Greenhouse Effect
Investigating Global Warming

OBJECTIVE
Students will design three different environments, including a control group. They will identify which environment results in the greatest temperature change. Using the temperature probes and the computer graphing software, data will be collected and analyzed for each environment modeled in the experiment. At the end of the experiment, students will be able to define the greenhouse effect and predict future changes in our atmosphere.

LEVEL
Middle Grades: Earth Science

NATIONAL STANDARDS
UPC.2, UPC3, A.1, A.2, B.3, D.2, F.4, F.5

TEKS
6.1(A), 6.2(A), 6.2(B), 6.2(C), 6.2(D), 6.2(E), 6.3(A)

7.1(A), 7.2(A), 7.2(B), 7.2(C), 7.2(D), 7.2(E), 7.14(C)

8.1(A) 8.2(A), 8.2(B), 8.2(C) 8.2(D), 8.2(E), 8.6(C), 8.9(A), 8.9(C), 8.12(C), 8.14(C)
IPC 1(A), 2(A), 2(C), 2(D), 8(A), 8(E), 9(A), 9(B), 9(C)

CONNECTIONS TO AP
AP Environmental Science

IV Environmental Quality A. Air/Water/Soil 1. major pollutants

V Global Changes and Their Consequences A. First-order Effects 1. atmosphere; B. Higher-order Interactions 1. atmosphere

TIME FRAME
50 minutes

MATERIALS
(For a class of 28 working in groups of four)

7 Lab Pro's	1 large bag of soil
7 computers w/Logger Pro software	28 600 mL beakers
21 temperature probes	21 rulers
7 lamps with 100 watt bulbs	Plastic wrap
tape	200 grams baking soda
850 mL of vinegar	

TEACHER NOTES

The Greenhouse Effect deals with global warming as a result of changes in the composition of the atmosphere. The lab may be done when studying the atmosphere, energy sources or environmental changes.

The students will be using the materials provided to create three different environments and measure the changes in temperature for each environment when under a heat lamp for 15 minutes. At the beginning of class, question students regarding their knowledge of the earth's atmosphere. After brainstorming information, describe the three beakers the students will be testing during the experiment. The uncovered beaker acts as a control, the covered beaker represents the earth with its atmospheric blanket, and the CO_2 beaker represents an atmosphere with high levels of CO_2 . Students will investigate how changing the composition of the atmosphere might change the heat trapping ability of the atmosphere.

POSSIBLE ANSWERS TO THE CONCLUSION QUESTIONS AND SAMPLE DATA

Data Table 1			
	Beaker 1	Beaker 2	Beaker 3
Time (minutes)	Probe 1 (Celsius) Control Group	Probe 2 (Celsius) W/out Gas Added	Probe 3 (Celsius) W/ Gas Added
0-minute Temp.	27	27	27
1-minute Temp.	27	27	27
2-minute Temp.	28	28	28
3-minute Temp.	28	28	29
4-minute Temp.	29	29	29
5-minute Temp.	29	30	30
6-minute Temp.	30	30	30
7-minute Temp.	29	30	30

8-minute Temp.	29	29	30
9-minute Temp.	29	29	29
10-minute Temp.	28	29	29
11-minute Temp.	28	30	30
12-minute Temp.	29	31	31
13-minute Temp.	30	31	31
14-minute Temp.	30	32	32
15-minute Temp.	30	32	33

Data Table 2		
Time (minutes)	Temperature difference between beaker 1 and beaker 2	Temperature difference between beaker 1 and beaker 3
0-minute Temp.	0	0
1-minute Temp.	0	0
2-minute Temp.	0	0
3-minute Temp.	0	1
4-minute Temp.	0	0
5-minute Temp.	1	1
6-minute Temp.	0	0
7-minute Temp.	1	1

8-minute Temp.	0	1
9-minute Temp.	0	0
10-minute Temp.	1	1
11-minute Temp.	2	2
12-minute Temp.	1	2
13-minute Temp.	1	1
14-minute Temp.	2	2
15-minute Temp.	2	3

ANALYSIS

1. In the spaces provided in Data Table 2, subtract to find the temperature differences.
    - on chart

CONCLUSION QUESTIONS

2. During periods when the lamp was on, did the covered beakers warm faster or slower than the control? Did the covered beakers (beakers 2 and 3) have about the same temperature or different temperatures throughout the experiment?

• The covered beakers heated faster. The covered beakers were not the same. The beaker with carbon dioxide had a higher temperature.

3. Give a possible explanation for your answers in question 2.

• The covered beakers let heat in, but did not let heat out. Carbon dioxide retains more heat than regular air.

4. What important greenhouse gas did the air in beaker 3 contain?

• Carbon dioxide

5. During the periods when the lamp was off, did the uncovered beaker cool faster or slower than the covered beakers? Justify your answer.

• The control beaker (uncovered) cooled off more quickly because it was uncovered and lost heat faster.

6. Explain why a closed automobile heats up in the sun.

• A closed automobile in the sun allows heat to come into the car but then traps the heat and doesn't let the heat get out. A closed car acts like a greenhouse when parked in the sun.

7. Design an experiment to test the ability of methane to trap heat.

• Repeat the experiment as done here, but replace carbon dioxide in the third beaker with methane. Heat with a lamp and measure the change in temperature in the three beakers.

Experiment
14

Name _____

Period _____

Greenhouse Effect
Investigating Global Warming

The earth is surrounded by a layer of gases which help to retain heat and act like a greenhouse. Greenhouses allow gardeners to grow plants in cold weather. Radiation from the sun passes through the glass and experiences a change in its wavelength. The new wavelength radiation is unable to pass back through the glass and is trapped inside the greenhouse. As a result the temperature of the air inside the greenhouse is increased. This, along with the lack of mixing between the inside and outside air, keeps the greenhouse consistently warm.

Similarly the gases in our atmosphere trap heat. The main components of our atmosphere are N_2, O_2, CO_2, H_2O and Ar.

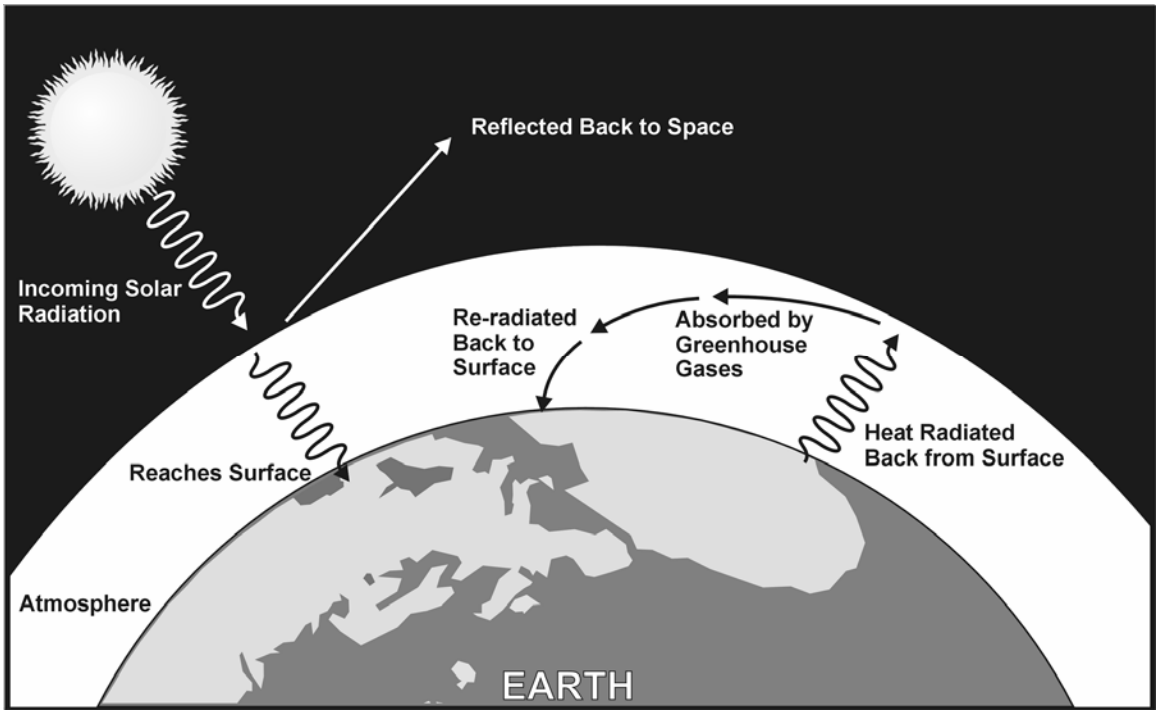

figure 1

In this experiment you will have three beakers to model different environments. The first beaker will be filled with soil, remain uncovered, and serve as our control. The second beaker will contain soil and have a plastic cover, representing the earth with its atmospheric layer. The third beaker will contain soil, a plastic cover and CO_2, which is a gas that has been increasing in our atmosphere over the last 100 years.

PURPOSE

You will analyze temperature data from the three beakers, draw conclusions and make predictions from the data.

MATERIALS

1 Lab Pro and computer	3 rulers
3 temperature probes	Tape
1 lamp with 100-watt bulb	Soil
4 600 mL beakers	plastic wrap
15 grams of baking soda	20 mL of vinegar

Safety Alert
1. Students should avoid touching the heat lamp.
2. Students should wear goggles when mixing the baking soda and vinegar together.

PROCEDURE

1. Make a hypothesis about which beaker will retain the most heat.

2. Plug the temperature probes into channels 1, 2 and 3 of your **Vernier** computer Interface.

3. Tape each temperature probe to a ruler as shown in Figure 2. The probe tips should each be 3 cm from the ruler ends and the tape should not cover the probe tips.

4. Prepare the computer for data collection by opening **Logger Pro** on your computer. The computer should automatically detect the temperature probes that are connected in each channel. A data collection window should open. Check with your teacher if the computer does not detect the probes.

5. Obtain four beakers and prepare three of them for data collection.

6. Place a layer of soil 1 cm deep in each beaker.

7. Place the temperature probes into the beakers as shown in Figure 2.

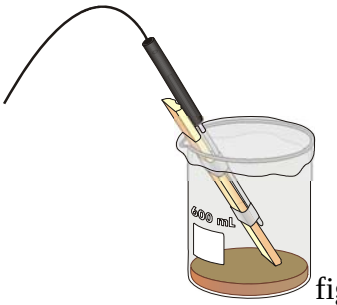
figure 2

8. Cover the top of beakers 2 and 3 tightly with plastic wrap. Remove any excess plastic wrap covering the sides of the beaker. Beaker 1 should be open to air (NO PLASTIC WRAP) and is the control. Beakers 2 and 3 represent your covered greenhouses.

9. In a **separate clean beaker**, combine **15 grams of baking soda and 20 mL of vinegar**. The mixture should immediately produce a gas, as demonstrated in the following equation.
$CH_3COOH_{(aq)} + NaHCO_{3\,(s)} \rightarrow NaCH_3COO_{(aq)} + H_2O_{(l)} + CO_{2\,(g)}$

10. Remove the plastic covering from beaker 3 and pour the gas **slowly** into the beaker. Be careful and **do not allow any liquid to be transferred**. After all the gas has been successfully poured into beaker 3, immediately cover it with plastic wrap.

11. Position a light bulb the same distance from all three beakers, about 7 cm above the tabletop and the same distance from all three temperature probe tips.

12. Click Collect to begin data collection. Turn on the lamp.

13. Monitor the time in the meter window. When 5 minutes have passed, **turn off** the lamp. Data will continue to be collected.

14. At the 10-minute mark, **turn the lamp back on**. Data collection will stop after 15 minutes.

15. When data collection stops, turn the lamp off and remove the temperature probes from the beakers.

16. Turn on the **EXAMINE** feature by clicking the **EXAMINE** button, on the toolbar.

17. Move the cursor to the 0-minute mark on the graph. Use the **EXAMINE BOX** to determine the temperatures in beakers 1, 2, and 3, and record them in the data table.

18. Use the same method to determine the temperatures at the 1-, 2-, 3- minute, etc. marks and record them in the data table.

19. Print copies of the graph as directed by your teacher.

20. Choose **STORE LATEST RUN** from the **DATA** menu.

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HYPOTHESIS

DATA AND OBSERVATIONS

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7-minute Temp.			
8-minute Temp.			

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Data Table 2		
Time (minutes)	Temperature difference between beaker 1 and beaker 2	Temperature difference between beaker 1 and beaker 3
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8-minute Temp.		
9-minute Temp.		
10-minute Temp.		
11-minute Temp.		
12-minute Temp.		

13-minute Temp.		
14-minute Temp.		
15-minute Temp.		

ANALYSIS

Printed Graph

1. In the spaces provided in the Data Table 2, subtract to find the temperature differences.

CONCLUSION QUESTIONS

2. During periods when the lamp was on, did the covered beakers warm faster or slower than the control? Did the covered beakers (beakers 2 and 3) have about the same temperature or different temperatures throughout the experiment?

3. Give a possible explanation for your answers in question 2.

4. What important greenhouse gas did the air in beaker 3 contain?

5. During the periods when the lamp was off, did the uncovered beaker cool faster or slower than the covered beakers? Justify your answer.

6. Explain why a closed automobile heats up in the sun.

7. Draw a sketch and describe an experiment to test the ability of methane to trap heat.