Episode 2

Kitchen Chemistry

Any questions?
Reach out
svcamp@engr.uvic.ca

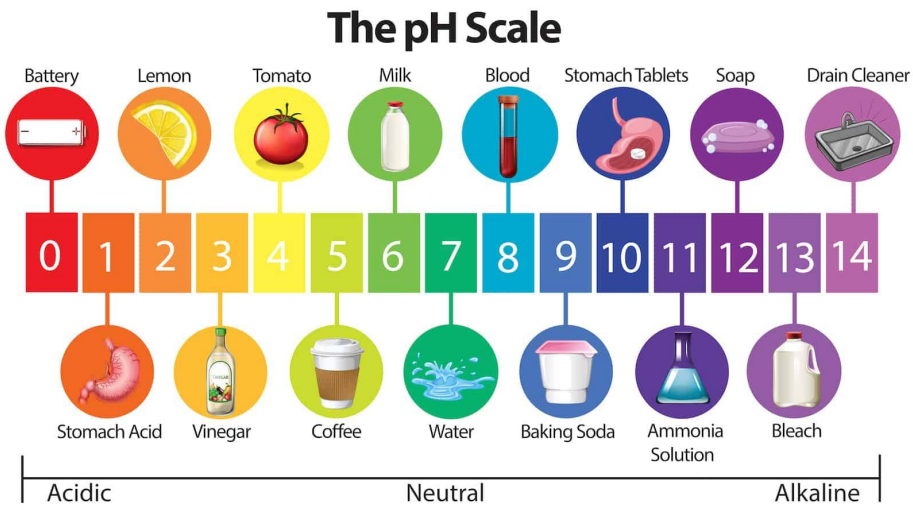
Rainbows with Cabbage Indicator

Many household substances fall into one of two categories: acids or bases. What determines if the substance is an acid or a base is how many hydrogen and hydroxide ions it releases in solution. A substance that releases hydrogen ions is acidic, whereas a substance that releases hydroxide ions is basic. Substances that are neutral give off an equal amount of both hydrogen ions and hydroxide ions. Water, which is normally considered to be neutral, can act as both an acid or a base depending on the reaction involved.

$$2H_2O \text{ --> } H_2O + H^+ + OH^- \rightarrow H_3O^+ + OH^-$$

Scientists use something called the pH scale to measure the acidity or alkalinity of a solution. A pH value of 1 is the most acidic, while a pH value of 14 is the most basic. A pH of 7 indicates neutral, where the amount of hydrogen ions and hydroxide ions is equal.

A pH indicator contains some sort of coloured substance that changes colour (and molecular structure) depending on the pH of a solution. Some pH indicators work over a wide range of pHs, whereas some only cover a specific range.



Red cabbage can be used to create a pH indicator because it contains a pigment called flavin, which changes from purple to red or blue depending on the pH of the solution it is added to. While red cabbage indicator does not offer a lot of specificity for pH, it can be used to show the difference in acidity or alkalinity between substances.

pH	pH less than 7 = Acid			pH more than 7 = Base		
	2	4	6	8	10	12
Colour	Red	Purple	Violet	Blue	Blu-Grn	Grn-Yel

Red Cabbage Indicator Colour Changes

Rainbows with Cabbage Indicator

Materials:

- Red cabbage
- Sharp knife for chopping or a blender/food processor
- Medium sized pot
- Stove
- Water
- Mixing spoons (one small one large)
- Strainer or sieve
- Solutions that you want to test the pH of, e.g. lemon juice, soap, coffee, water, tea, laundry detergent, baking soda in water, etc.
- Cups (preferably clear)

Safety Considerations:

- Strong acids and bases can burn you! Please be safe and handle with caution
- Be safe while using knives (adults only)
- Be safe while using the stove (also adults only)

Keywords

Acid: a solution that has an excess of H^+ ions

Base or alkali: a solution that has an excess of OH^- ions

Neutral: a solution that is neither acidic nor basic (i.e. has an equal amount of H^+ and OH^- ions) -- has as pH of 7

Solution: a homogeneous mixture of two or more substances

pH: a logarithmic scale used to specify how acidic or basic a solution is

Rainbows with Cabbage Indicator

Make Cabbage Indicator

This can be done in advance and kept in the refrigerator, or even frozen.

Steps

1. Pull off a few of the outer layers of the cabbage (great way to get little hands involved!) and tear them/roughly chop them into smaller pieces (you want them to be small-ish so that you can stir them around in the pot
2. Add the cabbage leaves to the pot, and cover the leaves with water -- roughly a 1:2 of cabbage to water
3. Put the pot on the stove and heat up the water; bring it to a boil, then turn it down to a simmer
4. Stew the cabbage on the stove, stirring occasionally, until the liquid is a deep purple colour
5. Remove the pot from heat and let cool
6. Once cooled, strain out the cabbage leaves and discard (or eat if that's to your liking), keeping the liquid ← this is your indicator solution! It is basically red cabbage tea.
7. Once cooled, you can use it right away, or store it in the fridge or freezer. It keeps for months in the freezer, so I often make a big batch and defrost it whenever I am doing experiments

Make Rainbow Gradient

The measurements in these instructions as a guide, but each batch of cabbage indicator is slightly different so you can adjust accordingly

Steps

1. Assemble the solutions/substances that you would like to measure the pH of. Be creative, but safe! If you choose to use a thick liquid (like soap) or a powder (like baking soda), It is recommended to mix it with water to make it easier to test.
2. Add about a quarter cup of each liquid (or solution) to a series of cups. It is recommended to use small glasses so you can better see the colour change, but it doesn't really matter.
3. To each cup, add a teaspoon of cabbage indicator and stir -- if the solution isn't neutral, you should see a colour change!
4. The colour changes depending on how acidic/alkaline the solution is:
    i. Yellow = Most Basic (pH 12-14)
    ii. Green = Basic (pH 10/11)
    iii. Teal = Slight Basic (pH 8/9)
    iv. Blue = Neutral (pH 7)
    v. Purple = Slightly Acidic (pH 5/6)
    vi. Light Pink = Acidic (pH 3/4)
    vii. Dark Pink/Red = Very Acidic (pH1/2)
5. In the video, a bunch of different household items were used to try and make a pH rainbow!