

Investigating the impact of changes in carbon dioxide concentration on ecosystems

Carbon dioxide and temperature

Question: Does the concentration of carbon dioxide affect air temperature in a closed environment?

Adapted from The Greenhouse Effect: Does the Concentration of Carbon Dioxide Affect the Air Temperature in a Closed Environment? Climate Science Investigations: South Florida <http://tiny.cc/fope9x>

Key concepts

The greenhouse effect

<http://cleanet.org/clean/literacy/index.html>

Carbon cycle:

<http://earthobservatory.nasa.gov/Features/CarbonCycle/>

Changing atmospheric CO₂ concentrations over time

<http://co2now.org/>

Methods

1. Fill each 500 ml flask (total of 3) with 100 ml of water.
2. Label the flasks, No CO₂, CO₂ + light, and CO₂ and no light.
3. Add Alka-Seltzer tablets in the CO₂ conditions (each group can select the number of tablets to test, we recommend at least 4).
4. Cover each flask with a rubber stopper and position thermometer through stopper. Use playdough to make a seal around the thermometer.
5. Place a piece of plastic wrap loosely over the thermometer at the top of the flask. Place a rubber band around the top of the flask.
6. Place under appropriate light condition and take initial temperature.
7. Record temperature in each condition every 2 minutes over a period of 20 minutes.

Results

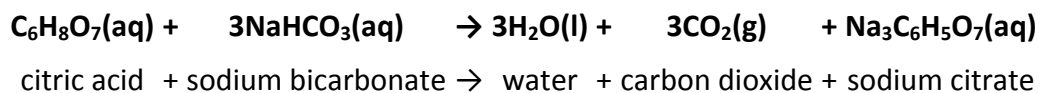
<i>Air Temperature (°C)</i>	<i>Initial Temp</i>	<i>2 min</i>	<i>4 min</i>	<i>6 min</i>	<i>8 min</i>	<i>10 min</i>	<i>12 min</i>	<i>14 min</i>	<i>16 min</i>	<i>18 min</i>	<i>20 min</i>
<i>Control 0 Alka-Seltzers</i>											
<i>Experimental ___ Alka-Seltzers light</i>											
<i>Experimental ___ Alka-Seltzers no light</i>											

Graph your data

Construct a line graph that summarizes your results. Include a title, label the axes, and include a legend.

Discussion

Below is the equation representing the chemical reaction that occurs when Alka-Seltzer tablets are dropped into water.



1. Explain how this reaction allows us to model the greenhouse effect. How does this compare to the greenhouse effect on Earth?
2. What other variables might you test if you were able to repeat this experiment?

3. What would happen to the global temperature if more CO₂ is added to the atmosphere?

Carbon dioxide and ocean health

Question: Does the concentration of carbon dioxide affect water pH in a closed environment?

Key concepts:

Ocean acidification http://www.nasa.gov/topics/earth/features/climate_acidocan_prt.html

Changing atmospheric CO₂ concentrations over time <http://co2now.org/>

Visualizing carbon dioxide uptake by water:

When carbon dioxide reacts with water, a weak acid (carbonic acid) is formed (see chemical reaction below). The more carbon dioxide you breathe into the BTB solution, the faster it will change color to yellow.



To visualize carbon dioxide production, students will breathe through a straw into a solution of bromthymol blue (BTB). BTB is an acid indicator; when it reacts with acid, it turns from blue to yellow.

Methods

PART A: Resting (no exercise)

1. Use a graduated cylinder to measure out 20 ml of tap water and pour it into a small beaker.
2. Use a dropper to add 8 drops of bromthymol blue to make a BTB solution.
3. Using a straw, exhale into the BTB solution (CAUTION: Do not inhale the solution!).
4. Time how long it takes for the blue solution to turn yellow. Record the time.
5. Wash out the beaker and repeat steps 1-4.
6. Average the results of the 3 trials. Record data.

PART B: Increased muscle activity (exercise)

1. Exercise for 1 minute by doing jumping jacks.
2. While you are exercising, your partner should get the BTB solution ready as in Part A.
3. After 1 minute of exercise, immediately exhale through the straw into the BTB solution. Time how long it takes for the BTB to turn yellow. Record this data.
4. Exercise as you did before, but for 2 continuous minutes.
5. Immediately exhale through the straw into the BTB solution. Time how long it takes for the BTB to turn yellow. Record this data.
6. If there is time, repeat the entire procedure for your lab partner. Record data from 2 OR 3 other subjects in the class to get more data, depending on if your partner was able to participate or not.

Results:

Trial number	Resting BTB Conversion Time	Exercise (1 min) BTB Conversion Time	Exercise (2 min) BTB Conversion Time
Trial 1			
Trial 2			
Trial 3			
Average			

Discussion

1. Why did the BTB solution change colors when you blew into it?
2. What impact did exercise have on the rate of color change of the BTB?
3. How might this experiment model what is happening in Earth's oceans as a result of increasing atmospheric concentrations of carbon dioxide?