



RED CABBAGE CHEMISTRY

OBJECTIVES

Students will explore acid and base by using red cabbage juice as a pH indicator to test the pH of common household liquids.

ESSENTIAL QUESTIONS

- Why does red cabbage work as a pH indicator? And is it a reliable and accurate indicator?
- Do all the acids or bases change the indicator the same color? What do you think this means?
- Does adding a larger quantity of an acid or base change the color more?

MA STATE FRAMEWORK(S)

6.MS-PS1-8

MATERIALS NEEDED

Each group needs:

- eight 5-ounce paper cups, containing vinegar, lemon juice, milk, 7-Up or Sprite, baking soda, Windex, and red cabbage juice indicator
- 7 pH indicator strips
- Red Cabbage Chemistry worksheet (attached)
- 2 red cabbages
- large pot, water, stove, strainer
- pitcher or jug
- marker
- tablespoon

PROCEDURE

Create a Demo for Students:

1) Set three glasses, side by side and fill each glass half full with cabbage juice.

2) Add a little vinegar to the first glass of cabbage juice and stir.

3) Ask students what they notice.

The color will have changed to red, which shows that vinegar is classified as an acid. All acids will turn red when mixed with cabbage juice.

4) In the second glass, add a teaspoon of laundry soap and ask students what they notice. The liquid will have turned green, indicating that the detergent chemical is a base.

5) Explain to students that you have used the cabbage juice as a pH indicator. It can tell you whether something is an acid or a base, as well as how acidic or basic it is, based on how much the color changes. Red cabbage contains a water-soluble pigment called **flavin** which is an **anthocyanin** that changes color when it is mixed with an acid or a base. Flavin is a pigment found in cabbage, apples skins and grapes. The pigment turns red in acidic environments with a pH less than 7 and the pigment turns bluish-green in alkaline (basic) environments with a pH greater than 7. Scientists can tell if a substance is an acid or a base by means of an **indicator**. An indicator is typically a chemical that changes color if it comes in contact with an acid or a base, but in this experiment the indicator is cabbage juice.

Gather materials and make student copies of the Red Cabbage Chemistry worksheet.

- 1) The day before the activity, make the red cabbage indicator. Boil a large pot of water and add red cabbage leaves. Boil leaves until the water is a deep purple, then strain the leaves out and place the cabbage indicator juice in a pitcher.
- 2) For each group, label eight paper cups: milk, water, baking soda, Windex, soda pop, lemon juice, vinegar, cabbage indicator. You can also have students label their own cups.
- 3) On the day of the activity, fill each cup halfway (or less) with its respective liquid or powder (a tablespoon of baking soda). Double up on the Windex cup to prevent it leaking through. It does not take much indicator before one can see a color change, so small amounts of the cabbage indicator from its cup will be added to each of the seven cups of other liquids.

With the Students

- 1) Divide the class into small groups and hand out a worksheets and send each group to a station to work.
- 2) Instruct student groups to pour a small amount of the "cabbage indicator" cup into the seven cups of different liquids and a powder- only enough indicator until a color change appears. Have students record their observations on the worksheet and rank the test items based on their pH values (1 = lowest pH, 7 = highest pH).
- 3) Have students use pH-indicator strips to measure and record the pH of the liquids in each cup.
- 4) Students should discuss in their groups and complete the worksheet questions.
- 5) Lead a class discussion to compare results and conclusions, and make the connection to real-world applications.
 - How did your results from the red cabbage pH indicator compare to the pH indicator strips? What are similarities and/or differences? (Listen to student experiences; answers will vary. From most acidic to most basic, the pH values of the tested items are: lemon juice [2], vinegar [3], soda pop [4], milk [6], pure water [7, neutral], baking soda [9], Windex [11, an ammonia solution].)
 - What other acids and bases do we encounter every day? (Listen to student ideas. Example everyday acids and their typical pH values: Battery acid [0], citrus fruit juices [citric acid] such as in lemonade [2-3], tea [4-6], bananas [5], black coffee [5+], rainwater [5-6], shampoo [varies, usually slightly acidic]. Example everyday bases: Egg whites [8], antacids [9-10], soapy water [12], bleach [13], oven cleaner [13], liquid drain cleaner [14]. Oven cleaners are designed to have pH values greater than 12 because the grease, fat and carbon found in ovens are easily dissolved in reaction with extremely alkaline [base] solutions. A range of pH values are found in the human body from highly acidic gastric acids [1] to skin [5.5] to blood [7.4]. Tums® is a base that is designed to help neutralize stomach acids. See if students want to extend the activity by testing other items of interest.)

Vocabulary:

acid: a solution with a sour-taste and low pH value.

base: a solution with a sweet taste and high pH value.

indicator: a solution that changes colors in the presence of acids and bases to help indicate the pH value.

pH: a scale that measures acidity and basicity.

EXTENSIONS & VARIATIONS

Students can make their own pH indicator strips using coffee filter paper in concentrated cabbage juice. Soak the filter paper and remove from the cabbage juice and hang by a clothespin to dry. Cut the dried paper into thin strips. Now students can dip them into a liquid to see its pH.

REFERENCE INFORMATION

Acids = low pH (0-7)

Bases = high pH (7-14)

Cabbage Color	pH
red	2
purple	4
violet	6
blue	8
blue-green	10
green-yellow	12

Data Gathering

1. Pour a small amount of the red cabbage indicator liquid into each of the seven cups of different liquids. Add just enough of the indicator until you see a color change. Record your observations, and rank them based on their pH, using this scale: 1= lowest pH, 7 = highest pH

Solution	Color	Cabbage Color pH	Ranking
Lemon Juice			
Baking Soda			
Milk			
Vinegar			
Soda			
Windex			
Water			

2. Use pH indicator strips to measure and record the pH values in the table below.

Solution	Strip Color	pH
Lemon Juice		
Baking Soda		
Milk		
Vinegar		
Soda		
Windex		
Water		

