Acid and Base Indicators: How Do You Know What the pH of a Solution Is?

Indicators provide a quick and convenient way to measure a solution's pH. Indicators are themselves either a weak acid or a weak base, able to exchange protons with the solutions they are testing via an equilibrium reaction. Because the protonated and unprotonated forms of the indicator are different colors they give a quick visual indication of the pH.

Watch Video 1

Observe Part 1

Predict: What color do you think the indicator will be when mixed with each of the common household chemicals?

I predict that the rust and stain remover will turn red and be acidic, the baking soda will turn green and be basic, the vinegar acidic, the glass cleaner basic, and the liquid hand soap basic.

Watch Video 2

Observe Part 2

Explain: How close were your predictions? Were there any results that surprised you?

Most of my predictions were correct except for the baking soda and liquid hand soap. I know that baking soda reacts with acids, so I was expecting it to be basic; however, the baking soda did not seem to dissolve very well so maybe that was the problem. I was surprised to learn about all the additives that are put into hand soap to lower the pH.

Identify an Experimental Design Flaw

How could using tap water instead of distilled water affect the indicator?

Tap water can contain many dissolved gases, salts, and minerals. These contaminants can affect the pH of the solution as well as potentially react with the samples being tested.

Refine/Expand the Experiment

How could you modify the experiment to give quantitative results instead of just qualitative?

The different forms of the indicator absorb light at different wavelengths. Since the indicator changes color as the result of an equilibrium reaction, multiple species will be present in solution with their prevalence determined by the pH. By using a spectrophotometer to measure the relative absorbances of the indicator, the true pH of the solution could be determined.

Practice Scientific Reasoning

How did the color of the cabbage compare to the color of the indicator solution? What might you infer from this about the pH of the cabbage?

The prepared indicator solution was blue in color; whereas, the cabbage was an intense red color. The indicator solution with the acid added to it was red. From this I can deduce that the cabbage cells that contain the color are acidic.

Watch Video 3

Connect to Your World

Carbon dioxide can react with water to form carbonic acid. However, no matter how much dry ice was added, the first cylinder did not change color. Why do you think this was?

If you look carefully you can see that the solution has changed color slightly, so the pH has been lowered. Furthermore, each indicator changes color at a different pH, so it is entirely possible for the solution to be below the tipping point for the final three cylinders but not the first. This implies that there is a limit to the amount of carbon dioxide that can dissolve in water, and hence a minimum pH that can be achieved.

Learn More by Exploring This Link

Acid-Base Solution https://phet.colorado.edu/en/simulation/acid-base-solutions

At-Home Extension

Red cabbage is not the only natural pH indicator, many brightly colored fruits and flowers can be used as an indicator. Select several different specimens to extract with hot water. You can use vinegar to acidify the solution, or an ammonia based clean to basify it. Record the changes in color associated with each sample you tested.

In School

For an introduction to natural indicators, we recommend the following kit:

360Science™: Design a Natural pH Indicator https://www.flinnsci.com/360-science-design-a-natural-ph-indicator/