**Greenhouse Gas Lab**

**Purpose:**   
1. Students observe and contrast thermal properties of three major greenhouse gases.

**Background:**   
Earth’s atmospheric gases are often divided up into constant and variable components. The major constant gas components remain the same over time and location are: 78% nitrogen (N2), 21% oxygen (O2), and 1% argon (Ar). The major variable gas components that vary over time and location are: 0.038% carbon dioxide (CO2), 0-4% water vapor (H20), and traces amounts of methane (CH4), sulfur dioxide (SO2), ozone (O3), nitrogen oxides (NO, NO2, N2O). While nitrogen and oxygen make up 99% of the atmospheric gases, they have little effect on the atmosphere and, therefore, little to no effect on weather or climate. The gases which make up less than 1 percent of the atmosphere have a greater influence on both short-term weather and long term climate.

The less abundant gases (water vapor, carbon dioxide, methane, nitrous oxide, and sulfur dioxide) all have an important property. These gases have the ability to absorb heat emitted by the Earth and are therefore able to warm the atmosphere. This warming is what we call the "greenhouse effect." There are obvious benefits to these so-called greenhouse gases as without them the surface of the earth would be about 30 degrees Celsius cooler, and far too cold for life to exist. On the other hand, these greenhouse gases are so good at absorbing heat that even very small amounts can cause Earth’s lower atmospheric temperature to rise.

Current concern about global climate change refers to the change of temperature and precipitation resulting from the buildup of greenhouse gases from human activity. Greenhouse gases, which include water vapor, carbon dioxide (CO2), and methane (CH4) are most responsible for absorbing the heat and causing climate change.

**Pre-Lab Questions:**

1. What gases absorb heat and cause climate change?
2. What is the “greenhouse effect”?
3. Why does the Earth need greenhouse gases?
4. Why are too many greenhouse gases a bad thing?
5. List two factors that can change when you have a buildup of greenhouse gases.

**Materials:**Thermometer Methane Gas  
Vinegar Clear Plastic Bottle (1 per group)  
Baking Powder Lamp (1 per group)

**Procedure:**

1. Obtain your materials.
2. Make sure that your thermometer can be easily read when it is all assembled.
3. Record the starting room temperature in your data table (at time = 0 minutes)
4. Place the gas that you have been assigned into your plastic bottle.
   1. Refer to your group’s special instructions below for this step.
5. Screw the cap on tightly. Be careful with the thermometer!  
    \*\*\*\*TIGHTLY!!\*\*\*
6. Place your bottle at a distance of 15 inches from the light bulb.
7. Turn on the lamp and start your timer.
8. Record the temperature every minute (without touching the thermometer) for 15 minutes.
9. Once you have collected data for 15 minutes with the light on, turn the light off.   
    \*\*\*Keep your timer running!\*\*\*
10. Record the temperature every minute (without touching the thermometer) for 10 additional minutes.
11. Once your data table is complete, begin graphing your results.
12. After all groups are done collecting data, we will share our results.

**Special Instructions:**

* Bottle with Air: Just tighten the cap
* Bottle with Saturated Air: Place a piece of a wet sponge in the bottom of your bottle. The sponge has to cover at least half of the bottom of the bottle. Cap the bottle.
* Bottle with Carbon Dioxide: Pour 30 mL of vinegar into a beaker. Spoon in ½ teaspoon of baking powder. Allow the bubbling to happen without disturbing it. When the fizzing is done, pour the carbon dioxide into the bottle. \*\*Do not let any liquid get into your bottle!\*\* **Repeat these instructions two more times.** Cap the bottle.
* Bottle with Methane: Turn your bottle upside down over a gas nozzle and allow gas to enter the bottle for 15 seconds. Cap the bottle.

**Data Table:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Green House Gases Time/Temperature Recordings (OC) | | | | |
| **Time (minutes)** | **Dry (air only)** | **Saturated (wet)** | **Carbon Dioxide** | **Methane** |
| 0 (room temp) |  |  |  |  |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |
| 7 |  |  |  |  |
| 8 |  |  |  |  |
| 9 |  |  |  |  |
| 10 |  |  |  |  |
| 11 |  |  |  |  |
| 12 |  |  |  |  |
| 13 |  |  |  |  |
| 14 |  |  |  |  |
| 15 (turn light off) |  |  |  |  |
| 16 |  |  |  |  |
| 17 |  |  |  |  |
| 18 |  |  |  |  |
| 19 |  |  |  |  |
| 20 |  |  |  |  |
| 21 |  |  |  |  |
| 22 |  |  |  |  |
| 23 |  |  |  |  |
| 24 |  |  |  |  |
| 25 |  |  |  |  |

**Post Lab Questions:**

1. For your bottle, what happened to the temperature when the light was on? When the light was off?
2. Which of the other bottles had a temperature change that was similar to your bottle? Support your claim using QUANTITATIVE data.
3. Which of the other bottles had a temperature change that was different than your bottle? Explain the difference with QUANTITATIVE data.

**Post Lab Questions Continued:**

1. What gas showed the smallest temperature rise? What gas showed the largest temperature rise? Support your choices with QUANTITATIVE data.
2. How does your bottle represent Earth’s atmosphere?
3. In what ways is Earth’s atmosphere different than your bottle?
4. How does this lab showcase the “greenhouse effect”?
5. Explain if you think that the term “greenhouse effect” is a good way to describe what is currently happening with heat in Earth’s atmosphere.

