Science and Art with Acids and Bases

Introduction

Red cabbage juice has been used in science classrooms for years to introduce students to acids and bases. In this variation, creativity flows as students combine their scientific and artistic skills to make unique, colorful patterns on blotting paper treated with red cabbage indicator solution. A great integrated learning activity!

Concepts

- Acids vs. bases
- Indicators
- pH scale

Materials

Household substances, various
Universal indicator, red cabbage extract, 0.4–0.6 g
Water, distilled or deionized, 300 mL
Balance, 0.1-g precision
Beaker, 400-mL
Blotting paper, 30 cm × 48 cm
Container, plastic (larger than 10 cm × 12 cm)
Cotton swabs
Gloves
Paper towels
Scissors or paper cutter
Spatula
Stirring rod
Weighing dish

Safety Precautions

Some household chemicals are toxic by ingestion or inhalation and are skin and eye irritants. Avoid contact of all solutions with eyes and skin and clean up spills immediately. All food-grade items that have been brought into the lab are considered laboratory chemicals and are for lab use only. Do not taste or ingest any material in the lab and do not remove any remaining food items after they have been used in the lab. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Please follow all laboratory safety guidelines. Please review current Safety Data Sheets for additional safety, handling, and disposal information.

Preparation (Must be completed at least 4–5 hours in advance of the lab.)

1. Cut each sheet of blotting paper into 12 rectangular pieces, each approximately 10 cm × 12 cm, one per student.
2. Cut one 10 cm × 1 cm blotting paper test strip for each student.
3. Fill a 400-mL beaker with 300 mL of distilled or deionized water.
4. Measure a small amount (0.4–0.6 g) of red cabbage extract powder into a weighing dish.
5. Stir the red cabbage extract powder into the beaker of water.
6. Pour the red cabbage indicator solution into a plastic container.
7. Place no more than three of the larger rectangular pieces of blotting paper into the plastic container. Wait about 30 seconds to allow the blotting paper to absorb the indicator solution.
8. Wearing rubber gloves or using tongs, carefully remove the blotting paper pieces from the solution and lay them out on paper towels to dry.
9. Repeat steps 6–8 for the remainder of the blotting paper pieces.
10. Allow the treated blotting paper pieces to dry completely, about 4–5 hours.
11. See the *Tips* section for preparation of household solutions.

Procedure

1. Obtain one 10 cm × 1 cm test strip of prepared blotting paper, a paper towel, and several cotton swabs.

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2. Dip one end of a cotton swab into one of the prepared household solutions. Dab excess solution on a paper towel if necessary.
3. Lightly dab the wet end of the cotton swab on the test strip.
4. Observe and record the color change.
5. Identify the solution as acid, base or neutral based on the following general guidelines—acids produce reddish-pink to lavender colors, bases produce bluish-greens to yellows, and neutral solutions produce a purple to blue color.
6. Dip the other end of the cotton swab into another household solution, dabbing excess solution on a paper towel.
7. Lightly dab the new solution on another spot on the test strip. Be careful not to place the spots too close together, as the solution may spread somewhat.
8. Repeat steps 2–7 three more times, using a fresh cotton swab tip each time. Reserve a few cotton swabs for your final artwork.
9. Obtain a 10 cm × 12 cm piece of blotting paper.
10. Choose three to six solutions to create a colorful piece of art. Use a variety of dots, lines, arcs, and other patterns. *Note:* Removing some of the dry cotton from the end of a clean swab may help create a smaller spot or line of color.
11. Allow the finished artwork to dry on a fresh paper towel.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Red cabbage indicator solution may be disposed of down the drain with an excess of water according to Flinn Suggested Disposal Method #26b.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
MS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions
Disciplinary Core Ideas: High School
HS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions

Science and Engineering Practices
Developing and using models
Constructing explanations and designing solutions

Crosscutting Concepts
Patterns
Cause and effect
Structure and function
Stability and change

Tips

- The following household substances are suggestions for classifying acid–base solutions with the red cabbage indicator.

Ammonia, household	Laundry detergent
Antacid tablet	Lemon juice
Baking powder	Liquid dish soap
Baking soda	Mouthwash
Club soda	Soft drinks
Dishwasher detergent	Vinegar
Drain cleaner	Vitamin C tablet
Grapefruit juice	Water, distilled and tap

- Dissolve solid substances in a small amount of distilled or deionized water. Tablets may be crushed with a mortar and pestle or between layers of waxed paper.
- Household solutions may be placed in labeled containers such as plastic cups, small jars or beakers, well plates, or test tubes for student access. Set up several material dispensing stations around the room to avoid congestion.

- Advise students regarding smelling chemicals in the lab. Substances with a strong odor such as ammonia should be kept in a container with a lid or in a stoppered test tube.
- The red cabbage indicator solution may produce an unpleasant odor over time. Refrigerate in a tightly-sealed container if the solution will not be used for a few days. Long-term storage is not recommended.
- Some of the colors produced may fade with time. Laminating the finished artwork will preserve the color intensity for a longer time period.
- If your school has a die cut machine, cut the completed artwork into appropriate shapes such as beakers, flasks, and test tubes. Or create a message for your classroom by cutting the artwork into letter shapes.
- This activity is an excellent and fun way to introduce acids and bases along with their application in industry, health, and the environment.
- Red cabbage extract is available from Flinn Scientific (Catalog No. U0014) and comes with a color chart for more quantitative results. Please note that not all red cabbage extract is alike! This procedure was tested with Flinn's U0014 Red Cabbage extract. Other sources may not produce expected results or may require a higher concentration solution.
- This activity is available from Flinn Scientific as a student laboratory kit, "Chem"-eleon Indicators (Catalog No. AP7018).

Discussion

Acids are compounds that release hydrogen ions (H^+, the same as a proton) in solution. Acids are corrosive, sting if they contact broken skin, and taste sour. *Bases* are compounds that release hydroxide ions (OH^-) in solution. Bases feel slippery as solutions, are corrosive, and have a bitter taste. (*Note:* Taste should never be used to identify a lab chemical, and chemicals should not be touched with the bare skin.)

To express the concentration of hydrogen ions in solution, a term called *pH* (potential of hydrogen) is used. The *pH scale* ranges from 0–14. If the concentration of H^+ ions is greater than the concentration of OH^- ions, then the substance is considered acidic and has a pH value lower than 7. Conversely, if the concentration of OH^- ions is greater than the concentration of H^+ ions, then the substance is basic and has a pH value greater than 7. If the H^+ and OH^- ion concentrations are equal (as in pure water, H_2O), the substance is neutral, with a pH value of 7. Figure 1 provides pH values for some common substances.

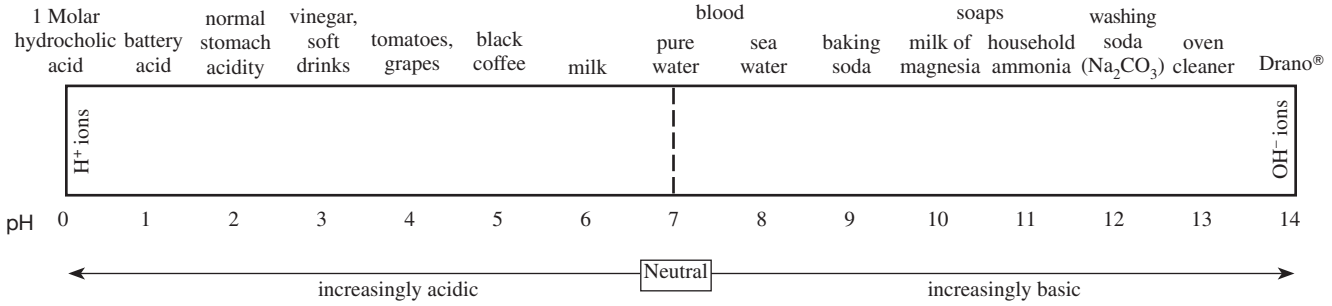

Figure 1. pH Values for Some Common Substances

Red cabbage contains water-soluble pigments called anthocyanins. A solution prepared from red cabbage extract acts as an indicator because it will react with various solutions and change color depending on the pH of the solution.

Materials for *Science and Art with Acids and Bases* are available from Flinn Scientific, Inc.

Catalog No.	Description
U0014	Universal Indicator, Red Cabbage Extract, 10 g
FB0678	Blotting Paper, 10 sheets
AP1737	Cotton swabs, 300/pkg
AP7018	"Chem"-eleon Indicators—Student Laboratory Kit

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.