Greenhouse Gases Lab Investigation Day **Score _____ / 20**

Names _____ Per _____ Your Lab Group _____

V. Materials and Equipment Required

- Vernier LabQuest
- beaker, 500-mL
- Temperature Probe
- 1/8" vinyl tubing (0.5 m)
- CO_2 Sensor
- Erlenmeyer flask, 125-mL
- Small Tripod Base & Rod
- 1-hole stopper (for flask)
- Three Finger Clamp
- insulating lid
- plastic tubing connector nib (2)
- clamp or clothes pin
- insulated mitt
- 150-W incandescent light source
- protective gear
- CO_2 via dry ice (50 g)
- Bromethyl blue

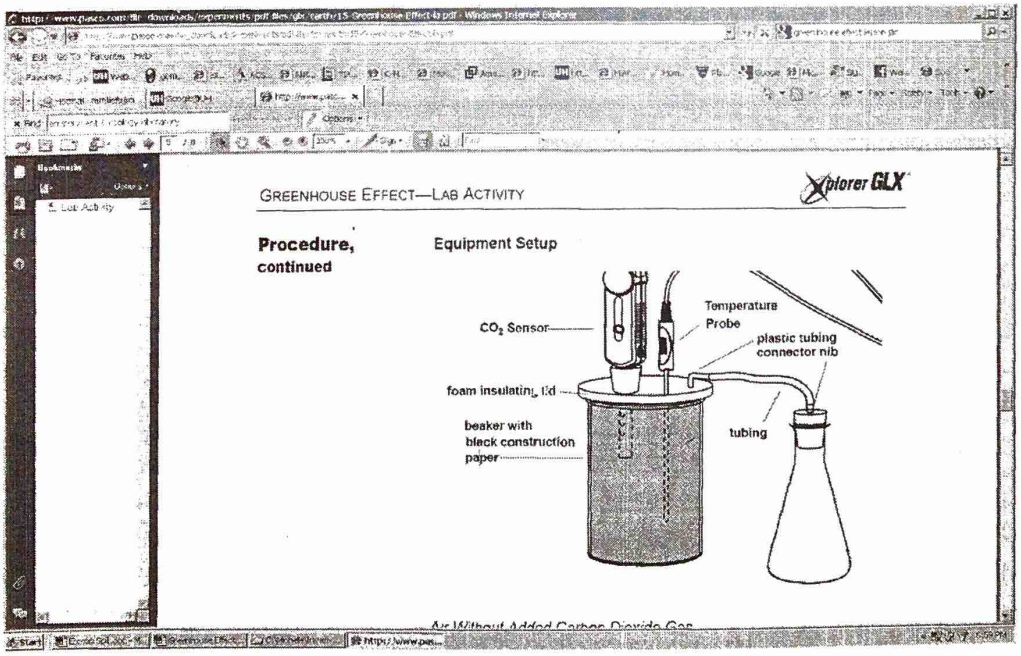
Safety Notes *Wear protective gear at all times (gloves, goggles, etc.).*
Avoid contact of dry ice with skin and eyes. Handle the dry ice with an insulated mitt. Dry ice can burn your skin.

VI. Equipment Setup & Procedure

Each lab group will have a particular experiment to set up in order to examine a particular greenhouse gas' effect on temperature under a light. All groups will record their data in the class Google Sheet online.
Each group is responsible for understanding all experiments within the lab.

Enter and review the data here:
https://docs.google.com/spreadsheets/d/1enYKZ9q1m1IW8hjotKTBCRXz3S7XdbIvoJ05UAY70pM/edit?ts=591bc466#gid=0

A. Experiment A. – CONTROL: *Air Without Added Carbon Dioxide Gas*

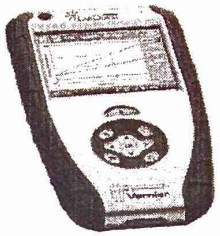


Air Without Added Carbon Dioxide Gas

1. Place the insulating lid on the top of the container.
2. Put the CO 2 Sensor into one of the holes in the lid, making it a snug fit.

3. Press the Temperature Probe through a stopper, and put the contraption through the other hole in the lid
4. Using a ruler, place the light source 6 inches from the beaker, at an angle to avoid a fire on the sensors.
5. The CO 2 Probe should be set to high

Vernier LabQuest



Procedure

Vernier LabQuest Setup

1 Plug the Vernier CO 2 Sensor and temperature probe into the Vernier LabQuest.

1. Connect the CO 2 Gas Sensor to the interface.
2. Start the data-collection software.
3. The software will identify the CO 2 Gas Sensor and load a default data-collection setup. You are now ready to collect data.

Note: Allow the CO_2 Gas Sensor to warm up for about 90 seconds before collecting data.

CO_2 Probe **Temperature Probe**

Data

1. In order to record the data on the correct time scale go to: Experiment ->data collection-> Then change the time scale to minutes and change the number of minutes to 20. Hit okay.

2. Turn on the light, wait for 30 seconds, and press the **Start/Stop** (▶ Start) key to begin recording data.

3. Collect data for 20 minutes. Press **Start/Stop** (■ Stop) key to stop recording data.

B. **Experiment B. – CONTROL**: ***Air <u>With Added Carbon Dioxide</u> Gas***

Equipment Setup

1. Carefully take the rubber stopper out of the Erlenmeyer flask, put several pieces of dry into the flask, and put the stopper back into the flask.

Important: Use the insulated mitt to handle the dry ice.

Important: Do not move or bump the rest of the equipment setup.

Record Data

1. In order to record the data on the correct time scale go to: Experiment ->data collection-> Then change the time scale to minutes and change the number of minutes to 20. Hit okay.

2. Turn on the light, wait for 30 seconds, and press the **Start/Stop** (▶ Start) key to begin recording data.

3. When the carbon dioxide concentration levels off, put the clamp on the tubing to prevent any further addition of CO_2.

Note: The purpose of this step is to isolate the beaker from the cold flask.

3. Collect data for 20 minutes. Press the **Start/Stop** (■ Stop) key to stop recording data.

4. Follow your instructor's directions for cleaning up your work space.

Data for Experiments A & B

Table 1. CO_2 & Temperature Data

	w/out added CO_2		w/ added CO_2	
Time (min)	**CO_2 ppm**	**Temp °F**	**CO_2 ppm**	**Temp °F**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Observations:

Graphs for Experiments A & B

1. Open the Graph display.

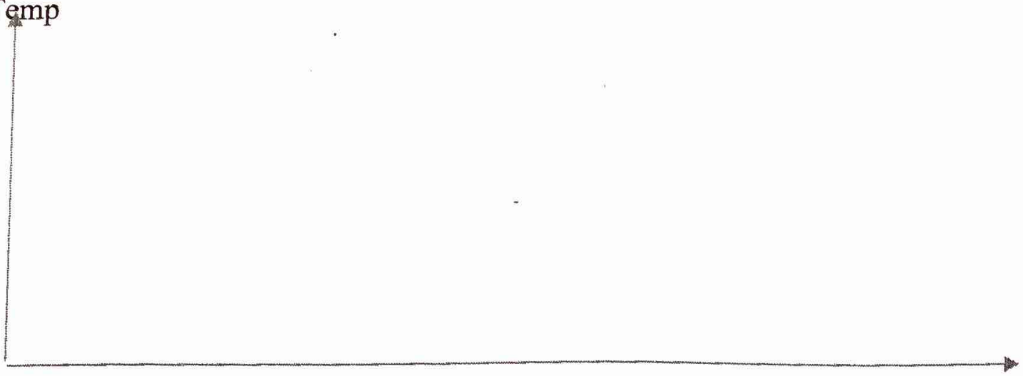
Result: The Graph display opens displaying Temperature for 2 runs.

2. Press the select key, use the arrow keys to highlight the first **Run #**, select it, use the down arrow to highlight the run for the air-only test situation, and select it. Repeat for the second Run #, and select the run for the air plus CO_2 test situation.

Result: The Temperature vs. Time graphs for your 2 runs of data will be displayed.

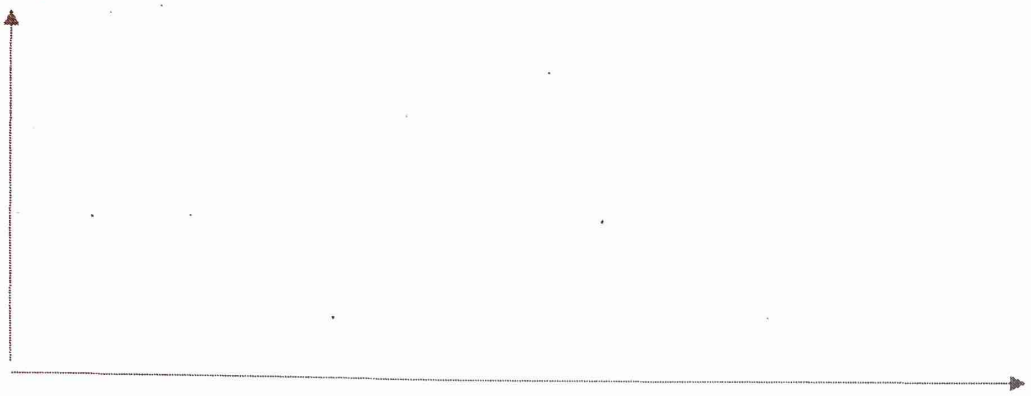
3. Graph **CO_2 Concentration** on the y axis and time on the x axis

Temp

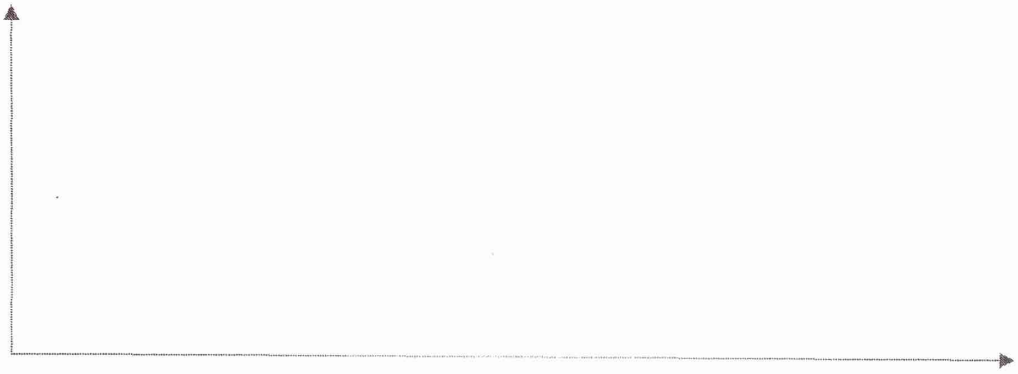


5. Graph **Temperature** on the y axis and time on the x axis

Temp



6. Now graph Temperature as a function of carbon dioxide concentration.



C. **Experiment C.** – ***Air With Added Methane Gas***

1. In order to record the data on the correct time scale go to: Experiment ->data collection-> Then change the time scale to minutes and change the number of minutes to 20. Hit okay.
2. Set up the lamp on a ring stand, insert tubing into rubber stopper, and make sure that the tube has a valve on the end. Also, insert temperature probe into rubber stopper, but do not plug it into the lab quest mini. Make sure that the lamp is the same distance away from your ring stand as the control. Open logger pro, and plug the lab quest mini into the computer. It is beneficial to adjust the time window now, by pressing the clock inside a graph (it is in the toolbar, near the end). Now, the lab should be set up.
3. Bring the Erlenmeyer flask, with the rubber stopper, over to the teacher to fill the flask with methane from the gas valve. Make sure the valve at the end of the tubing is open, to allow the air inside to escape and preventing a pressure build up. Once the flask is filled with methane (you should be able to smell gas above the flask), close the gas valve, as well as the valve at the end of the tubing.
4. Bring the flask over to your lab station, and plug the temperature probe cable into the lab quest mini and use tape to cover any remaining holes in the stopper. A temperature (in degrees C) should be displayed in the bottom left corner of the screen. If you see this, the computer is ready. Press the green collect button, and turn the light on. Record for 20 minutes.
5. If time permits, repeat the experiment. Remember to empty the flask and refill it with methane.

D. **Experiment D.** – CONTROL: ***Air Without Added Methane Gas***

1. Follow the same instructions as for experiment C except without the addition of methane.
2. Following your teacher's instructions, obtain the container of natural gas, comprised primarily of methane.

Data for Experiment C & D – Natural Gas

Table 1. CH_4 & Temperature Data

	w/out added CH_4		w/ added CH_4	
Time (min)		**Temp °F**		**Temp °F**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
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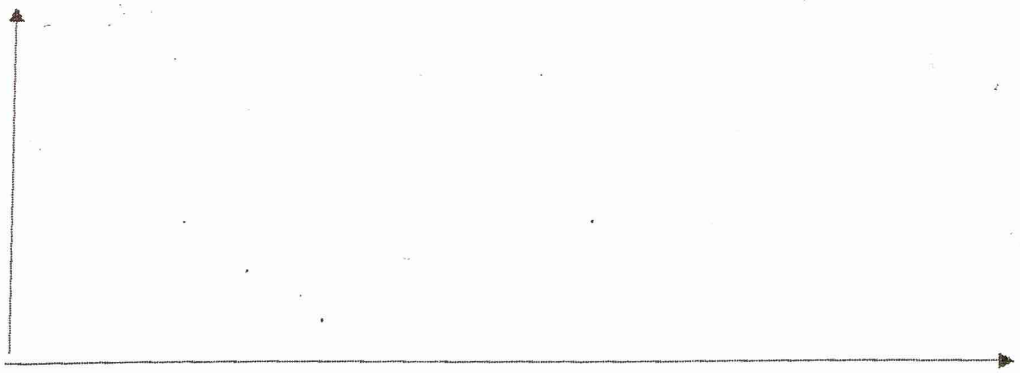
Observations:

Graphs for Experiment C & D

Graph **Temperature** on the y axis and time on the x axis for both the control and the flask with methane

Temp



VII. Analysis Questions

1. Which system retained the heat longer? How do you know? Why do you think so?

2. Why are the controls necessary?

3. Based on your results, what can you assume about the effect of CO_2 on temperature in the atmosphere?

4. Results can vary depending on the experimental design of the activity. List the possible variables in your experiment.

5. How are heat and infrared radiation related? How do they play a role in the greenhouse effect?

6. How does Earth benefit from the greenhouse effect? What is the concern about adding greenhouse gases to the atmosphere?

VIII. Conclusion (in paragraph form, typed or written neatly)

What did you learn? What was most surprising or interesting to your group? What new questions do you have regarding the topic? What new related experiment would you like to try?