

# Carbon cycle: releasing dinosaur breath in the lab (teacher's notes)

## Level

This material is designed for students aged 12 to 14 (years 8 and 9).

## Topic

This activity is one of five aimed to teach students about the nature of **carbon**, the different types of compounds it exists in (eg charcoal, glucose, carbon dioxide), the biochemical reactions it takes part in (**photosynthesis** and **respiration**), the range of processes that carbon and carbon compounds are involved in on Earth, and how these link together to form the **carbon cycle**.

The other activities are

*Carbon cycle: where is this crucial carbon?*; a teacher-led discussion interspersed with demonstrations in which the teacher burns a range of materials over a Bunsen flame, forming charcoal, to illustrate that they contain carbon.

*Carbon cycle in the lab: carbon products and the processes that link them*; which involves working in small groups to place examples of the carbon cycle products in the correct places on a diagram of the cycle.

*Cycling carbon: seeing how plants use carbon dioxide in the lab*; a short pupil practical exploring the uptake of carbon dioxide from the atmosphere by plants for photosynthesis.

*Carbon cycle: exchanging carbon dioxide between the atmosphere and ocean*; a short pupil practical comparing how well carbon dioxide dissolves in sea water compared with fresh water.

## Context

An understanding of the carbon cycle is essential to the debate about **global warming**, an environmental issue that most students will have heard about. Since the Earth's atmosphere formed, it seems to have always contained carbon dioxide in varying amounts. Carbon dioxide is a '**greenhouse gas**' through which light radiation can pass but which absorbs some of the heat radiation produced by light irradiating the Earth's surface. This causes the Earth's surface and atmosphere to be warmer than it would otherwise be and without the '**greenhouse effect**' the Earth would probably be completely frozen. Humans, as all life on Earth, have always been part of the carbon cycle, but now (since the industrial revolution) the large scale burning of oil, coal and natural gas, along with deforestation, is leading to increasing atmospheric carbon dioxide levels. This in turn is related to an enhanced greenhouse effect and consequent climatic change. An understanding of the factors affecting global warming leads to an understanding of the measures required to reduce their impact. This can link into economic and political debates on the subject. Students should have already covered photosynthesis and respiration in order to do this activity effectively.

## Teaching points

In this activity, carbon dioxide is released from some **chalk** (calcium carbonate) by reacting it with vinegar (a solution containing a weak acid). Millions of years ago the carbon (in the carbon dioxide released) was used by the fossil marine organisms that make up the chalk to make their hard parts and has been stored there ever since (until we came along and poured acid onto them!).

Animals get their carbon by eating plants and/or other animals. When oxygen combines with food in cells during respiration, carbon dioxide is released into the atmosphere during exhalation.

Some of the carbon dioxide from the atmosphere is stored in the ocean which acts as a **carbon sink**. Some of this dissolved carbon dioxide is used by marine organisms to make their 'hard parts' of calcium carbonate, for example the shells of shelly organisms and the discs of **calcareous algae** that form much of the chalk.

Limestone, including natural chalk, is made of the remains of marine organisms that lived and died millions of years ago (Chalk is largely made of calcareous parts of **planktonic algae** and so is formed mostly of plant remains, not animal remains.) When limestone and chalk are formed carbon is locked away (as calcium carbonate) for millions of years.

Students should work on this activity in pairs.

## Apparatus and materials

Each group of pupils will need:

Eye protection

Crushed natural chalk

Vinegar (alternatively use dilute hydrochloric acid ( $1 \text{ mol dm}^{-3}$ ), which has the advantage of not smelling)

Flask

Balloon

Test-tube

Limewater (calcium hydroxide solution)

## Safety

Wear eye protection

## Activity

Students follow the activity sheet by pouring limewater into a test tube; then placing crushed chalk into a flask; adding vinegar (or hydrochloric acid) to the flask and placing a deflated balloon tightly over the flask neck so that no gas can escape. When the reaction has stopped they pinch the balloon tightly at the balloon neck, so no gas can escape, remove it from the flask and over to the test tube. They squeeze it so that the gas goes into the limewater, observing it as they do so.

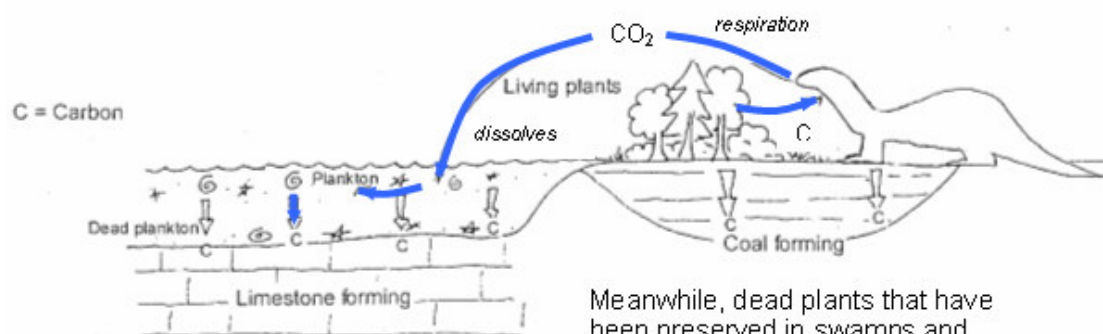
Once they have done this, the students should record their observations by answering the following questions:

- Q 1. What colour was the limewater to begin with? = *Colourless.*
- Q 2. What happened to the limewater when you added the gas from the balloon? = *It became cloudy.*
- Q 3. Where did the gas in the balloon come from? = *The chalk.*
- Q 4. What reaction was responsible for creating it? = *The reaction of calcium carbonate with acid.*
- Q 5. What gas was released from the chalk by the reaction? = *Carbon dioxide.*

Then they should attempt the following extension questions which require more thought, and should enable them to place their experiment in the context of the

carbon cycle and to think about how the carbon cycle works over very long time scales:

- Q 1. Where did the dinosaurs get their carbon from? = *Eating plants and/or animals*
- Q 2. Why could you say that “dinosaur breath” was released from the chalk? How did it get there? = *Chalk is made of the hard parts of millions of tiny organisms. They used carbon, to make their hard parts (calcium carbonate) which they obtained from the sea water in which they lived in the form of dissolved carbon dioxide (many of these tiny organisms were photosynthesisers). The carbon dioxide in the ocean got there via gas exchange with the atmosphere. Carbon dioxide in the atmosphere, in turn, got there from animals (including dinosaurs) exhaling. So, the carbon dioxide is released from chalk might have been breathed out by a dinosaur (although, of course the carbon has been through many stages and has been combined in a range of other molecules in between times).*
- Q 3. Draw a dinosaur on the geological carbon cycle diagram and draw arrows to show the steps from how the dinosaurs got carbon to how carbon dioxide from the dinosaur got into the chalk. =



Over millions of years the hard parts of plankton that have accumulated on the ocean floor, become deeply buried under layers of sediment and eventually turn into limestone

Meanwhile, dead plants that have been preserved in swamps and peat bogs on land become buried under layers of sediment and eventually form coal.