Cooking Chemistry
Activity 5—Make a Natural pH Indicator Solution

Materials Needed:

- red cabbage, finely chopped (about 2 cups)
- water (about 4 cups)
- measuring cups
- large pot to boil water
- mesh strainer or colander
- either a knife with cutting board or a blender to chop up the cabbage
- variety of household/kitchen items to test (especially foods, either powders or liquids)
- 2 containers for each item tested
- pH test paper strips (provided by library)

Some ideas for items to test: antacid tablets, baking powder, baking soda, fruit juices (especially citrus), milk, vinegar, salt solution (dissolve table salt in water), sugar solution (dissolve sugar in water).

If you decide to also test household cleaners or cosmetics, be sure to take proper safety precautions! Scientists use eye protection, gloves, and close-toed shoes when working with any kinds of chemicals!

What to Do:

1. **Chop your red cabbage and boil cabbage and water together (grown up help needed).** Chop up about 2 cups of red cabbage. Boil 4 cups of water in a large pot and add the chopped cabbage, letting it cook for about 20 minutes (like you're making extra strong cabbage tea) until the water is blue-violet. You've extracted the cabbage chemicals into the water to make an *indicator solution*.

- You can make more or less, but the *ratio* of cabbage to water should be about *1:2* (meaning, the *volume* of cabbage is half as much as the water). When the water turns a blue-violet color, you are ready to move on to the next step! Alternatively, you can blend the cabbage and the boiling water together and let it sit for 20 minutes until the water turns a blue-violet color.

Notice how the cabbage leaves lose their color (pictured right).

2. **Strain the mixture to get your indicator solution.** Once you've reached the correct color, strain the cabbage mixture through a mesh strainer or colander, making sure any *solids* are separated from the *liquid.* This liquid is your *indicator solution*. You can discard or compost the cabbage.

On the right is the indicator solution with a neutral pH, on the left, some of the solution was poured into a cup, then another liquid was poured in to test.

3. **Test the pH of different items using your indicator solution and record your prediction and results on the handouts provided.** Dispense the solution into containers that you can use to test your items. As you add items to the indicator solution to test their pH, it will turn redder for more *acidic* items/solutions, or bluer for more *basic* solutions. Very strong bases will be greenish. Since the indicator is liquid, you can drop dry tablets or powders into it and stir.

(Optional) Can you change it back? After you've changed the indicator color with one of your test items, experiment to see if you can change it back to *neutral* using another test item. How would you do this?

4. **Double-check the pH using the test paper strips.** Using cups or plates, dip the end of the strip into fresh supplies of the items you tested before. The indicator paper strips will come with a pH color scale telling you what the pH is. Is this method easier to use? Does the universal indicator paper seem more precise? Use the worksheet to predict what colors you'll get, and compare your *natural indicator* to the *universal indicator paper*.
    - For dry ingredients, you will need to dissolve them in water to make a *solution* that you can dip your strip into.
    - Don't dip the strips in anything you plan to eat or drink!

STEAM Connections

In this activity, you're exploring pH, acids and bases, an important concept in chemistry. pH is the measurement of how *acidic* or *basic* something is. Pure distilled water, at room temperature, has a *neutral* pH of 7. An *acid* will have a *lower pH*, while a *base* will have a *higher pH*. According to the universal indicator scale:

- a *strong acid* will have a pH between 0 and 3 (these will turn the cabbage solution very red)
- a *weak acid* will have a pH between 3 and 6
- a *neutral* solution will have a pH of 7
- a *weak base* will have a pH between 8 and 11 (these will turn the solution blue)
- a *strong base* will have a pH between 11 and 14 (these will turn the solution green)

Foods and their ingredients are usually acidic or basic. Your stomach has acid in it to dissolve food, too! A food that is very acidic will have a *low pH*.

You're also engaging in math concepts like measurement, fractions (especially if you decide to multiply or divide your indicator recipe), and ratios.

How does this experiment work? *Anthocyanins* (ANTH-oh-SIGH-uh-nins) are the *pigments* (water-*soluble* molecules that give something its color) that make red cabbage purple/red. Anthocyanins are a group of pigment molecules found in red, purple, and blue food plants and flowers. Anthocyanins can be from a bright red (like cherries) or blue (like blueberries), to very dark purple (like grapes) or blackish (like black beans). They one type in a bigger group of molecules called *flavonoids*.

(Optional Activity) Take it further: what happens if you soak it in an acid or a base? Do you have other vegetables, fruits, or plants that contain *anthocyanins* (maybe some berries or beets)? Make a hypothesis and then test it by soaking the fruit or vegetable in your test substances. Do you think it will change color? If not, how might you get it to change color (for example, blending or boiling it to extract anthocyanin like you did with the cabbage)? What else can you use for a natural pH indicator? How else could you get creative with this experiment using colors?

Vocabulary used in this activity:

- acid/acidic—how does the word "acid" turn into "acidic?"
- anthocyanin
- base/basic—how does the word "base" turn into "basic?"
- indicator—what does it mean to indicate something?
- pH
- pigment
- solution—mixture of a *solute* dissolved in a *solvent*; for example, in salt water (also called a *saline solution*), salt is the solute, water is the solvent.
- water-soluble—dissolves in water but still retains its chemical composition. For example, if you evaporate the water in a sodium bicarbonate (baking soda) solution, you will be left with the baking soda.

Other pH Resources:

- https://sciencing.com/acids-bases/
- https://www.thoughtco.com/home-and-garden-ph-indicators-601971
- https://www.toppr.com/guides/science/acids-bases-and-salts/natural-indicators-around-us/

pH Testing Chart

Item Tested • What are you adding to your solution or dipping your paper test strip into?	**Hypothesis** • Do you think it's an acid or a base? • What color do you think it will turn?	**Results** • What color was it? • Is it an acid or base? How strong or weak?	**Comparison and Notes** • How did the cabbage indicator compare to the universal test strip? • What is the pH?
