Ocean Acidification

Recommended style of activity	
Public engagement: Family drop-in activity, group demonstration	**Schools:** Teacher demonstration followed by class activity
Suggested age range: 8-15 years	
Approximate time : 5 minutes demonstration; 5-10 minutes class/group activity	

Background Science

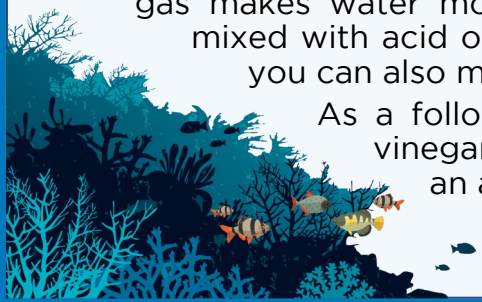
The ocean soaks up carbon dioxide (CO_2) gas from the air as part of the natural carbon cycle. As CO_2 is absorbed in water it forms an acid called carbonic acid. Human activities are adding more CO_2 to our atmosphere, which means that more is being absorbed by the ocean and the oceans are getting slightly more acidic. While this change is not enough for humans to notice, it will have a big impact on creatures with skeletons or shells made of calcium carbonate (chalk).

The changing chemistry will make it harder for these creatures, including cold-water corals, to get the ingredients they need to build their skeletons or shells from the water. This might make them more likely to become diseased or mean they grow more slowly. While the creatures are alive, they are mostly protected from the corrosive effects of a more acidic ocean but this is not the case once they have died. A lot of creatures make their home in dead coral 'rubble' and many reefs are built up on the rubble of previous colonies. In a more acidic ocean, the rubble could be in danger of collapsing, causing many creatures to lose their homes or even damaging the whole reef.

Ocean acidification is a developing area of research and scientists are running long-term experiments to help us determine the effects of a more acidic ocean as well as attempting to understand how this acidification might vary through the oceans.

In this series of experiments you can use indicators to prove that absorbing CO_2 gas makes water more acidic. These pH indicators change colour when mixed with acid or alkali liquids—some are manufactured chemicals but you can also make your own using kitchen ingredients.

As a follow-up activity, you can use household acids such as vinegar or lemon juice to demonstrate the corrosive effect of an acid on calcium carbonate shells.



Scottish Curriculum Links (CfE):

I can distinguish between living and non–living things. I can sort living things into groups and explain my decisions. **SCN 1-01a**

I can identify and classify examples of living things, past and present, to help me appreciate their diversity. I can relate physical and behavioural characteristics to their survival or extinction. **SCN 2-01a**

By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed. **SCN 2-15a**

I can explain some of the processes which contribute to climate change and discuss the possible impact of atmospheric change on the survival of living things. **SCN 3-05b**

I can discuss the environmental impact of human activity and suggest ways in which we can live in a more environmentally responsible way. **SOC 2-08a**

Kit List:

Note: Bromothymol Blue is an indicator which you can get from suppliers which provide chemicals for schools or education centres. If you cannot obtain this, or are not comfortable using it (for example with younger children) you can make red cabbage indicator instead.

If running this as a Public Engagement Activity, you can also use the A3 explanatory activity sheets—available online at www.eu-atlas.org/Education

For experiments using Bromothymol Blue:

- Bromothymol blue, diluted as suggested in the supplier guidelines or to about 1 part Bromothymol blue to 4 parts water.
- Jar or container with a loose-fitting cover (e.g. a beaker with a petri-dish on top)
- Smaller container which can be fixed to the inside of the larger one using tape.
- Bicarbonate of soda
- Vinegar/lemon juice
- (Optional extras: clear cup with a lid which has a hole for a drinking straw)

For experiments using Red Cabbage:

- Chopped red cabbage
- Hot water
- Vinegar/lemon juice
- Fizzing tablets (e.g. alka seltzer)
- Plasticine/modelling clay
- Plastic drinking straw
- Plastic bottle cap

Kit list (continued)

For the shells in acid experiment:

- A selection of small shells (a good source is craft shops/websites e.g. BakerRoss)
- Enough vinegar or lemon juice to immerse the shells
- Suitable container
- (Optional: light box or torch to assist with seeing the effects)

Bromothymol blue Experiment:

- Fill the large container around 1/4 depth with bromothymol blue
- Put a teaspoon of bicarbonate of soda into the smaller container, then use tape to attach it inside the larger one, making sure that the bottom doesn't touch the bromothymol blue.
- Pour about a teaspoon of vinegar or lemon juice into the small container—it should start fizzing! This reaction is releasing CO_2 gas.
- Quickly cover the large container with the cover or lid.
- Wait for a minute or two then look closely at the container. There should be a thin layer of yellow liquid on top of the blue. It may help to hold the cup against a white background to see it. This shows that the CO_2 from the reaction has been absorbed by the bromothymol blue, which mimics the absorption of CO_2 at the ocean surface. The colour-change is an indication that the water has become more acidic when the CO_2 is absorbed.
- You could stir the liquid with a spoon to simulate the movement of wind, waves and ocean currents mixing the absorbed CO_2 into deeper waters.
- You can demonstrate that the colour change is caused by an increase in acidity by using another clear container with bromothymol blue and adding lemon juice or vinegar—it should change from blue to yellow.

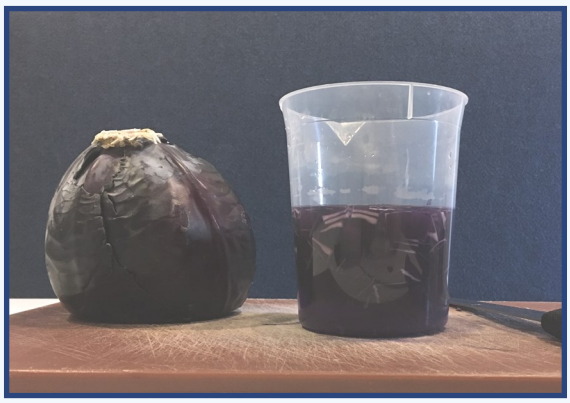
Optional Extension (performed by demonstrator/teacher):

This demonstration will show that it is CO_2 which is being absorbed and causing the colour change:

- Fill the clear cup about half-full with Bromothymol blue. Fix the lid on and push the straw in.
- Blow bubbles down the straw—after about 10 seconds the colour should change to yellow. The action of blowing bubbles mixes the air which you are breathing out into the liquid.
- Get your audience/class to make the link between humans breathing out CO_2 and the colour change which indicates an increase in acidity.

Red Cabbage indicator experiment:

To prepare red cabbage indicator:



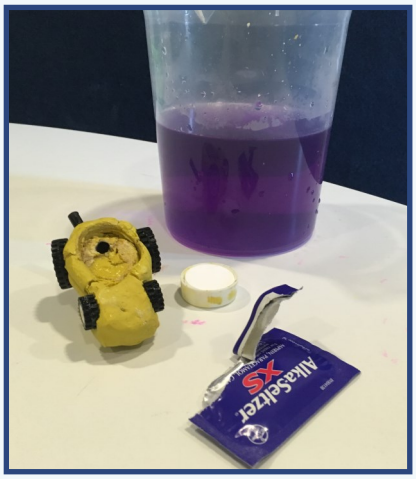
- Roughly chop around 1/2 a red cabbage.
- In a large bowl or jug, mix the chopped cabbage with boiling water.
- Leave for a few minutes then strain the cabbage out. You should be left with a dark purple liquid. This indicator will change to pink when mixed with an acid and dark blue when mixed with an alkali (such as bicarbonate of soda).

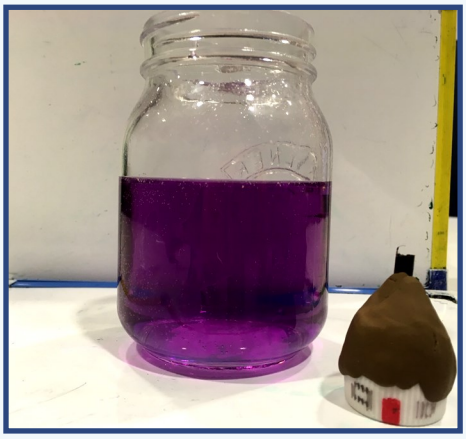
To prepare CO_2–releasing objects: (you can skip this step to save time!)

- Use small pieces of plasticine/modelling clay to mould around a straw, then build up into house or car shapes, ensuring that the straw is still sticking out at the top and bottom.
- Use the scissors to trim the straw at the bottom so that it sticks out just enough to fit inside a bottle cap. You can mould a rim around the cap to help it fit better.
- Trim the straws at the top so that they stick out a little a bit like a chimney or exhaust.

Running the experiment:

- Fill a container with the red cabbage liquid, deep enough to submerge your car or house.
- Take the bottle cap from the bottom of the car/house and fit a fizzing tablet or alka-seltzer inside it.
- Immerse the car/house in the liquid—it should start to release bubbles of CO_2 gas via the straw.





Red Cabbage indicator experiment (continued):

- After around 5 minutes look closely at the liquid—it should have turned a little bit pink. The change can be quite subtle so you might want to hold it against a white background or drop a fizzing tablet straight into the liquid to make it more obvious.
- You can also demonstrate that the colour change is caused by an increase in acidity. Use another clear container with red cabbage liquid and adding lemon juice or vinegar—it should change from purple to pink.

Acid and shells experiment:

- Put a couple of small shells into a container and cover with lemon juice or vinegar.
- If you look closely you will see small bubbles forming which show that the calcium carbonate shells are reacting with the acid—if you have a light box or torch you can use it to highlight this effect.
- If you leave the shells for more than 10 minutes you will see them become more transparent and eventually dissolve.

Although the oceans will not become as acidic as vinegar or lemon juice, over time the acidity will be enough to damage or possibly dissolve dead coral rubble.

For more oceans-themed activities and experiments, please visit https://www.eu-atlas.org/education/education-packs

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