

21C Acids, Bases, and pH

What is pH?

Life exists inside a certain range of pH values. A pH value describes whether a solution is acidic, basic (alkaline), or neutral by describing the concentration of hydronium ions in a solution. An acid is a substance that produces hydronium (H_3O^+) ions when dissolved in water, and a base (or alkali) is a substance that produces hydroxide (OH^-) ions when dissolved in water. Neutral solutions have equal numbers of H_3O^+ and OH^- ions.

In this investigation, you will learn the pH of several common solutions by making a pH scale using a pH indicator and chemicals of known pH. You will also identify two 'mystery' chemicals with your pH scale.

Materials (per group)

- 2 or 3 well plates depending on the size (need 12 wells)
- Permanent marker
- Eyedroppers or pipettes
- 5 mL of red cabbage juice (a pH indicator)
- 12 each red and blue litmus papers (pH indicators)
- 2 mL each of the 12 solutions listed in the data table
- Two 250 mL beakers – one contains warm water for rinsing pipettes, one empty beaker for discarded rinse water



WARNING — This lab contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

1 Stop and think

Look at the table in the investigation. Using the pH values listed, predict whether the antibacterial soap will be acidic or basic and whether the apple juice will be acidic or basic. Of the solutions in the list, to which are they most closely related?

2 Doing the experiment

A. Make a pH scale using indicators

1. To create your pH scale, you will be using solutions 1 to 7 in the table below. Place the following labels for these solutions in order on a well plate. If you don't have seven wells in a row on one well plate, place two plates side by side. The labels should describe the solution and its pH: Lemon – pH 2, Vinegar – pH 3, Seltzer water – pH 4, Red cabbage juice (the control) – pH 6.5, Baking soda – pH 8.5, Bar soap – pH 10, and Ammonia – pH 11.
2. Using a pipette, place three drops of red cabbage juice in each of the seven labeled wells.

- Using a pipette, add two drops of each of the solutions to the appropriately labeled well. Use a different eyedropper or pipette for each solution. However, if you must use the same dropper or pipette, thoroughly rinse it in fresh water after each solution before using it for a new solution. Record the color changes in your data table. The color series you see on the plate(s) represents a pH scale. We will refer to it as the pH test plate. You will use it to identify the pH of other solutions.
- Dip the red litmus paper and the blue litmus paper into each well of the pH test plate. Record the results according to the directions in the data table.

Name of solution	Color when mixed with red cabbage juice	Red litmus paper: if paper turns blue, write "base" or make an "x"	Blue litmus paper: if paper turns red, write "acid" or make an "x"	pH
1. Lemon				2
2. Vinegar				3
3. Seltzer				4
4. Red cabbage juice				6.5
5. Baking soda solution				8.5
6. Bar soap solution				10
7. Ammonia				11
8. Green tea				
9. Antibacterial cleaner				
10. Apple juice				
11. Mystery solution A				
12. Mystery solution B				

B: Using pH indicators to measure unknown pH

1. Repeat steps A2 through A4 for solutions 8 to 12. Use another well plate for these five solutions. The labels should describe the solution. At this point, you do not know the pH of these solutions.
2. Identify the pH of solutions 8 to 12. Compare the color reactions and the litmus paper results for solutions 8 to 12 with the pH test plate.

3 Thinking about what you observed

- a. What is the role of a pH indicator? What is the range of pH measured by each of the indicators you used (red cabbage juice, red litmus paper, blue litmus paper)?

- b. Which of your solutions has the highest concentration of H_3O^+ ions? Which has the highest concentration of OH^- ions? Explain your reasoning.

- c. The red cabbage juice used in the investigation has two roles. It is the pH indicator and, in the series on the pH test plate, it is a control. Why is a control needed on the pH test plate?

- d. Mystery solutions A and B are identical to two other solutions you used in this lab. Use your results to identify these solutions. What is the identity of mystery solution A? What is the identity of mystery B? List evidence to support your claims.

- e. List the pros and cons of using red cabbage juice and litmus paper as pH indicators.

- f. Various professions use pH indicators. For example, photographers traditionally used and still sometimes use stop bath in developing, and swimming pools are maintained using information from pH indicators. Find out how these pH indicators work in these (or other) situations, and what the color changes mean.
