Climate Change, Greenhouse Gas Effect, & Carbon Cycle

Activity A – What have you heard about greenhouse gases?

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# Activity A – What have you heard about greenhouse gases?

Discuss the following questions with your group:

1. What have you heard about greenhouse or heat-trapping gases?

Can you name some greenhouse gases?

1. What do you think the effect of greenhouse gases in our atmosphere might be? What makes you think that?
2. Where do you think greenhouse gases come from?

**Experiment B – Greenhouse Gas Computer Model Experiments**

In these experiments we will use a computer simulation to explore the effect of a greenhouse gas on Earth's temperature.

Let's write down a hypothesis.

Hypothesis 1: What do you think will happen to the Earth's temperature in the computer simulation as you add more greenhouse gas to the atmosphere? Why?

**Group Discussion Question:**

The computer simulation includes a representation of photons. What do you think a photon is?

Tasks:

1. On the computer or tablet, open the PhET Greenhouse Gas Simulation.
2. Under the "Atmosphere during" tab, select the "Adjustable Concentration" button.
3. Slide the "Greenhouse Gas Concentration" lever to "None."
4. You can slow down the speed of the simulation by the sliding the lever at the bottom of the screen from "fast" towards "slow".
5. In this simulation there are no greenhouse gases in the atmosphere. Observe what happens to the sunlight (yellow dots), and the infrared photons (red dots). Record your observations in the first row of the Table for Experiment B on the next page. The amount of greenhouse gases called carbon dioxide (CO2) and methane (CH4) is 0 ppm.
6. Look at the temperature shown at the bottom left of the screen. Wait at least 30 seconds for the temperature to stop changing as much. Record the temperature in the first row of the Table.
7. Next, change the greenhouse gas concentration by selecting the "1750" button under "Atmosphere during".
8. Observe what happens to the greenhouse gases called carbon dioxide (CO2) and methane (CH4), the sunlight (yellow dots), and the infrared photons (red dots). Record your observations in the second row of the Table.
9. Look at the temperature shown at the bottom left of the screen. Wait at least 30 seconds for the temperature to stop changing as much. Record the temperature in the second row of the Table.
10. Increase the greenhouse gas concentration even more by selecting the "Today" button under "Atmosphere during".
11. Observe what happens to the greenhouse gases called carbon dioxide (CO2) and methane (CH4), the sunlight (yellow dots), and the infrared photons (red dots). Record your observations in the third row of the Table.
12. Look at the temperature shown at the bottom left of the screen. Wait at least 30 seconds for the temperature to stop changing as much. Record the temperature in the third row of the Table.

**Table for Experiment B:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Atmosphere During | Amount of CO2 and CH4 (ppm) | Where do sunlight (yellow) photons come from? Where do they go? | Where do infrared (red) photons come from? Where do they go? | Temperature  (see bottom left of screen) |
| No Greenhouse Gases |  |  |  |  |
| 1750 |  |  |  |  |
| Today |  |  |  |  |

**Discussion Questions - B**

What do you think is the source of sunlight photons? What is the source of infrared photons?

How does the amount of infrared photons at the Earth's surface change when you raise the amount of greenhouse gases in the atmosphere? Why do you think this happens?

What happens to the temperature at the Earth's surface when you raise the greenhouse gas concentration? Why do you think this happens?

Revisit your hypothesis.

* Did the experiment support your hypothesis?
* If yes, does your reason for picking that hypothesis seem correct or did it happen for a different reason?
* If no, why do you think it turned out differently?

**Experiment C – What is infrared radiation?**

In this experiment we will use a special camera to explore the difference between visible radiation and infrared radiation.

Examine the visible and infrared radiation handout on your table.

1. How do the wavelengths and energy of visible and infrared radiation differ?
2. How do the temperatures of the Sun and Earth differ?
3. Why do you think the Sun emits visible radiation and the Earth emits infrared radiation?
4. Do you think the temperature of greenhouse gases in Earth's atmosphere are closer to the temperature of the Earth or the Sun? What type of radiation do you think greenhouse gases emit?

Tasks

1. As a group, look at the mug on the hot plate using the infrared camera provided. *Be careful not to touch the mug and hot plate - they are HOT!*

This is a special camera that can detect infrared radiation and visible radiation.

1. What do you notice about the mug and hotplate when looking through the infrared radiation camera? Record your observations in the Table below.
2. Hold the glass picture frame in front of the camera. How does the radiation reaching the camera change? Record your observations in the Table below.
3. Now hold the garbage bag frame in front of the camera. How does the radiation reaching the camera change? Record your observations in the Table below.

**Table for Experiment C:**

|  |  |  |
| --- | --- | --- |
| **Type of Frame:** | **Infrared Radiation** | **Visible Radiation** |
| None |  |  |
| Glass |  |  |
| Garbage Bag |  |  |

**Discussion Questions - C**

What does the glass do to the infrared and visible radiation? What does the garbage bag do?

Do you think the Earth's atmosphere is like the garbage bag, the glass, or both? Why?

Which frame is most similar to greenhouse gases? Why?

**Experiment D – Greenhouse Gas in a Bottle**

In this experiment we will investigate what happens to temperature in the atmosphere when we add more of a greenhouse gas called carbon dioxide.

In the experiment, the air in the bottle represents the Earth's atmosphere. The soil in the bottle represents the Earth's land. We will place the bottle with soil into the microwave to represent the land being heated by the sun. Then, we will add carbon dioxide to the atmosphere in the bottle by dissolving Alka-Seltzer tablets in water, which releases carbon dioxide bubbles.

Let's develop a hypothesis.

Hypothesis 1: What do you think will happen to the temperature in the bottle's atmosphere after we add more carbon dioxide? Why?

Tasks:

1. Heat the bottle and soil in the microwave for 15-17 seconds. Remove the thermometer first!
2. Quickly place the thermometer in the bottle.
3. Have one group member watch the thermometer closely. After the temperature stops changing (~30seconds to a few minutes), record the temperature in Table on the next page.
4. While one group member is watching the thermometer, quickly attach the straw from the small container to the side of the bottle.
5. As soon as the temperature stops changing, put 5 Alka-Seltzer tablets into the small container with water and close the lid quickly. This will create carbon dioxide bubbles that are piped into the bottle.
6. Watch the temperature on the thermometer. Does it rise? Wait until the temperature stops changing and record the temperature in the Table.

**Table for Experiment D:**

|  |  |
| --- | --- |
| **Bottle after:** | **Temperature** |
| Heating in microwave |  |
| Adding carbon dioxide |  |
| Difference  (Carbon Dioxide - Microwave) |  |

**Discussion Questions - D**

How did the addition of greenhouse gases change the air temperature in the greenhouse gas bottle?

Why do you think this happened?

Revisit your hypothesis.

* Did the experiment support your hypothesis?
* If yes, does your reason for picking that hypothesis seem correct or did it happen for a different reason?
* If no, why do you think it turned out differently?

How do you think carbon dioxide gets into the atmosphere?

What are some places on Earth that store carbon? These places are called carbon reservoirs.

**Experiment E – Where does carbon dioxide come from?**

In this activity we will use a game to explore how carbon atoms move through and get stored in various places on earth. We will then use a second version of the same game to test how fossil fuel emissions change where carbon atoms are stored.

Tasks

1. Form small groups of about 4 to 6 people.
2. Find the game board labeled "Paper Clip Carbon Cycle **Model #1**."
3. On the game board, note that *each oval represents a carbon reservoir*. List the different carbon reservoirs in the first Discussion Question on the next page.
4. Each oval on the game board has a different color. Place 10 paper clips inside each oval carbon reservoir on the game board. The color of the paper clips should match the color stated inside the oval.

Each paper clip represents a carbon atom.

In the following steps you will move the paper clips around the oval carbon reservoirs. The color of the paper clip will help you remember which carbon reservoir the carbon atoms started in.

1. Have one group member roll two dice.
2. Look for the arrows pointing away from the *ocean reservoir* that have the same numbers as the dice.
3. For each arrow that has the same number as the dice, move one paper clip from the ocean reservoir into a new reservoir.
4. Take turns rolling the dice and moving the paper clips from the ocean reservoir until each member has had a turn.
5. Then, move clockwise to the next reservoir where each group member takes another turn rolling the dice and moving paper clips.
6. Continue until you have visited all of the reservoirs.
7. Leave all the paper clips on the Model #1 board. Don't move them.
8. Now, look at the game board labeled "Paper Clip Carbon Cycle **Model #2**."
9. How does the Model #2 board differ from Model #1 board? (Hint: Look at the arrows pointing away from the Fossil Fuels reservoir.)
10. Write down your hypothesis:

Hypothesis #1: How do you think the results from Model #2 will be similar or different from Model #1? Why?

1. Play the paper clip game the same way but this time use the board for Model #2.
2. Leave all the paper clips on the Model #2 board. Don't move them.

# Discussion Questions - E

What carbon reservoirs are represented in the model game?

Compare the results from Model #1 and Model #2. What differences do you notice?

Revisit your hypothesis.

* Did the experiment support your hypothesis?
* If yes, does your reason for picking that hypothesis seem correct or did it happen for a different reason?
* If no, why do you think it turned out differently?

**Activity F – Climate Change Personal Action Plan**

How do you think climate change with affect life on Earth?

Remembering what you have learned about where greenhouse gases come from, can you think of things you currently do to help prevent climate change?

Tasks:

1. Look at the "PlanetVision Personal Actions" idea boards on the table.
2. Note the actions you would like to try and write them on your Personal Action Plan on the next page.
3. Share with the group which actions you are excited about.
4. Take your action plan home and hang it on your wall or refrigerator. Feel free to draw a picture on it first!

Climate Change Personal Action Plan

I can help prevent climate change by:

I want to encourage others to help prevent climate change by: