Greenhouse Effect

**Objective:** To describe how the “greenhouse effect” affects temperature on the earth and to use evidence to support whether the “greenhouse effect” is detrimental or advantageous for the earth.

**Background:** Global warming is perhaps the “hottest” topic in today’s headlines. The cause of warming is usually blamed on the “greenhouse effect” or “greenhouse gases.” The following simulation will allow you to first examine how the “greenhouse effect” works in a greenhouse. You will then experiment with a simulation of the earth’s atmosphere where the concentration of greenhouse gases can be varied. Finally, you will use the results of the two simulations to describe how the “greenhouse effect” affects temperature on the earth and discuss whether the “greenhouse effect” is good or bad for the earth.

**Website:** <http://phet.colorado.edu/en/simulation/greenhouse>. Click on “Run Now” to run the simulation.

Part I. **Introduction to the Simulation:**

* What do the yellow dots moving down represent? What do the red dots represent?
* Watch them carefully. Do they all move upwards? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Why or why not?
* Which greenhouse gases are considered by the simulation?

Today

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Record the composition of the atmosphere (on the right side of the screen):

|  |  |
| --- | --- |
| H2O (water vapor) |  |
| CO2 (carbon dioxide) |  |
| CH4 (methane) |  |
| N2O (nitrous oxide) |  |

*(ppm means “parts per million”)* | Record the temperature on the thermometer:

|  |  |
| --- | --- |
| K (kelvin) |  |
| °F (degrees Fahrenheit) |  |
| °C (degrees Celsius) |  |

 |

1750

*Click on “1750” on the right side of the screen to set the atmosphere to the proportions for that date. Wait a few minutes for the temperature to stabilize.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Record the composition of the atmosphere (on the right side of the screen):

|  |  |
| --- | --- |
| H2O (water vapor) |  |
| CO2 (carbon dioxide) |  |
| CH4 (methane) |  |
| N2O (nitrous oxide) |  |

 | Record the temperature on the thermometer:

|  |  |
| --- | --- |
| K (kelvin) |  |
| °F (degrees Fahrenheit) |  |
| °C (degrees Celsius) |  |

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Ice Age

*Click on “Ice Age” on the right side of the screen to set the atmosphere to the proportions for Earth’s last major ice age. Wait a few minutes for the temperature to stabilize.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Record the composition of the atmosphere (on the right side of the screen):

|  |  |
| --- | --- |
| H2O (water vapor) |  |
| CO2 (carbon dioxide) |  |
| CH4 (methane) |  |
| N2O (nitrous oxide) |  |

 | Record the temperature on the thermometer:

|  |  |
| --- | --- |
| K (kelvin) |  |
| °F (degrees Fahrenheit) |  |
| °C (degrees Celsius) |  |

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Glass Layers

*Click on the “Glass Layers” tab at the top of the screen. On the right side of the screen, set the Number of Glass Panes to “1”.*

1. Watch the yellow photons carefully. Do they pass through the glass or are they blocked?
2. Watch the red photons carefully. Do they pass through the glass or are they blocked? (Move the slider at the bottom of the screen to slow down the animation if necessary.)
3. Record the temperature on the thermometer: \_\_\_\_\_\_\_\_\_\_K, \_\_\_\_\_\_\_\_\_\_\_ °F.
4. Your family’s car has been parked outside on a cold but sunny day. When you get in the car, it is much warmer than the air outside. Explain how this can happen.

Photon Absorption

*Click on the “Photon Absorption” tab at the top of the screen.*A methane molecule sits in the middle of the screen. Use the slider on the left side of the screen to shoot some infrared photons at the molecule.

1. Do all the photons pass through the molecule?
2. When a photon gets absorbed, what happens next?
3. When a new photon is emitted, is it always sent in the same direction?

Use the buttons on the right side of the screen to test different molecules. Record your observations in the table below. Write “yes” if any photons get absorbed; write “no” if no photons get absorbed.

**Which gases absorb photons?**

|  |  |  |
| --- | --- | --- |
|  | *Infrared Photons* | *Visible Photons* |
| CH4 (methane) |  |  |
| CO2 (carbon dioxide) |  |  |
| H2O (water vapor) |  |  |
| N2 (nitrogen) |  |  |
| O2 (oxygen) |  |  |

1. Which three gases contribute to the greenhouse effect in our atmosphere?
2. Which two gases do NOT contribute to the greenhouse effect?
3. This computer simulation represents a *model* of global warming for a simplified Earth. What are some simplifications made by the computer programmers? Could a computer simulation of the Earth ever be 100% accurate?

**Part 2. Your experiment.**

Using the PHET Greenhouse Effect Simulation (specifically, the photon absorption application), you will be **creating** and **conducting a lab** that answers the scientific question: *Which atmospheric gas (CH4, CO2, H20, N2, or 02) is the best absorber of infrared photons? Rank these gases from worst absorber to the best absorber.*

Below are the steps you must follow to create and conduct a perfect lab. Check things off as you go.

**Note:** For the purposes of this lab, you can assume that everyone has access to this PHET application. Therefore, you don’t need to explain how to get to it in your lab.

**A. Planning Your Experiment**

1. Write ahypothesis that follows the hypothesis guidelines in the attached rubric. Make sure that it is specific and measurable and includes background information.
2. Design an experimental that will directly answer the scientific question and follows all of the guidelines in the rubric. It is suggested that you sketch out your experiment by writing a rough draft **before** you begin writing your procedures.
3. Write out your experimental procedures. These should be in a list format and should follow all of the guidelines given in the rubric. Consider including screen shots (there is more on this in Appendix 1.1 of this lab packet).

**B. Conducting Your Experiment**

1. Create a data table. Make sure that it has a title.
2. Follow your procedures, start collecting your data and record your results in your data table.

**C. Writing Your Lab Report**

1. Closely examine the attached rubric and all of its parts.
2. Create a title for your lab (you may want to do this last!).
3. Write the background information section of your lab. **Refer to the** **rubric** and be sure to write at least one full paragraph. Additionally, you must **include diagrams** and label them as figures (you should start with Figure 1.1).
4. Write your hypothesis.
5. Write your experimental procedures.
6. Present your data and results in an organized way. You **must** include a **data table**.
7. In paragraph form, analyze your results. **Refer to the rubric.**
8. In paragraph form, write your conclusions. **Refer to the rubric**. You must include a discussion of transmission, absorption, and reflection of electromagnetic waves. Importantly, be sure to explain the implications of your findings. What does this mean for the future of our planet? Use the given background information to help you!
9. Be sure you’ve followed the formatting guidelines **outlined in the rubric**. Using the attached rubric, grade your own lab report. Be sure to record a total grade out of 100. Staple your lab report to the self-completed rubric.

**Sources:**

Charles N. Long, et al (2005). Changes in Earth’s Reflectivity. Science 308 (5723).

Lesson plans adapted from Phet.colorado.edu.

**Infrared Absorbers Lab Report - Grading Rubric Name** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Section** | **Excellent** | **Good** | **Fair** | **Poor** | **Points Possible** | **Points Earned** |
| **Title** | Creative, relevant titleIncludes your name and date | Relevant title, missing one piece of information | Missing two pieces of information | Missing 3 pieces of information  | **4** |  |
| **Background Information***Overview of necessary information* | * Begins with a strong topic sentence that introduces the major topic of the lab
* Explains many important scientific terms and concepts about wave behavior that are important for understanding the lab (*must include* ***explanation and diagram*** *of transmission, absorption, and reflection.)*
* Sentences and paragraphs connect with each other and flow logically
 | Includes all criteria under “excellent” but has room for improvement:* Needs topic sentence
* Missing 1-2 key concepts or diagram
* Sentences connect but flow could be better
 | * Missing several key terms or concepts or diagram
* Lacks flow between sentences
 | * Lacks topic sentence
* Explains few concepts
* Lacking connections between sentences
* Has no diagram
 | **20** |  |
| **Purpose & Hypothesis***Reasons for experiment* | Purpose stated and explained. Hypothesis stated correctly, including reasoning *(hypothesis must include a specific prediction about the infrared absorbing abilities of the given gases.)* | Purpose *and* hypothesis stated without reasoning, OR explanations are not clear. | Either purpose or hypothesis stated, no reasoning, OR explanations are very unclear/inaccurate | No purpose or hypothesis stated | **8** |  |
| **Procedure***Steps of your experiment* | Procedure describes the steps you took to conduct the experiment and determine how well each gas absorbs infrared photons. | Procedure is generally complete but misses a few key steps. | Procedure includes some relevant steps but is missing a number of important details. | Procedure is drastically incomplete or missing. | **16** |  |
| **Data and Results***Present the results of the lab.* | Data and results are complete and presented in an organized way (all data is labeled and easy to follow with a **clear** **organizational** **table**). | Data is complete but is disorganized, not labeled, or difficult to follow. | Data is incomplete and/or highly disorganized | Data and results are incomplete | **16** |  |
| **Analysis***Interpret your results.* | In paragraph form, analyze your results. This should include analysis of how well each atmospheric gas absorbs infrared photons. Refer to **specific evidence** from your data! | Results are explained, but explanations are unclear or incomplete. | Incomplete explanation of what the results mean. | No analysis included | **12** |  |
| **Conclusions***Explain what you can conclude from the data* | Describe the conclusions that you can draw from the data. This should include:* Identify what type of gases are the best/worst absorbers.
* Reflect on whether your results support your hypothesis and explain why or why not
* Discuss how this lab relates to the transmission, absorption, and reflection of electromagnetic waves.
* Explain the implications of your findings. What does this mean for the future of our planet?
 | Conclusion is generally strong but missing one component ORAll components included in the conclusion, but explanations unclear or missing details | Conclusion is missing two componentsORConclusion is complete but extremely unclear and missing many key details | Conclusion is drastically incomplete | **16** |  |
| **Formatting***Make your report look professional* | Proper formatting includes:* Times New Roman, size 12 font, double spaced
* Sections have clear headings and are in the correct order.
* Visual representations (graphs, tables) neat and professional.
* Spelling and grammar checked.
 | One element of improper formatting. | Two elements of improper formatting. | Three elements of improper formatting. | **8** |  |

 **TOTAL GRADE =\_\_\_\_\_\_\_/100**