

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

# Greenhouse Effect Gizmo

**Background:** How does a greenhouse work? It lets heat in and then traps it, which raises the temperature inside. A similar thing is happening to Earth, and it could have serious negative effects.

The **greenhouse effect** is the warming of Earth due to carbon dioxide and other gases in the atmosphere. Warming occurs as sunlight strikes the Earth. Much of the sunlight is reflected back into space. But Earth's atmosphere absorbs much of the heat and slows its escape from Earth. In this way, the Earth is like a greenhouse. The atmosphere encloses the Earth just as panes of glass enclose a greenhouse. Because of their heat-trapping abilities, the carbon dioxide and other gases in Earth's atmosphere are often called **greenhouse gases**.

## Part I: Daily Cycles of Heat and Temperature

*In this activity, you will examine the relationship between the time of day and the temperature.*

1. Launch the Greenhouse Effect Gizmo. With **Greenhouse gases (relative percent)** set to 10%, click **Play** and watch as several days go by. Notice the moving red arrow at the top of the **SIMULATION** pane indicating the time of day.
2. Next click on the **BAR CHART** tab. The bar charts show heat flow (expressed in arbitrary units) and temperature in degrees Fahrenheit. Set the **Simulation speed** slider to **Slow** and hit play again for a few more days.

- a. How does the heat flow going in ( $H_{in}$ ) fluctuate throughout the day?

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- b. At what time is the most heat entering the atmosphere? (use am/pm on all times) \_\_\_\_\_

- c. During what time range is there no heat at all entering the atmosphere? \_\_\_\_\_ to \_\_\_\_\_

- d. Why do you think this is? \_\_\_\_\_

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- e. How does the heat leaving the atmosphere ( $H_{out}$ ) change during the day? \_\_\_\_\_

- f. How does the temperature change throughout the day? \_\_\_\_\_

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- g. At about what time is it hottest? \_\_\_\_\_

- h. At about what time is it coolest? \_\_\_\_\_

3. Click **Reset**. Then click on the **TABLE** tab. You will now look at 24 hours of heat and temperature data. Click **Play** and watch the time pass in the data table. When **Time (hr)** reaches 24.00, click **Pause**. Then use the scroll bar on the right side of the table to answer the questions below.

- a. At what time does heat ( $H_{in}$ ) begin to enter the greenhouse? \_\_\_\_\_
- b. What happened at that time? \_\_\_\_\_
- c. At what time did the greatest amount of heat enter? \_\_\_\_\_
- d. Why do you think this is? \_\_\_\_\_
- e. What do you notice about  $H_{out}$  throughout the day?  
\_\_\_\_\_
- f. What was the maximum temperature? \_\_\_\_\_
- g. At what time did the maximum temperature occur? (Convert your answer from "military time" to "a.m. and p.m." time.) \_\_\_\_\_
- h. What was the minimum temperature? \_\_\_\_\_
- i. At what time did the minimum temperature occur? \_\_\_\_\_

4. Click **Reset**. Then click on the **GRAPH** tab. You will be looking at graphs of  $H_{in}$ ,  $H_{out}$ , and **temperature** over time. **Answer these questions before you click play.**

- a. What do you expect the graph of  $H_{out}$  to look like over a number of days? Describe or sketch.
- b. What do you expect the graph of  $H_{in}$  to look like over a number of days? Describe or sketch.
- c. What do you expect the graph of  $T^{\circ}F$  to look like over a number of days compared to  $H_{in}$ ?

5. Adjust the **Simulation speed** slider so that the speed is about halfway between **Slow** and **Fast**. Then click **Play**. When about four or five days have passed, click **Pause**.

- a. Do the three graphs look like you expected? (*Circle one*) Yes No
- b. Explain why each graph looks like it does.

▪  $H_{out}$

▪  $H_{in}$

▪  $T^{\circ}F$

## Part II: Changing Levels of Greenhouse Gases

Where do greenhouse gases come from? Animals release carbon dioxide (CO<sub>2</sub>) during cellular respiration. Also, burning fossil fuels such as coal, oil, and natural gas produces CO<sub>2</sub>. Much of the CO<sub>2</sub> in the atmosphere is used by green plants in photosynthesis, but too much CO<sub>2</sub> can be a serious problem. In this activity, you will see the effects of variations in the amount of greenhouse gases.

6. Make sure you are still on 10% Greenhouse gasses and click on the **TABLE** tab. Speed up the simulation to fast and click **Play** for a whole month (30-31 days). Keep track of the days in the left corner above the simulation.

- a. Have the daily highs and lows changed over these 20 or 30 days? (*Circle one*) Yes No
- b. Fill in the 10% column table below. Steps 7 and 8 will help you fill in the other columns, **please continue to number 7 after completing the first column.**

| Feature                          | 10% (Day 30)<br>Greenhouse<br>Gasses | 20% (Day 7)<br>Greenhouse<br>Gasses | 20% (Day 30)<br>Greenhouse<br>Gasses | 30% (Day 7)<br>Greenhouse<br>Gasses | 30% (Day 30)<br>Greenhouse<br>Gasses |
|----------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|
| High H <sub>in</sub><br>(units)  |                                      |                                     |                                      |                                     |                                      |
| High H <sub>out</sub><br>(units) |                                      |                                     |                                      |                                     |                                      |
| Daily High<br>Temp (°F)          |                                      |                                     |                                      |                                     |                                      |
| Daily Low<br>Temp (°F)           |                                      |                                     |                                      |                                     |                                      |

7. Click **Reset**. Set **Greenhouse gases (relative percent)** to 20%. (To set a slider to a specific value, type the number in the field to the right of the slider and hit **Enter**.) Click **Play** and watch for 7 days and click **pause**.

- a. Fill in the 20% Day 7 column on the table above.

8. Click play and watch until 30 days then **pause**.

- a. Fill in the 20% Day 30 column on the table above.

- b. Switch to the **graph** pane. With higher levels of greenhouse gases, how has **H<sub>in</sub>** changed, if at all?

(*Circle one*) Increased Same Decreased

- c. How has **H<sub>out</sub>** changed, with more greenhouse gases in the atmosphere?

(*Circle one*) Increased Same Decreased

- d. How have the daily temperatures changed? (*Circle one*) Increased Same Decreased

- e. Let the simulation run for a while. What happens to the temperature line?

(*Circle one*) Increased Same Decreased

(*If necessary, click – to the right of the graph to zoom out.*)

9. Click **Reset**. Set **Greenhouse gases (relative percent)** to 30%. Click **Play** and watch for 7 days.

- a. Fill in the 30% Day 7 column on the table above.

10. Click **Play** and watch until Day 30 then **pause**.

- a. Fill in the 30% Day 30 column on the table above.
- b. With higher levels of greenhouse gases, how has  $H_{in}$  changed

(Circle one) Increased Same Decreased

- c. How has  $H_{out}$  changed? (Circle one) Increased Same Decreased

- d. Compare how the temperature change from day 7 to 30 at 30% is different from when the

**Greenhouse gases** slider was set to 20%: \_\_\_\_\_  
\_\_\_\_\_

11. With **Greenhouse gases (relative percent)** still set to 30% let it play until day 60.

- a. What happens to the temperature? (Circle one) Continue to increase Eventually level off

12. With the simulation still running, adjust the **Greenhouse gases (relative percent)** back down to 10%.

- a. How do the daily high and low temperatures change?

(Circle one) Continue to increase Eventually Level off Begin to decrease

- b. How quickly does that change occur? (Circle one) Immediate One Month Two Months

13. The influence of greenhouse gases on temperature is called the **greenhouse effect**. Based on what you have seen, how do greenhouse gases affect the heat flow into and out of Earth's atmosphere?

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14. Take the quiz at the end of the gizmo. **Record your score:** \_\_\_\_\_