## **Greenhouse Effect Lab (Student Guide)**

*Please type your answers into the student guide in the spaces highlighted in blue.*

### **Purpose**

The purpose of this investigation is to determine the effect of changing the concentration of greenhouse gases in the atmosphere.

### **Hypothesis**

I predict that increasing the concentration of greenhouse gases in the atmosphere will

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the **temperature on the Earth’s surface**.  *(increase, decrease, not change)*I predict that increasing the concentration of greenhouse gases in the atmosphere will cause:

* energy **into** the atmosphereto \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and
 *(increase, decrease, not change)*
* energy **out of** the atmosphereto\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
 *(increase, decrease, not change)*

### **Materials**

* [PhET Greenhouse Effect](https://phet.colorado.edu/en/simulations/greenhouse-effect) simulation
* [Online Timer](https://www.timeanddate.com/timer/)

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### **Procedure**

**Part 1: Comparing the different time periods**

1. Select the Waves simulation in the *Greenhouse Effect* page.
2. Click on the Calendar icon in the Greenhouse Gas Concentration box on the right of the screen.
3. Choose the Ice Age time period.
4. Record the surface temperature **before the simulation starts** and record that in Table 1 of the Observations section under “Initial Temp oC”.
5. Set a timer for 60 seconds.
6. Click on Start Sunlight and start the timer as soon as you can after starting the simulation.
7. Observe the simulation as the timer is running.
8. Pause the simulation when the timer finishes.
9. Record the new surface temperature in Table 1 of the Observations section under “Final Temp oC”.
10. Reset the simulation settings using the orange circle icon. 
11. Choose the 1750 time period and repeat steps 4-10.
12. Choose the 1950 time period and repeat steps 4-10.
13. Choose the 2020 time period and repeat steps 4-10.

**Part 2: Observing the energy in and out**

1. Click on the checkbox next to Energy Balance.
2. Slide the Greenhouse Gas Concentration to None.
3. Click on Start Sunlight.
4. Observe the simulation and pay attention to the Energy Balance section in the top left corner.

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| **In** | The amount of energy *coming into**the atmosphere* is represented by the arrow. |
| **Out** | The amount of energy *going out of**the atmosphere* is represented by the arrow. |
| **Net** | The difference between the energy in and the energy out if there is one. |

1. Pause the simulation as soon as the energy balance is stable *(meaning the Net arrow has disappeared).*
2. Record your observations in Table 2 of the Observations section below. Use words to describe what you see happening to the In, Out, and Net arrows over time. *Are they increasing or decreasing or staying the same? Is the change happening slowly or quickly?*
3. Reset the simulation settings using the orange circle icon. 
4. Slide the Greenhouse Gas Concentration to Lots and repeat steps 1-7.

### **Observations**

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| **Table 1** |
| Greenhouse Gas Concentration | **Initial Temp. (°C)** | **Final Temp. (°C)** |
| Ice Age |  |  |
| 1750 |  |  |
| 1950 |  |  |
| 2020 |  |  |

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| **Table 2** |
| Greenhouse Gas Concentration | **Energy Balance****IN** | **Energy Balance****OUT** | **Energy Balance****NET** |
| None |  |  |  |
| Lots |  |  |  |

### **Analysis**

1. What happens to the sunlight (yellow) waves over time? Do they only go in one direction or do they get reflected? Do clouds affect them at all?

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1. What happens to the infrared (red) waves over time? Do they only go in one direction or do they get reflected?

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1. Based on what you have seen, as greenhouse gases increase over time (from **Ice Age** to the year **2020**), what is the impact on the surface temperature of the Earth? Explain your answer.

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1. Does the concentration of greenhouse gases affect the flow of energy **coming in** or the energy **going out** or both?

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### **Conclusions**

According to the data that you collected, were your hypotheses correct?

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What did you learn about the greenhouse effect through this investigation?

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