Greenhouse Effect and Global Climate System Lesson Plan

For Teachers: The following lesson plan is designed for use with the section of the After Earth Climate Change webpage entitled “The Greenhouse Effect.” We recommend that you download and print the student worksheet pages and distribute them for interactive use with the learning tools and animations provided by the web site. A key is provided with answers embedded, below.

Goal: Understanding the greenhouse effect and how this phenomenon contributes to climate change.

Objective: Students will be able to diagram the greenhouse effect and list the four major greenhouse gasses.

Overview: Directions for the exercise are contained in the body of the lesson plan.

- Students will first gain some related vocabulary. We recommend that you allow students to access the web freely to define these terms, and then conduct a discussion to agree as a class on a definition for each term.

- Students will next access the web site and use the worksheet to master the material presented on the site.

- Possible formative assessments for this lesson:
  1) Draw a labeled diagram of the greenhouse effect
  2) Show how the greenhouse effect operates by creating a skit that has the following characters: Nitrous Oxide, Water Vapor, Solar Energy, Heat, Carbon Dioxide, Methane, and Air Temperature.

Key for Program Notes: (Underlined words are blanks on student sheet)

Earth’s average temperature is controlled by a dynamic balance between the amount of solar energy trapped as heat by the atmosphere, and the amount of energy that is reflected and radiated back into space. That balance, in turn, is largely controlled by concentrations of four gases in the atmosphere: carbon dioxide, water vapor, methane, and nitrous oxide. These gases are called greenhouse gases, because they function somewhat like the glass in a greenhouse. They allow most wavelengths of solar energy to enter, but they trap heat inside.

Watch the animation.

Without any greenhouse effect, Earth would be about 55 degrees (F) cooler than it is today. If concentrations of these greenhouse gases in the atmosphere rise, they trap more heat, so Earth warms. If their concentrations fall, more heat escapes, so Earth cools. Where does much of the extra carbon dioxide gas in the atmosphere come from? (Sample answer: From burning fossil fuels, natural gas, wood)
Watch the animation/movie called “Carbon Crisis in 90 Seconds”. (next link) Answer the questions below:

1. How are a banana and coal similar?
   (Sample answer: Both have carbon in them.)

2. Why does the movie call the carbon in the banana “young” carbon?
   (Sample answer: The carbon in the banana was CO2 in the air just weeks or months ago.)

3. What happens to some of the carbon from the banana after you eat it?
   (Sample answer: You use it for energy and then you breathe it out as CO2)

4. What happens to the carbon from the coal when you burn it?
   (Sample answer: It releases CO2 (and other) gases, and produces energy for power.)

5. Why does the animation call the carbon from coal “old carbon”?
   (Sample answer: This carbon was bound into plants and animals millions of years ago, and would still be underground if we hadn't dug it up)

6. If you burn wood from a tree that was 100 years old, would the carbon from the wood be old carbon or young carbon? Defend your answer. Accept either position--as long as it is defended. From the perspective of a student, 100 years is a really long time. However, compared to coal, it is young. There are interesting discussion possibilities here. It takes many more years to grow a tree than to burn one!

7. At the end of the movie, we see a scientist named Peter Griffith from NASA. What does Peter suggest that we do in order to cut down the amount of CO2 we are adding to the atmosphere? (Sample answer: Find other ways to produce energy.)

8. The concentration of carbon dioxide (CO2) in the atmosphere is increasing. Again, this is not a hypothesis, or a model, but a scientific fact, based on hard data. For several decades, an atmospheric observatory near the summit of Mauna Loa, in Hawaii, has been gathering and analyzing air passing over it. The concentration of carbon dioxide (CO2) in that air is shown below. (We’ll explain why the concentrations wriggle up and down shortly.)

9. Watch the animation “Atmospheric CO2 at Mauna Loa by Month” What does this graph show?
   (Sample answer: Rising concentrations of CO2 in atmosphere near Mauna Loa over the last 50+years.)

10. What is the time frame of the x axis?
    (Sample answer: 1958-2012.)
11. What is the value on the y axis?
(Sample answer: Carbon dioxide in Parts per million (PPM))

12. What is the overall trend of the graph?
(Sample answer: Upwards, every year the concentration is increasing—even though it goes up and down over the months of the year.)

Different kinds of measurements enable us to look at the concentration of CO2 in the atmosphere over the last 1,000 years. Ever since the industrial revolution began during the 1800’s, human activity has been releasing more and more greenhouse gases into the atmosphere, as shown below.

Watch the animation “Atmospheric CO2 since 1010.”

1. What does this graph show?
(Sample answer: Concentrations of CO2 in atmosphere over the last 1000 years.)

2. What is the time frame of the x axis?
(Sample answer: 1010-2010.)

3. What is the value on the y axis?
(Sample answer: Carbon dioxide in Parts per million (PPM))

4. What is the overall trend of the graph?
(Sample answer: Steady, and then increasing somewhere around 1800.)

5. What do you think caused the change in the trend of the graph around 1800?
(Sample answer: Industrial revolution)

Is the rise in CO2 since 1800 an example of “old” or “young” carbon being added to the atmosphere? Defend your answer. (Sample answer: Old—the industrial revolution has been fueled mainly by fossil fuels—coal, gas and oil. All are made from bodies of ancient organisms.)
Objective: Students will be able to diagram the greenhouse effect and list the four major greenhouse gasses.

Draw your favorite greenhouse below (you may look up what one looks like first if you don't already have a picture in your mind):

Include and label in your drawing: the sun, the material of the roof, the material of the sides, how heat gets trapped, and some plants that grow.

Why is a greenhouse warm?

Define the following terms:

Greenhouse

Solar Gain

Carbon Dioxide (Include the formula)

Water Vapor (Include the formula)

Methane (Include the formula)

Nitrous Oxide (Include the formula)
Now access the webpage called “climate change” by following the link from the After Earth Science webpage. Go to the section entitled “The Greenhouse Effect.” Complete the program notes, below by reading the information on the webpage and filling in the blanks, and answering the questions.

Earth’s average _____________ is ____________ by a dynamic balance between the amount of __________ __________ __________ as __________ by the atmosphere, and the amount of __________ that is ______________ and ____________ back __________ __________.

That balance, in turn, is largely controlled by concentrations of four gases in the atmosphere:

c________________________ __________________
w________________________ __________________
m________________________ __________________
n________________________ __________________

Now write the chemical formula for each compound on the line beside it, above. (Use your definitions from vocabulary on the first page if you don’t remember these formulae.)

These gases are called ______________ ______________, because they __________ somewhat like the __________ in a ______________. They __________ most ______________ of __________ __________ to __________, but they _______ __________ inside.

Watch the next animation.

What do the squiggly red lines stand for? ________________________________

In your own words, explain what is happening in the animation.

Watch the animation again. Can you match the molecular drawings to the chemical formulae you wrote above? Draw the following molecules below their names:
Without any ___________ ___________ Earth would be about ______ _______ _______ than it is today. If __________ of these greenhouse gases in the atmosphere _________, they trap _______ heat, so Earth _________. If their ___________ _________, more heat __________, so Earth __________.

Where does much of the extra carbon dioxide gas in the atmosphere come from?

Watch the animation/movie called “Carbon Crisis in 90 Seconds.”
Answer the questions below:

1. How are a banana and coal similar?

2. Why does the movie call the carbon in the banana “young” carbon?

3. What happens to some of the carbon from the banana after you eat it?

4. What happens to the carbon from the coal when you burn it?

5. Why does the animation call the carbon from coal “old carbon”?

If you burn wood from a tree that was 100 years old, would the carbon from the wood be old carbon or young carbon? Defend your answer.
At the end of the movie, we see a scientist named Peter Griffith from NASA. What does Peter suggest that we do in order to cut down the amount of CO2 we are adding to the atmosphere?

The concentration of carbon dioxide (CO2) in the atmosphere is ___________. Again, this is not a hypothesis, or a model, but a _______ _______, based on _______ ________. For several decades, an atmospheric___________ near the summit of _______ _______, in __________, has been _______ and _______ air passing over it. The concentration of _______ _________ _________ in that air is shown below.

Watch the animation “Atmospheric CO2 at Mauna Loa by Month.”

What does this graph show?

What is the time frame of the x axis?

What is the title of the y axis?

What is the overall trend of the graph?
Different kinds of ___________ enable us to look at the ________________ of ________ in the ________________ over the last ________________ years. Ever since the__________ _________________ began during the ___________, human ________________ has been ________________ more and more ________________ __________ into the ________________, as shown below:

What is the time frame of the x axis?

What is the value on the y axis?

What is the overall trend of the graph?

What do you think caused the change in the trend of the graph around 1800?

Is the rise in CO2 since 1800 an example of “old” or “young” carbon being added to the atmosphere? Defend your answer.