

Tropical FORESTS

cleaning the air?

ACTIVITY



Activity Overview

Green plants use energy from the sun to make their food. During this process of photosynthesis, they take in carbon dioxide (CO_2) and water and release oxygen. Scientists believe the amount of CO_2 that tropical forests “use up” in photosynthesis is significant enough to lower the amount of CO_2 in the atmosphere. They debate whether this reduces the greenhouse effect and in turn global warming.

In this activity, you will measure the change in the amount of CO_2 in a bottle that contains spinach leaves when it is exposed to light. Using a CO_2 Gas Sensor connected to a TI CBL 2™ or Vernier LabPro and a TI-73 Explorer™, you will collect CO_2 data and observe the effects of photosynthesis as you add leaves to the bottle. You will simulate the sun with a lamp. By measuring and graphing CO_2 changes in the bottle that contains different quantities of leaves, you will observe that the greater the number of leaves in the bottle, the more quickly the level of CO_2 drops.

Does the quantity of spinach leaves make a difference in how quickly CO_2 is being removed from the bottle? How can the experiment help you understand how plants use carbon? What role do you think tropical forests play in keeping the Earth healthy?

Focus Question
How do plants reduce carbon dioxide from the atmosphere?



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Procedure

1 Prepare the plant.

- Select four fresh spinach leaves that are of equal size. Each leaf should be about 4 cm in diameter. You may need to cut the leaves.
- Blot dry the spinach leaves by placing them between two pieces of paper towel.
- Set the leaves aside.

2 Connect the CO₂ Gas Sensor to the CBL 2™ or LabPro (interface) and the interface to the TI-73 Explorer™.

- Plug the CO₂ Gas Sensor into CH1 of the CBL2™ or Vernier LabPro.
- Use the link cable to connect the TI-73 Explorer™ to the interface.
- Firmly press in the cable ends.
- If possible, connect the AC Adapter to the CBL2™ when using the CO₂ Gas Sensor. The sensor significantly decreases the battery life of the CBL2™.

3 Set up the TI-73 Explorer™.

- Turn on the TI-73 Explorer™ and start DATAMATE. (*For instructions on DATAMATE, see Appendix A.*)
- Press **CLEAR** to reset the program.
- If the calculator displays a CO₂ sensor in channel 1, proceed directly to step 4. If it does not, continue with this step to set up your sensor manually.
- Select SETUP from the MAIN SCREEN.
- Press **ENTER** to select CH1.
- Select MORE from the SELECT SENSOR MENU.
- Select CO₂ GAS from the SELECT SENSOR MENU.
- Select CO₂ GAS (PPM) as the unit.
- Select OK to return to the MAIN SCREEN.
- Collect CO₂ data from an empty bottle.

4 Collect CO₂ data from an empty bottle (control).

- Flush the inside of the bottle by filling it with tap water and then dumping out the water. Completely dry the bottle with paper towels.
- Wait for 2 minutes and then place the CO₂ Gas Sensor into the bottle.
- Gently twist the stopper on the shaft of the CO₂ Gas Sensor into the chamber opening. Do not twist the shaft of the CO₂ Gas Sensor or you may damage it.
- You may place the bottle on its side for stability.

5 Collect your CO₂ data.

- Position the light close to the bottle with the CO₂ Gas Sensor.
- Place the 1 L bottle or beaker filled with tap water between the light and the bottle to serve as a heat shield. Turn the light on and wait 3 minutes.
- Select START on the TI-73 Explorer™.
- Your graphing device will collect data for 5 minutes (300 seconds) and will stop automatically.
- At the end of the 5 minutes, a graph of CO₂ GAS vs. TIME will be displayed.

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Materials*

- TI-73 Explorer™
- TI CBL2™ or Vernier LabPro
- TI-73 DataMate
- CO₂ Gas Sensor
- 250 mL glass bottle (comes with sensor)
- Lamp with 60-watt bulb
- Fresh spinach leaves
- 1 L bottle or beaker filled with tap water



TI-73 Explorer™



CBL2™

* This activity has been written for the TI-73 Explorer™ but you can easily substitute the TI-83 or TI-83 Plus. Also see Appendix A for steps on how to transfer DataMate to your graphing device and how to use DataMate for data collection.



Adapted from "Experiment 31B — Photosynthesis and Respiration," *Earth Science with Calculators*, written by Johnson, Robyn L., DeMoss, Gretchen Stahmer, and Sorensen, Richard, published by Vernier Software & Technology, 2002.

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6 Store your data so you can use it later.

- Press **ENTER** to return to the MAIN SCREEN.
- Select TOOLS from the MAIN SCREEN.
- Select STORE LATEST RUN from the TOOLS MENU.

7 Place one spinach leaf in the bottle.

- Rinse the inside of the bottle with tap water and completely dry with paper towels.
- Wait for 2 minutes and then add one leaf to the bottle and reattach the CO₂ Gas Sensor.
- Place the CO₂ Gas Sensor into the bottle.
- Gently twist the stopper on the shaft of the CO₂ Gas Sensor into the chamber opening. Do not twist the shaft of the CO₂ Gas Sensor or you may damage it.
- You may place the bottle on its side for stability.
- Collect your data by repeating step 5 and then proceed to step 8.

8 Store your data so you can use it later.

- Press **ENTER** to return to the MAIN SCREEN.
- Select TOOLS from the MAIN SCREEN.
- Select STORE LATEST RUN from the TOOLS MENU.

9 Place three spinach leaves in the bottle.

- Gently remove the CO₂ Gas Sensor from the bottle. Do not twist the sensor or you may damage it.
- Remove the leaf in the bottle and rinse the bottle with tap water. Dry completely using paper towels.
- Wait for 2 minutes and then add three fresh spinach leaves making sure to spread them so they do not overlap.
- Reattach the CO₂ Gas Sensor.
- Collect your data by repeating step 5 and then proceed to step 10.

10 Analyze your data.

- Press **ENTER** to return to the MAIN SCREEN.
- To graph all three runs on a single graph, select GRAPH from the MAIN SCREEN to see the last graph, and then press **ENTER**.
- Select MORE, then select L2, L3 AND L4 VS L1 from the MORE GRAPHS MENU.
- Complete the Data Analysis section. Answer the questions in your journal.

↻ *To do the experiment again, press **ENTER** to return to the main screen of DataMate and repeat the steps above.*



CO₂ Gas Sensor



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Data Analysis

A. Compare results by observing your graph.

Draw a sketch of the graph created by your graphing device.

1. By observing your graph, how did the CO₂ concentration change in the bottle with no leaves?
2. By observing your graph, how did the CO₂ concentration change in the bottle with 1 leaf?
3. By observing your graph, how did the CO₂ concentration change in the bottle with 3 leaves?

Use the arrow keys to move the cursor along each curve. Use the left and right arrow keys (←, →) to move the cursor along a curve. Use the up and down arrow keys (↑, ↓) to move the cursor from one curve to the next. The time (x) and level of carbon dioxide (y) values of each data point are displayed below the graph. (Note: P3 represents the container with zero (0) leaves, P2 represents the container with one (1) leaf, and P1 represents the container with three (3) leaves.)

Move the cursor along each curve to answer the following questions and record your answers in the table provided. (Copy the table in your journal.)

| Number of leaves | Starting CO ₂ Level (ppm) | Final CO ₂ Level (ppm) | Change in CO ₂ Level (ppm) | Increase or Decrease |
|------------------|--------------------------------------|-----------------------------------|---------------------------------------|----------------------|
| 1 | | | | |
| 3 | | | | |

B. Describe your results with one leaf inside the container.

1. What is the level of CO₂ at the start ($x = 0$)?
2. What is the level of CO₂ at the end of the 5-minute period ($x = 300$)?
3. Subtract to find the difference (*change in CO₂ level*) between the starting CO₂ level and the final CO₂ level.
4. Did the level of CO₂ increase or decrease at the end of the 5-minute period?



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C. Describe your results with three leaves inside the container.

1. What is the level of CO₂ at the start ($x = 0$)?
2. What is the level of CO₂ at the end of the 5-minute period ($x = 300$)?
3. Subtract to find the difference (*change in CO₂ level*) between the starting CO₂ level and the final CO₂ level.
4. Did the level of CO₂ increase or decrease at the end of the 5-minute period?

D. Compare your results.

1. During the 5-minute time period, which container had the greatest change in carbon dioxide (CO₂) levels, the container with one leaf inside or the container with three leaves inside?
2. According to your data, what factor(s) caused the change in CO₂ levels?
3. According to your data, what factor(s) caused the greatest change in CO₂ levels?
4. Based on your results and the information about the carbon cycle from the research article, explain why deforestation is of great concern in areas like Panama.



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