**Climate Change in the Arctic**

**Modelling the Greenhouse Effect – Teacher’s Guide and Answer Key**

**Task**

Build a model of the greenhouse effect on the Arctic using discarded plastic bottles. Compare the effects of an increase in greenhouse gasses on the temperature of the atmosphere and on ice melting rates. Make two different models, with the control model representing Earth with the current concentration of greenhouse gasses and the second model representing Earth with an increased concentration of greenhouse gasses in the atmosphere. The bubbles in pop provide the extra carbon dioxide.

**Materials for a class of 32 students**

16 1L and/or 2L plastic drink bottles

16 thermometers

16+ relatively uniform ice cubes in a cooler

6-2L bottles of cola

Plasticine

aluminum foil

8 rulers

3-4 permanent markers

8 scissors for cutting the tops off bottles and for making holes in bottles

8 stop watches (optional)

2 scales for weighing ice cubes

**Prediction**

Increasing the amount of greenhouse gasses in the atmosphere will *increase* (increase/decrease) the temperate of the atmosphere because *heat is absorbed by greenhouse gasses.* This will result in the ice *in the bottle with the extra carbon dioxide melting faster than in the control.*

**Teacher Preparation**

1. Prepare for this activity ahead of time by having students bring in 1L and 2L empty plastic drink bottles instead of putting them in recycling. You may want to keep a bin of empty bottles in your classroom for other activities as well.
2. Open three of the cola bottles the day before the experiment and pour them into open containers. Leave it open overnight until the cola has gone flat. Do not open the other bottles before the experiment begins. All the cola should be at room temperature.
3. This experiment should be conducted outside on a sunny day. However, preparation for the experiment should be done in the shade (the shady side of a school or portable or under the shade of some trees). If you are unable to do the experiment outside, it could be done in the classroom with 150-watt spotlights and light stands. In this case, tables should be arranged beside outlets so that cords are not a tripping hazard. The spotlights will be hot.
4. Have students cut the tops off the empty drink bottles, mark a liquid depth of 7cm and make a hole 7cm from the top of each 1L bottle (or 12cm from the top of each 2L bottle) for the thermometer.
5. Have students fill one bottle to the line with flat cola and fill the other bottle to the line with carbonated cola. DO NOT insert the thermometers because the bursting bubbles could wet the thermometer and give lower temperature readings because of evaporation. Let the bottles stand for 5-10 minutes to allow the carbon dioxide to fill the container. Carbon dioxide is heavier than air so it will stay in the container.
6. Have students make two “boats” from aluminum foil to float the ice cubes on the cola.
7. Have students find two ice cubes with the same mass and put one in each foil boat and float one in each bottle on the cola.
8. Have students put the thermometers through the holes in the sides of the bottles (step 2) so that the tips of the thermometers are in the middle of the bottles at the same height and secure the thermometers with Plasticine.
9. Have students place the tops back on the bottles and use tape to secure the tops in place. This will help to minimize outside air flowing into the bottle. The caps should be removed to prevent build-up of pressure in the bottle with carbonated cola.
10. Have students record the results of the experiment (temperature and ice melted). Note that the amount of ice melted should be recorded as a qualitative result. As the air and carbon dioxide heats up over time, it will expand and rise out of the bottle, potentially lowering the temperature.

**Observation Table**

Design a well labelled table to record the temperature in the bottles and your observations of the ice cubes every 2 minutes from zero minutes to 20 minutes.

|  |  |  |
| --- | --- | --- |
| **Time****(minutes)** | **Control Bottle** | ***Bottle with additional CO2*** |
| ***Temperature******(C)*** | ***Ice Melted*** | ***Temperature******(C)*** | ***Ice Melted*** |
| 0 |  |  |  |  |
| 2 |  |  |  |  |
| *4* |  |  |  |  |
| *6* |  |  |  |  |
| *8* |  |  |  |  |
| *10* |  |  |  |  |
| *12* |  |  |  |  |
| *14* |  |  |  |  |
| *16* |  |  |  |  |
| *18* |  |  |  |  |
| *20* |  |  |  |  |

**Conclusions**

Do your results support your prediction? *Various answers*

What did you use to represent an increase in greenhouse gases? *We used carbon dioxide released from the carbonated pop to represent increased greenhouse gasses.*

Explain why your results do or do not support your prediction.

*Yes – The additional carbon dioxide in the second bottle caused the atmosphere to warm up more which caused the ice cube to melt faster.*

*No – The thermometer in the second bottle got wet from bubbles bursting in the carbonated pop and gave lower temperature readings because of evapouration. or There was not enough carbon dioxide in the second bottle. Accept any reasonable explanation.*

**Analysis**

What two changes could be made to improve this model? *Accept any reasonable answers.*

What are two major limitations of this model compared to our real atmosphere around Earth? *The atmosphere does not have a layer of plastic around it. The depth of the atmosphere is much greater than the depth of gas in the model. Accept any reasonable answers.*

Explain which Arctic plants and animals will be most affected by the increased melting of Arctic ice due to climate change. *Animals that depend on the ice for migration, hunting and resting will be most affected by melting Arctic ice. E.g., polar bears, walruses, seals. Melting of the permafrost will allow southern species of plants to spread northward potentially choking out plants that have adapted to the permafrost. Accept any reasonable answers.*

This experiment is modified from “Carbon Dioxide and the Greenhouse Effect” in

*Teaching About Climate Change*, New Society Publishers, 2001. ISBN: 0-86571-437-1