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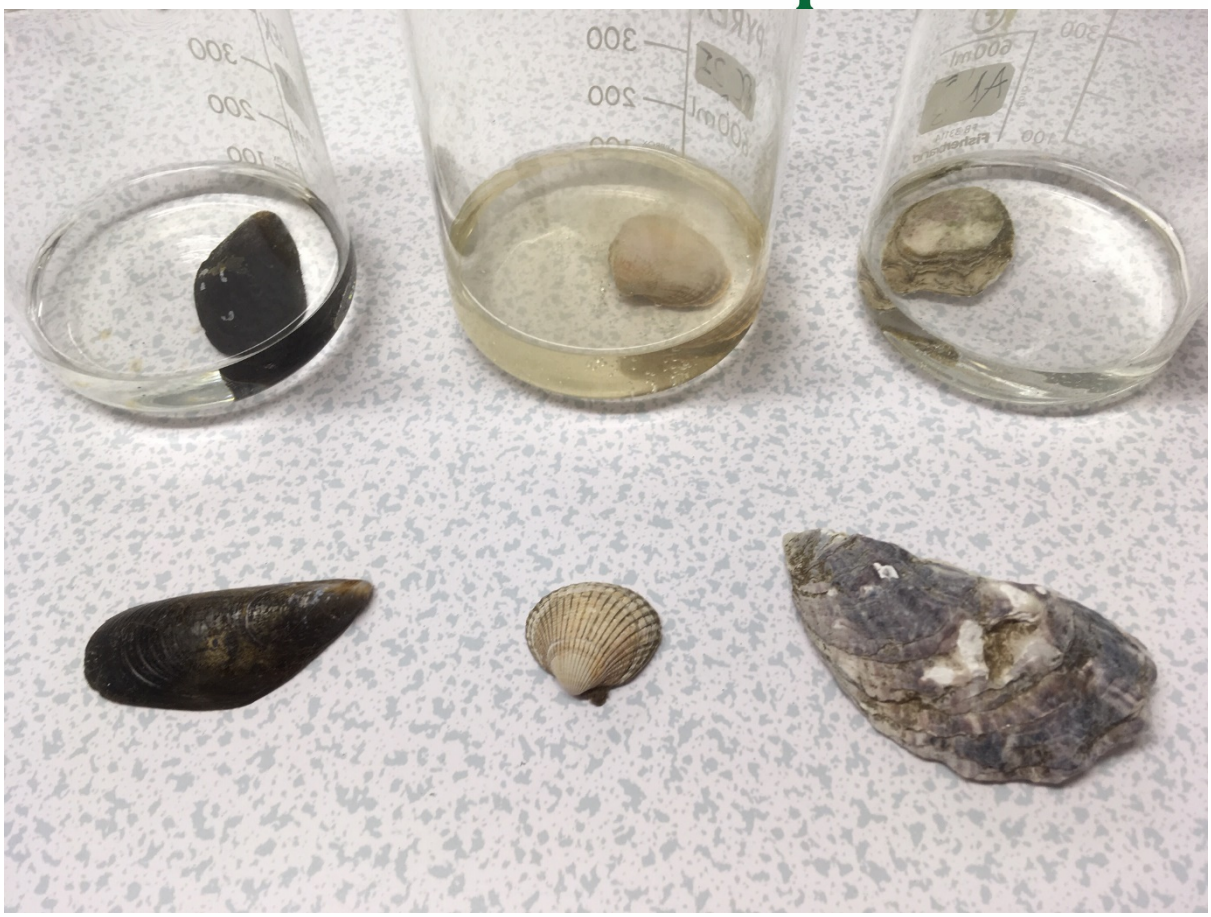
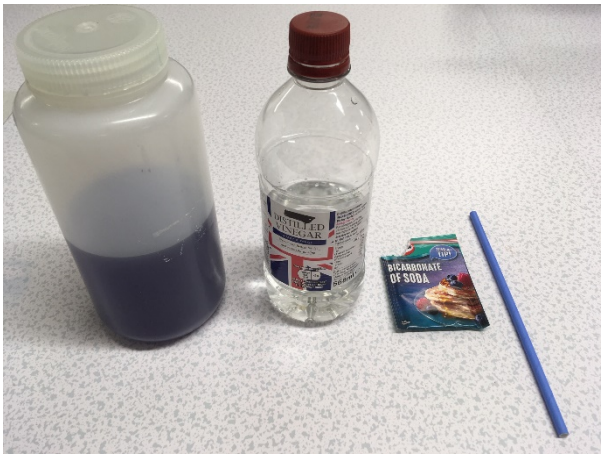


Shells on acid home experiments!

You will need:



Natural pH indicator, left of image (Soak red cabbage in boiling water for 15 mins, drain and collect)

White vinegar

Baking soda

A straw

3 clear glasses

Cockle, mussel and oyster shells or any shells from the beach!

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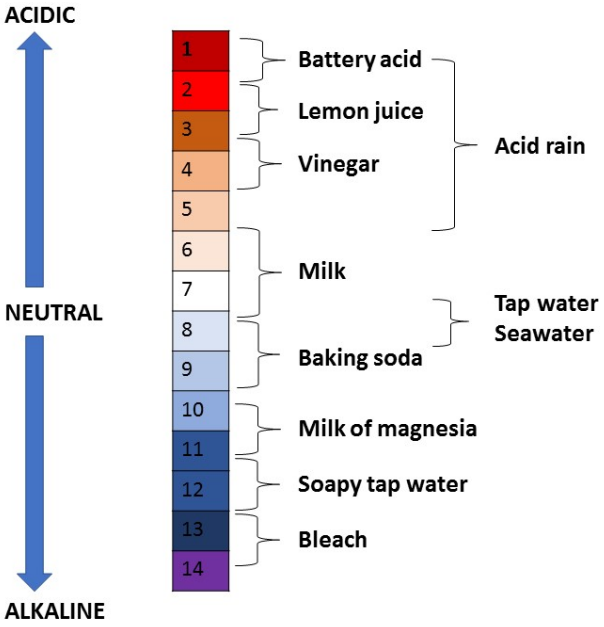
Experiment 1. Natural acids and alkalines

The pH scale is a measure of the acidity of a solution and runs from 1 to 14. An acid is formed where hydrogen ions are dissolved into a solution reducing the pH. An alkaline is formed when a solution reduces its hydrogen ions increasing the pH. The pH scale is calculated on powers of 10 of the concentration of hydrogen ions in a solution. pH 1 is the most acidic, for example battery acid, and pH 14 is the most alkaline, for example bleach, as seen in the pH scale picture below. pH 1 is 10 times more acidic than pH 2. The image below shows the pH scale with examples of common acids and alkalines.



The pH of seawater is naturally alkaline at pH 8.0. As carbon dioxide is absorbed into seawater, chemical reactions occur reducing the pH making it slightly more acidic. This process is called 'ocean acidification'.

Reactions causing ocean acidification:

CO_2 (aq) + H_2O ↔ H_2CO_3
carbon dioxide + water ↔ carbonic acid

H_2CO_3 ↔ HCO_3^- + H^+ ↔ CO_3^{2-} + $2H^+$
carbonic acid ↔ bicarbonate + hydrogen ↔ carbonate + hydrogen

The excess hydrogen ions reduce the pH of the seawater. It is predicted that by the year 2100 the pH will reduce from 8.0 to 7.7. Even though this is such a small amount, this can cause many problems for the animals that live in the seawater.

Home experiment #1:

1. Pour the cabbage juice into 3 glass jars, filling just a few inches with the dark blue/ purple juice.
2. In the first jar add white vinegar or lemon juice. Watch the colour change to pink. This is more acidic.
3. In the second jar add baking soda, watch the colour become darker blue. This is more alkaline.
4. The third jar acts as a control to show you that without the addition of an acid or a base the juice will stay the same colour.

Please see the 'how to' video link for experiment #1.

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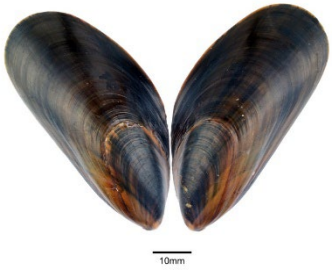
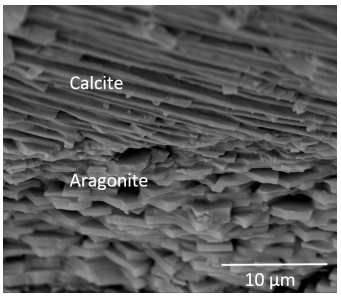
Experiment 2. Shells on acid!

Animals such as mussels, oysters and corals all grow calcium carbonate shells through a process called biomineralisation. Seashells are often in two main forms of calcium carbonate, aragonite, which is commonly called mother of pearl, and calcite. Mussel shells comprise of both aragonite on the inside of the shell and calcite on the outside of the shell. The aragonite is white and the calcite makes the blue part of the shell for common blue mussels.





In the above images, the blue calcite on the outside of the mussel shell (left) and white aragonite on the inside (middle image) of the mussel shell can be seen. The calcite and aragonite crystals can also be seen in the electron microscope image (right). The electron microscope image shows a cross section through a mussel shell from the outer calcite on the top to the inner aragonite on the bottom. The calcite crystal prisms are diagonally layers on top of the aragonite tablets which are horizontally stacked like a brick wall.

Other animal shell examples include cockles which produce aragonite only shells and oysters which produce calcite only shells. Different animals grow slightly different forms of calcium carbonate and some forms are more vulnerable to changes in seawater pH.

As the seawater becomes more acidic there are less carbonate ions for animals to form their shells. The excess hydrogen ions in the seawater break up the calcium carbonate mineral into soluble calcium and carbonate ions, causing the shell to dissolve. The below chemical reactions happen to shells in the acidified seawater releasing carbon dioxide and water:

$CaCO_3$ (calcium carbonate shells) ↔ Ca^{2+} (calcium ions) + CO_3^{2-} (carbonate ions)
Calcium carbonate ↔ calcium + carbonate

CO_3^{2-} (aq) + $2H^+$ ↔ HCO_3^- + H^+ ↔ H_2CO_3 ↔ CO_2 (aq) + H_2O
Carbonate + hydrogen ions ↔ hydrogen carbonate + hydrogen ion ↔ carbonic acid ↔ carbon dioxide and water

Home experiment #2:

1. Pour some white vinegar or lemon juice into a glass jar.
2. Place the shells in the vinegar or lemon juice.
3. Watch the bubbles form as the carbon dioxide is released.

Please see the 'how to' video link for experiment #2.

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Experiment 3: Home-made ocean acidification!

Ocean acidification happens when carbon dioxide in the air is absorbed into the seawater in the oceans. Increasing carbon dioxide in the air can come from many sources, humans, cows, and other animals breathe out carbon dioxide. Cars and factories can also produce carbon dioxide. It is predicted that future carbon dioxide in the atmosphere will continue to rise and will reduce the pH of seawater from 8.0 to 7.7 by the year 2100 (See the Intergovernmental Panel on Climate Change website link). The final home experiment will demonstrate how the carbon dioxide we breathe out can change the pH of water.

Home experiment:

1. Pour some natural pH indicator into a glass jar.
2. Place a straw in the cabbage juice and blow bubbles.
3. Watch the colour of juice change from dark purple to pink as the solution becomes more acidic.

Please see the 'how to' video link for experiment #3.

For more information about the 'Shells on acid' event or to request an alternative format for the resources please contact:

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Natural acids and alkalines worksheet

The pH scale is a measure of the acidity of a solution and runs from 1-14. pH 1 is the most acidic, for example battery acid, and pH 14 is the most alkaline, for example bleach. A natural pH indicator, such as cabbage juice, can change colour when the pH of the solution changes.

Experiment #1.

Hypotheses (What do you think will happen in the experiments?):
What do you think will happen to the cabbage juice when you pour in the vinegar?

What do you think will happen to the cabbage juice when you pour in the baking soda?

What do you think will happen to the cabbage juice if you leave it as a control for the experiment?

Results
Now watch the video for experiment #1 or run the experiments at home.
What happened to the cabbage juice when you poured in the vinegar? Did the pH of the solution change?

What happened to the cabbage juice when you poured in the baking powder? Did the pH of the solution change?

What happened to the cabbage juice after you left it for a few mins during the experiment? Did the pH of the solution change?

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Shells on acid worksheet

Animals such as mussels, oysters and corals all grow calcium carbonate shells through a process called biomineralisation. Seashells are often in two main forms of calcium carbonate, aragonite, which is commonly called mother of pearl, and calcite. Different animals grow slightly different forms of calcium carbonate and some forms are more vulnerable to changes in seawater pH. Animals which produce aragonite shells are more vulnerable to shell dissolution under ocean acidification as aragonite is 50% more soluble than calcite.

Experiment # 2.
In the demonstration video we have placed different animal shells into each of three jars of vinegar. The video demonstrates how shells with different composites of aragonite and calcite react in vinegar. The three jars, from left to right, contain the following shells with the form of calcium carbonate shell in brackets:

1. Cockles (aragonite shell)
2. Mussels (aragonite inner and calcite outer shell)
3. Oysters (calcite shell)

Hypotheses (What do you think will happen in the experiments?):
Which shells would you expect to dissolve the most in the vinegar?

Explain why?

Results
Now watch the video, after 24 hours which shells have dissolved the most?

Why did these animal shells dissolve more compared to the others?

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Home-made ocean acidification worksheet

Ocean acidification happens when carbon dioxide in the air is absorbed into the seawater in the oceans. Increasing carbon dioxide in the air can come from many sources, humans, cows, and other animals breathe out carbon dioxide. Cars and factories can also produce carbon dioxide.

Experiment #3.

Hypotheses (What do you think will happen in the experiments?):
Will the carbon dioxide in your breath make the cabbage juice in the glass change colour?

What colour would you expect the juice to change to if purple is the colour for an alkaline solution and pink is the colour for an acidic solution?

Results:

Blow bubbles through the straw in the cabbage juice or watch the experiment #3 video.

What happened to the cabbage juice in the glass jar?

Has the pH changed of the cabbage juice changed?

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