How can you observe the greenhouse effect?

1. Introduction

Have you ever noticed how hot it can get inside a car on a summer day? It'll seem really hot outside, but when you climb into your car you'll find that it's even hotter inside than out. This is because your car acts like a greenhouse by trapping the sun's heat. The purpose of this lab is to demonstrate how a greenhouse works, and to explain how this process is exhibited in the Earth's atmosphere.

2. Background

The chemical bonds in carbon dioxide molecules absorb solar energy, trapping heat within the atmosphere in the same way glass traps heat within a greenhouse. Because of this heat-trapping ability, gases such as carbon dioxide, methane, and nitrous oxide are known as greenhouse gases. The warning of the atmosphere that results from greenhouse gases is known as the **greenhouse effect,** as shown in Figure 1.

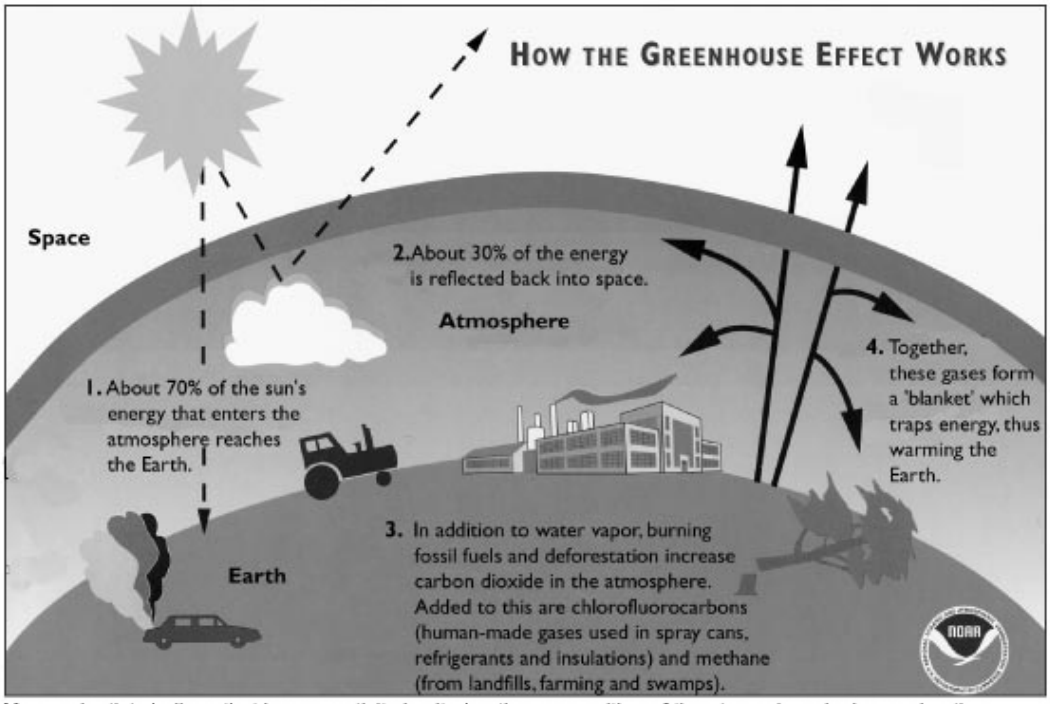


Figure 1. The Greenhouse Effect (www.dcnr.state.pa.us/.../ spring02/warming.htm)

Human activities are greatly increasing the concentrations of greenhouse gases in the atmosphere. The average global temperature is directly correlated with the increasing

concentration of these gases in the atmosphere. Major problems associated with global worming include rising sea levels and changes in patterns of rainfall. Sea levels may have already risen 5 centimeters from global warming. If the polar ice caps melt, sea levels would rise by more than 150 meters, flooding the entire Atlantic cost of North America inland for several hundred kilometers!

3. Objectives

In this experiment, you will

- Use a temperature probe sensor to measure temperature changes.
- To have students understand the greenhouse effect as a physical phenomenon.
- Plot the temperature changes vs. time.

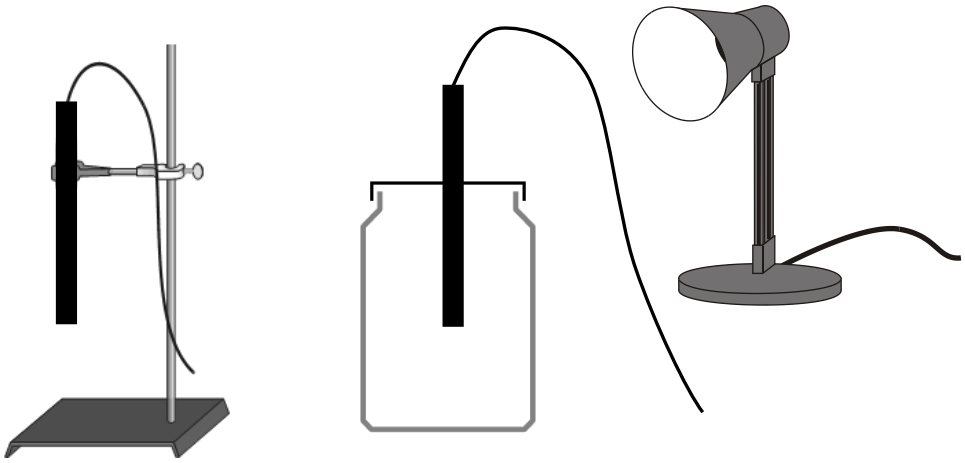


Figure 2.

4. Equipment

Logger Pro
Vernier Temperature probe
Lamp or sunlight
1 quarter jar
Lid with a small hole in the center
Tape

5. Experiment Procedure

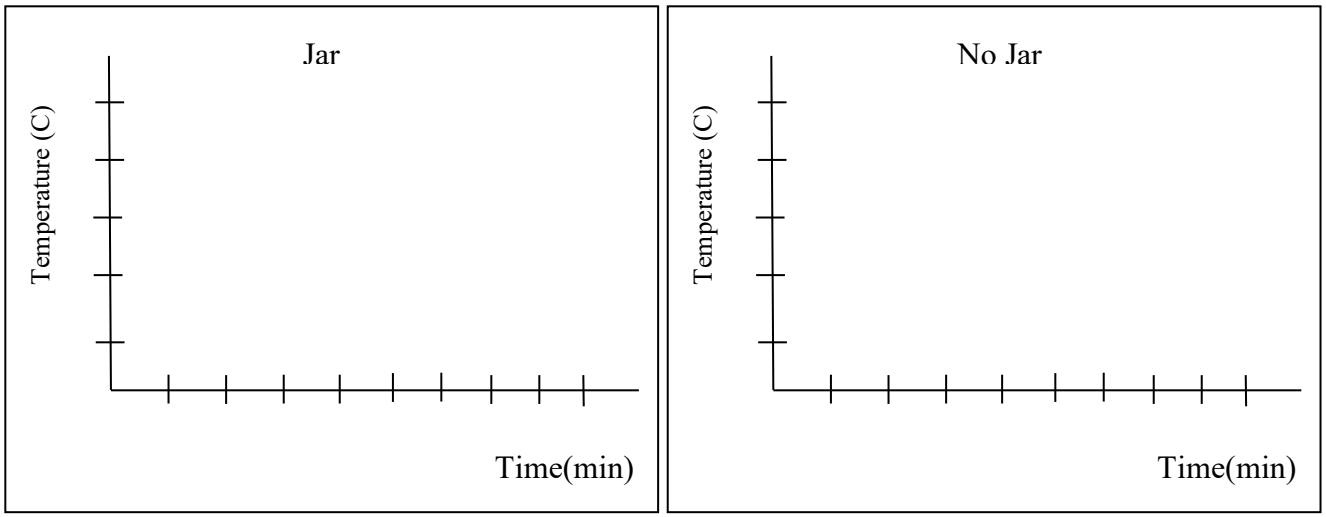
1. Before collecting data, set up the data collection mode.
    a. To select MODE, press up arrow key twice and press ENTER key.
    b. Select TIME GRAPH from the SELECT MODE menu.
    c. Select CHANGE TIME SETTING from the TIME GRAPH SETTING menu.
    d. Enter "6" as the time between samples in seconds.
    e. Enter "150" as the number of samples (data will collect for 15minutes).
2. Connect the Temperature probe Sensor to Channel 1 of the Vernier computer interface.
3. Insert the end of one probe into the hole in the lid of a quarter jar, and tape the probe in place. *The jar should be airtight.
4. Place the other probe about 4 in. from the jar and at the same height as the first probe.
5. Place the jar about 30 cm from a heat-radiating source (lamp), and then turn on the lamp.
6. After the three-minute time period is up, select START to begin data collection. Data will be collected for 15 minutes.
7. When data collection has finished, determine the change in temperature over time:
    a. Press ENTER to view the graph of TEMPERATURE VS. TIME. Sketch a copy of your graph in the Graph section below. When finished, press ENTER to return to the graph menu.
    b. When finished, press ENTER to return to the graph menu. Select MAIN SCREEN from the graph menu.
8. Perform a linear regression to calculate the rate of Temperature increasing.
    a. Select ANALYZE from the main screen.
    b. Select CURVE FIT from the ANALYZE OPTIONS menu.
    c. Select LINEAR (CH 1 VS TIME) from the CURVE FIT menu.
    d. The linear-regression statistics for these two lists are displayed for the equation in the form:

$$Y=A*X+B$$

    e. Enter the value of the slope, *A*, as the rate of respiration/photosynthesis in Table 1.
    f. Press ENTER to view a graph of the data and the regression line.
    g. Press ENTER to return to the ANALYZE menu.
    h. Select RETURN TO MAIN SCREEN from the ANALYZE menu.
9. Repeat step 6~8 to collect data with temperature sensor without a jar.

6. Results

Table 1	
Leaves	Temperature change (°C/min)
Jar	
No Jar	



7. Analysis

1. Which thermometer indicates the higher temperature?

2. Why is that so?

3. How is the jar behaving like the Earth's atmosphere?

4. What in the atmosphere acts like the glass of the jar?

5. What is this process called and why?

6. What would the Earth's climate be like if we did not have the greenhouse effect?

- Which thermometer indicates the higher temperature? *The one inside the jar.*
- Why is that so? *The glass jar traps the heated air inside and does not allow it to escape; the temperature rises and stays higher than that shown by the thermometer outside.*
- How is the jar behaving like the Earth's atmosphere? *The glass of the jar has a similar effect to that of greenhouse gases.*
- What in the atmosphere acts like the glass of the jar? *Atmospheric greenhouse gases: carbon dioxide, methane, nitrous oxide, water vapor and fluorocarbons.*
- What is this process called and why? *The greenhouse effect, because the gases in the atmosphere act like the glass in a greenhouse.*
- What would the Earth's climate be like if we did not have the greenhouse effect? *Climate would be too cold for life.*