ARCTIC MARINE SCIENCE CURRICULUM

MODULE 5

HUMAN USE & GOVERNANCE

LAB MANUAL

2001

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LAB 1 - THE GREENHOUSE EFFECT

INTRODUCTION

To observe and investigate a model of how light and the atmosphere interact to make Earth suitable for life.

MATERIALS (per group):

- Two large disposable plastic cups
- Dirt to fill each cup
- Something to prop up thermometers (a slightly smaller cup or stack of books will work)
- One rubber band
- Two Celsius thermometers
- Hole punch
- Graph paper

PROCEDURE:

1. About 2 cm from the top of each plastic cup, use the hole punch to make a hole big enough for a thermometer to be inserted.
2. Fill each cup with dirt until the dirt is about 2.5 cm below the hole just made.
3. Insert a thermometer through each hole so that the bulb is about 2.5 cm above the dirt and centered near the middle of the cup (see Figure 1).
   Caution: Do not force the thermometer through the hole. If it will not go, punch a bigger hole.

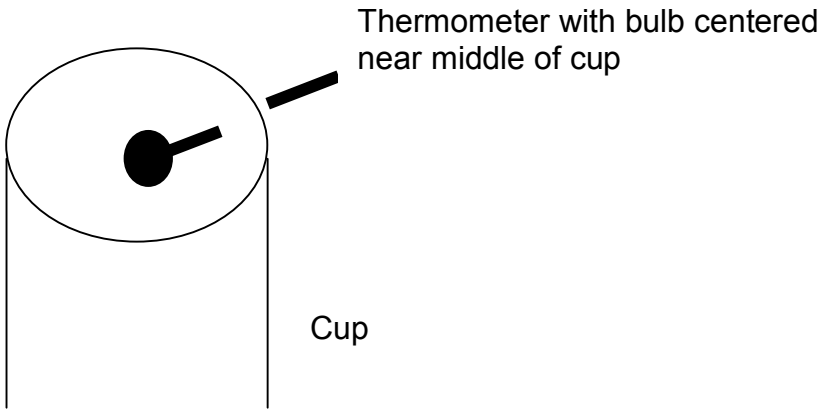

Figure 1: Setting Up the Experiment

4. Turn the thermometers so they can be read.
5. Cover one cup with plastic wrap. Leave the other cup uncovered. Secure the plastic wrap on the cup with a rubber band.

6. On a sunny day, take the two cups outside at the beginning of class. Place them where they will not be disturbed. Stabilize the thermometers so they do not move.
7. Record the initial temperature on each thermometer in the Data Table.
8. Record temperatures every 5 minutes for 30 minutes. During the first five minutes, write a prediction of what you think will happen to the temperatures of the two cups and give a reason for your prediction. Do this in the space below the Data Table.
9. Make a graph for each cup's temperature readings on a sheet of graph paper. Graph the temperatures on the vertical scale and the elapsed time on the horizontal scale. Designate each line as representing either the covered or the uncovered cup.

DATA TABLE

TIME (5 MINUTE INTERVALS)	TEMPERATURE OF COVERED CUP	TEMPERATURE OF UNCOVERED CUP	OTHER OBSERVATIONS
TOTAL DIFFERENCE IN TEMPERATURE			

QUESTIONS AND CONCLUSIONS

1. This lab is a model of what happens on Earth. What do the dirt and plastic wrap represent in this model?

2. What did you predict would happen?

3. Do your graphs support your prediction?

4. How does what you observed in each cup compare with your prediction? If the two are different, how can you account for this?

5. How does this use of a model compare with what scientists do to study the Earth's climate?

LAB 2 - GREENHOUSE GASES

INTRODUCTION

This lab is designed to illustrate the heat-absorption capability of atmospheric carbon dioxide. Carbon Dioxide is identified as a "greenhouse gas" because of its ability to trap heat within Earth's Environment. The lab compares carbon dioxide's ability to absorb thermal energy to air. During this lab, you will build a visual representation of the greenhouse effect.

MATERIALS (per group):

- Two 250 ml flasks
- One #6 no-hole stopper or equivalent
- Two #6 one-hole stoppers or equivalent
- Large pan or bucket of water
- One extension cord if needed
- Alka-Seltzer
- Short glass tube
- Two thermometers
- Two lamps with 100 watt light bulbs
- 30 cm of flexible tubing

PROCEDURE

Preparing the Bottles

1. Fill a 250 ml flask with water to the rim. Stopper the flask with a #6 no-hole stopper.
2. Place the flask upside down into a pan or bucket of water. Remove the stopper. The flask should remain filled with water as it sits upside down in the pan.
3. Add 100 ml of water to the second flask.
4. Insert a short glass tube into a #6 one-hole rubber stopper. Attach a piece of tubing to the glass tube.
5. Feed the free end of the tubing under the water in the pan and into the inverted flask.
6. Drop one Alka-Seltzer tablet into the flask containing 100 ml of water. Quickly stopper the flask with the tube assembly. The carbon dioxide from the dissolving Alka-Seltzer will begin to displace the water in the inverted flask in the pan.
7. After the water has been evacuated from the flask in the pan, place the #6 no-hole stopper in the flask and remove the flask from the pan of water.
8. Insert a laboratory thermometer into each of two #6 one-hole stoppers. Dip the thermometers in glycerine before attempting this procedure.
9. Place one of the stoppers containing a thermometer into an empty flask. This will be a sample of air.
10. Remove the stopper from the flask of carbon dioxide gas. Quickly replace it with a thermometer stopper. (Note: carbon dioxide gas is denser than air and should remain in the flask after it is opened.)

Measuring Temperature:

1. Place each flask 5 cm from a 100-watt light bulb.
2. Record the beginning temperature in each flask of gas on the data sheet below.
3. Turn on the light and record the temperature in each flask in degrees Celsius. Have all students begin at the same time and record their data at precise one-minute intervals for 25 minutes, or until temperatures begin to level off.
4. Construct a line graph of the collected data using separate coloured pens for each flask.

CLASS DATA TABLE

TEAM #	CARBON DIOXIDE TEMPERATURE	AIR TEMPERATURE	CARBON DIOXIDE PERCENTAGE INCREASE	AIR PERCENTAGE INCREASE

DATA ANALYSIS - GREENHOUSE GASES

1. What was the beginning temperature of the air sample?

2. What was the ending temperature of the air sample?

3. By how many degrees did the temperature of the air sample increase?

4. By what percent did the temperature of the air sample increase?

5. What was the beginning temperature of the carbon dioxide sample?

6. What was the ending temperature of the carbon dioxide sample?

7. By how many degrees did the temperature of the carbon dioxide sample increase?

8. By what percent did the temperature of the carbon dioxide sample increase?

9. Which gas experienced the largest percentage of increase in temperature?

10. What is the class average for the percentage increase of the air sample temperature?

11. What is the class average for the percentage increase of the carbon dioxide sample temperature?

DISCUSSING THE RESULTS AND RELATING THE LAB TO THE GREENHOUSE EFFECT:

1. Compare the data as a class and discuss results. What does the data show?

2. We have already learned that the greenhouse effect is a natural phenomenon responsible for sustaining a liveable climate on Earth. Why are we so concerned about carbon dioxide?

3. How do you think scientists measure carbon dioxide in the atmosphere? What do you think might make it difficult to prove whether or not carbon dioxide levels are increasing?

4. Compare this experiment to an example of a car parked under the sun on a hot day with all the windows and doors shut.

   a) *What happens to the temperature inside the car?*

   b) *Does the temperature keep rising as long as the sun is shining?*

   c) *How can you cool the car down?*

   d) *Why does that work?*

LAB 3 - AN INTRODUCTION TO FIELD DATA COLLECTION

INTRODUCTION

How does the temperature vary on the Earth's surface? Is there a difference at different levels? If there is a variation – if so, why does it happen? Can you represent the data over a large area in a format this is easy to understand?

MATERIALS (per group):

- Three thermometers
- Five metre sticks
- Graph paper
- Field notebook

PROCEDURE

You have been selected to provide the site verification in a designated area of a global climate map. This map will be generated by new mapping program. The map will be used to check a new program that predicts current conditions over the northern hemisphere. This new program will be helpful in studying climate changes that may occur as a result of human production of greenhouse gases. This new program combines satellite images, topographic data, and vegetation data with weather service measurements of daily temperature conditions.

The sampling procedure is uniform throughout the Northern Hemisphere and requires a physical confirmation (you need to make the measurements at the research site) of conditions within the study quadrant. Your team will record the temperature at 3 levels at each of 11 sites on a 100m transect.

The 3 readings are at:

1. Soil surface
2. .02m above the surface
3. 1.5 m above the surface.

Each team will take their measurements along a different quadrant, as identified by the project leader (the teacher).

Upon completion of your observations and measurements, your group will display the data in table and graphical format and supply a copy of that data to the class.

ANALYZING THE DATA:

Use the data supplied by the other field teams to draw a map of temperature differences on the study area. Use isotherms to connect regions of like temperature for each data set. On the map of isotherms draw a map of vegetation.

Analyze your maps and write a summary of the class findings. What does this information tell you about the study area?