HCl?

Step 1: Calculate transition point pH from Ka	
Step 2: Determine $[H_3O^+]$ in solution, convert to to calculate pH	

Step 3: Locate pH of solution on pH range of indicator to determine colour	

Mixtures of Indicators

UNIVERSAL indicator is a mixture of _____, _____, and _____.

- It gives a spectrum of colours (ROY G BIV) that represent the range of pH values.

Indicator	pH 0-3.8	pH 3.8-6.8	pH 6.8-9.1	pH 9.1-14
Methyl orange pKa =_____				
Bromothymol blue pKa = _____				
Phenolphthalein pKa = _____				
Combined colour				

Therefore, the pH guide for **UNIVERSAL indicator** is as follows:

pH	colour
3	
4	
5	
6	
7	
8	
9	
10	

Do Hebden set 30 p. 162 #109, 112, 116, 120
"INDICATOR PRACTICE" Worksheet