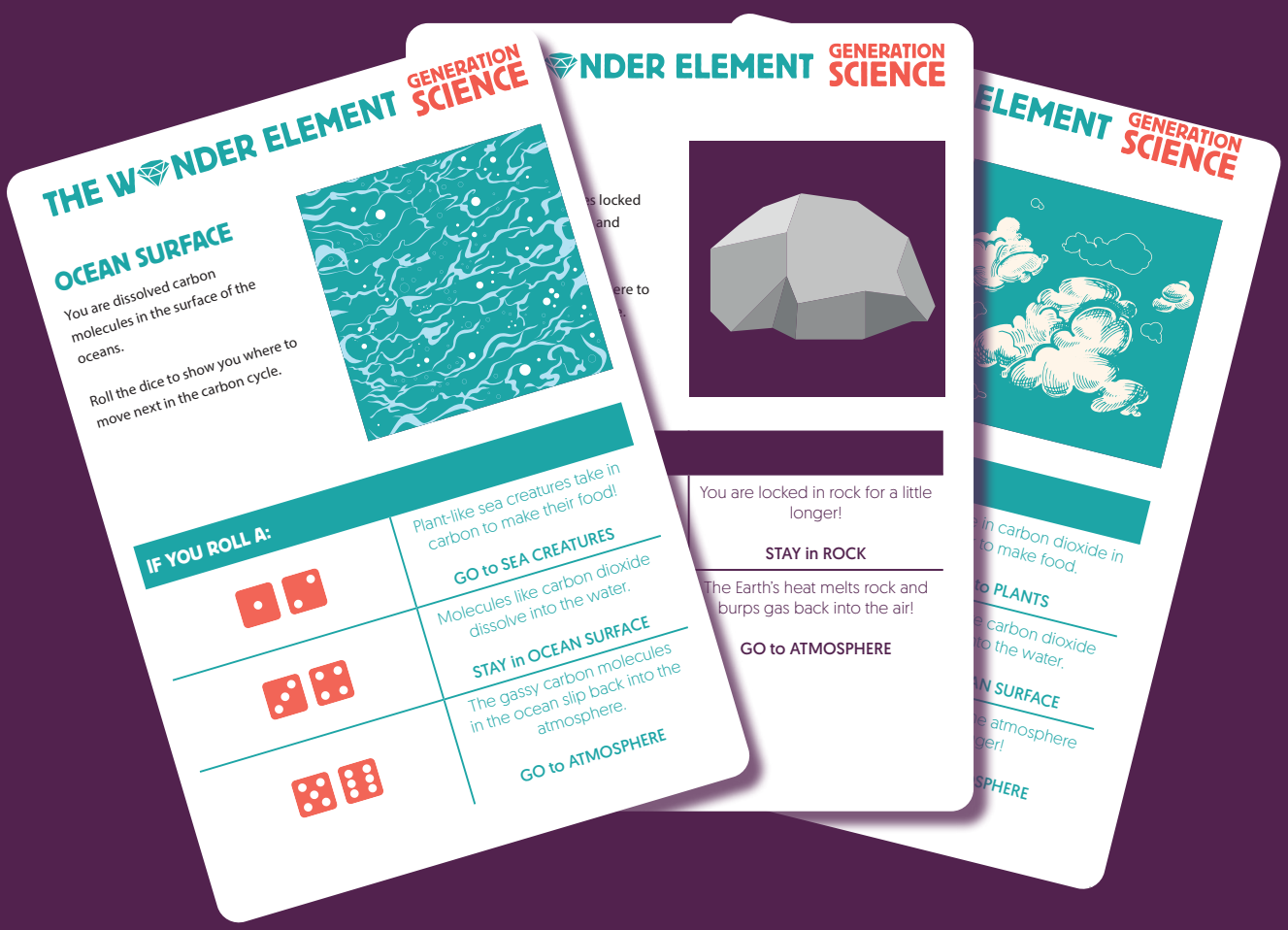
GENERATION SCIENCE

EDINBURGH SCIENCE

THE WONDER ELEMENT



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Welcome!

...TO GENERATION SCIENCE 2022
THE W  NDER ELEMENT

Generation Science has been providing unique science experiences to schools across Scotland for over 30 years. Traditionally in-person experiences, the last few years has seen us broaden our horizons with a greater focus on supporting the teachers, as well as the pupils, to deliver unique, hands-on, fun experiences within the classroom.

Our *Generation Science* workshop boxes contain everything you need to run your very own *Generation Science* experience in the classroom.

This STEM based lesson is built around the Curriculum for Excellence and includes links to videos of our expert science communication presenters, engaging activities and support resources packages.

Thank you for your ongoing interest and support of what we do and we hope you enjoy this experience as much as we enjoyed creating it.

Lastly, but by no means least, a huge thank you to our generous sponsors for their continuous support in helping to make all of this possible. Enjoy!

The Generation Science Team

CONTENTS

BOX CONTENTS

Please note, this kit contains materials which are suitable for children aged seven and above. All materials should be used under teacher guidance and supervision.

WORKSHOP KIT

1x box for citric acid powder
1x box for Alka Seltzer tablets
1x box for limestone (rock sample 2)
1x box for granite (rock sample 1)
1x box for dice
1x box for red cabbage powder
3x long handled scoops (1 for bicarb, 1 for citric acid, 1 for red cabbage powder)
2 x pop-up buckets

KIT PER PAIR OF PUPILS

2x 250ml measuring beakers
2x blue scoops
2x J cloths
1x dice
2x small plastic tubs
2x gloves (1 per pupil)
1x Set of *Experiment Cards*
1x Set of *Method Cards* (if needed)
1x Set of *Reservoir Cards* game cards
2x Carbon Graphs print

CONSUMABLES

250x wooden stirrers
50x sets large gloves
50x sets medium gloves
70x Alka Seltzer tablets
500g citric acid
250g bicarbonate of soda
50g red cabbage powder (in large plastic tub with Alka Seltzers for transit)
1x blue roll
1x A4 sticker sheet for beakers (if needed)

PRINT

1x lab rules poster
1x *Welcome Booklet*
1x set of printed Safety Data sheets (Alka Seltzer tablets, citric acid, bicarbonate of soda, red cabbage powder, limestone)
1x Printed risk assessment

THE WONDER ELEMENT: BEFORE THE WORKSHOP

DETAILS

Target Age Group: 7–11
Minimum time required: 105 minutes

AT A GLANCE

The Wonder Element allows pupils to explore how the carbon cycle works and how humans have altered the delicate balance through burning fossil fuels. Following a series of videos, pupils will carry out some simple chemical reactions and play games explaining the way that carbon moves around our planet!

SESSION OVERVIEW

The Wonder Element is delivered via a series of pre-recorded videos, after which pupils will carry out experiments or take part in an activity.
The workshop can be delivered in one or two sessions depending on what works for your class. If using all elements in one session, we recommend a break in the middle. If delivering over two shorter sessions we advise at least 60 minutes for session one [videos 1-3] and 45 minutes for session two [videos 4-6].

1. WHAT IS CARBON?	**Video**	Introduction to carbon atoms and molecules
	Activity	Pupils look for clues in the video that help them find out how much carbon certain objects contain. They use this information to plot their carbon graph.
2. CHEMICAL REACTIONS	**Video**	Introduction to chemical reactions and what they do in the carbon cycle
	Activity	Pupils write methods and carry out three simple experiments involving chemical reactions, two during the video with pause screens, and one at the end of the video
3. CARBON RESERVOIRS	**Video**	Looking at different carbon reservoirs and how carbon atoms move between them
	Activity	Pupils take on the role of a carbon atom in a game about how carbon moves around the carbon cycle
4. GLOBAL WARMING AND CLIMATE CHANGE	**Video**	Looking at how altering the carbon cycle affects our planet
	Activity	Pupils take part in an activity demonstrating global warming
5. OCEAN ACIDIFICATION	**Video**	Looking at the effects of releasing carbon dioxide on the ocean
	Activity	Pupils carry out an experiment looking at how adding extra carbon dioxide to our oceans makes them more acidic
6. THE FUTURE	**Video**	Explaining how we might help the carbon cycle in the future and looking at some extra activities
	Activity	No specific activities but pupils and teachers can plan for future sessions on the topic with follow-up activities

KEY LEARNING OUTCOMES

Pupils will be able to represent their current understanding as they:

- Describe the difference between atoms and molecules
- Recall that the carbon cycle moves carbon molecules around the world
- Identify different natural carbon reservoirs
- Design simple experimental methods

CURRICULUM LINKS

The Wonder Element complements the following experiences and outcomes:

SCN 2-19a: I have collaborated in activities which safely demonstrate simple chemical reactions using everyday chemicals. I can show an appreciation of a chemical reaction as being a change in which different materials are made.

SCN 2-20b: I can report and comment on current scientific news items to develop my knowledge and understanding of topical science.

TEACHER BACKGROUND INFORMATION

Carbon and Molecules

Carbon is the sixth most abundant element in the universe and a key ingredient for life on Earth. Its structure allows it to bond with other carbon atoms in multiple ways, so that it can form materials with extremely different properties, including hard diamond, and soft graphite. Due to the number of electrons it has orbiting its nucleus, it can also form bonds with many other elements. For this reason, it is present in numerous important molecules like DNA, hydrocarbons (including petroleum), amino acids and chlorophyll.

The Carbon Cycle

Carbon is found all over the Earth, in living and inanimate objects. Carbon moves between these stores of carbon, or carbon reservoirs, through chemical reactions and tectonic activity. For example, carbon in the atmosphere (carbon dioxide) may enter the leaf of a plant and be used to make their food (glucose). The carbon cycle is also naturally self-regulated as rising carbon dioxide in the atmosphere or the oceans cause a chain of reactions that slowly restore balance.

Carbon Reservoirs

Carbon reservoirs are where carbon is stored on the planet. The largest on Earth include rocks, the ocean and our soils. Despite all the attention it receives, carbon dioxide makes up only 0.04% of our atmosphere. However, this shows that even a small increase in the amount of carbon dioxide could have dramatic effects.

Global Warming and Climate Change

In the last two hundred years, humans have burnt more and more fossil fuels to drive industry and make energy for our modern lives. This has resulted in a huge amount of carbon dioxide being released into the atmosphere from carbon stores in oil, coal and gas. The speed of the carbon release has moved our natural carbon cycle out of balance. Not only does a rise in carbon dioxide level in our atmosphere lead to our world becoming warmer (currently at over 1 degree Celsius on average), but it means that other carbon sinks are taking in more carbon. Extra carbon dioxide in our water reacts with the water molecules to produce a weak carbonic acid, lowering the pH of the water and making life hard for the animals living there. Deforestation worldwide has reduced the capacity for plants to take in a store a lot of this extra carbon, which is why you so often see a push to plant trees as part of 'carbon offsetting'.

EQUIPMENT

For the class:

- Alka-seltzer tablets
- Citric acid
- Stickers
- Red cabbage powder
- Bicarbonate of soda
- Blue roll
- 2x pop-up buckets
- J-cloths (to place under the beakers and prevent spills)
- Water*

For each pair of pupils:

- 2x measuring beakers
- 2x teaspoons
- 1x piece of granite (rock 1)
- 1x piece of limestone (rock 2)
- 1x dice
- 1x small plastic tub
- 2x gloves (one per pupil)
- 1x set of experiment and method cards (4 cards)
- 2x carbon graph
- 1x set of *Reservoir Cards* (7 cards)
- 1x mat
- Pens and notebooks*

Please note all items marked * are not supplied in the *Generation Science* 2022 kit. If you are unable to source these, please get in touch with the *Generation Science* team. There is a full list of kit included in the box on p4 of this booklet.

PREPARATION

Before the workshop please:

- Read this welcome booklet fully to prepare you for the workshop
- Decide if you are going to run all the workshop together or split it across two sessions (videos 1–3 and videos 4–6)
- Make sure each pupil has pens and paper/a notebook
- Read through the experiment and method cards so you understand the requirements for each
- For session one, if there is no easy access to water for all the pupils, collect water in one of the pop-up buckets for the pupils to use in the experiments
- Split up the kit so that each pair of pupils has the correct equipment for the activities after videos one to three
- Set up a station (which is monitored by an adult) where the pupils can collect citric acid, alka-seltzer tablets, and the rocks for the activity after **experiment two**
- **Please ensure all pupils wear a protective glove when handling the rock samples and alka-seltzer tablets, and wash their hands at the end of the workshop**
- Keep the method cards at the front of the classroom to be handed out to any pair who wants to check them during the experiment
- Decide on a space where the carbon cycle game can be played. There needs to be room for 7 stations each representing a different carbon reservoir, that the pupils can move to
- For session two, gather some spare coats or jumpers for the activity after video four
- Set up a station where the pupils can collect the bicarbonate of soda and red cabbage powder for the activity after video six

THE WONDER ELEMENT: DURING THE WORKSHOP

LESSON PLAN

Details of the individual activities can be found below. Each video has corresponding activities, games or experiments that take place throughout and afterwards.

SECTION	TEACHER GUIDANCE
Video One: Carbon Carbon graph activity	1. Play video one 2. Split the pupils into pairs 3. Hand out the carbon graphs 4. Replay the video looking for the hidden clues. They are hidden on the green book, the yellow pennant and in the grey photo frame 5. Help the pupils find the correct pairings. The answers are: diamond 99.9%, anthracite (coal) 80%; plastic bag 80%; tree branch 50%; human 18%; water 0% 6. Please note: although a plastic bag has 80% carbon and a human only 18%, if you compared a plastic bag and a human, a human would contain more carbon by weight because a plastic bag is so small and light in comparison. Plastic bags contain more carbon than a human but only as a percentage of what they are made from overall.
Video Two: Chemical Reactions Exp 1: Carbon release Exp 2: Acidic carbon release Exp 3: Fizzing rock	**Experiment 1** 1. Play video two until the first pause screen 2. Hand out the corresponding experiment card 3. Find the kit listed on experiment card one 4. Help pupils write out their method and carry out their experiments. Hand out method card one if necessary 5. The tablet should dissolve in the water, giving off a stream of carbon dioxide bubbles **Experiment 2** 1. Play video two until the next pause screen 2. Empty and wash kit from experiment one and find the kit listed on experiment card two 3. Help pupils write out their method and carry out their experiments. Hand out method card two if necessary 4. The beaker with acid and water will create more bubbles/foam and dissolve the tablet more quickly than the beaker with just water **Experiment 3** 1. Play the rest of video two 2. Empty and wash kit from experiment two and find the kit listed on experiment card three 3. Help pupils write out their method and carry out their experiments. Hand out method card three if necessary 4. Rock two is limestone which contains carbon. When placed in acidic water, it will give off a steady stream of small bubbles

THE WONDER ELEMENT: DURING THE WORKSHOP

Video Three: The Carbon Cycle

Carbon cycle game

1. Play video three until the first pause screen
2. Hand out a pack of carbon cycle cards to each pair and let them familiarise themselves with the content before the next section
3. Play the rest of video three and play the carbon cycle game

Carbon Cycle Game Steps

1. Set up seven stations representing each carbon reservoir: deep ocean; ocean surface; plants; soil; rock; atmosphere; sea creatures
2. Collect kit for each pair: a dice; a pack of *Reservoir Cards*; a pen and notebook
3. Spread the pairs of pupils equally among each reservoir to start the game and ask them to place the corresponding card on top of their deck
4. Pupils note which reservoir they start in in their notebook
5. Pupils all roll at the same time and move to another reservoir according to their card. Note, the card may tell them to stay in the same place
6. Pupils note where they have moved to and place the corresponding card on top of their deck
7. Repeat this up to ten times
8. Get pupils to look for patterns in their data (see below)
9. Finish session one here, or continue to video four

Carbon Cycle Game Data

1. You can ask pupils to write down how many times they stay in a reservoir for more than three turns in a row, and collate the class information. Pupils are more likely to stay in rock, deep ocean and even soil for longer periods, mirroring that these are the largest global reservoirs where carbon can be stored for thousands or millions of years
2. You can ask pupils to look for patterns in how they moved around. Did they always move in a cycle e.g. from atmosphere to plants, to soil, to atmosphere? This is unlikely to happen because carbon in the carbon cycle doesn't follow a linear pattern.
3. Note, the exact probabilities of carbon moving from one reservoir to the other in the game are skewed to keep it flowing. Realistically, most of the carbon stays in a reservoir for a long period before moving on as part of the 'slow' carbon cycle. The 'fast' carbon cycle refers to the movement of biological molecules through the food chain and is measured in decades as opposed to thousands of years.

Video Four: Climate Change

Greenhouse gas game

1. Play video four until the first pause screen
2. Pupils get coats and jumpers for the next game
3. Play the rest of video four and play the greenhouse gas game

Greenhouse Gas Game Steps

1. A volunteer lies face up in a clear space on the floor
2. Pupils place a few coats on the volunteer representing normal levels of carbon dioxide. This should make the pupil warm
3. Pupils place the rest of the coats on the volunteer. After a few minutes, ask the volunteer if they are feeling hotter
4. The extra coats are like all the extra carbon dioxide released into the atmosphere making us all hotter
5. Repeat with another volunteer as necessary

Video Five: Ocean Acidification Exp 4: Ocean Acidification	1. Play video five until the first pause screen 2. Collect the kit listed on experiment card four 3. Pupils make a mixture of two powders: two spoons of the bicarbonate of soda to one spoon of the red cabbage powder 4. Play video five until the next pause screen 5. Pupils add the powder mixture to their beaker and note the colour. N.B. Use cloth provided with kit under the beakers to prevent spills and stains from the cabbage powder 6. Pupils add citric acid to the beaker and note the colour change 7. Play the rest of video five 8. Pupils repeat the experiment but add a tablet to the mixture instead of citric acid **Experiment 4: Notes** • When citric acid is added to the indicator solution, it will turn very pink • When the tablet is added to the indicator solution, it will turn purply pink • The learning point is to show that extra carbon dioxide makes our oceans more acidic, although not as acidic as adding pure citric acid crystals • In reality, while the tablet is producing carbon dioxide bubbles, there is also a small amount of citric acid inside. This means that a number of things help to change the colour of the indicator solution, which is why we try the experiment again with dry ice (pure frozen carbon dioxide) in video six • The reason we add the bicarbonate of soda to the indicator powder is to get a better colour change. The bicarb helps make the solution slightly alkaline to begin with, making the colour change more pronounced when the acid is added
Video Six: Wrap-up	1. Play video six 2. Use this guide to help you with any follow up activities

THE WONDER ELEMENT: AFTER THE WORKSHOP

LESSON SUPPORT

This section gives you a list of links to videos and websites that you can use to talk more about this topic as well as some follow up activities to expand on the learning outcomes. Where possible, we have suggested places where you can reuse your *The Wonder Element* kit to continue its usefulness in your classroom.

Experiment:
Make your own red cabbage indicator ice cubes in the classroom or at home! This is a summery take on a classic experiment that allows pupils to go through the process of making their own indicator to test for pH. You can then make a colourful activity by using kitchen substances. Reuse your beakers, spoons and stirrers to make it all work! #Activity #AtHome
https://sciencekiddo.com/red-cabbage-ph-indicator/
https://www.youtube.com/watch?v=OMXMlWybv8A

Video Discussion:
Watch the video from the Hay Festival and NERC which touches on greenhouse gases, carbon dioxide levels, and climate change. The video could stimulate various discussions, including how we release carbon dioxide [1.42–2.02], and ways we can reduce carbon emissions [2.24–2.31] #WatchTogether #Activity
https://www.youtube.com/watch?v=931drXJDqT4

Video:
Watch the video together to learn more about the greenhouse effect. You can also pair this video with follow-up activity two! #WatchTogether
https://climatekids.nasa.gov/greenhouse-effect/

Design Project:
Look at the structure of carbon dioxide: two oxygen atoms and a carbon atom. Ask pupils to find some materials in the class or at home and make a carbon dioxide model. If you are feeling adventurous, why not find out about another simple carbon molecule and make that! #Activity

Design Project:
Design and draw a machine that helps draw carbon from the atmosphere and store it somewhere else. Get the pupils to use their imagination! #Activity

Research Project:
Ask the pupils to research a recent story about the climate crisis and its impacts and share them with the class. Are most of the stories positive or negative? Can the pupils think of solutions to some of the problems in the stories?
#AtHome #Activity

Game:
Why not try to make up your own game about the effects of climate change? Do some research on the most likely problems and solutions and reuse the dice from your box! #Activity

USEFUL LINKS

Some more experiments to explore chemical reactions using kitchen supplies.

Turmeric invisible ink:
https://researchparent.com/color-changing-invisible-ink/

Baking soda volcano:
https://www.thoughtco.com/baking-soda-volcano-science-fair-project-602202

An explanation of the carbon cycle [for teachers]:

https://earthobservatory.nasa.gov/features/CarbonCycle

WWF have a climate change resource page including an introduction to climate change for teachers and a climate crisis information poster [for teachers]:

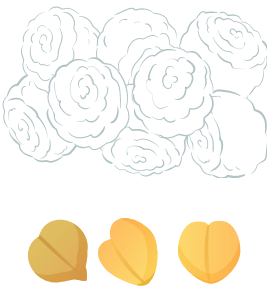
https://www.wwf.org.uk/get-involved/schools/resources/climate-change-resources

FOLLOW UP ACTIVITY 1

GROW A PLANT EXPERIMENT

You will need:

- 3x dried chickpeas
- 5x balls cotton wool
- 1x beaker
- Water



Step 1:

Soak the chickpeas in water for 24 hours

Step 2:

Take the cotton wool and loosely tear them apart

Step 3:

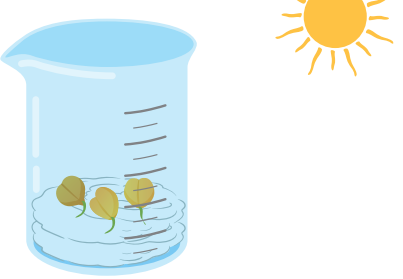
Place 3 balls of cotton wool at the bottom of the beaker and soak with water

Step 4:

Place the pre-soaked chickpeas on the cotton wool

Step 5:

Add two more balls of cotton wool on top and soak with water.
Leave in a warm place for a few days.



Step 6:

When you see roots developing, remove the top layer of cotton wool and place in a sunny spot.
Watch the chickpeas grow!

Extension

When the chickpeas start sprouting, you can transfer them into soil in a pot and watch the plants grow taller. You can use the period while the chickpeas are growing to do a research project on how much carbon bigger plants like trees draw from the atmosphere. If you want to try something similar, why not use the plastic tubs from your kit to grow cress seeds at the same time?

Explanation

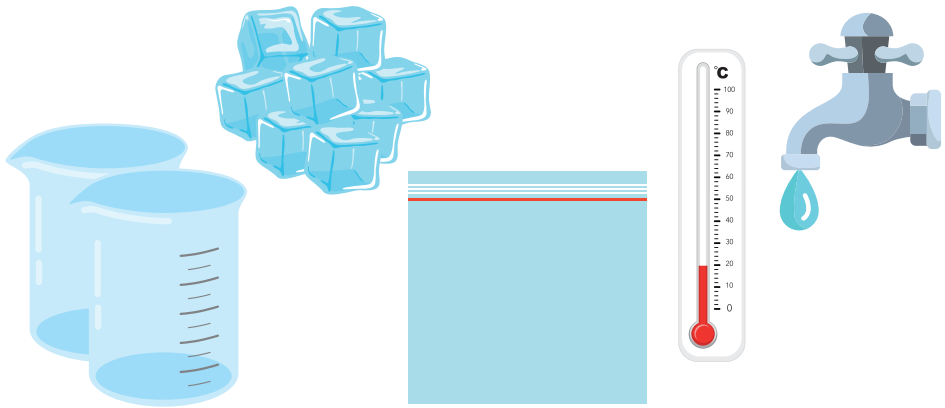
Plants take in carbon dioxide from the atmosphere through their leaves and use it in the process of photosynthesis. The carbon dioxide molecules undergo a chemical reaction and the carbon is used to make simple sugars that the plants use as food. Some of this carbon forms cellulose which is used in leaves, stems, roots and woody trunks of plants.

FOLLOW UP ACTIVITY 2

THE GREENHOUSE GAS EFFECT

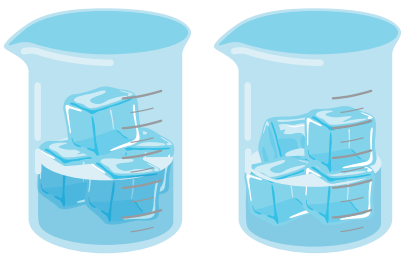
You will need:

- 2x beakers
- 8x ice cubes
- 1x sandwich bag/piece of clingfilm
- 1x thermometer
- Water



Step 1:

Fill your beakers with 150ml of cold water

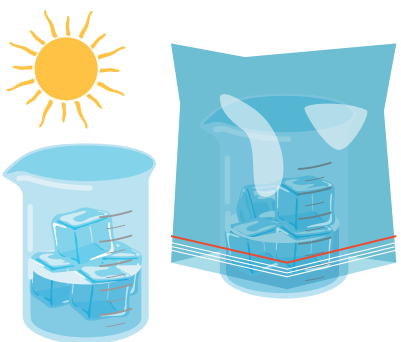


Step 2:

Add four ice cubes to each beaker

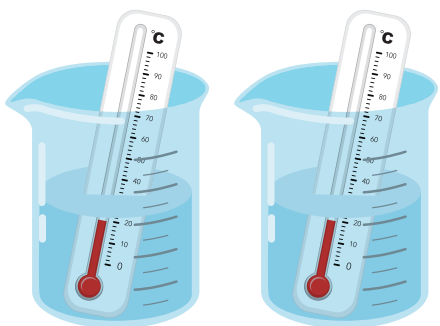
Step 3:

Cover one of the beakers with the plastic bag to represent the presence of greenhouse gases



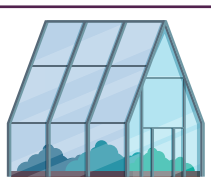
Step 4:

Leave both jars in a sunny spot for an hour



Step 5:

Measure the temperature of the water in each beaker. You can also check visually to see how much of the ice has melted in each container



Extension

If you have access to a greenhouse, measure the temperature inside it and outside it at different points in the day to see how different the temperature is.

Explanation

The sun can shine through the clear plastic, heating up the liquid inside. However, when the heat tries to escape from the beaker, some of it is trapped by the bag. This is how a greenhouse, made from plastic or glass, keeps plants warm even when it is cold outside. It is also very similar to how greenhouse gases trap heat radiated out from the Earth as it cools

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