

Name _____ Date _____

Partners _____

Lab Exercise: Greenhouse Effect
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Equipment: 2 identical empty large soda bottles (1.5 or 2 liters), 2 split rubber stoppers, 2 thermometers, about 10-12 ounces fresh warm soda (1 can), 2 plastic cups or beakers, a spoon, sunny day or lamp, graph paper or spreadsheet, ruler.

Background: A planet gets energy from the sun, heats up, then releases this energy back into space. The release is controlled mainly by any gases the planet has as an atmosphere.

The Earth is somewhat warmer than expected judging from its known distance from the sun. This is due to its atmosphere which acts as a kind of thermal blanket to keep in some of the energy received from the sun. This “greenhouse effect” has caused the average temperature of the Earth to be 15 C (59 F) rather than -19 C (-1 F) which it would be if there were no air present. The atmospheric gases responsible for the Earth’s greenhouse effect are mostly water vapor (H₂O), carbon dioxide (CO₂), and methane (CH₄). These gases are important even in low amounts.

Measurements of the Earth’s temperature in the most recent hundred years have shown a marked rise on a timescale which is very fast for any geologic processes. Many people now believed that this is due to an additional greenhouse effect caused by human activities. For instance, we can measure that the amount of the greenhouse gases CO₂ and CH₄ is also rising, and accelerating.

“We are collectively doing an experiment on a very large scale.”

The Claim: An atmosphere of CO₂ will cause the temperature to rise to a higher stable temperature than will an atmosphere of mixed N₂ and O₂ (air).

Procedure:

We will measure the effect that an atmosphere composed of a lot of carbon dioxide has on the temperature in an “Earth in a bottle.” As a control we will have another “Earth in a bottle” with an atmosphere of normal air. We realize that this is an extreme experiment compared to the tiny amount of carbon dioxide in the Earth’s atmosphere now. However, it will give us some data to think about.

Place each thermometer in its rubber stopper such that it will fit loosely into a soda bottle and have its bulb near the middle of the upper half of the bottle. The gap in the stopper will provide an escape path for heated gas. (We do not want the bottles to explode!) Set the thermometers and stoppers aside for now.

We want one soda bottle to have an atmosphere of mostly CO₂. The other soda bottle will have an atmosphere of plain air. Both bottles will have an ocean of de-gassed soda in the bottom.

Open the warm soda and pour it evenly into the two cups. It is important to get the amounts pretty equal.

Pour one cup into one large soda bottle. Swirl it around for two minutes to release the carbon dioxide fizz into the bottle and push out the air.

Stir the other cup really vigorously in the open air to release its carbon dioxide. After two minutes pour this cup into the other soda bottle and then cap both bottles with their split stopper holding the thermometer.

Place the bottles on identical surfaces in the sunshine so that they are not in any shadows, not even the shadow of each other. Measure the temperature in each bottle every minute for 15 minutes or so and record these in the data table. (Read the temperatures to tenths of a degree C.)

Analysis: Graph the temperature (vertical axis) vs. the time (horizontal axis) for the CO₂ bottle. On the same graph plot the temperature of the air bottle with another symbol. Take one more measurement after an additional 10 minutes or so.

Which bottle had the temperature rise quicker? _____

Which bottle reached the higher stable temperature? _____

Conclusion: (evidence for or against the claim)

Applications:

Agriculture

Water resources

Weather

Species of animals

Glaciers and permafrost

Insects and diseases

References:

IPCC (Intergovernmental Panel on Climate Change), April, 2007

Keating, CF, A Simple Experiment to Demonstrate the Effects of Greenhouse Gases, The Physics Teacher, September, 2007, p 376

Reiland, Robert, Variations on Greenhouse Gas Experiment, The Physics Teacher, November 2007, p 468

