

Experiment at Home/School:

How does CO₂ Cause Global Warming?

The aim of this activity is to demonstrate how rising carbon dioxide (CO₂) levels in the atmosphere contribute to global warming and climate change.

Age Suitability: The activity can be adapted to suit classes from 1st to 6th class. Classes can working in small groups for this experiment.

Materials:

- 2 x 2 Litre Plastic Bottles with Lids
- Markers
- 2 Thermometers
- Scissors, Ruler, Sticky Tape
- Vinegar, Bicarbonate of Soda
- Measuring Jug/Spoons, Funnel, Scale
- 1 Lamp, which will be used to simulate the Sun for the experiment
- Optional: rocks, ice cubes, water, weighing scales

Method:

1. What do you think the plastic bottles in the experiment represent? **Earth and its atmosphere!** To begin this experiment, we'll get creative. Decorate one side of each plastic bottle using markers to draw plants, animals, or whatever you feel like! Make sure to only decorate one side, as the light will need to be able to shine into each of the bottles. This will be important later.
2. Using the ruler and scissors, cut off the top of each plastic bottle in the same place. We're beginning this experiment by keeping things *constant*. Why might it be important to keep things the same? **For fair testing: in an experiment, you are usually testing the effect of one factor/variable. When you keep the other variables in the experiment constant, you ensure that the results you see are in fact due to the variable that you wanted to test!**
3. Place and tape a thermometer in one bottle, then use the sticky tape to position the other thermometer in the other bottle in the same way.
4. As an option, you can add rocks to one side of the bottom of both bottles. Using the measuring jug, pour an equal amount of water into each bottle. What might this simulate? **The rocky section simulates land, while the section with water simulates the ocean.** Using the weighing scales, make sure you add an equal amount of ice cubes to each bottle, placing half of the ice cubes on "land" and half in the "ocean." Mark the level of the water on each bottle using sticky tape at the beginning of the experiment.
5. Seal both bottles using sticky tape. Place the bottles on a table at an equal distance from the lamp (not too close as the plastic might melt). What does the lamp represent in this experiment? **The Sun.** In this experiment, we will simulate two different situations for Earth's atmosphere, one with ordinary air and one with an increased level of carbon dioxide. Label one of the bottles "Air" and the other "CO₂."

6. As a group discuss and write down your predictions (hypothesis) for this experiment? What do you think will happen?
7. Record the initial temperature of both bottles. Prepare the “CO₂” by pouring (or funneling) 15 g or 2 teaspoons of bicarbonate of soda into the “CO₂” bottle. Pour 150 mL of vinegar in the bottle and immediately put on the lid. Make sure to do this quickly. Gas molecules move fast, and we don’t want to let them escape!
8. Record the temperature of each bottle every 5 minutes. What happens?
9. If you are using water, rocks and ice cubes, use the ruler to record the rise in water level every 5 minutes.
10. Record your results. How could you display the results of your experiment?
11. How do these results apply to global warming and climate change?

Additional Investigation Questions:

- Can anyone think of any other Greenhouse Gases besides CO₂?
- What human activities release carbon dioxide into the atmosphere?
- What can we do to help combat climate change and global warming?
- Challenge Question: Can anyone explain the chemistry behind the reaction between vinegar and bicarbonate of soda? Why is CO₂ formed?

The Science

In this experiment, students are demonstrating the effect of an atmosphere rich in CO₂. The closed container and source of light, as well as the bottle with the CO₂, simulate something called the greenhouse effect. The greenhouse effect traps heat from the Sun in our atmosphere. Gases that do this are called greenhouse gases, one of which is CO₂. The problem is, when humans burn things like fossil fuels, they increase the amount of CO₂ in the atmosphere to unprecedented levels. This enhances the greenhouse effect and is currently resulting in something called “Global Warming.”

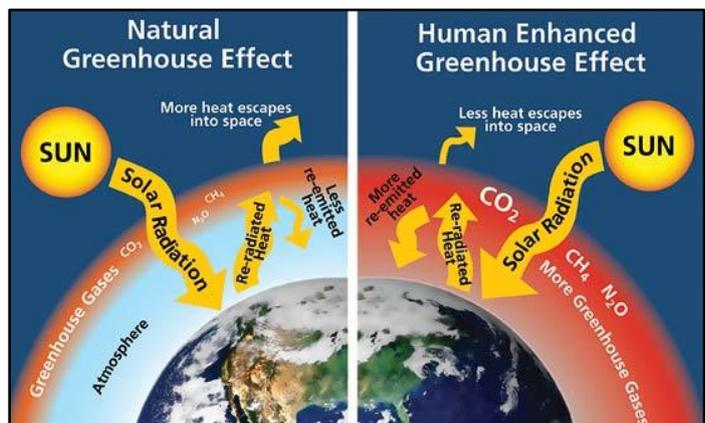


Image Source: W. Elder, NPS

The other phenomenon demonstrated in this experiment is sea-level rise. In terms of melting, sea ice won’t have much of an effect. The mathematician Archimedes discovered something called Archimedes’ Principle. This principle shows that the sea ice displaces just as much water frozen as it would when it melts. The frozen sea ice and the liquid it produces upon melting take up the same amount of space! The big problem is ice on *land*. Land ice, like the huge ice sheets of Greenland and Antarctica, has never been in the ocean before. When this ice melts, the ocean will have more water in it, causing something called sea-level rise. If all the land ice melted, the sea level could rise up to 70 meters! This would result in coastal and low-lying towns and cities like Dublin to be underwater! Students will observe that the water rises faster in the container labelled “CO₂.”