

# pH Test Strips

## Student Activity

### What is this activity about?

Helen Free enjoyed a long career in chemistry with the passion to help others through her work. In 1953, Helen along with her husband Al and many research workers at Miles Laboratories developed a colorimetric paper test that could perform 10 tests critical to the diagnosis and maintenance of care for patients with diabetes. The test strips were so convenient and easy to use that they became an instant success and a big seller for the company. Helen Free often meets people her work has helped. Her response to their praise is, "It's a wonderful feeling, knowing that your work changed people's lives—it gives me shivers when I think about it."

Paper test strips are convenient and have varied purposes. One purpose is to determine the acid content of substances by measuring the pH, or concentration of hydrogen ions. This type of paper contains a dye that changes color within a certain range of pH values. The dye or indicator may be made from natural substances called anthocyanins, which are found in cabbage juice, flower petals, berries, rhubarb, and fruits. In this activity you will make your own pH paper using cabbage juice as the indicator, then test common household substances to determine the level of acidity or alkalinity. Comparison to universal indicator values will serve as confirmation of your results.

### What Materials do I need?

Chemical splash goggles  
Filter paper, coffee filters, or acid free 'art paper'  
Distilled water  
Cabbage juice  
Ceramic dish  
Universal Indicator Solution  
Cotton swabs (Q-tips) or disposable pipettes  
Small plastic cups

Suggested household substances for testing:

Lemon juice	Sprite
Apple Juice	Milk
Orange juice	Tea
Vinegar	Soft drinks
Toothpaste	Tomato juice
Dish soap	Pure water
Dishwasher detergent	Tap water
Laundry detergent	Shampoo
Household ammonia	Mouthwash
Baking soda solution	
Aspirin (dissolved in water)	

### What safety precautions and disposal actions must I take?

- 1) Indicators and household substances are chemicals. Wear splash goggles when working with these materials.
- 2) Label all containers of substances being tested.
- 3) Cotton swab and test strips may be thrown in the trash.
- 4) Cabbage juice may be poured down the drain.
- 5) The list of suggested household items may be flushed down the drain.

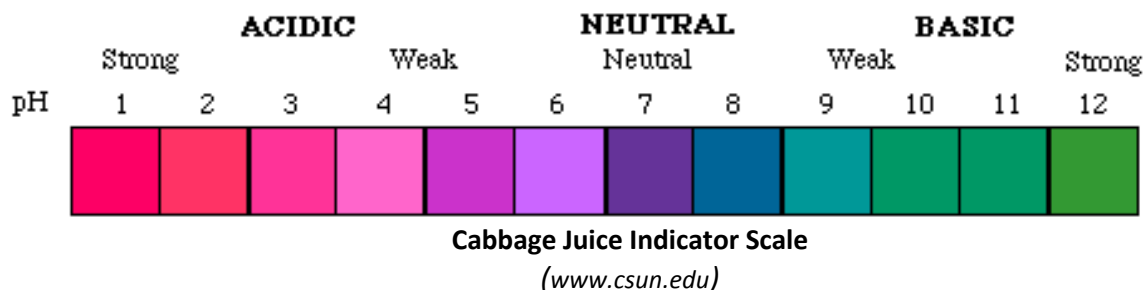
### What procedure must I follow?

#### *Day 1: Preparation of Acid-Base indicator paper*

- 1) Obtain the cabbage juice indicator from your teacher.
- 2) Pour the cabbage juice solution into a large ceramic dish.
- 3) Immerse the paper in the cabbage juice and allow it to soak until uniformly wet.
- 4) Allow the paper to dry in an area free of acid and alkaline vapors.

#### *Day 2: Testing household substances*

- 1) Carefully cut the dried indicator paper into strips.
- 3) Obtain small samples of household chemicals to test.
- 2) Dip a cotton swab into a household solution and then spread on an individual strip of indicator paper. Do not reuse cotton swab or strips of indicator paper.
- 4) Compare the color of the test strip to the cabbage juice indicator scale. Record your results on the data table.
- 5) Using the Universal Indicator Solution, repeat the test of the household substances.
- 6) Record your results in the data table.
- 7) Compare the pH values of the universal Indicator to your cabbage juice paper.
- 8) Clean up your work station by discarding all used test strips and cotton swab into waste containers. Clean all glassware. Follow your teacher's directions for discarding the household items.



### How is this activity related to my knowledge of science/chemistry? (Questions)

- 1) What is the color range of cabbage juice for an acid?
- 2) What is the color range of cabbage juice for a base?

- 3) What is an indicator?
- 4) How can an anthocyanin be used as an acid/base indicator?
- 5) Name three additional substances that could be used to make pH indicator paper.
- 6) Are most household cleaning products acidic or basic?
- 7) Are most foods acidic or basic?
- 8) Unused test strips should be stored in a tightly sealed container. Explain
- 9) Your class is going on a field trip at the local aquarium to test the acidity of the various fish tanks. What advantage(s) does the indicator paper have over the Universal indicator for this trip?

**How can I extend my learning with this activity? (Extensions)**

- 1) Use another anthocyanin for the test solution.
- 2) Construct your own pH color scale using cabbage juice.
- 3) Make a 'secret message' using cabbage juice as the developing solution.

# pH Test Strip Activity

## Teacher's Guide

### Concepts:

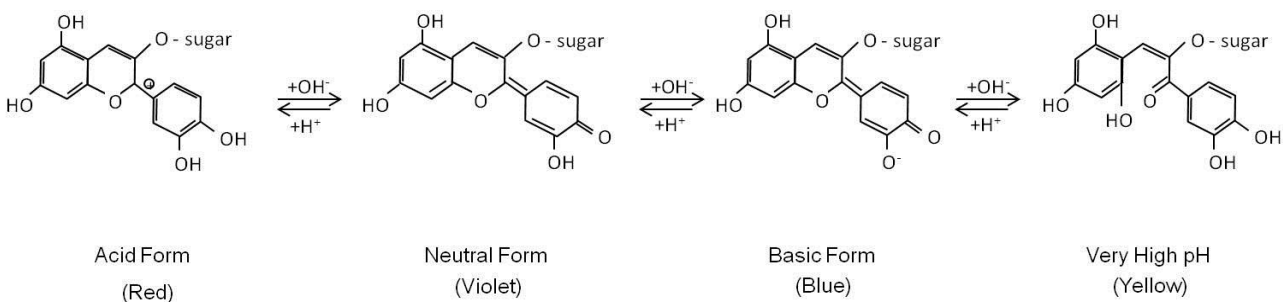
- Natural indicators (anthocyanins)
- Acid, base and neutral solutions
- Light absorption and transmission
- pH range

### Background:

Chemical compounds which change color according to the concentration of the hydrogen ion, also known as pH, are called acid-base indicators. A universal indicator exhibits a gradual change in color over a wide pH range, values from 1 - 14. Indicators are often made from natural substances called anthocyanins, which are commonly found in cabbage juice, flower petals, berries, rhubarb, and fruits. Indicators are most often found dissolved in liquids or as pH paper which special paper that has been soaked in the indicator solution and dried.

### Chemistry:

The color changes in anthocyanins are due to the gain or loss of hydroxide ions ( $\text{OH}^-$ ). This alters the wavelength at which the pigment absorbs and transmits light.



### Materials:

One head red cabbage  
Blender  
Strainer  
Large ceramic dish  
Suggested common household substances

### Procedure:

Prepare the cabbage juice solution.

- 1) Boil 500 mL distilled water in a microwave oven.
- 2) Place chopped red cabbage leaves (about  $\frac{1}{4}$  head) in a blender or food processor.
- 3) Pour the water into the blender and process until the water appears dark purple.
- 4) Let the mixture stand for 10 minutes to cool.
- 5) Strain and retain the liquid.
- 6) Add about 50 mL isopropyl alcohol to prevent growth of bacteria.
- 7) If the solution turns blue or green, add vinegar to retain the purple color.
- 8) Store this solution in a refrigerator.

Set out small cups or beakers of substances to be tested.

Test strips can be dried overnight or use a hair dryer to hasten the drying process.

Because some papers may contain bleach, the indicator solution may turn blue or green as students soak their paper. Add vinegar to the solution to retain the purple color.

### **Safety and Disposal:**

Wear goggles when handling all materials.

Store unused test papers in a jar or sealed container. Keep in a cool, dark location.

All used materials can be safely washed down the drain or disposed of in the trash.

### **How is this activity related to my knowledge of science/chemistry?**

#### **(Questions/Targeted Answers)**

- 1) What is the color range of cabbage juice for an acid?

*Red-Pink*

- 2) What is the color range of cabbage juice for a base?

*Blue-Green-Yellow*

- 3) What is an indicator?

*An indicator gives us specific information about something. For example, cabbage juice is a chemical indicator. It changes color at different pH values.*

- 4) How can an anthocyanin be used as an acid/base indicator?

*It is red in an acid and blue to green in a base. In strong bases it is yellow.*

- 5) Name three additional substances that could be used to make pH indicator paper.

*Red roses, grape juice, blueberries.*

- 6) Are most household cleaning products acidic or basic?

*Basic*

- 7) Are most foods acidic or basic?

*Acidic*

- 8) Unused test strips should be stored in a tightly sealed container. Explain.

*To keep the anthocyanins stable and away from any acids and/or bases.*

- 9) Your class is going on a field trip at the local aquarium to test the acidity of the various fish tanks. What advantage(s) does the indicator paper have over the Universal indicator for this trip?

*The paper is more convenient to transport and use. Clean-up is easier.*

### Extensions:

#### A) Preparation of pH color scale

- 1) Using a micro wellplate, place 10 drops of 0.1M HCl into well one.
- 2) Add 1 drop of this solution to well two. Add 9 drops of distilled water. Stir with a toothpick.
- 3) Add 1 drop of the solution in well two to well three. Add 9 drops of distilled water and stir.
- 4) Repeat this procedure for wells 4-7.
- 5) Add 5 drops of cabbage juice indicator and record colors.
- 6) In a second wellplate, repeat steps 1-5 replacing the 0.1M HCl with 0.1M NaOH. This activity relates pH scale to  $[H^+]$ . Students should observe a color change from red-pink-violet as the acid is diluted and a color change of yellow-green-blue-violet as the base is diluted.

#### B) Make a secret message.

- 1) Dip a cotton swab into vinegar and write a message on a piece of paper or foam board.
- 2) Allow the message to dry (2-3 min.)
- 3) Using a spray bottle, mist the invisible writing with cabbage juice.

#### C) Make an indicator infusion using dahlia, rose petals or berries in place of or as addition to cabbage juice.

### Note:

On May 1, 2010 at ETHOS in Elkart, Indiana, The Development of Diagnostic Test Strips was designated a National Historic Chemical Landmark by the American Chemical Society. Information about Test Strips, Helen Free, and the dedication can be obtained from the link in the References section.

### References:

Brownlee, Christen, *ChemMatters* **2004**, 9

Definition of Word PH Paper , eHow.com [http://www.ehow.com/facts\\_5788444\\_definition-word-ph-paper.html#ixzz1czKOXdGA](http://www.ehow.com/facts_5788444_definition-word-ph-paper.html#ixzz1czKOXdGA)

Experiments with Acids and Bases, G. Carboni, March **2004**,

[http://www.funsci.com/fun3\\_en/acids/acids.htm#6](http://www.funsci.com/fun3_en/acids/acids.htm#6)

[www.csun.edu](http://www.csun.edu)

<http://www.wikihow.com/Make-Homemade-pH-Paper-Test-Strips>

[http://www.demochem.de/p26\\_anth-e.htm](http://www.demochem.de/p26_anth-e.htm)

Lech, Jenna and Dounin, Vladimir. *J. Chem. Educ.* **2011**, 88, 1684-1686

American Chemical Society National Historic Chemical Landmarks. Development of Diagnostic Test Strips.

<http://portal.acs.org/portal/PublicWebSite/education/whatischemistry/landmarks/diagnosticteststrips/index.htm>

## Data Table

Substance	Color of Indicator Paper	Classification	Results using Universal Indicator	Do both tests agree?

### Key

**Classification:** Use these terms - weak acid, strong acid, neutral, weak base, strong base

**Universal Indicator:** Use these terms - weak acid, strong acid, neutral, weak base, strong base