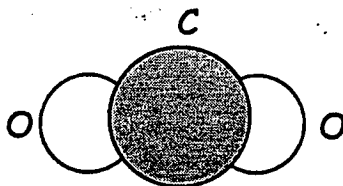


Teaching Activity: Getting to Know Carbon Dioxide

Introduction: Carbon dioxide is a chemical compound composed of one carbon (C) atom and two oxygen (O₂) atoms. Its chemical formula is CO₂ and a molecule would appear as:



Carbon dioxide is a colorless, odorless gas that is found in very small amounts in the Earth's atmosphere. It accounts for only 0.035% of the total mass of the atmosphere but is essential for our survival. ever since the Earth was young, CO₂ has been emitted from volcanoes, from decaying plants and animals, from forest fires and from animal respiration and plant photosynthesis. This natural CO₂ has kept the temperatures on Earth in a range suitable for life. CO₂ is also emitted into the atmosphere by human activity. Over the last 200 years atmospheric CO₂ concentrations have increased noticeably largely through the activities of a growing human population. The largest contribution is through the combustion of fossil fuels in power plants, automobiles and virtually all industrial processes. It is also added to the atmosphere, both directly and indirectly, by deforestation and changes in land use patterns. CO₂ is expected to account for about 50% of the increase in the Earth's average global temperature due to human activity.

Part I: Properties of CO₂:

Objective:

- To familiarize students with the basic properties of CO₂;

Important Terms: Physical and chemical property, chemical reaction, compound, decay, deforestation, fossil fuels, respiration, photosynthesis;

Materials: Baking soda, vinegar, small candle, glass or plastic bottle with long neck, graduated cylinder, plastic cup for candle, funnel, paper and pencil;

Procedure:

NOTE: This is designed as demonstration activity to be conducted by the teacher or a pair of students before the class. It can be adapted for use by the entire class if necessary.

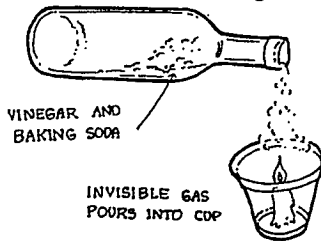
1. Separate 4 tablespoons of baking soda and 100 mL of vinegar.
2. Secure the candle to the bottom of the small container by melting a few drops of wax in the bottom.
3. Take the empty long-neck bottle:

- Pour in 100 mL of vinegar using the funnel.
- Add 4 tablespoons of baking soda also using the funnel.

4. Have students observe and record what happens in either written form or as a drawing with labels.

- Have one student hold their finger over the opening to the bottle and report what he/she feels.

5. Light the candle.



- Hold the opening of the bottle over the flame and "pour" the gas not the liquid onto the flame.
- Students should be observing the procedure and recording the results on their lab sheet.

Note: The CO_2 will fill up the cup and block the O_2 from reaching the flame. The flame will go out.

6. Students should complete question #1-9 in the **Analysis and Comprehension** section.

Part II: Animals and Carbon dioxide

Objective:

- To collect and detect carbon dioxide in exhaled air;

Important Terms: Indicator, exhale, sugar, cell;

Materials: Lime water (lime powder and water), medium sized jar with top, filter paper, funnel straw;

Procedure:

- 1) Prepare some lime water to use as the indicator for CO_2 .
 - Mix 1 teaspoon of lime powder in 1 cup of water.
 - Use filter in the funnel set in the jar to filter the mixture.
 - The lime water in the jar should be clear.
 - Students should observe and record what happens during the demo on their lab sheets.
- 2) Fill the jar half full with lime water. The space above the level of the water is filled with air.
 - Cap the jar and shake it vigorously so that the air bubble through the lime water. The liquid should still be quite clear; the air contains only about 0.03% CO_2 .
 - Students should observe and record what happens on their lab sheets.

3) Blow through the straw into the lime water.

- The water should cloud up quickly indicating that CO_2 has been added.
- The air we breath out is 0.04% CO_2 which is formed from the breakdown sugars in our cells.
- Students should observe what happens and record it on their lab sheets.

4) Students should answer questions #10 - 17 in the **Analysis and Conclusion** section.



Part III: Decomposers and CO_2 :

A vital part of all the food chains in any ecosystem are the decomposers. Lacking chlorophyll, these organisms - fungi and bacteria - get their energy by breaking down dead plant and animal tissues. In the process, large amounts of CO_2 are produced. Decomposition is occurring all the time on the floor of the forest, at the bottom of the ocean, in the ground of a prairie, and in the mud of a marsh. It is a normal and necessary and process. When humans upset the balance in these communities by cutting down trees, for example, decomposition occurs at faster rates, adding even more carbon dioxide to the atmosphere.

Objective:

- To produce, collect and detect carbon dioxide from decomposers;

Important Terms: Decomposers, fungi, bacteria, food chain, chlorophyll;

Materials: A package of dry yeast, sugar, water, measuring cup, match;

Procedure:

1. Dissolve some sugar in 1/2 cup of warm water (not boiling).
2. Add a small amount of yeast to the liquid (1/8 teaspoon).
Note: yeast is a fungus that feeds on sugar. Even though the package appears to contain nothing more than a dry powder, that powder is really living one-celled plants that are still alive but in a dormant stage. They become active when exposed to warmth and moisture. They grow and reproduce as they breakdown the sugar into alcohol and carbon dioxide.
3. Hold a lighted match near the surface of the mixture.
 - Students should observe and record what happens.

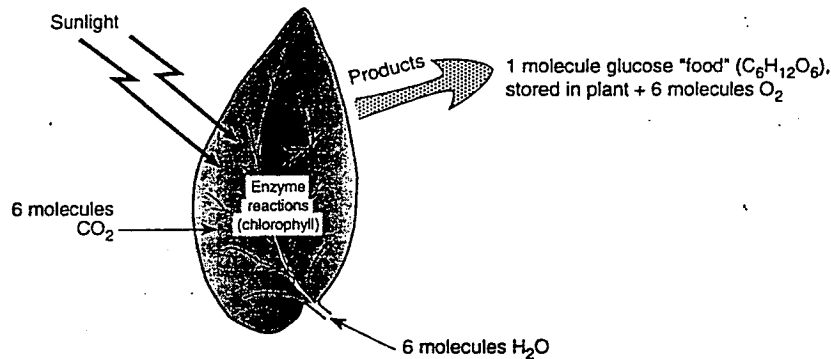
4. Students should then answer questions # 18-27 in the **Analysis and Comprehension** section.



Part IV: The Ins and Outs of Photosynthesis

Green plants perform a special process called *photosynthesis*. In photosynthesis, light energy is used to combine carbon dioxide and water to produce sugars and oxygen:

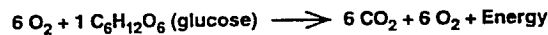
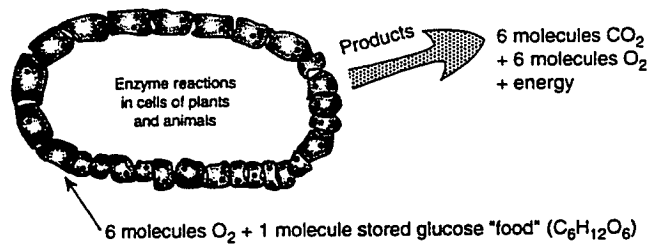
PHOTOSYNTHESIS (ENERGY-STORING PROCESS)



Most photosynthesis takes place in the leaves of plants. The carbon dioxide enters the plants through microscopic openings on the underside of leaves called *stomata*. In addition to allowing CO_2 to enter, the stomata allow water and oxygen to exit.

The glucose produced during photosynthesis is broken down to release the energy needed to carry out other life functions. The complementary process called *respiration*. Because all living things need a constant supply of energy, respiration is performed constantly. Although respiration, like photosynthesis, occurs in a series of complex steps, the overall reaction can be shown in the following equation:

RESPIRATION (ENERGY-RELEASING PROCESS)



The oxygen given off by plants is taken in by animals and used to break down food to release energy. The breakdown of food also produces carbon dioxide, which is released from the body of animals when they exhale. The constant cycling of carbon dioxide and oxygen between plants and animals is known as the *Carbon dioxide - Oxygen cycle*.

Objective:

- To observe the "ins and outs" of photosynthesis and the complementary process of food breakdown, or respiration;

Important Terms: Photosynthesis, respiration, decomposition, chemical formula, stomata, CO_2 , O_2 , glucose;

Materials (Per group): 3 125 mL flasks, 3 #5 rubber stoppers, Bromthymol blue solution, ammonium hydroxide, 2 sprigs of Elodea, about the same size, a light source, drinking straw;

Procedure:

1. Divide the class into groups of three to six students.
2. Gather all materials at least one day prior to the activity.
3. Prepare enough Bromthymol blue (BTB) solution (300 mL per group, plus a little extra "just in case"). To do this add enough 0.1% stock solution (0.5 g BTB dissolved in 50 mL of water) to the water to give it a blue-green color.
 - Add a drop or two of ammonium hydroxide to turn the solution a definite blue.
4. **Pre-Activity Discussion:**
 - Have students read the **Procedure** to the activity.
 - Present the following questions:
 - a. How many flasks will you be preparing?
 - b. How many will contain Elodea?
 - c. Why do you have to be careful when handling the BTB solution?
5. Write the word "photosynthesis" on the board.
 - Ask student for the formula for this process.
 - Fill in the formula on the board.
6. Write the word "respiration" on the board.
 - Tell students that by the end of this activity they will be able to fill in the formula for this process.
7. **Discovery Strategies:**
 - Present the following questions to the class:
 - a. What would happen if you sealed an animal in an airtight jar?
 - b. What would happen if you sealed an animal in a jar with a number of live plants?
 - c. What would happen to plants sealed in an airtight jar? Explain your answer.
 - d. Why would the plants survive?

8. Instruct students to use a graduated cylinder to measure out 100mL of BTB solution for each of the 3 flasks.

CAUTION!!! This solution can stain hands and clothing.

9. Students should then place a straw into one of the flasks and gently blow bubbles until there is a change in the appearance of the liquid.

- Students should record their observations on the lab sheet.
- Students should repeat this procedure with the other two flasks.

Student Activity Sheet #

Analysis and Comprehension:

1. What are two properties of CO_2 ?
2. What is the chemical formula for carbon dioxide?
3. Name 3 natural sources of carbon dioxide.
4. Name 3 sources resulting from human activities.
5. Which 2 substances were used to produce the CO_2 for this demo?
Give their names as well as their chemical formulas.
6. What happened when the vinegar and the baking soda were put together?
7. What type of event is this? Why? What did it produce?
8. When the gas was poured onto the flame, what happened?
9. Why do you think this happened?
10. What process in animals adds CO_2 to the atmosphere?
11. As the population of humans and domestic animals like cows and sheep increase, what could happen to the concentration of carbon dioxide in the atmosphere?
12. What was used as an indicator of CO_2 in this demo?
13. How did the lime water appear when first mixed? Why?
14. How did the lime water appear after the bottle was shaken?
Why?
15. After air was blown through the straw into the jar, what happened to the water? Why?
16. What was present in the jar at the end of the demo that was not there at the beginning?
17. What does that tell you about the exhaled air of humans and other animals?
18. Name 2 decomposers.
19. How do they get their energy?
20. What is the equivalent process in plants? Why can't decomposers do it?
21. Name two locations where decomposition takes place.
22. What effect does human activity have on decomposition in natural ecosystems?
23. What type of decomposer was used in this activity?
24. What 2 conditions were needed for the decomposer to become active?
25. How do they produce CO_2 ? What is the other by-product?
26. When the match was held to the surface of the mixture, what happened?
27. What does that indicate?
28. What color is the BTB solution when you first added it to the 3 flasks?

Student Activity Sheet #

29. How did the solution change when you blew air into it?
30. After 24 hours, what did you observe in each of the flasks?
31. What substance did you add to the BTB solution when you blew into it? How do you know?
32. Where did this substance come from?
33. What effect did this substance have on the solution?
34. What happened in the flask that was kept in the dark? Explain why this happened.
35. What happened in the flask containing the Elodea that was kept in a sunny place? Why?
36. What was the purpose of the flask that did not contain Elodea?
37. How are the "ins" of photosynthesis related to the "outs", or products of respiration?
38. How is photosynthesis related to respiration?

Calculating Activity:

An apple tree which has 200,000 leaves. Each of the leaves has a surface area of 20 cm². The lower surface area of each leaf contains 25,000 stomata per cm². In a single summer, each leaf loses about 86 mL of water through transpiration.

Use a calculator to answer the following questions. Show your calculations on paper.

1. What is the total leaf surface area of the tree? _____
2. How many stomata are on the lower surface of each leaf? _____
3. Assuming that the stomata are only on the undersides of each leaf, how many stomata are on the tree? _____
4. How much water is transpired by the entire tree in a single summer? _____