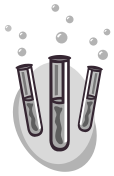

Plant Indicators for Acids and Bases

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Topic

Acid/base indicators

Time

Preparation by teacher 50 minutes; Part B, 45 minutes

Safety

Adult supervision is required. Please click on the safety icon to view the safety precautions.

Materials

For teacher

½ pint blueberries
½ pint radish skins
⅛ head red cabbage
water
400-mL beaker or saucepan
three labeled dropper bottles
Bunsen burner, hot plate, or stove
0.1 *M* HCl (.3 mL of 12 *M* HCl added to 1L distilled water)
0.1 *M* NaOH (4.00 g NaOH added to 1 L distilled water)
vinegar (unknown A)
diluted household ammonia (unknown B; 1 part ammonia to 3 parts distilled water)

For student

12 small test tubes and test-tube rack
marking pencil
10-mL graduated cylinder
dropper pipette
distilled water

Procedure

Part A: Teacher Preparation of Indicators

1. Indicator solutions should be fresh for this procedure. Store for no more than 2 days in the refrigerator.
2. In a 400-mL beaker, place about ⅛ head of chopped red cabbage, and fill beaker with distilled water to about 300 mL total volume.
3. Heat (do not boil) for about 40 min.
4. Pour the indicator solution into labeled dropper bottles.
5. Repeat steps 2 to 4 for blueberries and for radish skins.
6. Prepare the solutions of HCl and NaOH. To prepare the HCl solution, add 8.3 mL of 12 *M* HCl to 500 mL distilled water. Stir and then bring level of water up to 1,000 mL.

PART B: STUDENT PREPARATION AND TESTING OF STANDARD SOLUTIONS

1. Calibrate the pipette by counting how many drops are needed to increase the volume in the graduated cylinder by 1 mL. To find how many drops are needed to deliver 0.5 mL, divide the number of drops determined above in half.
2. Label five clean test tubes 1 to 5.
3. Into tube 1, add 5 mL 0.1 *M* HCl (pH = 1).
4. Using the pipette, transfer 0.5 mL of the solution in tube 1 to tube 2.
5. Using the graduated cylinder, add 4.5 mL distilled water to tube 2, and mix well. Tube 2 now contains a $^1/_{10}$ dilution or 0.01 *M* HCl (pH = 2).
6. To prepare tube 3, remove 0.5 mL from tube 2. Then add 4.5 mL distilled water to tube 3. The concentration of tube 3 is now $^1/_{10}$ that of tube 2, or 0.001 *M* (pH = 3).
7. Prepare test tubes 4 and 5 in the same manner, always transferring 0.5 mL from the previous test tube and adding 4.5 mL distilled water.
8. Rinse the dropper pipette with distilled water after preparing test tubes 1 to 5.
9. Now label five clean test tubes 6 to 10. Follow the dilution procedures in steps 3 to 8, but start with a 0.1 *M* solution of NaOH (pH = 13) in tube 6. Transfer 0.5 mL of that solution into tube 7. Add 4.5 mL distilled water to tube 7 (which will have a pH of 12), and so on.
10. Now add 3 drops of the same indicator—blueberries, radishes, or cabbage—to each test tube (1 to 10), and record the resulting solution colors on the data table. Save the solutions for Part C.

DATA TABLE

Indicator used: _____

Test tube	Solution color with indicator	pH
Acid standard solutions		
1		1
2		2
3		3
4		4
5		5
Test tube	Solution color with indicator	pH
Base standard solutions		
6		13
7		12
8		11
9		10
10		9

Part C: pH of an Unknown Solution

1. Obtain 5 mL of an unknown solution that your teacher has prepared (unknown A) in a clean test tube, and add 3 drops of indicator solution. Match the color of the unknown solution to one of your standard solutions; record the tube number and the pH value.
2. Repeat step 1 using your teacher's other unknown solution (unknown B). Record the tube number and pH of the matching standard solution.
3. Pour all solutions down the drain.
4. What color was the indicator solution you began with? What range of colors did you get when it was added to an acid ranging from pH 1 to 5? When it was added to a base ranging from pH 13 to 9?
5. Based on your results, what was the approximate pH level of unknown A? Was it an acid or a base? Weak or strong?
6. Based on your results, what was the approximate pH level of unknown B? Was it an acid or a base? Weak or strong?
7. Compare your results with those of students using different indicators. Did you all identify the same pH levels for unknowns A and B? Explain.

What's Going On

Colors of unknowns will vary according to indicator used. The pH of vinegar ranged from 1 to 5. The pH of household ammonia ranged from 9 to 13.

Connections

Scientists use a pH scale as a measure of acidity (the hydrogen ion concentration of a solution). Solutions having a pH less than 7 are considered acidic; those with a pH greater than 7 are basic. Frequently, scientists use indicators, such as litmus paper, to determine pH. (Indicators are substances that signal the occurrence of a chemical reaction by a color change.) Many plants also contain pigments that have acid/base indicator properties. In this experiment, you prepared standard acidic and basic solutions of known pH values, observed and recorded indicator colors for each pH value tested, and determined the pH of an unknown solution by comparing it to the indicator colors you have prepared.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say "be careful with hot liquids" or "don't cut yourself with the knife" does not mean that you should be careless when simmering water or stripping an electrical wire. 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, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don't use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- 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 thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES