Indicators and its types

i. What is an Indicator?

An indicator is a special substance that is used to test whether a substance is an acid or a base. It does this by changing its color when it comes in contact with acidic or basic solutions.

Explanation: Imagine you have three clear, colorless liquids: one is water, one is lemon juice (an acid), and one is soap water (a base). How can you tell them apart without tasting them? (Tasting unknown chemicals is very dangerous!). This is where indicators come in. They act like chemical detectives, changing color to reveal the secret identity of the substance.

- **Acids:** Substances that are sour in taste (like lemon, vinegar).
- **Bases:** Substances that are bitter in taste and feel soapy to touch (like baking soda, soap).
- **Neutral Substances:** Substances that are neither acidic nor basic (like pure water, sugar solution).

ii. Key Points and Important Terms

- **Indicator:** A substance that shows a color change in acidic or basic media.
- **Acidic Solution:** A solution containing an acid.
- **Basic Solution (or Alkaline Solution):** A solution containing a base.
- **Neutral Solution:** A solution that is neither acidic nor basic.
- **Natural Indicators:** Indicators obtained from natural sources like plants.
- **Synthetic Indicators:** Indicators that are man-made chemicals.

Types of Indicators

We can classify indicators into two main types:

Natural Indicators: These are found in nature, mostly in plants.

Litmus

- Source: Extracted from plants called lichens.

How it's used: It is available as a solution or as strips of paper, known as litmus paper (red and blue).

Color Change:

- In an acidic solution, blue litmus paper turns red.
- In a basic solution, red litmus paper turns blue.
- In a neutral solution, there is no change in color.

Example Problem

Question: A drop of vinegar is placed on a strip of blue litmus paper. What will you observe?

Solution: Vinegar is an acid. Therefore, the blue litmus paper will turn red.

Turmeric (Haldi)

- **Source:** Turmeric powder, a common spice in the kitchen.
- **Natural Color:** Yellow.

Color Change:

- In an acidic or neutral solution, it remains yellow.
- In a basic solution, it turns reddish-brown.

Example Problem

Question: You spill some curry on your white shirt. When your mother washes it with soap, the yellow stain turns reddish-brown. Why?

Solution: Curry contains turmeric (yellow). Soap is a base. Turmeric acts as an indicator and turns reddish-brown when it comes in contact with a base (the soap).

China Rose Petals (Gudhal)

- **Source:** Petals of the China Rose flower.

How it's used: The indicator is prepared by soaking the petals in warm water. The colored water is then used as the indicator.

Natural Color of Indicator: Light Pink.

Color Change:

- In an acidic solution, it turns dark pink (magenta).
- In a basic solution, it turns green.

Example Problem

Question: A few drops of China rose indicator are added to a test tube containing baking soda solution. What color change will you see?

Solution: Baking soda solution is a base. The light pink China rose indicator will turn green.

Synthetic Indicators

- These are man-made indicators used in laboratories.
- Phenolphthalein

Description: A colorless, man-made chemical.

Color Change:

- In an acidic or neutral solution, it remains colorless.
- In a basic solution, it turns pink.

Example Problem

Question: A scientist adds two drops of phenolphthalein to a test tube of hydrochloric acid. What is the observation?

Solution: Hydrochloric acid is a strong acid. Phenolphthalein remains colorless in an acidic solution. Therefore, there will be no color change; the solution will remain colorless.

iii. Common Misconceptions and Clarifications

- **Misconception:** "If an indicator doesn't change color, the substance must be neutral."
- **Clarification:** Not always! For example, if you put red litmus paper into an acid, it will stay red. This doesn't mean the substance is neutral; it just means you used the wrong paper to test for an acid. You must use blue litmus to test for an acid. Similarly, turmeric does not change color in an acid, but that doesn't make the acid neutral.
- **Misconception:** "All liquids are either acids or bases."
- **Clarification:** Many common liquids are neutral. Pure water, sugar solution, and salt solution are excellent examples of neutral substances that will not cause a color change in most indicators (except for the specific color of the indicator itself).

iv. Practice Problems with Step-by-Step Solutions

Problem: You are given three unlabelled test tubes. One contains distilled water, one contains an acidic solution, and the third contains a basic solution. You are

only given a strip of red litmus paper. How will you identify the contents of each test tube?

Step 1: Test all three solutions.

- Dip the red litmus paper into each of the three test tubes one by one.

Step 2: Identify the base.

- The solution that turns the red litmus paper blue is the basic solution.

Step 3: Use the now-blue litmus paper.

- The litmus paper that turned blue in the basic solution can now be used to test the other two liquids.

Step 4: Identify the acid.

- Dip this blue litmus paper into the remaining two test tubes. The solution that turns it back to red is the acidic solution.

Step 5: Identify the neutral solution.

- The last remaining solution, which did not change the color of either the red or the blue litmus paper, is the distilled water (neutral solution).

Problem: A student tests a liquid with a turmeric paper, and it stays yellow. Then, she tests it with phenolphthalein, and it remains colorless. Finally, she tests it with blue litmus paper, and it turns red. What is the nature of the liquid?

Step 1: Analyze the Turmeric test.

- Turmeric stays yellow in acidic or neutral solutions. So, the liquid is either an acid or neutral.

Step 2: Analyze the Phenolphthalein test.

- Phenolphthalein stays colorless in acidic or neutral solutions. This confirms the liquid is either an acid or neutral.

Step 3: Analyze the Blue Litmus test.

- Blue litmus turns red only in an acidic solution.

Conclusion: Since the blue litmus paper turned red, the liquid is definitively acidic.

v. Summary of Main Concepts

- Indicators are substances that change color to identify acids and bases.
- We use indicators for safety, as we cannot taste all substances.

- Acids turn blue litmus red. Examples: Lemon juice, vinegar.
- Bases turn red litmus blue. Examples: Soap, baking soda.
- Neutral substances cause no change in litmus paper. Example: Pure water.
- Natural Indicators include Litmus, Turmeric, and China Rose.
- Synthetic Indicators include Phenolphthalein.
- Each indicator has a unique set of color changes that you need to remember. The summary chart is the best tool for this.