Tropical FORESTS cleaning the air?

TEACHER

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, students 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™, students will collect CO_2 data and observe the effects of photosynthesis as they add leaves to the bottle. Students will simulate the sun with a lamp. By measuring and graphing CO_2 changes in the bottle that contains different quantities of leaves, they will observe that the greater the number of leaves in the bottle the more quickly the level of CO_2 drops.

Conclusion: Plants exposed to light use CO_2 in photosynthesis. Tropical forests may play an important role in reducing the greenhouse effect on the Earth by absorbing large amounts of CO_2 from the atmosphere during their natural life process.

Activity at a Glance

Grade: 4-9
Subject: Science
Category: Life Science, Earth Science
Topic: Living Things, Plants, Photosynthesis, Respiration, Climate

Time Required

- Two 45-minute periods

Level of Complexity

- High

Materials*

- TI-73 Explorer™
- TI CBL2™ or Vernier LabPro
- TI-73 DataMate
- CO_2 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

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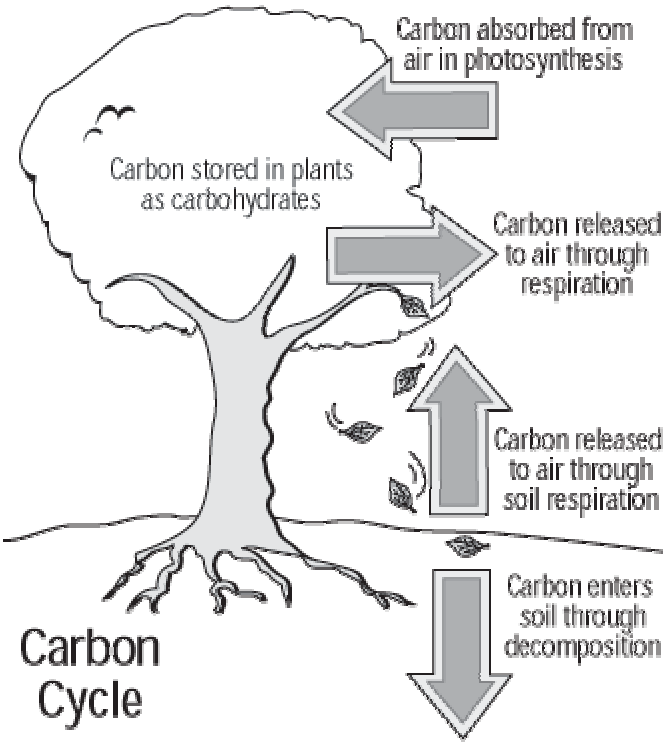
Concept Background

- Plants absorb carbon from the air through photosynthesis, store it as carbohydrates, and release it through decomposition into the soil, from which it enters back into the air. (See diagram below.)
- In theory, a mature forest ecosystem should give off about as much carbon as it absorbs. Yet, some forests are carbon sinks — usually fast-growing, young ones. Carbon sinks absorb more carbon than they give off.
- Tropical forests store about 1/5 of all the carbon that is contained in the Earth's terrestrial ecosystems.
- Human activities such as emissions and deforestation add CO_2 into the atmosphere. Each year the total amount of CO_2 in the atmosphere increases by 3.3 trillion kilograms.
- According to the National Academy of Sciences, the Earth's surface temperature has risen by about 1/2 a degree Celsius in the past century. They have linked this increase in temperature to increased greenhouse gases (about a quarter of which is carbon dioxide) in the atmosphere. This is cause for concern.



National Education Standards

Science Standard C: Life Science
Students should develop an understanding about the structure and function of living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and the diversity and adaptations of organisms.

Science Standard F: Science in Personal & Social Perspectives
Students should develop an understanding of personal health, populations, resources, environments, and natural hazards. Students should also learn about the role of science and technology in society.

Geography Standards 7-8: Physical Systems
Students should learn how physical processes and human activities can shape the patterns of the Earth's surface, how Earth-Sun relationships affect physical processes and patterns on Earth, and how to predict the consequences of physical processes on the Earth's surface.

Geography Standard 14: Environment & Society
Students should understand how human actions modify the physical environment.

Math Standard: Data Analysis and Probability
Students should develop an understanding about how to collect, organize, display, and interpret data.

English Language Arts Standard 3
Students should apply strategies to comprehend, interpret, evaluate, and appreciate text.

Preparation and Classroom Management Tips

- Flushing the bottle with tap water before collecting data will force in fresh air. This will help keep the initial CO_2 concentration in the bottle more or less equal to the CO_2 concentration in the room.
- It is important to completely dry the bottle after flushing between trials. If there is any water left in the bottle it may skew results.
- The spinach leaves need to be small as suggested in the procedure. Big leaves do not work well because they will condensate the bottle and may skew the results.
- The run with no leaves in the bottle serves as a control. Explain to your students the purpose of controls in experiments.
- Like many science experiments there are quite a few variables that can affect consistency of results. In this experiment, the freshness of the spinach leaves, the size of leaves, and water vapor in the bottle may cause variations in the results.
- Turn the lamp on 3 minutes before you begin data collection.
- The CO_2 Gas Sensor may need to be calibrated before completing this activity. Refer to the CO_2 Gas Sensor booklet that comes with the sensor.
- The CO_2 Gas Sensor goes through a 90-second warm-up cycle. Don't be surprised to see CO_2 readings ranging from 0 ppm to 5000 ppm during this time.
- The CO_2 Gas Sensor is quite sensitive. When students perform the experiment they have to be extremely careful not to position it differently in each trial. Also they should not touch it during the experiment.
- The CO_2 Gas Sensor is heat sensitive. It is important to place the heat shield bottle between the light and the bottle with leaves.
- Do not place the CO_2 Gas Sensor tube directly in any liquid.
- You cannot run two CO_2 Gas Sensors at the same time even if the CBL2™ or LabPro is plugged into AC power.
- This activity works well with students in groups or as a demonstration.
- Encourage students to answer the questions in Data Analysis in a journal.
- Create your own student questions for use on your student's TI graphing devices using the Texas Instruments StudyCard applications.

Vocabulary

Biogeochemist A scientist who studies the chemical interactions between the Earth's living features (such as plants and animals) and its non-living features (such as atmosphere, rocks, and water).

Deforestation A process that involves cutting down, burning, clearing, or otherwise damaging forests.

Decompose To be consumed and broken down by bacteria and other microorganisms after death.

Fossil A rock containing a trace of an ancient organism.

Global environmental change A change in the environment that occurs throughout the world.

Greenhouse Gas Any gas present in the Earth's atmosphere that is particularly effective at preventing the planet from radiating heat.

Hypothesize To suggest a scientific explanation that seems reasonable and can be tested with experiments.

Photosynthesis The process by which plants use sunlight, carbon dioxide, and water to make their own food (sugar). Oxygen is a by-product.

Sustainable use Use of an ecosystem's resources (such as water, or trees in a forest) that allows time to replenish what is used and continues to meet the needs of the organisms that depend on it.

Terrestrial ecosystem A group of land-based living things interacting with each other and their environment.

Transpiration The process by which a plant absorbs liquid water through its roots, pulls the water upward, and then releases water vapor through its leaves.

Data Analysis

A. Compare results by observing your graph.

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

1. **Q.** By observing your graph, how did the CO_2 concentration change in the bottle with no leaves?

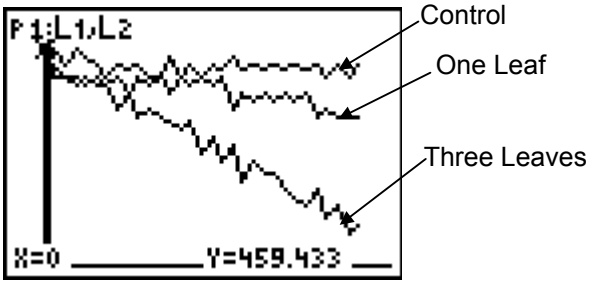
   A. *The CO_2 concentration remained relatively constant.*

2. **Q.** By observing your graph, how did the CO_2 concentration change in the bottle with 1 leaf?

   A. *The CO_2 concentration decreased.*

3. **Q.** By observing your graph, how did the CO_2 concentration change in the bottle with 3 leaves?

   A. *The CO_2 concentration decreased the most*.



Sample Graph

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 control, P2 represents the container with one (1) leaf, and P1 represents the container with three (3) leaves.)

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

1. **Q**. What is the level of CO_2 at the start (x = 0)?

   A. *Answers will vary.*

2. **Q**. What is the level of CO_2 at the end of the 5-minute period (x = 300)?

   A. *Answers will vary.*

3. **Q.** Subtract to find the difference (*change in CO_2 level*) between the starting CO_2 level and the final CO_2 level.

   A. *Answers will vary.*

4. **Q**. Did the level of CO_2 increase or decrease at the end of the 5-minute period?

   A. *The level of CO_2 decreased.*

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

1. **Q.** What is the level of CO2 at the start (x = 0)?

   A. *Answers will vary.*

2. **Q.** What is the level of CO_2 at the end of the 5-minute period (x = 300)?

   A. *Answers will vary.*

3. **Q.** Subtract to find the difference (change in CO_2 level) between the starting CO_2 level and the final CO_2 level.

   A. *Answers will vary.*

4. **Q.** Did the level of CO_2 increase or decrease at the end of the 5-minute period?

   A. *The level of CO_2 decreased.*

D. Compare your results.

1. **Q.** During the 5-minute time period, which container had the greatest change in carbon dioxide (CO_2) levels, the container with one leaf inside or the container with three leaves inside?

   A. *The container with three spinach leaves inside had the greatest change in CO_2 levels.*

2. **Q.** According to your data, what factor(s) caused the change in CO_2 levels?

   A. *The presence of leaves in the container was one factor that caused a change in CO_2 levels. The light, which is necessary for photosynthesis, was another factor.*

3. **Q.** According to your data, what factor(s) caused the greatest change in CO_2 levels?

   A. *The number of leaves in the container was the factor that caused the greatest change in CO_2 levels.*

4. **Q.** Based on your results and the information about the carbon cycle from the JASON XV Research Article, explain why deforestation is of great concern in areas like Panama.

   A. *The data shows that the greater the number of spinach leaves in the container the more CO_2 is absorbed during photosynthesis. Tropical forests absorb a great amount of CO_2 from the atmosphere. Deforestation threatens this important role that tropical forests have.*