Exploring climate science

atmosphere

Carbon Cycle Caper

Teacher notes

Give your students an 'atom's eye' view of the carbon cycle with this engaging session and get them to play out how the burning of fossil fuels is affecting the atmosphere.

Age group: KS3 and KS4

Timing of activity: Approx. 70 minutes

Number of students: Up to 60 students

Venue: School hall

Number of staff: 2 teachers (additional helpers optional)

Overall learning outcome:

Students understand the carbon cycle, how it has been affected by our use of fossil fuels since the Industrial Revolution – and how this underlies current concerns about climate change.

The activity

Introduction (approx. 5 minutes)

1. Overview: 'Today we will be looking at the carbon cycle – where carbon is present and the processes by which it moves.'
2. Introduce the 'stations' – OCEAN, ATMOSPHERE, PLANTS, ANIMALS, FOSSIL FUELS, DEAD ORGANISMS – and explain that all the balls, regardless of their colour, represent units of carbon. All will become clear...

Game 1

Where's carbon? (approx. 10 minutes)

Learning objective:

- To identify the six areas where carbon is present in the biosphere – and in what form.

What to do:

1. Read out each question on the 'Where's carbon?' sheet and get all students to run to the carbon station they think answers the question. Reveal the answer, and get the students to move to the correct station.
2. In each case, explore any misconceptions, and discuss the forms of carbon found in that place (refer to the background science document if necessary):
   - Carbon dioxide gas (ATMOSPHERE)
   - Methane gas (ATMOSPHERE)
   - Carbohydrates and other organic molecules (PLANTS, ANIMALS and DEAD ORGANISMS)
   - Dissolved carbon dioxide (OCEAN)
   - Hydrocarbons (FOSSIL FUELS)

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Game 2

Move that carbon! (approx. 20 minutes)

Learning objective:

- Introduce or reinforce the key processes by which carbon moves around the carbon cycle.

What to do:

1. Illustrate some of the basic processes involved in the carbon cycle, to introduce the coming games. For example:
   - Choose some students to represent a forest, and some to be the atmosphere. The 'trees' take carbon dioxide from the 'atmosphere' to manufacture carbohydrates in their leaves (they take balls from the atmosphere students).
   - Choose some students to represent coal burning in a power station, and some to be the atmosphere. The 'coal' students give balls to the 'atmosphere' students, to represent carbon dioxide being produced.
   - Choose some students to be animals/plants in the process of decomposition, turning carbohydrates into methane and carbon dioxide. They give balls to the atmosphere students.
2. Choose ten 'Challenge Quizmasters', and divide the remaining students into ten teams; assign one Challenge Quizmaster to each team. The Challenge Quizmaster holds a set of challenge cards and answers, and a scorecard. Each team is given a set of key process cards, which contain basic information:
   - PHOTOSYNTHESIS
   - RESPIRATION
   - EATING
   - COMBUSTION OF FOSSIL FUELS
   - DYING
   - DECOMPOSITION
   - ABSORPTION INTO THE OCEAN
   - RELEASE FROM THE OCEAN

   The Challenge Quizmaster asks the team to identify which process is being described in each of the questions, e.g. 'Which process transfers carbon from dead organisms to the atmosphere?' (Answer: DECOMPOSITION)
3. The team can confer. As soon as they find the correct answer, one team member runs to the correct carbon station and moves one ball where necessary (for example, from DEAD ORGANISMS to ATMOSPHERE in the case of DECOMPOSITION) to complete that process. Then the member returns to his/her team, and the Challenge Quizmaster selects the next challenge card.

   The first team to complete all the challenges wins. When more than one answer is required – for example, 'Which processes release carbon dioxide to the atmosphere?' – team members run to the different stations to complete the answer simultaneously.

Note 1: Shuffling the cards first means that teams complete their challenges in different orders.

Note 2: You will need to place the balls in the ball containers before the start of Game 3 – 30 balls in each.

Game 3

Carbon cycle shuffle (approx. 20 minutes)
Before Industrial Revolution (carbon in balance)

Note 3: In what follows, the balls represent carbon moving around the cycle, and NOT the total amount of carbon at each station/in each system.

Learning objective:

- To understand what the carbon cycle was like before the Industrial Revolution.

What to do:

1. Assign a 'Station Manager' to each of the six stations (use them as your ball monitors): ATMOSPHERE, OCEAN, PLANTS, ANIMALS, DEAD ORGANISMS and FOSSIL FUELS.

2. Divide the remaining students into **eight teams** – one for each process: PHOTOSYNTHESIS, RESPIRATION, EATING, COMBUSTION, ABSORPTION, RELEASE, DYING and DECOMPOSITION. Give each team a golden envelope containing a process information card and a set of student stickers representing that process.

3. Students stick on their label (the forehead is a popular choice) and move to the starting point indicated on their process information card. For example, the PHOTOSYNTHESIS team starts at the ATMOSPHERE station.

4. Explain that teams will need to work together to move their stated number of balls from their starting point to whichever station is required, in any way they choose* within each ten-second cycle. So, the PHOTOSYNTHESIS team move 14 balls from ATMOSPHERE to PLANTS in each cycle. (*A prize could be given for the most creative approach.)

   Note:

   - The RESPIRATION team will need to divide into two halves to move some balls from PLANTS to ATMOSPHERE and some from ANIMALS to ATMOSPHERE.

   - The COMBUSTION team will have no balls to move at this stage, so make a joke of it – perhaps give them magazines to read or some other task to occupy them.

5. Go round the cycle getting one member of each team to say what their process is and what they will be doing.

6. Use the countdown timer to run through five cycles (each lasting 10 seconds). At the end of the five cycles ask the Station Manager at each station to report back on whether his/her carbon container has more, fewer or the same number of balls. The numbers should have remained the same.

Note 4: Get each Station Manager to check there are 30 balls in his/her container before the start of Game 4.

Game 4

Carbon cycle shuffle (approx. 10 minutes)
After Industrial Revolution (carbon is out of balance)

Learning objective:

- To understand what the carbon cycle has been like since the beginning of the Industrial Revolution, and how that has affected the amount of carbon dioxide in the atmosphere.

What to do:

1. Repeat Game 3, but this time the COMBUSTION team have something to do. You could move each team round one process if you wish. **Give the COMBUSTION team a new process information card**: they now have to move two balls from FOSSIL FUELS to ATMOSPHERE in each cycle. The rest of the teams continue as before.

2. Run five cycles again, then ask the Station Managers to report back on the carbon levels. You should find that FOSSIL FUELS are much lower and ATMOSPHERE is much higher, but the rest of the levels are about the same. Why do your students think that is?

Wrap up (approx. 5 minutes)

Recap what you have covered in the session, using the **animation** if desired. Discuss with the group what they think was happening to the carbon cycle, and if anything surprised them. Use the **Climate science: background briefing** sheet to support your discussions.

Discuss scenarios:

- Why is the amount of carbon dioxide in the atmosphere important?
- What if everyone switched to biofuels/renewable energies?
- What if we stopped using fossil fuels today? Would the carbon cycle become balanced again, and would carbon dioxide levels in the atmosphere return to their preindustrial values? If so, how? And when?

You will need ...

- 200 balls (e.g. plastic play balls from a supermarket or toy shop), representing units of carbon
- 6 gym mats and 6 netball posts to mark out the carbon stations (i.e. places where carbon is present)
- 6 see-through plastic boxes – containers for the 'carbon' units
- 10 golden envelopes, containing a process information card and process stickers for students
- Countdown timer (laptop, sound system and projector required)

Before the session...

1. Set up the hall with six carbon stations, with each station having a container for the 'carbon' (the balls). Get creative and decorate the station with soft toy animals, toy cars/planes/trains, green plants, water, etc. to illustrate what it represents.
2. Fill each carbon container with 30 balls and tape on a line to show the fill level.
3. Print out ...
   - Station signs: ATMOSPHERE, PLANTS, ANIMALS, DEAD ORGANISMS, FOSSIL FUELS and OCEAN
   - For Game 1: one set of 'Where's carbon?' questions
   - For Game 2: ten sets of 'Move that carbon!' process cards – PHOTOSYNTHESIS, RESPIRATION, EATING, DECOMPOSITION, COMBUSTION, ABSORPTION and RELEASE
   - For Game 2: ten 'Move that carbon!' challenge cards, ten 'Move that carbon!' scorecards
   - For Game 3: stickers representing each of the key processes for students
   - For Game 3: a set of process information cards – one card for each key process; each card states how many balls to move each cycle
   - For Game 4: a new process information card for the COMBUSTION team
   - Climate science: background briefing for teachers

National Curriculum links

KS3 Science QCA (2007):
1.1 a; 3.2 a–c; 3.4 c; 4 c, d, g, k; How science works: Attainment targets 2, 3

KS4 Science QCA (2007):
8 a, b; 6 a–d

KS3 Geography QCA (2008):
1.6 a, 3 h

KS4
Supports work in the AQA, OCR and Edexcel areas of climate and the environment.

Carbon Cycle Caper

Science Museum links:

For more information about climate science go to the Climate Science Info Zone.

www.sciencemuseum.org.uk/ClimateChanging/ClimateScienceInfoZone

The following animations are particularly useful to help prepare for or follow up the Carbon Cycle Caper activity:

- A great overview animation showing how the carbon cycle works when it's in balance.
  www.sciencemuseum.org.uk/ClimateChanging/ClimateScienceInfoZone/ExploringEarthsclimate/1point6.aspx

- Find out how carbon is released from carbon sources, such as dead plants and animals, through the process of decomposition.
  www.sciencemuseum.org.uk/ClimateChanging/ClimateScienceInfoZone/ExploringEarthsclimate/1point6/1point6point1.aspx

- Explore how carbon is stored in carbon sinks, such as plants, through the process of photosynthesis.
  www.sciencemuseum.org.uk/ClimateChanging/ClimateScienceInfoZone/ExploringEarthsclimate/1point6/1point6point2.aspx

- Explore how fossil fuels are formed.
  www.sciencemuseum.org.uk/ClimateChanging/ClimateScienceInfoZone/ExploringEarthsclimate/1point6/1point6point4.aspx

- Discover how human activity has changed the carbon cycle through our use of fossil fuels.
  www.sciencemuseum.org.uk/ClimateChanging/ClimateScienceInfoZoneExploringEarthsclimate/1point7.aspx