Name: _____ Period: ____Date: _____

Environmental Science

#9-2: Greenhouse Effect Simulations

1. First, review this NASA website for kids, "Meet the Greenhouse Gases!" (**go.nasa.gov/3i9s5ne**). According to this website, what are the six main gases generated by humans that are responsible for the greenhouse effect? For each gas, name a human activity that is responsible for adding it to the atmosphere.

Greenhouse gas	**Human activity generating this gas**

2. Load the new version of the PhET "Greenhouse Effect" simulation (**bit.ly/phetghenew**), click the yellow "Start Sunlight" button, and let it run for about a minute. In the lower left corner of the simulation, change the temperature in the simulation to °F. Watch what happens as sunlight comes down to Earth's surface and is turned into infrared light.
   a. What happens to the infrared light in the simulation as it's emitted from the surface into the air? Why do you think this happens?

   b. In the lower right side, click the checkbox next to "Cloud". What happens to the simulation now that there's a cloud in the sky? Why do you think this happens?

3. On the right side of the simulation, in the "Greenhouse Gas Concentration" box, click on the calendar icon at the bottom of the box (it looks like a rectangle with six tiny boxes inside). Again, watch what happens as sunlight comes down to Earth's surface and is turned into infrared light.
   a. Click the "Ice Age" button. According to the simulation, what was the average global temperature of the Earth during our last ice age around 20,000 years ago? How was this temperature possible during an ice age?

   b. Click the "1750" button. According to the simulation, what was the average global temperature of the Earth back in 1750? Why is that date important? What was different about the atmosphere back then?

c. Click the "1950" button. According to the simulation, what was the average global temperature of the Earth back in 1950? Why is that date important? What was different about the atmosphere back then?

d. Click the "2020" button. According to the simulation, what was the average global temperature of the Earth in 2020? What's different about the atmosphere now?

e. What's the difference in average global temperature between 1750 and 1950? Between 1950 and 2020? Based on this trend, what do you think the temperature will be by the end of this century? Why do you think so?

4. Now, load the *old* version of the PhET "Greenhouse Effect" simulation (**bit.ly/phetgheold** – *be patient, it's slow on Chromebooks!*) and let it run for about a minute. Watch what happens as the sunlight photons come down to Earth's surface and are turned into infrared photons.
   a. In the simulation, what sometimes happens to the motion of the infrared photons as they're emitted from the surface back into space? What is causing this motion to happen? What effect does this have on the surface temperature? *(Try playing with the "Greenhouse Gas Concentration" slider on the right.)*

   b. In your opinion, what is easier to understand – seeing light as waves, or seeing light as photons? Why do you think so?

5. At the top of the simulation, click on the blue tab that says "Photon Absorption". On the left side of the simulation, move the slider on the flashlight so that infrared photons start coming out. Try out each of the "Atmospheric Gases" in the upper right corner to see how they behave when struck by infrared light.
   a. Which gases interact with infrared photons, and how do they interact? What does this mean?

   b. Which gases do not interact with infrared photons? How do you know?

   c. Click on the "Visible Photon" button under the flashlight so that it emits visible light. Try out each of the gases like you did before. What happens now? Why do you think this happens?

6. After doing these simulations and the "Greenhouse Effect Lab" with alka seltzer tablets, which do you think gives students a better understanding of the greenhouse effect? Why do you think so?