Robogals Science Challenge

Minor Challenge Set #1
STEM Field: Chemistry / Chemical Engineering
Level: Intermediate
Challenge Name: Cabbage Chemistry
Project cost: 0-20 USD
Materials Required:

- Pen and paper
- A notebook to record experimental results
- Red cabbage
- Knife, or scissors
- Boiling pot of water
- A large bowl
- Strainer or sieve
- 3-5 cups, bowls or containers to test the pH of different solutions
- Liquid droppers, pipettes or tablespoons
- 3-5 household items to test the pH of, for example:
    - Lemon juice
    - Vinegar
    - Baking soda
    - Any cleaning products

Safety:

- Be careful with handling knife or scissors when cutting and chopping red cabbage
- Be careful with hot water
- Do not consume any solution being made in this project

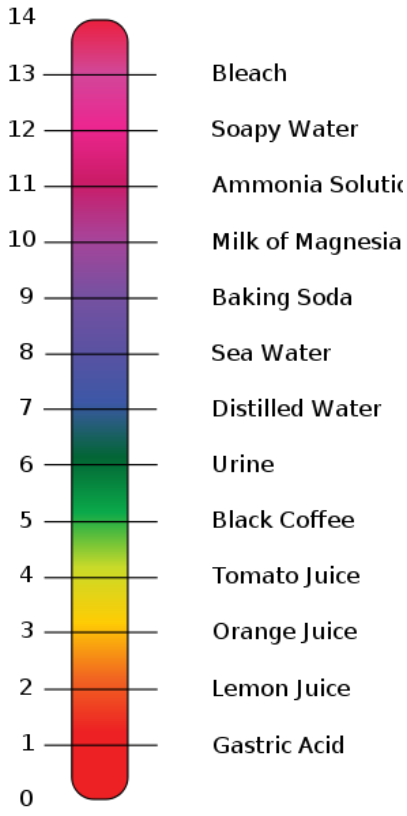
Duration:

- This challenge takes approximately 2 hours to finish, however, the time guideline is an estimation only, and students and mentors can complete the tasks around their schedules.

Introduction

In this project, we will be experimenting with some colour-changing liquid you can make with red cabbage. We will think about the pH level of some common household items, while learning about acids, bases, and how to test them.

A **solution** is a mixture of a soluble chemical dissolved in water. These solutions can be **acidic**, or **basic**, depending on the types of ions that are present in the solution. Scientists use a **pH scale** to measure how acidic or basic the solution is. The figure below shows the pH scale from 0 to 14.



From pH levels 0 to 7 are acids, with 0 being the strongest acid. From pH levels 7 to 14 are bases, with 14 being the strongest base. Strong acids and bases are very dangerous. Scientists often use them in chemical experiments in laboratories.

To tell if something is an acid or a base, you use a chemical called an **indicator**. In this project, we will make our indicator solution from red cabbage. The indicator solution will change colour depending on whether the solution is acidic or basic. The below table shows how you can estimate the pH by observing the colour.

pH	Color
2	Red
4	Purple
6	Violet
8	Blue
10	Blue-green
12	Greenish-yellow

Instruction

1. Make the “stock” pH indicator solution by finely cutting, chopping, or grating the red cabbage. Place the cabbage pieces into a large pot, as shown in figure below.

2. Boil some water in a separate pot. Once the water has boiled, pour boiling water into the cabbage pot to cover the cabbage completely.

   Safety Note: Be careful when handling hot water!

3. Leave the cabbage mixture steeping and occasionally stir for 10-20 minutes. After the liquid has turned reddish purple in colour, leave the stock solution to cool for 15-20 minutes. You should see the cabbage solution similar to the figure below.

4. Place the strainer over a second large bowl. Pour the mixture through the strainer into the large bowl, and remove the cabbage pulp. Press down on the pulp in the strainer to squeeze more liquid out of the pulp.

5. The “stock” pH indicator solution in the large bowl should be purple or blue in colour, similar to the figure below. This will be your indicator solution.

6. Pick 3-5 containers, bowls or cups to test different solutions. Add the same amount of indicator solution to each container, using a liquid dropper, pipette or tablespoon. Do not fill the containers completely with the indicator solution.

7. Record the number of drops or tablespoons of indicator solution you add to each cup in a notebook.

8. Choose 3-5 household items to test the pH level. Make 3-5 labels next to each container.

9. Add the same amount of liquid from each household item to each container. Gently swirl the container as you add the drops, being careful not to spill the solution. Record the number of drops or tablespoons of household item liquid you add to each container in your notebook.

10. Record the approximate pH level and a description of each of the solutions in your notebook like the table below.

Item	Colour	Approximate pH

11. Analyse your results. How does the pH of the different household items you tested compare to each other?

Extension: Virtual Lab - pH of Different Solutions

Navigate to the website https://phet.colorado.edu/sims/html/ph-scale-basics/latest/ph-scale-basics_en.html on your computer. It is recommended you use Chrome browser.

In this virtual lab, you can mix water with different solutions such as hand soap, milk, and orange juice. The pH indicator will tell you the pH level of the solution, and if the solution is acidic or basic.

Reflection Questions

- Are there any improvements you would make to this challenge?
- What real world application can you apply the challenge to?
- What are the key concepts of science and engineering that relate to this challenge?

- What did you learn about the pH of different solutions you made? Are you surprised by any of your results?

Submission Guidelines

- Submit pictures of your solutions, your notebook, and answers to the reflection questions.

> Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your mentor first.

- The submission form is on the Minor Challenges page: https://sciencechallenge.org.au/index.php/minor-challenges/ Fill out the details and make sure you upload your submission.

Learn More! Resources

- If you are interested in learning more about a career in chemistry, Science Buddies has an article on some of the core tasks chemists do in their jobs. https://careerdiscovery.sciencebuddies.org/science-engineering-careers/earth-physical-sciences/chemist

Bibliography

- Ducksters. "Kids science: Acids and Bases." *Ducksters*, Technological Solutions, Inc. (TSI), www.ducksters.com/science/acids_and_bases.php. [Accessed 8 February 2022].
- Science Buddies Staff. 2021. *Cabbage Chemistry* | *Science Project*. [online] Available at: <https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p013/chemistry/make-cabbage-pH-indicator> [Accessed 8 February 2022].