

Experience The Greenhouse Effect: Pre-Experiment Questions and Ideas

What is carbon dioxide?

What is the percentage of carbon dioxide in Earth's atmosphere?

What is a greenhouse gas and what do greenhouse gases do?

What percentage of Earth's atmosphere is made up of greenhouse gases?

Carbon dioxide is considered a greenhouse gas. Why do you think that is?

Purpose

In this experiment, we will investigate how carbon dioxide, or CO₂, affects the temperature of a closed system, such as Earth.

You Will Need

- (4) Two-liter clear plastic bottles
- (4) Laboratory thermometers (or temperature probes)
- (4) Heat lamps (100 W or higher)
- (6) Alka-Seltzer tablets
- Water
- Timer or stopwatch
- (4) Rubber stoppers with holes (that the thermometers will fit in). These stoppers fit in the mouths of the 2-liter bottles
- Graphing Paper

You also will need the Greenhouse Gas Lab Activity Sheet on pages 3 through 5 of this guide. Before running the experiment ---

- **Review** the Method section below and record the steps you will take to run the experiment.
- **Make** a statement or pose a question about what you are investigating.
- **Make** a prediction, or hypothesis, about the outcome of the experiment.
- **Articulate** what you think will change (variables) and what will stay the same (controls) as you carry out each step of the investigation.

Method

1. Take the four clear plastic bottles and label each, as follows: write a number 1 on the first bottle, number 2 on the second bottle, number 3 on the third bottle, and number 4 on the fourth one. Write these labels near the top of each bottle in relatively small print.
2. Place the four plastic bottles on the table. In larger print write a 1 on bottle #1, a 2 on bottle #2, a 3 on bottle #3, and a 0 on bottle #4. These numbers correspond to the number of Alka-Seltzer tablets that will be placed in each bottle.

Fill the bottles halfway with water while making sure that each bottle contains the same amount. The air in each bottle is a model of Earth's atmosphere.

3. Insert a thermometer into each of the rubber stoppers so that when the rubber stoppers are inserted into the bottles the thermometers rest 2 inches above the water line. You may need to put soap or vegetable oil on the thermometers to make this process easier. The thermometers should only be measuring air temperature and should not be submerged in the water. Leave the rubber stoppers in the bottles for now. **NOTE!** Be careful with the thermometers: keep a loose grip. They can break and create sharp pieces.

Wait approximately 5 minutes to allow the thermometers to read the air temperature inside the bottles. Record this temperature on the chart on your activity sheet. This is the initial temperature for our entire experiment.

4. Take the rubber stoppers out of bottle #1, bottle #2, and bottle #3. In bottle # 1, place 1 Alka-Seltzer tablet into the water and quickly cork the bottle with the stopper. In bottle #2, place 2 Alka-Seltzer tablets and quickly recork the bottle with the stopper. In bottle #3, place three Alka-Seltzer tablets and quickly recork the bottle. Quickly replacing the rubber stoppers helps contain the reaction and controls variables in the experiment.

In bottle #4, leave only water and air. This bottle is our experimental control.

Allow approximately 5 minutes for the Alka-Seltzer tablets to release the CO_2 . During this time, make observations of the bottles as the Alka-Seltzer fizzes. Notice that Alka-Seltzer causes bubbles to appear in the water. The tablets are releasing carbon dioxide bubbles. This is raising the concentration of carbon dioxide (a greenhouse gas) in the three bottles into which you placed the Alka-Seltzer tablets.

5. Write a hypothesis about what will happen when the bottles are put in front of a heat lamp.

6. Place each of the four bottles in front of the four heat lamps for 20 minutes. Place each of the four heat lamps and bottles an equal distance from one other.
7. Take temperature readings each minute on each of the four bottles. Record the readings in the table on your lab activity sheet.
8. After 20 minutes turn off the heat lamps and allow the bottles to cool for 10 minutes. Once again, take a temperature reading on each of the four bottles every minute and record the corresponding temperatures on the activity sheet.
9. Use the data to make a line graph of temperature readings vs. time for each of the four bottles and use your graph to answer the post-lab questions. On your graph use a different color for each bottle.
10. Discuss the results and the conclusions with those around you.

Activity Sheet

Question You Will Investigate:	
Variables: What Will Change as You Run the Experiment?	
Controls: What Will Stay The Same?	
Hypothesis: Statement of What You Will Test	

Procedure: Steps for Carrying Out the Experiment	
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Record Your Data From The Experiment

Title: Recorded Baseline Temperatures

Bottle #1	Bottle #2	Bottle #3	Bottle #4

Hypothesize: What do you think will happen when you put each bottle in front of a heat lamp?

Title: Data Recorded From Warming Bottles

# of Minutes Passed	Bottle #1	Bottle #2	Bottle #3	Bottle #4
1				
2				
3				
4				
5				
6				
7				
8				

9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Title: Data Recorded From Cooling Bottles

# of Minutes Passed	Bottle #1	Bottle #2	Bottle #3	Bottle #4
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

BONUS: Make a line graph of the temperature readings vs. time. Use a different color for each bottle.

Conclusions: Explain What Happened and Discuss the Human Impact on Earth

Describe what took place during the experiment.

Before engaging with your peers in a thoughtful conversation on this experiment, answer the following questions on your own. Each question can be associated with one fact, such as those provided below.

In the United States, 15 million tons of CO₂ are used each year to power residential outdoor lighting alone, or what we use on our homes. An offset for this amount of CO₂ would be to plant 875 million trees each year.

Source:

<https://www.darksky.org/15-million-tons-of-carbon-dioxide-emitted-each-year-on-residential-outdoor-lighting-in-the-u-s/>

1. What is the equivalent of 15 million tons of carbon dioxide? Here is an example: 15 million tons of CO₂ is the equivalent of 5,000 bricks being released into the atmosphere annually. How creative can you be with the equivalencies you find? Check out the Greenhouse Gas Equivalencies Calculator at <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>
2. What are ways to reduce the use of outdoor lighting at your home?

The state's average temperature has risen by two degrees Fahrenheit in the past 30 years, an increase that ranks Colorado as the 20th fastest-warming state since 1970. Climate scientists project that the state's average temperature could be five degrees higher by 2050, 30 years from now. Such increases significantly outpace historical trends.

Source: <https://www.coloradohealthinstitute.org/research/colorados-climate-and-colorados-health>

1. It is projected that intense negative climate change will happen if our global temperature rises by just 2 degrees Celsius. Using the conversion below, convert 1 degree Fahrenheit to Celsius and use this number to predict where Earth will be in 2050 based on Colorado's current rate of temperature increase.
Conversion: $T(F) = T(C) \times 1.8$ (or $9/5$) + 32
 $T(C) = (T(F) - 32) \times 0.555$ (or $5/9$)
2. What is the equivalent of 2 degrees Celsius?

A typical passenger vehicle emits about 4.6 metric tons of carbon dioxide per year.

<https://drive.google.com/drive/u/0/folders/1XgHnEPR6iRNAS-Iu-Wg1jXkiacOVCm9a>

1. These 4.6 metric tons include all of the carbon dioxide from YOUR car. How can you make your family car trips more efficient?

2. On what days could you and/or your family ditch the car altogether? What trips do you currently take in a car for which you could either walk or bike?

After answering these questions, discuss your answers with others.