

12. Ocean acidification

Combine solid CO_2 and chemical indicators to show acidification of water



Overview

This demonstration uses colour and state changes to show an important message about the effect of carbon dioxide on water.

What's happening?

When solid carbon dioxide is added to water, it rapidly sublimates, sending bubbles up through the liquid. As the concentration of carbon dioxide is less in the water than in the bubbles, some of the carbon dioxide can diffuse into the water to form carbonic acid. We can see this when universal indicator is added. As more carbon dioxide is bubbled through the water, it will change from green (neutral, pH 7) to yellow (weak acid, pH 5, about as acidic as coffee) then eventually orange (acidic, pH 3, vinegar).

Why is this important?

Carbon dioxide (CO_2) is a colourless, odourless gas which can dissolve in water to form carbonic acid. This can decrease the pH of the solution, whether that's a beaker of tap water, or the Atlantic Ocean. When this happens on a global scale, with increasing CO_2 from anthropogenic sources, it can have a

huge impact on ocean species. By not understanding the wider roles gases play, our actions can have unintended consequences. Ocean acidification is one example, where the sea water becomes more acidic due to absorbing more carbon dioxide, which can be devastating for sea life.

More stories to tell

Are our oceans becoming more acidic?

Since we started producing CO_2 on large scales in the industrial revolution, the pH of the surface ocean has fallen by 0.1 pH units. This represents an approximate 30 % increase in acidity and current predictions suggest that by 2100, the surface waters of the ocean will be 150 % more acidic. This is great news for algae and seagrass which use CO_2 in photosynthesis but it will reduce



the amount of biologically important carbonate, which is the building block for the skeletons of oysters, clams, sea urchins, corals and many other species. When these shell organisms are at risk, the entire food web of the ocean is at risk.

What is the pH scale?

pH can stand for 'the power of hydrogen' as the vast majority of acids contain hydrogen ions (H^+ , hydrogen atoms without an electron), while the vast majority of alkalis contain hydroxide ions (OH^- , a hydrogen and oxygen atom bonded together covalently). It's actually possible to have values less than 0 and more than 14, although the pH scale is usually shown between 0 and 14. Below pH 7 (neutral) a solution is considered acidic and above pH it is considered more alkaline.

The Activity

Before the demonstration:

1. Fill a 2 L glass measuring cylinder up to the 1800 mL mark with warm water.
2. Add a single pellet of sodium hydroxide.
3. Add 30 mL of universal indicator.

The demonstration:

1. Using a polystyrene cup or other heat resistant material, pour five pellets of solid carbon dioxide into the tube.
2. The universal indicator and sodium hydroxide will mix and the solution will be a dark purple.

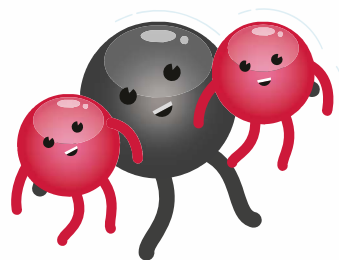
3. Continue slowly adding solid carbon dioxide pellets to the solution until the solution starts to change colour.

Disposal:

1. All materials can be washed down the sink with plenty of water.

Troubleshooting

1. Use warm water and prepare this demonstration at least 30 minutes before the show.
2. Start slowly when adding the solid carbon dioxide, and only add a little at a time. If you add too much it can spit small bits of solid carbon dioxide which may land on you and cause freeze burns.
3. This is best presented with good lighting and a white background behind the reaction vessel.
4. Do not be tempted to add more universal indicator, if there is too much the solution can just appear black until it reaches pH 5.





Health and Safety



Every delivery centre must undertake their own risk assessments for the specific audiences, locations and conditions they are presenting in. Sample assessments are available on The Secret World of Gases website. Below is a guide to the key risks and hazards:

1. Solid carbon dioxide risks. Please see the carbon dioxide handling section of the handbook.
2. Wear appropriate PPE when handling sodium hydroxide (gloves, eye protection, lab coat) and keep universal indicator away from all sources of ignition.

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SECRET GAS FACT

Carbon dioxide features heavily on the planet Mars, with over 95% of the planet's atmosphere comprised of CO₂. The permanent polar ice caps on the planet are comprised of a mixture of water ice and dry ice, and it is hoped that we can use this carbon dioxide to make clean, drinking water for future Martian missions.

