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Investigation of Energy Transfer in Different Atmospheric Gases

**Background Information**

The greenhouse effect is a natural warming of Earth’s lower atmosphere and Earth’s surface. The major gases involved in the greenhouse effect are water vapor, carbon dioxide, and methane. These greenhouse gases allow solar radiation to go through the atmosphere and reach Earth’s surface. Most of this energy is absorbed at Earth’s surface and radiated back into the atmosphere as infrared radiation. The greenhouse gases trap this infrared radiation and keep it close to Earth’s surface which causes the lower atmosphere to warm up. Without the greenhouse effect, Earth would be much too cold to support most types of life presently living on Earth. But an increase in the greenhouse effect could be devastating for life on Earth.

Scientific studies indicate that human activities over the last 200-300 years have strengthened the greenhouse effect. When the greenhouse effect is strengthened, global warming occurs. Global warming is a trend showing an increase in average global temperatures. Some human activities *add* water vapor, carbon dioxide, or methane to the atmosphere and other activities *reduce* the absorption of greenhouse gases, specifically carbon dioxide. There are many features on the surface of the Earth that absorb carbon dioxide. These are called “carbon sinks.” Oceans, rocks, and plant life are all examples of carbon sinks because they take in carbon dioxide from the atmosphere. In order to maintain a fairly constant global temperature, the release of greenhouse gases and the absorption of greenhouse gases must be balanced.

In this experiment you will investigate how well different greenhouse gases trap heat. Clear, plastic bottles will be filled with greenhouse gases and placed in the sun. The change in temperature will be measured for each bottle.

Tarbuck,E. and Lutgens, F. 2011. *Earth Science*. Pearson, Upper Saddle River, NJ.

**Problem Statement**

|  |
| --- |
| 1. What is the purpose of this investigation? (How does \_\_IV\_\_ affect \_\_DV\_\_?) 2. What is the independent variable? (What variable are we changing?) 3. What is the dependent variable? (What variable are we measuring?) 4. What conditions should be held constant in this investigation? |
|  |

**Hypothesis**

|  |
| --- |
| 1. What effect will the independent variable have on the dependent variable? 2. *Why* does the independent variable affect the dependent variable this way? 3. Provide a supporting statement from a reliable text or website 4. Add an APA *in-text* citation to the statement above. Ex: **(Dobson, Holman & Roberts, 2003)** 5. APA Reference at the end of the text:   Example: **Dobson, K., Holman, J., & Roberts, M. (2003). *Holt science spectrum: Physical science*. Austin: Holt Rinehart & Winston. Pp. 748-49** |

|  |  |
| --- | --- |
| Group # | Gas |
| 1 | CO2 |
| 2 | H2O |
| 3 | CH4 |
| 4 | CO2 |
| 5 | H2O |
| 6 | CH4 |
| 7 | CO2 |
| 8 | H2O |
| 9 | CH4 |

**Procedure**

Materials:

Group #\_\_\_\_\_\_\_\_\_\_

Your bottles will be:

1. AIR
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 2 clear, plastic bottles with caps, 2 L
* 1 thermometer
* 1 graduated cylinder, 20 mL
* Rubber hose (for CH4)
* Water (H2O), 15 mL
* Methane gas (CH4)
* Baking soda (NaHCO3), 1 scoop
* Vinegar, 15 mL

Procedure**: Each lab group will collect data for two bottles: air and one of these three gases: methane (CH4), carbon dioxide (CO2), water vapor (H2O). Refer to the table above to determine your 2nd bottle.**

To prepare bottles:

1. For the AIR bottle, place a thermometer in the bottle UPSIDE down. Place a cap on the bottle, and screw closed. This will be your control.
2. For the METHANE (CH4) bottle:
   1. Bring your bottle and a thermometer to the teacher, and he/she will fill the bottle.
   2. Place a thermometer in the bottle UPSIDE down.
   3. Place the cap on the bottle and screw the lid on so it is closed.
3. For the CARBON DIOXIDE (CO2) bottle:
   1. Place ONE scoop of baking soda (NaHCO3) into the bottle.
   2. Measure 15 mL of vinegar in a graduated cylinder and pour into the bottle.
   3. Place a thermometer in the bottle UPSIDE down.
   4. Place the cap on the bottle and screw the lid on so it is closed.
   5. Gently swirl to mix the baking soda and vinegar. This will create carbon dioxide (CO2) gas.
4. For the water vapor (H2O) bottle:
   1. Pour 15 mL of tap water into the bottle.
   2. Swirl the bottle to move the water around the bottom. This will create water vapor ( H2O).
   3. Place a thermometer in the bottle UPSIDE down.
   4. Place the cap on the bottle, and screw the lid on so it is closed.

To collect data:

1. Place your bottles on a flat surface, in FULL sunlight. Do NOT place your bottles in shadows.
2. Look at the thermometer in the bottle and record the temperature to the nearest tenth.   
   Record this as the temperature at time 0 min.
3. Record the temperature every two minutes for a total of 20 minutes.

**Results**

|  |  |
| --- | --- |
| **Graphing Requirements** | |
|  | Title includes both IV and DV; reflects relationship |
|  | Axes are labeled, have correct UNITS |
|  | DV on the Y-axis, IV on X-axis |
|  | Data points are plotted accurately |
|  | Consistent scale of numbers on each axis |
|  | Appropriate graphing style is used |
|  | At least 2/3 of the grid is used |

**Table 1. Internal Temperature of Plastic Bottles Containing Various Gases**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Time (min)** | **Temperature (oC)** | | | |
| **Air** | **CO2 gas** | **CH4 gas** | **H2O gas** |
| **0** |  |  |  |  |
| **2** |  |  |  |  |
| **4** |  |  |  |  |
| **6** |  |  |  |  |
| **8** |  |  |  |  |
| **10** |  |  |  |  |
| **12** |  |  |  |  |
| **14** |  |  |  |  |
| **16** |  |  |  |  |
| **18** |  |  |  |  |
| **20** |  |  |  |  |

To ensure that you make a GREAT graph, put a √ next to each box when you complete the task.

Graph: Graph the time and temperature data for all 3 greenhouse gases and air. Time should be on the X axis and temperature should be on the Y axis. The graph should show **4** lines (one for each gas)and all the requirements above.

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**Calculations**

1. Determine the temperature change for each gas. (Ending temperature – starting temperature = change) and show all work.

1. Carbon dioxide, CO2
2. methane, CH4
3. water, H2O
4. air

**Analysis**

1. Describe how the temperature change varied for the different gases. **Include numbers from data or calculations in your answer.**

2. Which gas absorbed or trapped the most heat?

1. Do your results support or reject your hypothesis? **Include numbers from data or calculations in your answer.**