Name______________________________

Date_______________ Class_______________

EXPERIMENT D17

Household Indicators

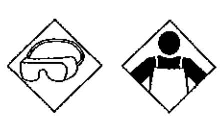
- **Extract** anthocyanins from red cabbage leaves.
- **Prepare** a pH indicator paper with the red cabbage anthocyanins.
- **Construct** a color indicator chart for anthocyanins from red cabbage.
- **Compare and evaluate** the accuracy of indicator papers for recording pH values of common items.

A visual indicator is a chemical substance that reflects the nature of the chemical system in which it is placed by changing color. Most visual indicators are complex organic molecules that exist in multiple colored forms, one of which could be colorless, depending on the chemical environment. Many visual indicators are used to test a solution's acidity.

Acid-base indicators respond to hydronium ion concentrations, $[H_3O^+]$. Acidic solutions have an excess of H_3O^+ ions, while basic or alkaline solutions have few H_3O^+ ions. A measure of the $[H_3O^+]$ is pH. Chemists use *p* to mean "power," so pH means the power of the hydronium ions. Formally, pH is defined as the negative logarithm of the $[H_3O^+]$ of a solution.

The most common acid-base indicator is litmus, a blue coloring matter extracted from various species of lichens. The chief component of litmus is azolitmin. Widely distributed among the higher plants, anthocyanins constitute most of the yellow, red, and blue colors in flowers and fruits. Anthocyanins are excellent acid-base indicators because they exhibit color changes over a wide range of pH values. Red cabbage is a ready source of this pigment. Unlike litmus and anthocyanins, universal indicator is a mixture of various synthetic indicator molecules. Universal indicator provides pH scale coverage from 1 to 14 pH units.

In this investigation, you will extract the pigment from red-cabbage leaves and use it to prepare strips of pH indicator paper. You will use these paper strips to test the pH of common household materials. Then you will compare your results with pH tests made with litmus and universal pH paper.



Always wear safety goggles and a lab apron to protect your eyes and clothing. If you get a chemical in your eyes, immediately flush the chemical out at the eyewash station while calling to your teacher. Know the location of the emergency lab shower and the eyewash station and the procedures for using them.

Do not touch any chemicals. If you get a chemical on your skin or clothing, wash the chemical off at the sink while calling to your teacher. Make sure you carefully read the labels and follow the precautions on all containers of chemicals that you use. If there are no precautions stated on the label, ask your teacher what precautions you should follow. Do not taste any chemicals or items used in the laboratory. Never return leftovers to their original containers; take only small amounts to avoid wasting supplies.

Call your teacher in the event of a spill. Spills should be cleaned up promptly, according to your teacher's directions.

Never put broken glass in a regular waste container. Broken glass should be disposed of properly.

Do not heat glassware that is broken, chipped, or cracked. Use tongs or a hot mitt to handle heated glassware and other equipment because hot glassware does not always look hot.

- 0.1 M CH_3COOH
- 0.1% household ammonia
- 0.1 M H_3BO_3
- 0.1 M HCl
- 0.1 M $NaHCO_3$
- 0.1 M NaOH
- household materials:
  ammonia, apple, distilled water, fresh egg, grapefruit, fruit jelly, ginger ale, lemon, milk, milk of magnesia, molasses, orange, mineral water, sauerkraut, sweet potato, tomato, salt water, and tap water
- 250 mL beakers
- clothespins
- colored pencils (red, rose, purple, blue, green, yellow)
- dropper bottles for acid solutions
- 9 cm diameter filter paper
- forceps
- hot mitt or pot holder
- hot plate
- litmus paper, neutral
- medicine dropper
- metric ruler
- red cabbage
- fine-point scissors
- 6-well spot plate, white
- string
- universal pH paper, (1–14 pH units)
- wax pencil

Part 1: Extracting anthocyanins from red cabbage

1. Choose a red-cabbage leaf that has a dark purple color. Tear the leaf into small pieces.

2. Fill a 250 mL beaker 2/3 full with the leaf pieces. Add enough distilled water to just cover the pieces of cabbage leaf. Place the beaker on a hot plate, and bring the water to a slow boil. Continue heating for 5 minutes. Then turn off the heat, and allow the mixture to cool for 10 to 15 minutes.

Part 2: Dyeing indicator strips

3. Using a hot mitt, remove the beaker from the hot plate. Carefully decant the cooled purple liquid into a second 250 mL beaker. Dispose of the cabbage-leaf material as directed by your teacher.

4. Using a pencil, write your initials on six filter paper circles. Using forceps, submerge the filter paper into the beaker containing the cabbage extract. Make sure that the papers are thoroughly wet. Then, using forceps, remove the filter papers from the beaker and allow them to dry thoroughly.

Day 1 / Day 2

5. After drying, use scissors to cut from the filter paper 30 individual strips, each measuring 1 cm × 6 cm.

Part 3: Constructing a color indicator chart for the anthocyanin-dyed pH paper

6. Use a wax pencil to label six wells in a spot plate 1 to 6.

7. Following the table below, add 10 drops of each named acid or base solution to its labeled well.

1	2	3	4	5	6
0.1 M CH_3COOH	0.1% household ammonia	0.1 M H_3BO_3	0.1 M HCl	0.1 M $NaHCO_3$	0.1 M NaOH

8. Into each of the six wells, dip a separate strip of the indicator paper prepared in **Part 2.** Record the color in **Data Table 1.** Rinse off the well plates.

Data Table 1

pH	Substance	Indicator color
1.0	0.1 M hydrochloric acid, HCl	
2.9	0.1 M acetic acid, CH_3COOH	
5.2	0.1 M boric acid, H_3BO_3	
8.4	0.1 M sodium bicarbonate, $NaHCO_3$	
11.1	0.1 M ammonia, NH_3	
13.0	0.1 M sodium hydroxide, NaOH	

9. Use colored pencils and the entries in **Data Table 1** to fill in the following color indicator chart.

pH color chart for anthocyanins extracted from red cabbage

1	2	3	4	5	6	7	8	9	10	11	12	13	14

Part 4: Comparing and evaluating the accuracy of indicator papers

10. Test each item listed in **Data Table 2** with universal pH paper, litmus paper, and the anthocyanin paper prepared in **Part 2.** Test each of the liquids listed by placing 10 drops of the liquid in a spot-plate well. Test the juice of each solid. Record the pH values in **Data Table 2.**

Data Table 2

Common substance	Measured pH	pH (neutral litmus paper)	pH (anthocyanin dyed paper)	pH (universal pH paper)
Ginger ale	2.0–4.0			
Lemon slice (lemon juice)	2.2–2.4			
Apple cider	2.4–2.9			
Apple slice	2.9–3.3			
Grapefruit (cut)	3.0–3.3			
Jellies, fruit	3.0–3.3			
Orange slice	3.0–4.0			
Sauerkraut	3.4–3.6			
Tomato slice	4.1–4.4			
Molasses	5.0–5.4			
Sweet potato slice	5.3–5.6			
Mineral water	6.2–9.4			
Milk	6.4–6.8			
Tap water	6.5–8.0			
Distilled water (CO_2-free)	7.0			
Fresh egg	7.6–8.0			
Salt water	8.0–8.4			
Milk of Magnesia	10.5			
Household ammonia	10.5–11.9			

Cleanup and Disposal

11. Clean all apparatus and your lab station. Return equipment to its proper place. Dispose of chemicals and solutions in the containers designated by your teacher. Do not pour any chemicals down the drain or put them in the trash unless your teacher directs you to do so. Wash your hands thoroughly after all work is finished and before you leave the lab.

1. Organizing Conclusions Do all three pH test papers cover the entire pH scale range? Use your data to support your answer.

2. Analyzing Data Which pH test paper was the most accurate within its respective pH scale range? Explain your reasoning.

3. Inferring Conclusions Suggest reasons for the variation in measured pH values.

4. **Analyzing Data** Use the pH of a fresh egg to determine the hydronium ion concentration for the egg.

1. **Inferring Conclusions** The pH of cow's milk is approximately 6.5. When milk spoils, we sometimes say it has gone sour because of the lemon-like taste it develops. From your knowledge of food pH chemistry, what is happening to the milk's pH?

2. **Designing Experiments** The acid-base indicator, phenolphthalein, is also a mild laxative and can be the active ingredient in commercial chocolate-flavored laxatives. Phenolphthalein is not soluble in water, but it is soluble in rubbing alcohol (70% isopropyl alcohol). How would you evaluate its effectiveness as an indicator?