Acid Or Alkali? Testing With Cabbage

Topic

Using vegetables as an acid/base indicator

Introduction

Forensic scientists need to discover if someone has tampered with liquids (e.g., cosmetics, cleaning products, cooking oils) at a crime scene. Perhaps someone has added acid to the victim's tea? One step in their analysis is an assessment of the acidity or alkalinity of the liquid. Such an assessment indicates the concentration of hydrogen ion (H^+) in the solution. The pH scale is a useful guide to the "power of hydrogen ions" in a solution; it runs from 0 to 14, with 0 representing a very acidic solution and 14 a very alkaline solution. Pure water is neutral, having a pH of 7. In the laboratory, the scientist uses various indicators, such as PHydronian paper and universal indicator solution, to detect the pH of a mystery solution. But even without such equipment, you can reveal the acidity or alkalinity of a solution using the color of vegetables as an indicator. In the first part of this experiment, you will take red cabbage, extract the color into water, and make testing papers. In the second part of the experiment, you will observe color changes when solutions of known acidity and alkalinity are dropped onto the test strips. In the third part of the experiment, you will use the strips to test the acidity/alkalinity of various household products.

Time required

Part A: 1 hour (including time for the liquid to stand and the paper towel to dry)
Part B: 20 minutes
Part C: 20 minutes

Materials

100 g red cabbage
sharp vegetable knife
150 ml boiling water
plate or saucer
pencil or waterproof pen
safety glasses
white paper towel (approximately 25 × 25 cm)
3 × 80 mm watch glasses (or white plates)
5 – 10 ml of 0.5M sodium hydroxide (10 g dissolved in 500 ml water) in a small container
5 – 10 ml of water in a small container
5 – 10 ml of lemon juice in a small container
eyedroppers (one for each test solution and one for each household product)
cutting board
600 ml beaker
plastic spoon
30 cm ruler
scissors
rubber gloves

household products to test:
- antacid (if using a tablet, crush thoroughly and mix with water)
- vinegar
- household cleaning products
- aspirin (crush the tablet thoroughly and mix with water)
- shower gel
- shampoo

Safety note

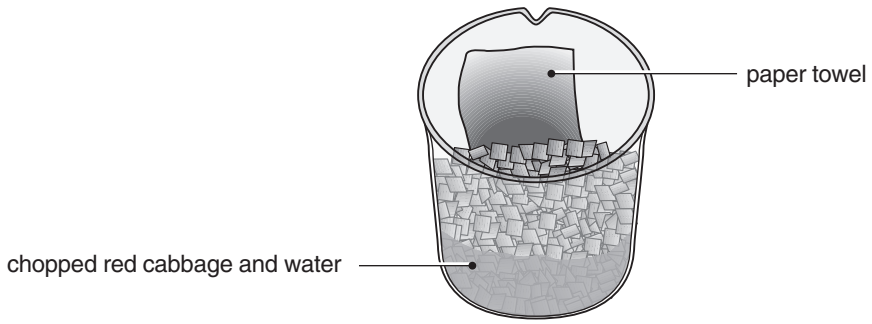
Be careful when using the sharp knife to chop the red cabbage. Sodium hydroxide is corrosive. Be careful not to get any of the liquids in your eyes. Wear safety glasses, especially when pouring liquids. Wear rubber gloves to chop the red cabbage and to handle the colored paper towel. Many household products contain dangerous chemicals. Ask your teacher to help you select appropriate products. Read all the safety precautions on the labels of their original containers before beginning the experiment. If any of the products carry "skin irritant" warnings, wear rubber gloves.

Procedure

Part A: Making the indicator

1. Place the red cabbage on the cutting board and chop into pieces about 0.5 cm square.
2. Half fill the beaker with chopped cabbage. *Be careful because the pieces of red cabbage could stain any items with which they come into contact.*
3. Pour 150 ml boiling water over the pieces of cabbage in the beaker and press down the cabbage into the water using the plastic spoon.
4. Cover the beaker with a plate or a saucer to keep the heat in and leave for about 30 minutes. At the end of this time, much of the color will have moved from the cabbage to the water, making a purplish solution.
5. Fold the paper towel four times and place in the beaker to soak up the colored liquid (see diagram 1 below).
6. When the paper towel has soaked up as much liquid as possible, remove it from the beaker and allow it to dry in a warm place. (Put on rubber gloves before handling the colored paper towel.)

1

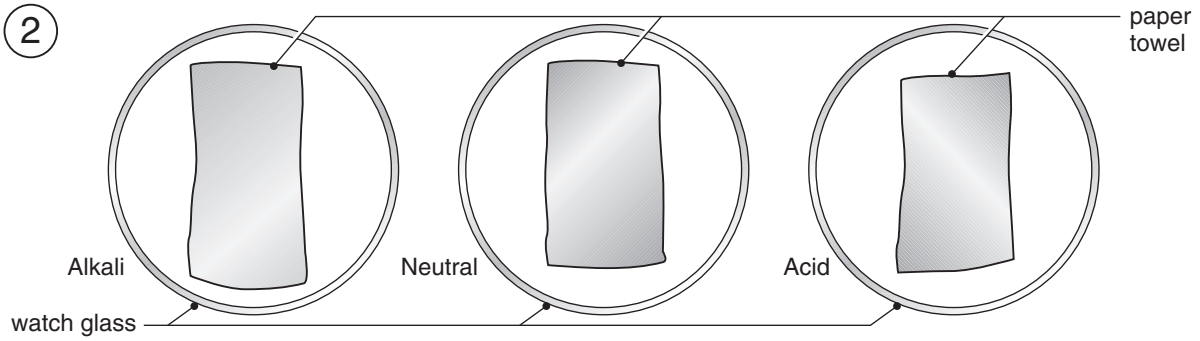


Paper towel soaking up the colored liquid

Part B: Acid/alkali color changes

1. Use the scissors to cut three pieces of the colored paper towel, each approximately 3 × 6 cm.
2. Place each piece of paper towel on a watch glass or plate. Label each test strip "Alkali," "Neutral," and "Acid" (see diagram 2 below) using a pencil or waterproof pen.
3. Using a clean eyedropper for each liquid, drop one or two drops of each liquid (Alkali – sodium hydroxide; Neutral – water; Acid – lemon juice) onto the correspondingly labeled piece of paper towel."
4. Observe the color changes. Record your findings (even if there is no color change) in data table A below.
5. Keep the test strips safely for later comparison.

2



Indicator papers on the watch glasses

Part C: Testing household products

1. Place a piece of red cabbage indicator paper on a watch glass.
2. Use an eyedropper to drip one drop of the test household product onto the indicator paper.
3. Observe the color change (if any). Record your findings in data table B on the next page.
4. Repeat steps 1 to 3 for other household products.

DATA TABLE A

	Solution	Color change
Alkali	sodium hydroxide solution	
Neutral	water	
Acid	lemon juice	

DATA TABLE B	
Solution being tested	**Color change**
Antacid	
Vinegar	
Shower gel	
Shampoo	

Analysis

Part A: Making the indicator

1. What did the pieces of chopped red cabbage look like after the experiment?
2. What do you think happened to the cabbage?

Part B: Acid/alkali color changes

1. What color changes did you see?
2. How can you use the color from red cabbage as an acid/base indicator?

Part C: Testing household products

1. Compare the color changes seen here with those from Part B.

Want to know more?

Part A: Making the indicator

1. The pieces of red cabbage looked much paler than before the boiling water was poured over them.
2. The color from the cabbage had moved into the water.

Part B: Acid/alkali color changes

1. Our data table looked like the one below.

DATA TABLE A

	Solution	Color change
A	sodium hydroxide solution	green
B	water	no change
C	lemon juice	bright pink

2. Sodium hydroxide is an alkali; thus, any liquid that turns red cabbage indicator green must be an alkali.
   Water is neutral; thus, any liquid that leaves red cabbage indicator unchanged must also be neutral.
   Lemon juice is an acid; thus, any liquid that turns red cabbage indicator pink must be an acid.

Part C: Testing household products

1. Products that turn red cabbage indicator paper green are alkalis (i.e., they have a pH between 7 and 14). Those that do not turn the indicator paper as bright a green as sodium hydroxide are less alkaline than sodium hydroxide (i.e, they have a lower pH). Antacid tablets turn the indicator paper pale green, showing that they are alkaline, but less alkaline than sodium hydroxide. Certain household cleaning products will also turn the indicator paper green.

Products that turn the red cabbage indicator paper pink are acids (i.e, they have a pH between 7 and 0). Those that do not turn the indicator paper as bright a pink as lemon juice are less acidic than lemon juice. Vinegar turns the indicator paper pale pink, showing that it is acidic, but less acidic than lemon juice. Aspirin also turns the indicator paper pale pink, showing is it slightly acidic.

Special Safety Note To Experimenters

Each experiment includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is absolutely essential that you read, copy, and remain mindful of the General Safety Precautions that follow this note. Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Be prepared for unexpected dangers by following basic safety guidelines the entire time you are performing the experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each experiment you are preparing to perform, and that you will remember them. Except in rare instances, the general precautions listed below will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say **BE CAREFUL WITH HOT LIQUIDS or DON'T CUT YOURSELF WITH THE KNIFE** does not mean that you should be careless when boiling water or cutting a section of a stem for microscope work. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out from a qualified adult that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to check the individual experiments in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:

—Clear all surfaces before beginning experiments
—Read the instructions before you start
—Know the hazards of the experiments and anticipate dangers

PROTECTING YOURSELF:

—Follow the directions step-by-step; only do one experiment at a time
—Locate exits, fire blanket and extinguisher, gas and electricity shut-offs, eyewash, and first-aid kit
—Make sure there is adequate ventilation
—Act sensibly at all times
—Wear an apron and safety glasses
—Do not wear open shoes, loose clothing, or loose hair
—Keep floor and workspace neat, clean, and dry
—Clean up spills immediately, being careful to follow the recommended procedure for dealing with the spilt substance
—Never eat, drink, or smoke in the laboratory or workspace
—Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:

—Set up apparatus far from the edge of the desk
—Use knives and other sharp or pointed instruments with caution
—Pull plugs, not cords, when removing electrical plugs

—Don't use your mouth to pipette liquids; use a suction bulb
—Check glassware is clean and dry before use
—Check glassware for scratches, cracks, and sharp edges
—Report broken glassware immediately so that it can be cleaned up by a responsible person
—Do not use reflected sunlight to illuminate your microscope
—Use only low voltage and current materials such as lantern batteries
—Be careful when using stepstools, chairs, and ladders

USING CHEMICALS AND BIOLOGICAL MATERIALS:
—Never taste or inhale chemicals
—Label all bottles and apparatus containing chemicals
—Read labels carefully
—Avoid chemical contact with skin and eyes (wear safety glasses, lab apron, and gloves)
—Do not touch chemical solutions
—Wash hands before and after using solutions
—Wipe up spills thoroughly
—Use sterile procedures when handling even common and harmless microorganisms
—Avoid contact with human blood
—Treat all living organisms with appropriate respect

HEATING SUBSTANCES:
—Wear safety glasses, apron, and gloves when boiling water
—Keep your face away from test tubes and beakers
—Use test tubes, beakers, and other glassware made of Pyrex™ or borosilicate glass
—Use alcohol-filled thermometers (do not used mercury-filled thermometers)
—Never leave apparatus unattended
—Use safety tongs and heat-resistant mittens
—If your laboratory does not have heat-proof workbenches, put your Bunsen burner on a heat-proof mat before lighting it
—Take care when lighting your Bunsen burner; use a Bunsen burner lighter in preference to wooden matches
—Turn off hot plates, Bunsen burners, and gas when you are done
—Keep flammable substances away from heat
—Keep sheets of paper and other flammable objects away from your Bunsen burner
—Have a fire extinguisher on hand

FIELDWORK:
—Be aware of environmental dangers (e.g., do not carry out fieldwork near dangerous roads, cliffs, or water)
—Remember that strong sunlight can be dangerous – pack sunscreen and a good supply of drinking water if you will be outside all day
—Never carry out fieldwork in areas where you cannot find your way to safety easily and quickly and never wander off on your own in search of new areas to study

FINISHING UP:
—Clean your work area and glassware (follow any instructions given by a supervising adult)
—Be careful not to return chemicals or contaminated reagents to the wrong containers
—Don't dispose of materials in the sink unless instructed to do so
—Wash your hands
—Clean up all residues and put in proper containers for disposal
—Dispose of all chemicals according to all local, state, and federal laws
—Dispose of all microbiological cultures by treatment with an appropriate disinfectant

BE SAFETY CONSCIOUS AT ALL TIMES