

Chemistry 20

Lesson 27 – Acid-base Indicators

Acid-base indicators are substances that change colour when placed in solutions with different pH. Our understanding of indicators comes from people's efforts to find colour dyes for clothing, hair, tattoos and other purposes. They are organic compounds that were initially derived from plants and eventually, after the mid-nineteenth century, were mostly produced synthetically. They also have exotic and sometimes unpronounceable names like thymolphthalein and bromothymol blue (see page 10 of your data booklet).

Chemically, indicators exist in either a base form or an acid form, where one or both forms are visibly coloured. Bromothymol blue, for example, is yellow when in its acid form (HBb) and it is blue when in its base form (Bb⁻). When it is placed in an acidic solution (pH < 7) the molecule exists in its acidic form and appears yellow. When the indicator is in a basic environment, the OH⁻ ions in the solution pull the H⁺ away from the bromothymol molecule and it is left in its basic form and appears blue. An intermediate color, in this case green, indicates equal amounts of the acid and base forms.

I. Indicator Charts

The **Acid-Base Indicators** chart (page 10 of your data booklet) is very useful for determining the pH of a solution. The Indicator Chart is set up to show the pH values which cause different indicators to be in acid form or in base form.

Using methyl orange as an example, and referring to the chart, the indicator is red when placed in solutions with a pH less than 3.2 and it is yellow when placed in a solution with a pH greater than 4.4. For pH values between 3.2 and 4.4, the indicator may be orange, red or yellow depending on the chemicals that are present. For the Chemistry 20 course the indicator will not be used to indicate pH values in this intermediate zone.

Example 1

A small sample of a solution is poured into 3 beakers and each beaker is tested with a different indicator. The following results were recorded:

methyl orange is yellow

bromothymol blue is yellow

bromocresol green is blue

Use the information to identify the approximate pH range for the solution.

(Try it first before turning the page.)

Solution:

methyl orange is yellow indicating that	$\text{pH} > 4.4$
bromothymol blue is yellow indicating that	$\text{pH} < 6.0$
bromocresol green is blue indicating that	$\text{pH} > 5.4$

\therefore pH of the solution is between 5.4 and 6.0

II. Assignment

1. Give an operational definition of the term **indicator**.
2. In a certain experiment a base is added to an acid until the acid is neutralized. Which indicator(s) would an experimenter use to indicate when neutralization has occurred? Explain. (Hint: What is the pH of a neutral solution?)
3. An unknown solution is tested with a number of indicators.
bromothymol blue turned yellow
methyl orange turned yellow
phenolphthalein is colorless
What is the pH range of the solution?
4. Do Lab Exercise 6.B on page 247 of the text.
5. Using the available indicators and the unknown solutions, what are the approximate pH values for solutions A, B, C, D and E? (Include Procedure, Observations, and Analysis in your answer.)