Tabletop Climate Change Simulation Lab

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Adapted from the original lab by Drs. David J. Davies and Ernest W. Blakeney
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Group Names (first/last): _____

Hour_____Date: _____ Why late? _____Score: + ✓ −

Purpose

The purpose of this demonstration/experiment is to show the environmental and economic effects of increased carbon dioxide (CO2) content in the atmosphere. It has been claimed that the Earth's climate is warming due to changes in the relative concentration of gases in the atmosphere.

In this experiment, air with increased concentrations of CO2 is produced and the rate of heat loss of that air is compared to today's "normal" air. This activity will demonstrate the insulating "greenhouse" effect that carbon dioxide has on heat, and will provide a background onto the relationship between loss of heat and levels of CO2 in the atmosphere.

Equipment and Materials

- A 1000 ml Waterford Fermenter (or other glass vessel)
- A laboratory thermometer (found on Waterford Fermenter)
- A source of heat or equivalent (found on the Waterford Fermenter)
- Alka-Seltzer tablets
- A watch or clock capable of measuring in seconds

Procedure

You will treat the air in two Waterford Fermenters as models of the atmosphere under varying conditions. The vessel will be covered and heated until the temperature rises to 45 degrees. The heater is then turned off ("nighttime"), and the air allowed to cool naturally. Temperature readings are taken at definite time intervals and plotted on graph paper.

One fermenter will show the rate of heat loss from "normal" (untreated) air. The CO2 concentration of the air in the other fermenter will be increased prior to exposure to the "sun". The results will demonstrate the effects of increased CO2 on the rate of heat loss from air. You will then evaluate claims that increasing carbon dioxide will significantly increase the temperature of the atmosphere, and thus lead to climate change, in your lifetime.

Note: because we are working with a very small system, it is extremely susceptible to even slight fluctuations in temperature. Drafty rooms, direct sunlight, and cold counters should be avoided. If possible, insulate your fermenter by placing it in a second unused chamber, in a small cardboard box, or on a padded surface or newspaper to reduce the impact of outside interferences.

Directions

1. Complete the first two questions on the next page. Use all space available.

2. Next, obtain two Waterford Fermenters for your group. Inspect them to ensure that there are no cracks and that all components are in place (particularly the heater and thermometer). Be sure that your double-bubble fermentation trap has water in it to prevent gas from escaping.

3. Fill each fermenter with 250 ml of tap water. Seal the containers.

4. After ensuring that both containers are completely sealed and are air-tight, remove the rubber stopper from the access port and add 1 (one) Alka-Seltzer tablet. Immediately reinsert the rubber stopper and seal tightly so that no gas can escape. Allow the table to react completely. Be sure to keep track which fermenter was treated with the tablet.
    a. The tablet will add CO2 to the air of your fermenter and increase CO2 levels above normal atmospheric levels.

5. Turn on both of your heaters by plugging them into an outlet. Ensure that the orange light inside the glass tubing of the heater turns on. If it does not, turn the heater onto a higher setting using the knob on top (arrows point which direction to turn).

6. Keep the heaters on until both reach 40-45^{o} C. If one reaches before the other, unplug or adjust the knob so that it stays at the same temperature.

7. Keep both fermenters within a degree of each other for at least 2 minutes. When you have balanced the temperature of both fermenters, unplug the heaters. Note the time.

8. Complete the table on the next page. Be sure to watch the clock carefully so that you do not miss an interval.

9. After you have completed recording the temperatures at each interval, begin graphing your results.

10. During or after your graphing, rinse out each fermenter chamber in a sink with tap water and dry with a paper towel. Return your fermenter to the location specified by your instructor.

11. Complete the accompanying questions.

Questions:

1. In a moment, you will be comparing the rate of cooling from a flask with 350-400 ppm of CO2 to a flask with much higher levels of CO2. What do you expect will happen when the heaters are switched off?

   We hypothesize that _____

   _____

   _____

2. Why do you think this will happen? What is your rationale?

   We think this because _____

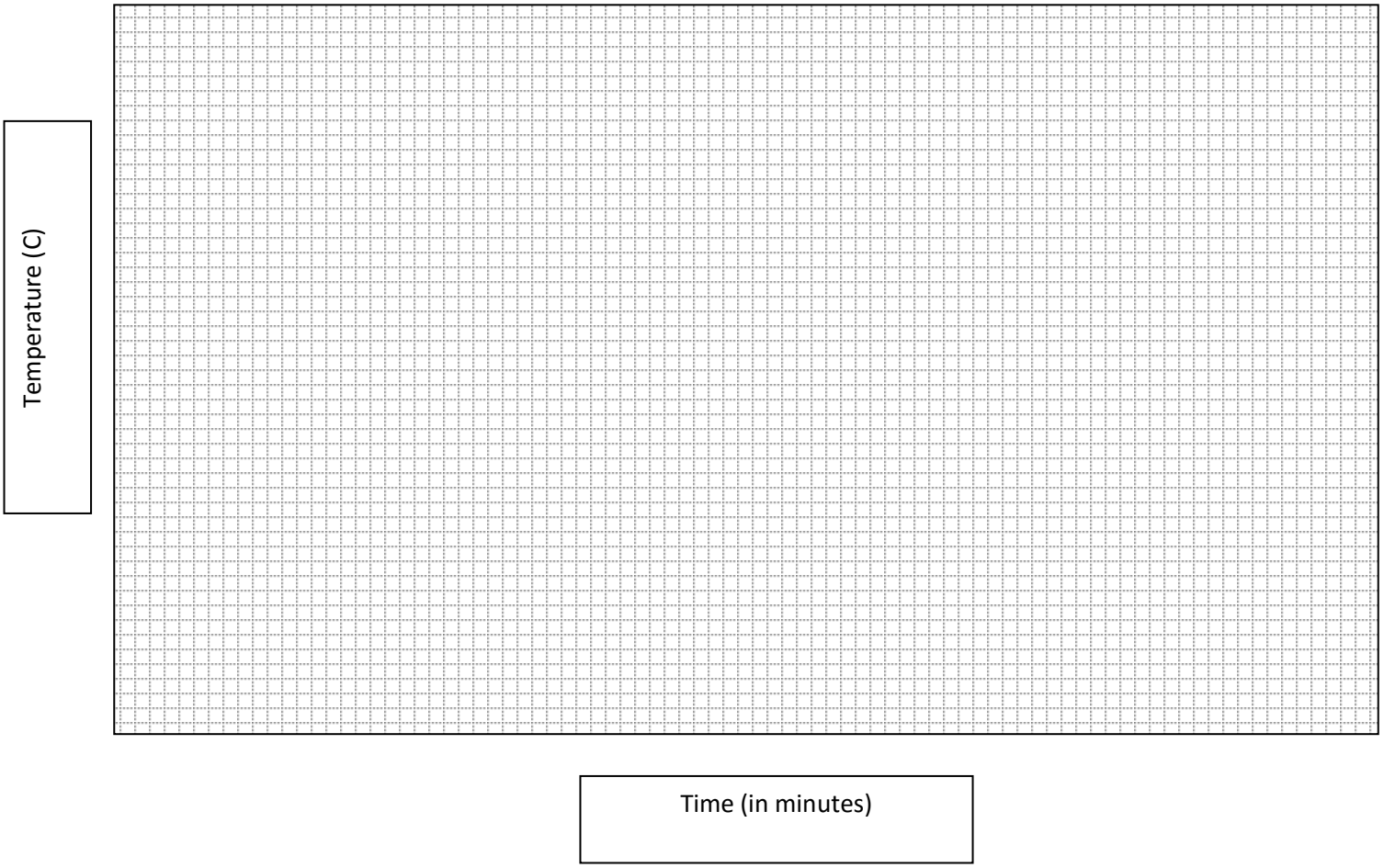
   _____

   _____

3. Complete the table below:

Record Temp (C) Below		
	Alka-Seltzer	Control
Initial Temp		
1 minute		
2 minute		
3 minute		
4 minute		
5 minute		
6 minute		
7 minute		
8 minute		
9 minute		
10 minute		
11 minute		
12 minute		

4. Graph your results from your table below. Include a legend and markings on each axis.



5. Create a caption for your graph below. A caption describes what the graph is about and describes the trends in the data (e.g. *this initially happened…then this happened…*)

6. Did your results support your hypothesis? Explain:

7. Briefly describe the relationship between the level of CO2 in the air and the ability of that same air to 'hold onto' heat.

8. Apply the relationship you described above to the earth's atmosphere. As CO2 levels continue to rise to unnaturally high levels due to human activity, what will happen to the heat on the surface of the earth?

9. How is this experiment a good model for what is happening in the atmosphere?

10. How is this experiment a poor representation of what is happening in the atmosphere?

11. For hundreds of thousands of years, atmospheric CO2 concentrations stayed between 200 and 300 ppm. Today CO2 levels are over 400 ppm. By 2100, they are expected to be between 500-900 ppm or even higher (unless we can reverse the rate of increase of CO2, which is unlikely). What impact do you think this will have on natural ecosystems on the planet?

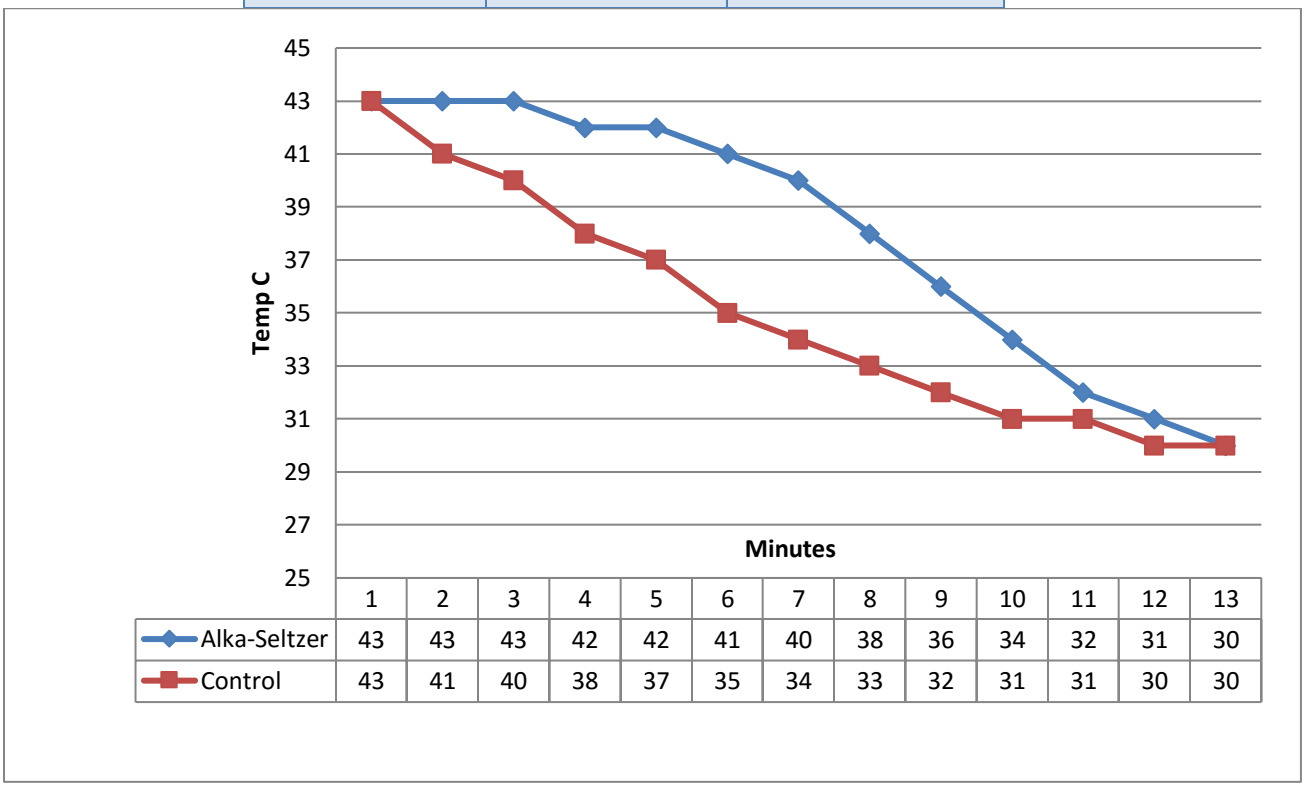
12. What impact do you think increased CO2 levels will have on coastal cities throughout the world?

13. What impact do you think increased CO2 levels will have on Midwestern crops adapted to a 20th century climate?

14. In your opinion what should be done, if anything, about increasing levels of CO2? Explain

Sample Data From Original Run

Record Temp (C) Below		
	Alka-Seltzer	Control
Initial Temp	43^0	43^0
1 minute	43^0	41^0
2 minute	43^0	40^0
3 minute	42^0	38^0
4 minute	42^0	37^0
5 minute	41^0	35^0
6 minute	40^0	34^0
7 minute	38^0	33^0
8 minute	36^0	32^0
9 minute	34^0	31^0
10 minute	32^0	31^0
11 minute	31^0	30^0
12 minute	30^0	30^0



	1	2	3	4	5	6	7	8	9	10	11	12	13
Alka-Seltzer	43	43	43	42	42	41	40	38	36	34	32	31	30
Control	43	41	40	38	37	35	34	33	32	31	31	30	30

