

## Lab: Greenhouse Gas Simulation

### FOR THE TEACHER

#### Summary

In this lab, students will create two simulations of the Earth's atmosphere. They will compare a control model with a one that has an increased presence of carbon dioxide gas in order to analyze how this effects temperature. They will also complete research in order to learn more about the makeup of the Earth's atmosphere.

#### Grade Level

Middle or High School

#### Objectives

By the end of this lab, students should be able to

- Identify the types and percentages of each gas that makes up the Earth's atmosphere.
- Explain what events, both past and present that lead to an increase in carbon dioxide levels in the atmosphere.
- Analyze a simulation that compares two different models of the Earth's atmosphere, and measure the temperatures of each.

#### Chemistry Topics

This lab supports students' understanding of

- Gas
- Temperature
- Chemical Change
- Energy

#### Time

**Teacher Preparation:** 30 minutes

**Lesson:** 60 minutes

#### Materials

(Per student group: students are in groups of 2 or 3)

- 1 Tablets/Chromebook
- 3 tablets Alka-Seltzer
- 2 empty, clear 2-liter bottles
- 2 liters of Water
- 2 rubber stoppers with hole in the center that fit 2-liter bottle openings (use modeling clay if these are not available)
- 2 temperature sensors (use thermometers if these are not available)
- Heat lamp or 100 watt spotlight and bulb holder with clamp
- Timer

#### Safety

- Always wear safety goggles when handling chemicals in the lab.

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#### Thanks to

Dow Chemistry Teacher  
Summit

- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
- Exercise caution when using a heat source. The heat lamp should be turned off and unplugged as soon as it is no longer needed.
- When using the heat lamp make sure it is not too close to the 2-liter bottles and exercise caution while it is on.

### Teacher Notes

- This lesson can be done as a demonstration or in small groups depending on the number of available temperature sensors or thermometers. The student directions are written as if each group is to carry out their own experiment.
- This lab is designed so that once it begins, students will periodically collect and graph the temperature data. In the meantime they will be using a tablet or Chromebook type device to be completing the research component.
- Students will research and discover that Alka-Seltzer tablets were used because when placed in water they cause a chemical reaction that produces carbon dioxide. This will cause an increase in carbon dioxide in one of the sealed 2-liter bottles which should register higher temperatures when placed near a strong light/heat source.
- Variations:
  - Students may be provided with a data table and double line graph instead of creating one on their own. This is dependent on if they have been previously taught how to create an appropriate data table and double line graph.
  - The 2-liter bottles could be replaced with any other container that traps the air but allows the radiant energy from the bulb to increase the thermal temperature inside the container.
  - Digital thermometers can be replaced with traditional thermometers provided they fit inside the container. All attempts should be made to monitor the air temperature near the top of the container though.
  - A heat lamp works best. A household bulb is likely not bright enough to produce measureable results.
  - Possibly use more than 2 bottles (control and experimental) and use multiple bottles with different quantities of Alka Seltzer tablets.
  - Consider spreading this lesson out as a STEM based unit in which students are given the task to create their own experiment to simulate greenhouse gas increases. Also, add 1 extra day at the end of the unit where students spend more time researching question #8 “In your opinion, what should be done by humans to protect Earth’s atmosphere?” Students can then present their findings through formal class discussions.

## FOR THE STUDENT

### Greenhouse Gas Simulation

#### Background

Earth's atmosphere is comprised of specific gases. When the percentages of these gases change, so does the temperature of the atmosphere. An increase in Earth's overall atmospheric temperature greatly affects life on Earth.

You will be given the equipment needed to make 2 simulations of Earth's atmosphere. One of these will have an increased level of greenhouse gases. It will be your job to explore how this was accomplished and the effects it has on the temperature inside the container.

#### Safety

- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- Follow the teacher's instructions for cleanup of materials and disposal of chemicals.
- Exercise caution when using a heat source. The heat lamp should be turned off and unplugged as soon as it is no longer needed.
- When using the heat lamp make sure it is not too close to the 2-liter bottles and exercise caution while it is on.

#### Materials

- Tablet/Chromebook
- 3 Alka-Seltzer tablets
- 2 empty, clear 2-liter bottles
- Water
- 2 rubber stoppers
- 2 temperature sensors
- 100 watt lamp
- Timer
- Graph paper

#### Procedure

1. Fill each 2 liter bottle halfway with water, about 1 liter.
2. Set-up and connect two temperature sensors for use.
3. Push each of the temperature sensors through the center hole in a rubber stopper.
4. Set up the heat lamp about 2 feet from the bottles, and adjust it so that the light will shine directly on the bottles. Do not turn it on until the timer is started.
5. Next, place the 3 Alka-Seltzer tablets in one of the bottles. This will be the bottle with the increased amounts of greenhouse gases. The other bottle is the control.
6. Place the stoppers with the temperature sensors in the 2 liter bottles. Turn on the light. Start the timer.
7. Record the initial temperature of each bottle in the data table below.

8. Also, plot the points for initial temperature on your double line graph on the graph paper. The X-axis should be time and Y-axis should be temperature. Don't forget to create a key with color coding.
9. Record the temperature of each bottle every 5 minutes until there are only 5 minutes left in your class period.
10. While the experiment is taking place, use the tablet/Chromebook to complete the questions and continue to plot the points for the double line graph.

**Data**

Time (minutes)	Temperature: Control Bottle	Temperature: Alka-Seltzer Bottle
0 (initial)		
5		
10		
15		
20		
25		
30		
35		
40		

**Investigation Questions**

Use the tablet or Chromebook to answer the following questions. Use your best judgment to research appropriate resources.

Suggested websites include:

- <http://www.epa.gov/climatechange/ghgemissions/>
- [http://education.nationalgeographic.com/education/encyclopedia/atmosphere/?ar\\_a=1](http://education.nationalgeographic.com/education/encyclopedia/atmosphere/?ar_a=1)
- <http://gcmd.nasa.gov/learn/pointers/meteo.html>

1. What gases and percentages of each make up Earth's atmosphere?
2. What does the term "Greenhouse Effect" mean in regard to Earth's atmosphere?
3. What happened to the Alka Seltzer when it was placed in the water? What type of change (chemical or physical) was it and how can you prove it?

4. How have humans contributed to an increase in carbon dioxide levels in the past 100 years?
5. What natural events contribute to an increase in carbon dioxide levels?
6. What happens to the air temperature when there is more carbon dioxide present?
7. Describe the data from the experiment you just carried out with the 2-liter bottles.
8. In your opinion, what should be done by humans to protect Earth's atmosphere?