

Cabbage pH Indicator Experiment

Safety and First Aid

This section will only deal with the specific safety issues regarding the chemicals involved and used in the video; other safety data may be required depending on the choice of liquids investigated. There are likely to be other safety issues that will need to be addressed outside the scope of this section and a full risk assessment should be performed prior to undertaking the experiment.

In the video we used battery acid to demonstrate a very low pH solution. We highly recommend you **DO NOT** try this; battery acid is very dangerous and can cause extensive, irreparable damage to the body. We have also used some household cleaning products that may not be suitable for the students. We would recommend that these experiments be performed by the teacher as a demonstration.

- Students should not ingest any of the experiment; good lab practice starts young!
- Bleach will cause extensive burns and eye damage; minimise exposure.
- Drain and cream cleaner may cause skin irritation and eye damage; minimise exposure.
- *First Aid* – wash the affected area with water. If bleach, drain cleaner or cream cleaner are ingested, DO NOT induce vomiting; rinse mouth with water and seek medical assistance.

Glossary

- *Pigment* – a material that changes the colour of the reflected light as a result of wavelength selective absorption
- *pH* – a measure of the acidity or basicity of an aqueous solution
- *Alkaline / basic* – these terms are often used interchangeably but actually have different definitions. An alkali is a compound that forms hydroxide ions in water while a basic compound reacts with an acid to form a salt and water. Therefore, all alkalis are basic, but not all bases are alkalis

Suggested Teaching Points

- *Acids and bases* – this experiment uses acids and bases
- *Natural chemicals* – this experiment can be used to introduce the concept that chemicals found in nature can be of use to humans (i.e. as pH indicators)

- *Properties of molecules* – this experiment could be used to introduce the idea that molecules can change their properties (e.g. colour) depending on environmental conditions
- *Investigative techniques* – students could be given a selection of liquids and asked to determine their pH

What to Expect

Please see the video for a detailed depiction of the experiment.

In this experiment, we will extract the natural pigment of red cabbage and use this to investigate the pH of common household items. The pigment of red cabbage can be extracted quite easily by simply pouring boiling water over the cabbage; this removes the pigment from the cabbage.

The key to this experiment is the fact that this pigment molecule can change its shape and structure when exposed to solution of different pH. This change in shape causes the pigment molecule to reflect a different wavelength of light and thus appears as a different colour. One of the unique properties of this pigment is that it can change its structure and shape several times depending on the pH of the solution, allowing for a range of colours. The table below shows the colours this specific pigment can turn:

pH	pH < 7 (acid)				pH > 7 (alkaline or basic)			
	1	2	4	6	8	10	12	14
Colour								

The exact colour that you observe for this experiment will also be affected by the intensity of the starting purple solution. We found that it was much easier to observe the colour changes in more dilute solutions.

Equipment and Chemicals

- Half a red cabbage
- A knife
- A source of hot water. We used a kettle but this could also be done in a saucepan on a cooking hob
- A large heatproof container
- Small containers (one for each liquid to be tested)
- Something to filter the cabbage (e.g. sieve, colander, funnel with cotton wool)

- A selection of liquids to investigate

Supplementary Instructions

- Extraction of the red cabbage pigment could be done prior to the lesson. The cabbage solution will be stable for about a week if stored in an air tight container.
- We recommend diluting the initial cabbage extraction so as to observe the colour changes more clearly.
- Only add a small amount of bleach to the test. Excess bleach will degrade the pigment and result in a colourless solution (itself an interesting reaction!).
- When testing solids, after the colour change has finished, you could filter the solution into a separate container to see the colour more clearly.
- You will need to experiment on the amount of test chemical to add to get the desired colour change
- It is advised to stir each solution after addition of the test compound to ensure the mixture is mixed properly

Suggested Questions for Students

- *Is there a pattern between the products application and its pH?* – you will notice that the majority of the cleaning products (e.g. bleach, drain cleaner, toothpaste) are bases with a pH above 7. This is because cleaning products require basic conditions to work efficiently. You will also notice that the food stuffs are acidic with a pH below 7. This is because acids tend to have a sharp, bitter taste.
- *Are pH indicators always useful?* – there are numerous uses for pH indicators in everyday life. Examples are measuring the pH of swimming pool and are used in the food and chemical industry. However, pH indicators have the disadvantage that they have to be added to the sample in order to work. This could complicate further investigation of the sample as the indicator is in the sample solution
- *Is this process reversible?* – this reaction should be reversible. If vinegar is added to a sample of toothpaste, then the colour should turn from blue to red *via* the initial purple. Likewise, addition of a basic compound to an acidic sample.

Suggested Improvements / Student Challenge

- *Use Ribena or beetroot* – this experiment can also be done using Ribena or beetroot. However, Ribena does not change colour in the presence of acids.
- *Make a specific pH* – students could be challenged to make a solution of a specific pH or colour using a selection of products. For example, starting from vinegar, what needs to be added to finish with a blue colour?

Clean up and Waste Disposal

The specific waste disposal protocols for this experiment will depend upon the choice of liquids used.

Cabbage indicator solutions can be disposed of in the sink.

Spillages can be cleaned with water and paper towel.