Ocean in Motion 4: Carbon dioxide - Can Plants Stop Global Warming?

A) OVERVIEW

1. The Ocean in Motion -- Carbon Dioxide and Global Warming

In this program students will explore mechanisms of the carbon cycle and it's importance to life on our planet. Plants and animals both have an impact on the levels of CO_2 in the atmosphere. Photosynthesis and respiration are natural processes which act in opposition to each other the control CO_2 levels. Burning (oxidation) of fossil fuels contributes greatly to the human contribution of CO_2 into the atmosphere. This causes heat to be trapped and creates a general atmospheric (natural vs. anthropogenic effects) warming called the Greenhouse effect.

2. Contents of package

Your packets contain copies of the following:

- Overheads from presentation
  - a) Man-made greenhouse gas contributions
  - b) Greenhouse effect
  - c) Photosynthesis and respiration
  - d) Carbon cycle
  - e) Greenhouse diet
- Activities
  - I. Plant Power
  - II Greenhouse Diet
  - III. Plants Breathe Too!
- Advanced activity
  - 1) Terrarium

B) PROGRAM PREPARATION

1. FOCUS POINTS

0The carbon cycle and carbon dioxide

a. The carbon cycle involves a number of components: land, oceans, plants, animals, atmosphere

b. Natural processes that regulate the carbon cycle are photosynthesis and respiration.

c. The greenhouse effect is necessary for life, yet unnatural sources of CO_2 are harmful to many aspects of life on the planet.

2). ADDITIONAL

a) Pre-Program Demo:

You may wish to present the following demonstration to students the day before the broadcast or, if time allows, just before broadcast. This is merely a suggestion; a similar demonstration during the broadcast will clarify the concepts of increased CO_2 concentrations to temperature.

Label three glass jars as A, B, and C. Place a thermometer in each jar. Jar A is the control; place a lid on it. Using your hands as a seal, cup them around jar B and exhale as much as you can into the jar and quickly seal. Use clay to affix a birthday candle to the inside of the jar C lid. Light the candle and allow it to burn for ten seconds, then blow it out. While the candle is still smoking, quickly put the lid on jar C. Record the starting temperature of each jar, and place in a sunny spot. Record the temperatures at regular intervals for 30 minutes. You may wish to construct graphs at a later time. Encourage students to explain why the temperature was higher in jars with excess CO_2.

2) Vocabulary

Carbon cycle => the process by which organic material is transferred throughout the atmosphere, land and the ocean.

Photosynthesis => the process by which plants produce food from carbon dioxide and water in the presence of light, using light energy and releasing oxygen

Respiration => the process by which organisms use organic materials (food) as a source of energy. As the energy is released, oxygen is released, carbon dioxide and water are produced.

Oxidation => the burning of food for energy; the loss of hydrogens or electrons from a molecule

Greenhouse effect => The heating of the earth's atmosphere that results from the absorption by components of the atmosphere, such as water vapor and carbon dioxide of infrared radiation from the earth's surface

3) Related Topics

Climate and weather

Hydrologic cycle

Meteorology, geology

Impacts (sea level rise, biological perturbances, social and economic, etc.)

C) SHOWTIME

1) Broadcast topics

This broadcast will link into discussions on carbon dioxide, global carbon cycle, respiration and photosynthetic cycles.

a. Carbon Cycle

Carbon can come from many different sources: organic matter, people, plants, paper, pencils, gas, coal, diamonds. It is also in air as a gas-mainly as CO_2. Carbon dioxide is vital in the process of photosynthesis, by which plants make their food, and then release oxygen. Respiration, the reverse process, is where the burning of food (a form of oxidation) produces energy and releases CO_2.

Overhead reproductions: Carbon cycle, Photosynthesis and Respiration

Follow-up activity: Plant Power

b)The Greenhouse Effect

Some atmospheric gases, such as carbon dioxide, trap infrared waves radiated from the earth, thus trapping heat and warming the atmosphere, creating a natural 'greenhouse'. This is necessary for sustaining life, but excess CO_2 has been accumulating over the past 100 years largely due to burning of fossil fuels and deforestation. The greenhouse effect is also caused by increases in CFCs (sprays, refrigerants, packaging), CH_4(landfills, livestock), and N_2O (fertilizers). Proportionally, the contributions to this effect are 55%, 17%, 15% and 6%, respectively. A demonstration will show that plants really can aid in reducing this effect and the many ways in which we can each help decrease CO_2 output will be explored.

Overhead reproductions: Greenhouse effect, Greenhouse Diet, Man-made contributions to Greenhouse Gases

Follow-up activities: Indicating the Presence of Carbon Dioxide

The Greenhouse Diet

D. ACTIVITIES

I. Plant Power

Reproduced with permission from "Forecasting the Future, Exploring evidence for global climate change." Education Department, Stephen Birch Aquarium-Museum. copyright National Science Teachers Association,1840 Wilson Boulevard, Arlington, VA 22201-3000.

Background and Objective: Atmospheric levels of carbon dioxide (CO_2) are rising. This molecule is one of a number of compounds called greenhouse gases. This name comes from the ability of certain gases to trap heat in the atmosphere, warming the earth. Plants produce food for themselves using carbon dioxide from the atmosphere and release oxygen as a by-product. This process is called photosynthesis. This deceptively basic process lowers the concentration of carbon dioxide in the atmosphere.

Respiration is the opposite of photosynthesis. In respiration, food and oxygen combine to release the energy stored in chemical bonds. Water and carbon dioxide result. Plants, animals, and virtually all organisms carry out this process. Respiration, the burning of food for energy is called oxidation. Other common examples of oxidation are the flames of campfires, the rusting of metals, and the ignitions of cars. All these processes can only occur in the presence of oxygen.

Materials:

- 2 identical wide-mouthed one gallon glass jars
- 2 identical lids fitting the jars, made from materials that do not melt
- several small sturdy, well-watered plants
- 4 small votive candles
- long matches
- stopwatch or clock

Method: Place 2 votive candles in each jar. Place the plants in one jar. (Make sure the plant isn't so large, that you will be prevented from closing the jar). Place all jars in well-lit locations so enough light is available for continual photosynthesis. Light all candles with long matches, and secure lids onto the jars immediately after the candles are lit. Time how long it takes for the candles to burn out. Record the rates at which the candle extinguish. Calculate the average duration of candles burned in jars having plants, and compare it to that of candles burned without plants.

Questions for Classroom Discussion:

a. Discuss the processes that are taking place inside the jar.

b. Discuss the various forms of combustion.

c. Why was it important that the plants in this study were well-watered and well-lit?

d. Discuss the effects of widespread deforestation.

e. Grow plants in the classroom, or organize a planting project around school grounds, to help combat deforestation and to experience plant power in action.

II. The Greenhouse Diet

Background and Objective: The US constitutes only 5% of the worlds population yet leads the world in CO_2 emissions, releasing an average of 39,600 lbs. of CO_2 per person every year. It's hard to actually imagine something that weighs almost 40000 pounds. Think of an average middle school student weighing 100 lbs. and pretend each is a "container" of CO_2; that would mean each one of you would produce 400 middle school student size "containers"" of CO_2 per year!

There are many things that each of us can do to help decrease our greenhouse gas output. Go on a "diet," by doing the simple things on this page.

Calculate your savings per week, per year, per classroom; what if you multiplied your savings by all the classrooms in the country? You'll probably be amazed at how much we can actually help individually and together! Some of these things will require your parents' help, too.

The Greenhouse Diet Worksheet is attached.

III. Plants Breathe Too!

Adapted from "Greenhouse Gases - Indicating the presence of Carbon Dioxide", by E.J. Cavalier and J. Herman, pp. IV27-8, In: National Science Foundation, University of Southern Mississippi: Walker, S.H. (project editor) 1996. Global Environmental Education Resource Guide for Middle School Teachers.

Materials:

- 150 ml beaker
- Water
- Bromo thymol blue indicator solution
- Dropper
- Straw
- *Elodea* or other aquatic plant

Objective: To allow students to observe the transformation of carbon dioxide to oxygen through the process of plant photosynthesis. This activity can then be related to classroom discussion on the increase in atmospheric greenhouse gases, and the methods that may be employed to either remove them, or decrease the amount placed into the air.

Method: Fill beaker with 100 ml of freshwater. Add drops of BTB (Bromo thymol blue solution) until water becomes light blue. DO NOT STIR LIQUID. Exhale through straw into liquid long enough to cause a color change. Record the color of the liquid (BTB is an indicator of carbon dioxide and will change color when carbon dioxide is added.) Add a small sprig of *Elodea* to the beaker. Place the beaker in sunlight or under an artificial light source for 30 minutes. Observe and record the color of the liquid.

Classroom Discussion Questions:

1. **What caused the color changes in the indicator?**
2. **What ideas does this give you about how we can slow global warming?**

2) Train Your Brain

I. Terrarium

Materials:

- two large terrariums or several individual "soda-bottle" terrariums
- soil; small green plants (such as herbs)
- worms
- plastic containers
- plastic wrap
- small ruler
- thermometers for each terrarium
- litmus paper.

Objective: The many different aspects of greenhouse effects may be explored including those upon animals, plants, temperature, and water (vapor and level). Greenhouse gases contribute to warming of the earth's atmosphere, also affecting photosynthesis, respiration, sea level, and solubility of gases in water.

Method: Prepare your terrariums. One will act as the control, while the other will represent the greenhouse earth. Try to duplicate conditions as closely as possible, and keep in well-lit area. Add soil and form "lakes" by adding water to plastic containers embedded in soil (optional). Place equal numbers of plants in terrariums; tape thermometer to the inside of each, keeping out of direct sunlight. Keep plants watered, but do not add extra water to lakes. Cover one terrarium with plastic wrap and leave the other exposed. Record differences in temperature, growth of beans, level and pH of water for one week. Add earthworms or some sort of “containable” animals and record temperature, growth, water level and pH again for one week. Are there any other visible changes?

Classroom Discussion Questions:

a) Graph the variable changes as a function of time.

b) Compare the greenhouse to the control terrarium. Describe the processes controlling these differences.