C3: GLOBAL WARMING

Overview

The Earth's atmosphere is our protective layer, shielding us from harmful cosmic rays as well as helping to maintain a relatively safe environment for us to live in.

In the 19th century scientist John Dalton worked out that this protective layer was composed of various gases, principally nitrogen and oxygen. In 1896 the Swedish chemist Svante Arrhenius introduced his theory of 'greenhouse' warming. Since then a variety of studies have shown that our atmosphere is composed of carbon dioxide, water vapour, methane, sulphur dioxide, ozone and various oxides of nitrogen. These gases absorb heat energy from Earth and so contribute to heating the atmosphere, creating knock-on effects on the global temperature.

The industrial revolution relied heavily on the burning of fossil fuels for energy, and this led to an increase of gases in the atmosphere, particularly carbon dioxide. Carbon dioxide is also emitted as part of the respiration process. There is a delicate balance between the emission of this gas and its re-absorption into nature. However, overabundance of this gas is one of the factors contributing to our changing climate and the overall rise in global temperature.

Today there is much debate about global warming or climate change. There are some who still believe global warming to be just another theory whereas over 97% of climate scientists agree that climate-warming trends over the past century are extremely likely due to human activities.
Source: https://climate.nasa.gov/scientific-consensus/.

C3 ACTIVITY 1: GLOBAL WARMING IN A BOTTLE is a small scale investigation of the effect of an overabundance of carbon dioxide.

One of the consequences of global warming is the increase in sea levels. The second activity, **C3 ACTIVITY 2: THE EFFECT OF GLOBAL WARMING ON THE POLAR ICE CAPS AND MELTING GLACIERS**, looks at two simple models to assess what happens when an iceberg in the sea melts and when an ice mass melts into the sea.

Suggested approaches:

- Ask the students to list the sources of carbon dioxide:
  - ✔ ***Respiration of all living organisms***
  - ✔ ***Plants using it as part of the photosynthesis process***
  - ✔ ***Burning of fossil fuels in homes***
  - ✔ ***Factory emissions***
  - ✔ ***Transport emissions***

Prompt the students to consider the importance of the rain forests and the global consequences of depleting these areas.

- **STRAND A: ENERGY AND SUSTAINABILITY** looks at how we manage our energy resources. Now consider the consequences of mismanaging them. This is a great opportunity for the students to enhance their research and debating skills by examining the various treaties relating to climate change:
  - ? ***Were there successful outcomes?***
  - ? ***Which countries were signatories and which were not?***
  - ? ***What reasons may have been given for an inability to comply with the proposed recommendations?***

Resources:

- The United Nations website focuses on all aspects of climate change.
- The Center for Climate and Energy Solutions website looks at climate change and energy demands.
- Click here for an overview of the main issues relating to climate change.
- The Environmental Protection Agency (EPA) website contains a wealth of excellent source material pitched at a local level, as well as a number of short videos explaining the various challenges to environmental protection.

C3 ACTIVITY 1: GLOBAL WARMING IN A BOTTLE

Background

Carbon dioxide (CO_2) is one of a number of gases that contribute to **global warming**. In this activity, students mimic the global warming effect by creating high levels of CO_2 in a bottle. This demonstrates the heating consequences of CO_2.

Equipment required (per group):

- Two large, clear plastic fizzy drinks bottles
- Alka-Seltzer tablets (or similar)
- Beaker with water
- One heating lamp (or similar)
- Two thermometers (digital thermometers give better results)
- A CD pen or other marker suitable for writing on the bottles

Suggested approaches:

- This investigation can be used as a starting point for a discussion on global warming or the carbon cycle among other topics. Before beginning, contextualise the learning with a short introductory discussion on **greenhouse gases, global warming** and their **consequences**.
- As the temperature rise is gradual, it is best if each group is given a different number of tablets.
- It is not imperative for the students to have prepared CO_2 in the laboratory before taking part in this activity. It is enough to explain to them that the effervescence indicates the release of CO_2.

What to do:

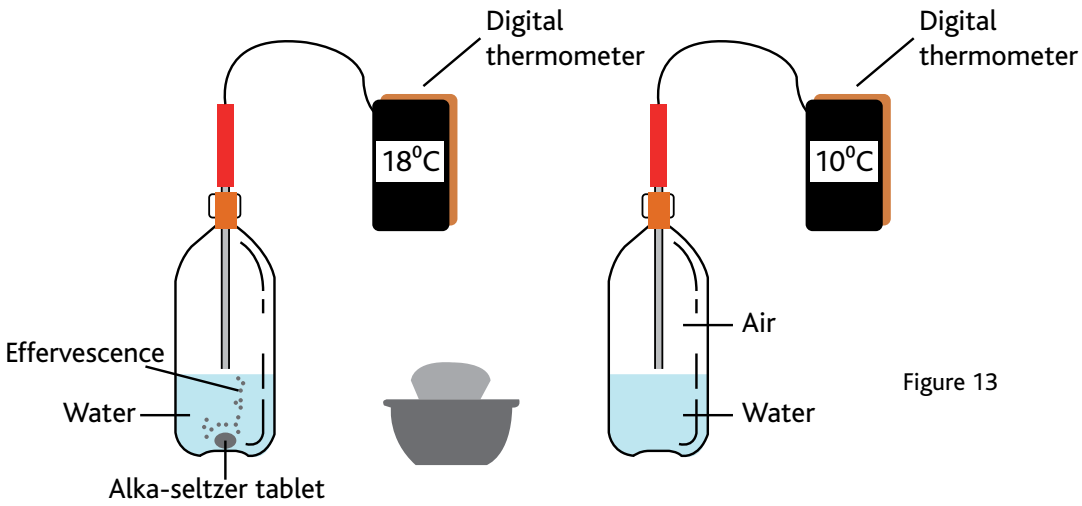

Figure 13

1. Set up the bottles as shown in Figure 13. Put equal quantities of water into each bottle (about ⅓ l).
2. Take the initial temperature of both bottles and record them.
3. Uncap one of the bottles, drop the Alka-Seltzer tablets into it and re-cap it.
4. Place both bottles at equal distances from the heater and switch it on.
5. Monitor the temperature of both bottles within an agreed time.
6. Compare your results with those of the other groups.

   ? ***Are there differences in results?***

   ? ***Why might this be?***

C3 ACTIVITY 2: THE EFFECT OF GLOBAL WARMING ON THE POLAR ICE CAPS AND MELTING GLACIERS

Background

This activity looks at how global warming affects sea levels, by looking at the difference between floating icebergs and the ice-covered landmasses of Greenland and Antarctica. Melting icebergs, no matter how large, will not result in increased sea levels, whereas chunks of ice landmass breaking (calving) from Antarctica, or melting glaciers from Greenland, will.

This activity mimics the effects of ice(bergs) melting in the waters of the oceans and ice (landmass-glaciers) melting into the surrounding oceans. The students will probably be surprised to discover that an ice(berg) melting does not contribute to a rise in water levels, whereas the ice (landmass-glaciers) melting into the water does.

Equipment required (per group):

- A drinking glass (any size)
- Two wide, transparent containers (A and B shown in Figure 14)
- Ice cubes
- Film canister (or similar) weighted with ballast, sand, small nails or pebbles, to ensure it doesn't float (D shown in Figure 14)
- Small plastic container (C shown in Figure 14)
- Marker
- Mounting needle
- Tea light
- Matches
- Water
- Salt (optional)

Suggested approaches:

- This is an ideal activity to set up at the start of the class, leave aside, and revisit later when all the ice has melted.
- Some of the groups could decide to add salt while other groups do not. At the end the groups can compare results and see if using salt water results in a marked difference from using fresh water.
- After carrying out this activity, you could present the students with an extra challenge. Place some ice cubes in a glass and fill it up to the brim. Ask the students to predict what will happen when the ice cubes melt in this container:

  ? ***Will the water overflow?***

  ? ***Will there be no change?***

  ? ***Will the water level drop in the glass?***
- If possible, take a photo of this setup for comparison between the water levels now, and later, when the ice cubes have melted.
- While waiting for the ice to melt, facilitate a discussion or a brainstorming session about climate change.

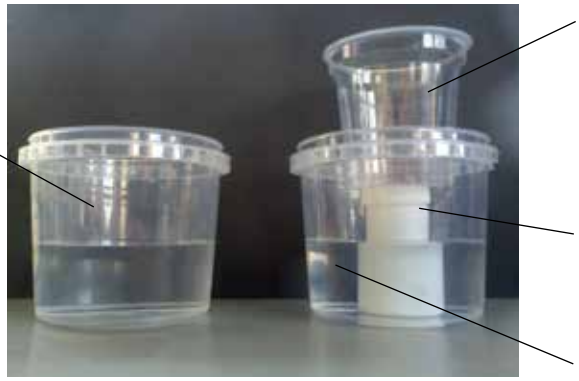

Figure 14

Suggested approaches:

- This is an ideal activity to set up at the start of the class, leave aside, and revisit later when all the ice has melted.
- Some of the groups could decide to add salt while other groups do not. At the end the groups can compare results and see if using salt water results in a marked difference from using fresh water.
- After carrying out this activity, you could present the students with an extra challenge. Place some ice cubes in a glass and fill it up to the brim. Ask the students to predict what will happen when the ice cubes melt in this container:
  - ? ***Will the water overflow?***
  - ? ***Will there be no change?***
  - ? ***Will the water level drop in the glass?***
- If possible, take a photo of this setup for comparison between the water levels now, and later, when the ice cubes have melted.
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What to do:

Preparing the equipment: Heat the mounted needle with the flame from the tea light. Make several holes in the base of container C to make it behave like a sieve.

1. Pour equal quantities of water into containers A and B. You can add salt to make salt water (but this does not change the outcome).
   - ✔ ***Explain to the class that containers A and B represent the sea.***
2. Stand item D, the weighted film canister, in container B. Make sure it does not float.
   - ✔ ***Explain to the class that D represents a landmass surrounded by sea.***
3. Mark the water level in container B.
   - ✔ ***Explain to the class that you are marking the sea level.***
4. Put some ice cubes into container A, making sure they float (i.e. make sure they are not touching the bottom).
   - ✔ ***Explain to the class that the ice cubes represent floating icebergs.***
5. Mark the water level in container A.
   - ✔ ***Explain to the class that you are marking the sea level.***
6. Put the same quantity of ice cubes into container C and place it onto D.
   - ✔ ***Explain to the class that container C with the ice cubes on it, represents the frozen ice caps of the Antarctic or Greenland.***
   - ✔ ***Ask the students to predict what will happen when the ice cubes in container A melt, and when the ice cubes in container C melt.***
7. This setup can be left aside and revisited when all the ice cubes have melted. If possible leave it in a relatively warm place to mimic global warming.