



Activity 1.3: Greenhouse Gas Emissions – Natural and Human Causes

Grades 5 – 6

Description: In this activity, students dig deeper into the greenhouse effect and explore natural and human caused greenhouse gas emissions. Students will brainstorm and then research natural and human activities that contribute to greenhouse gas emissions. They will diagram the causes and effects and then discuss how they can reduce their contributions to greenhouse gas emissions.

Total Time: One to two 45-minute class periods

Prior Knowledge

Review the difference between a cause and an effect.

Materials

- Overhead or LCD projector
- Computers (one for every two to four students)
- Books, articles, and other resources students can use to research sources of atmospheric CO₂
- Copies of Carbon Cycle and Natural & Human Sources of Greenhouse gases diagrams
- Where do Greenhouse Gases Come From handouts
- Greenhouse Gas Emissions Diagram handouts
- Colored pencils

National Science Education Standards

D.1.h The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor.

D.1.j Living organisms have played many roles in earth systems including affecting the composition of the atmosphere.

F.3.b Human activities can also induce hazards through resource acquisition, land-use decisions, and waste disposal.

F.5.c Technology influences society through its products and processes.

AAAS Benchmarks

5D/H3 Human beings are part of Earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

4B/M15 The atmosphere is a mixture of nitrogen, oxygen, and trace amounts of water vapor, carbon dioxide, and other gases.

4B/H6 pt 2 ...The burning of fossil fuels in the last century has increased the amount of greenhouse gases in the atmosphere, which has contributed to Earth's warming.

4C/M7 Human activities, such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming, have changed Earth's land, oceans, and atmosphere. Some of these changes have decreased the capacity of the environment to support some life forms.

8C/M11 By burning fuels, people are releasing large amounts of carbon dioxide into the atmosphere and transforming chemical energy into thermal energy that spreads throughout the environment.

4C/H1 Plants on land and under water alter the Earth's atmosphere by removing carbon dioxide from it, using the carbon to make sugars and releasing oxygen. This process is responsible for the oxygen content of the air.



Student Misconceptions: The ozone hole causes global warming.

Adapted from <http://www.nasa.gov/missions/earth/f-ozone.html> and http://www.giss.nasa.gov/research/features/200402_tango/

The stratosphere is the layer of the atmosphere from 10 to 30 miles above sea level. When there's ozone in this layer, it protects us from solar radiation. Regular oxygen molecules (O₂) are made up of two oxygen atoms stuck together. Solar energy shoots in from space and splits that molecule into two atoms. These stray O atoms attach to other O₂ molecules to create ozone (O₃). Ozone helps block solar radiation, including ultraviolet (UV) radiation, from reaching the Earth. UV radiation can cause skin cancer, but it also affects photosynthesis in plants, and that causes problems for the whole food chain. The thinning of the ozone layer in the stratosphere—what is known as the ozone hole—allows increased ultraviolet rays to reach the Earth, but the ozone hole does not cause climate change or increased temperatures.

There is a complex relationship between ozone depletion and climate. Ozone's impact on climate consists primarily of changes in temperature. Ozone is a greenhouse gas and the more ozone in a given parcel of air, the more heat it retains. Ozone generates heat in the stratosphere, both by absorbing the sun's ultraviolet radiation and by absorbing upwelling infrared radiation from the lower atmosphere (troposphere). Consequently, decreased ozone in the stratosphere results in lower temperatures the opposite of global warming. Observations show that over recent decades, the mid to upper stratosphere (from 30 to 50 km above the Earth's surface) has cooled by 1 to 6 degrees Celsius (2 to 11 degrees Fahrenheit). This stratospheric cooling has taken place at the same time that greenhouse gas amounts in the lower atmosphere (troposphere) have risen. The two phenomena may be linked.

Vocabulary

- **Fossil Fuel:** A source of energy formed over many years from the remains of living organisms (e.g. coal or gas).
- **Carbon source:** A place or entity that releases carbon into the atmosphere (e.g. an organism performing cellular respiration, decaying organic matter, a power plant).
- **Carbon sink:** A place or entity that removes or absorbs carbon from the atmosphere (e.g. a plant performing photosynthesis).

Resources

- Tim & Moby: What can you tell me about the carbon cycle <http://www.youtube.com/watch?v=jNIQ9KTMimQ&feature=related>. **Tim and Moby Videos** are available through the Brain Pop website. There are hundreds of short educational videos on a variety of science, math, social studies, English, arts, and health. The site is a subscription site with different price points for home, classroom, school, and district use. A year's classroom subscription was \$205 in 2013. They make a small number available for free at http://www.brainpop.com/free_stuff/. Some can be found on YouTube, including the one used in this lesson.



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- NASA resources on the causes of climate change, <http://climate.nasa.gov/causes/>
- University Corporation for Atmospheric Research information on climate and the carbon cycle, <http://eo.ucar.edu/kids/green/cycles6.htm>
- United States Environmental Protection Agency informatino on the sources of greenhouse gas emissions, <http://www.epa.gov/climatechange/ghgemissions/sources.html>
- Open Knowledge project sponsored by Allianz photo gallery and information on the top fifteen sources of greenhouse gas emissions, <http://knowledge.allianz.com/search.cfm?651/fifteen-sources-of-greenhouse-gases-gallery>
- United States Energy Information Administration information on where greehhouse gasses come from, http://www.eia.gov/energyexplained/index.cfm?page=environment_where_ghg_come_from
- Tim & Moby short video on the carbon cycle and climate change, <http://www.youtube.com/watch?v=jNIO9KTMimQ&feature=related>

Guiding Questions

- What is the role of greenhouse gases in the atmosphere?
- What are natural causes of greenhouse gas emissions?
- In what ways do humans contribute to greenhouse gas emissions?
- How can increased greenhouse gas emissions lead to climate change?

Assessment(s)

- Where do Greenhouse Gases Come From handout
- Greenhouse Gas Emissions Diagram

Before you start

- Collect reference materials on greenhouse gas emissions for students to use in their research activities (see list at the end of the unit).
- Review the websites on the handout “Where do Greenhouse Gas Emissions Come From?”
- Reserve the computer lab.

Part 1: Researching Greenhouse Gas Emissions

Procedure:

1. Review with the students what they learned during the Activity 1.2 Greenhouse Effect lab. Write student responses on the board. Discussion questions might include:
 - a. What is the greenhouse effect? Students should know that the greenhouse effect is the idea that some gases in our atmosphere act like a greenhouse (or a blanket), keeping in warmth (heat energy) that would otherwise escape into outer space.
 - b. Why are greenhouse gases are important to life on Earth? What would happen if the amount of greenhouse gasses were to decrease? What if we had no greenhouse gasses to keep Earth warm?
 - c. If greenhouse gases help keep Earth warm, what do you think would happen if the amount of greenhouse gases in the atmosphere were to increase? Remind them of the results of their lab if they are unsure of the response.



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2. Remind students that the primary greenhouse gases are carbon dioxide, methane, and nitrous oxide. However, because CO₂ is the most abundant greenhouse gas, that is what they will be focusing on today. Ask students what they know about carbon dioxide and write their answers on the board. Responses might include: We breathe it out, plants breathe it in, it is in the atmosphere.
3. Let the students know that there are natural cycles of carbon dioxide. When organisms breathe, through a process called respiration, they release carbon dioxide.
4. Ask all the students to breathe in. Have them hold in their breath and exhale at the same time. Let them know that they have released carbon dioxide into the atmosphere. All animals release CO₂ when they breathe. (Plants also undergo respiration and release small amounts of carbon dioxide into the atmosphere, however, depending on whether you have already covered photosynthesis, you may not want to highlight plant respiration at this point.)
5. Next, ask students if they know a process that takes carbon dioxide **out** of the atmosphere. Tell students that when plants perform photosynthesis they use carbon dioxide to make sugars, which they can use for growth or to make flowers or fruits. Tell students that plants are one of the few things on Earth that can actually remove carbon dioxide from the atmosphere. (Carbon is also sequestered in soils, fossil fuels, and oceans.) Photosynthesis and respiration represent the natural cycle of carbon dioxide through the atmosphere.
6. Project the Carbon Cycle Diagram on a screen and walk students through each step, illustrating the steps they have just discussed. Highlight the natural sources of carbon dioxide in the atmosphere and remind students that without the greenhouse effect, the Earth would be too cold to support life.
7. Ask students if they know of any ways that humans add CO₂ to the atmosphere besides breathing. Students may know that when some fuels are burned, they release carbon dioxide. Examples of this are when wood is burned for heat, or when fossil fuels such as gas are burned in our cars, boats, airplanes, etc. Tell students they are going to take some time to investigate both natural and human-created sources of atmospheric CO₂
8. Show the short movie (about three minutes) “Tim & Moby: What can you tell me about the carbon cycle”, <http://www.youtube.com/watch?v=jNIQ9KTMimQ&feature=related>, in which Tim & Moby describe the carbon cycle and how it is related to the greenhouse effect. Have students complete the accompanying handout while they watch the movie.
9. Discuss the movie and their answers to the questions. Ask students what the energy produced by fossil fuels being burned is used for. For instance, students may not know that fuel (usually coal) is burned to generate electricity, which powers everything from our televisions to computers to hair dryers.



NOTE: You can skip to Part 2 after students watch the movie or you can extend this activity with a web-based research component using the “Where do greenhouse gases come from?” handout. The handout has identified fairly straightforward websites where the answers to the questions can be found. However, they are adult-focused websites and student reading levels will need to be taken into account.

10. Break students into groups of three to four and hand out the “Where do greenhouse gases come from?” handout. Provide each group of students with the resources you have available books, articles, and/or a computer. They will explore the websites indicated on the handout to find the answers.
11. Once students have completed their research, discuss their answers.

Part 2: Diagramming Greenhouse Gas Emissions

Procedure:

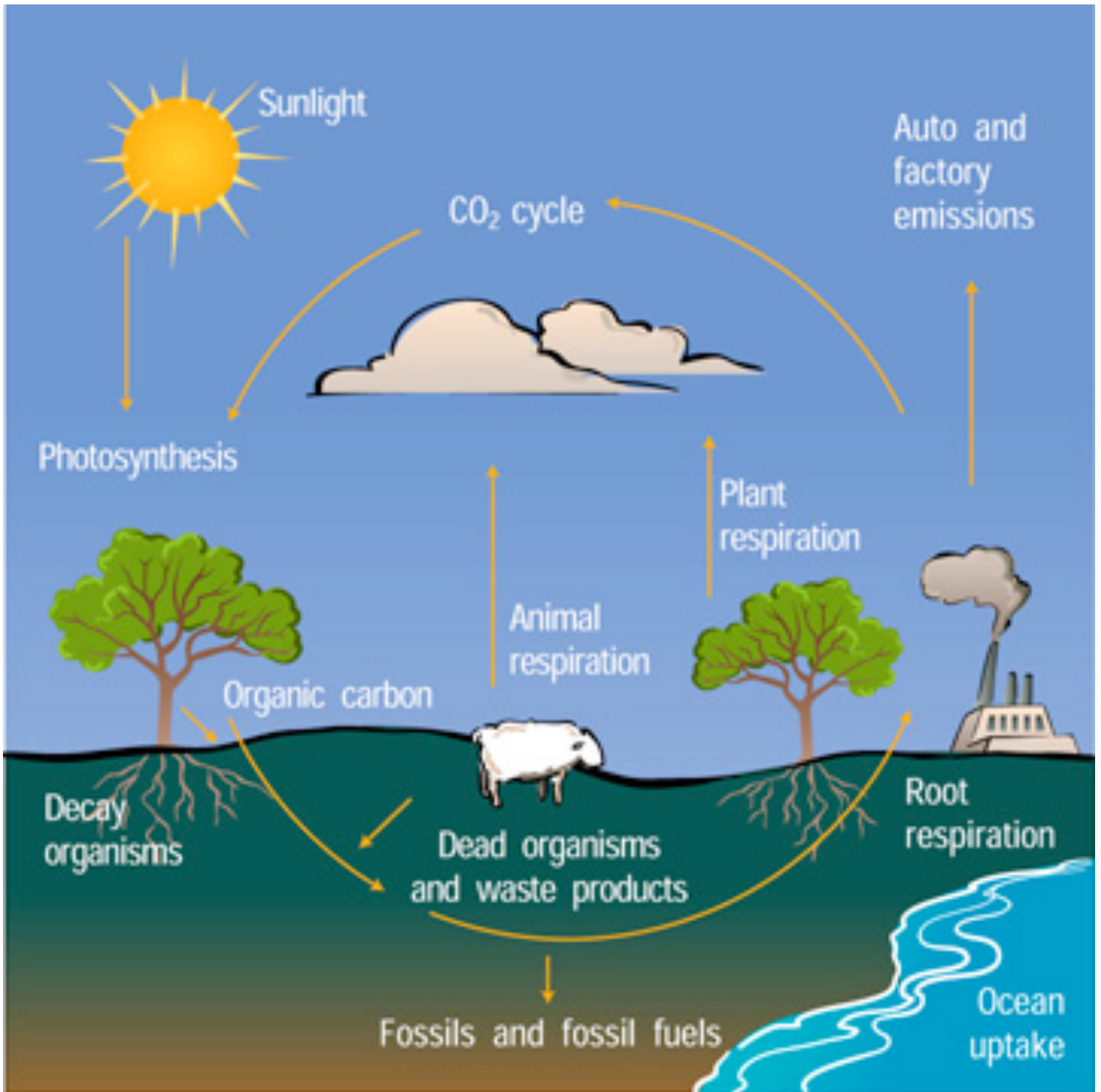
(This may be done as a full class or group activity, or as homework.)

1. Next, hand out the student work page “Greenhouse Gas Emissions.” Point out to students the layer of greenhouse gases in the atmosphere and Earth’s surface at the bottom of the page. Using the information they collected through their research, have students to draw natural and human-caused greenhouse gas emissions on their sheet. They should label the sources and note which are natural and which are human-caused.
2. After students have completed their diagrams, ask them to complete the two statements at the bottom of the page. Students are to write down the activities they think most contribute to greenhouse gas emissions and how they can work to reduce their emissions.
3. Have a discussion with students reviewing why they would want to reduce their emissions (reviewing the idea that increased greenhouse gas emissions contribute to climate change). For how they can reduce emissions, have students write down something they can and actually will do. You can post the sheets around the room or have students keep the sheets in their portfolio as a reminder of the commitments they have made to reduce greenhouse gas emissions.

Extensions:

- You may wish to issue a challenge to students regarding their greenhouse gas emissions. Have students choose a goal of reducing energy usage or transportation and assign them to keep a journal of the experience for a week or a month. You can also do a math extension asking students to quantify their greenhouse gas savings! (Note that there is a lesson in Unit 4 regarding carbon footprints. This may be a good time to introduce this lesson.)
- You could also discuss alternative energies with students—such as wind power, hydropower, or geothermal energy. These alternative energies can generate heat and electricity without as much carbon dioxide emission as such traditional energy sources as coal.

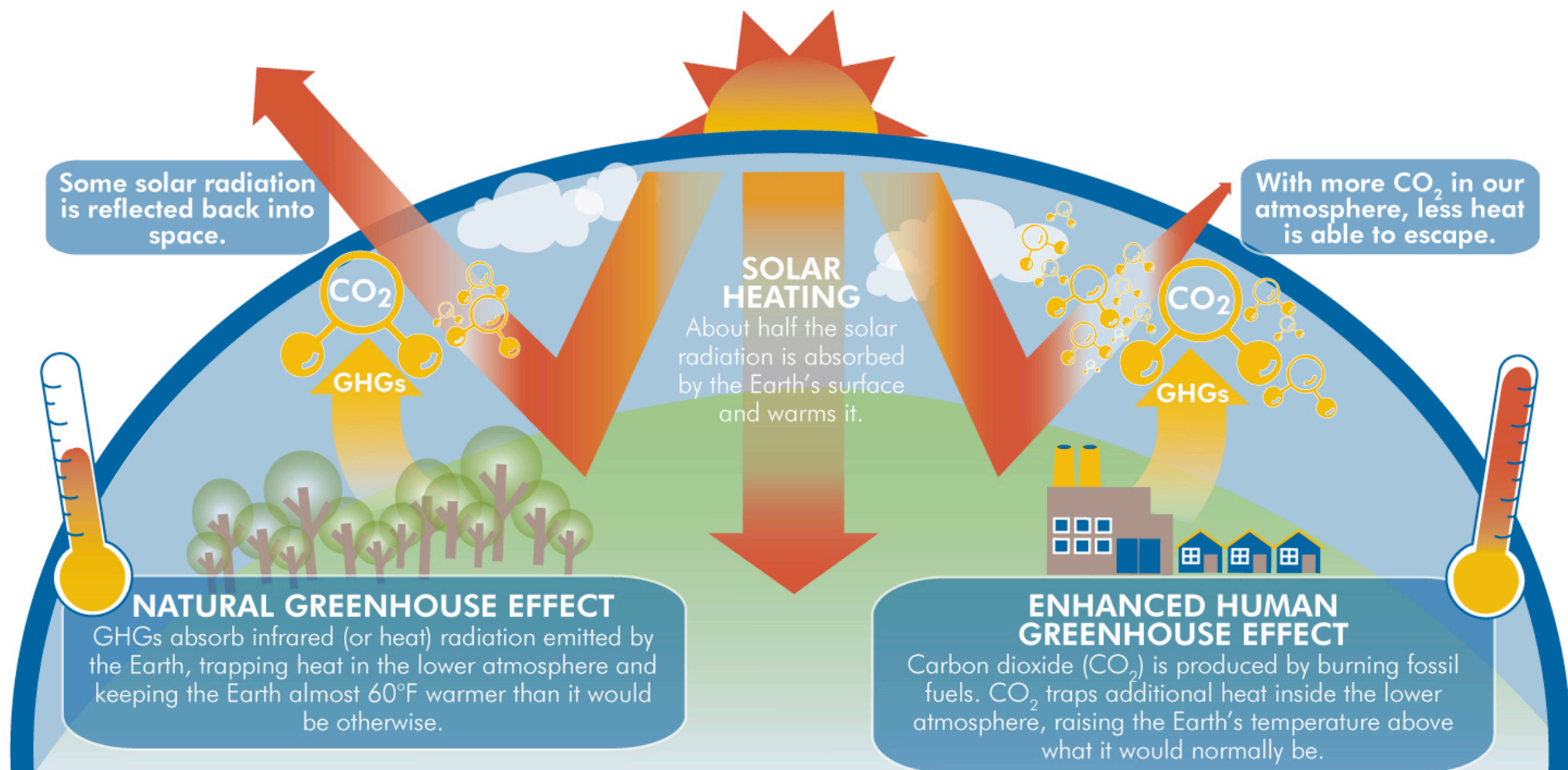
The Carbon Cycle



<http://eo.ucar.edu/kids/green/cycles6.htm>



Natural and Human Sources of Greenhouse Gas Emissions



Adapted from the Chicago Climate Action Plan



Tim & Moby: What can you tell me about the carbon cycle?

Watch and listen carefully to what Tim & Moby have to say about the carbon cycle and answer the following questions about the sources of greenhouse gas emissions.

1. List three places you would find CO₂ on Earth.

- _____
- _____
- _____

2. List two sources of natural CO₂ in the atmosphere.

- _____
- _____

3. List three ways that humans put CO₂ into the atmosphere.

- _____
- _____
- _____

4. Since the Industrial Revolution, the amount of CO₂ in the atmosphere has increased by _____ percent.

5. Why is the fact that humans are adding to the usual amount of greenhouse gases in the atmosphere important?

6. What are two ways that we can restore balance to the carbon cycle?

- _____
- _____



Where do Greenhouse Gases Come From?

Use the following sites and the resources provided by your teacher to answer the following questions about the sources of greenhouse gas emissions.

1. List the five main greenhouse gases.

<http://climate.nasa.gov/causes/>

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | |

2. List two sources of natural **CO₂** in the atmosphere. (Hint: remember the carbon cycle!)

<http://eo.ucar.edu/kids/green/cycles6.htm>

- | |
|----------|
| 1. _____ |
| 2. _____ |

3. List five sources of human-caused greenhouse gas emissions.

<http://www.epa.gov/climatechange/ghgemissions/sources.html>

<http://knowledge.allianz.com/search.cfm?651/fifteen-sources-of-greenhouse-gases-gallery>

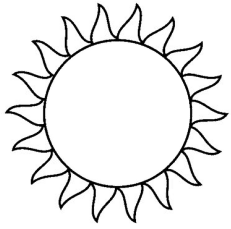
- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | |

4. What percentage of all of the human-caused greenhouse gases is

http://www.eia.gov/energyexplained/index.cfm?page=environment_where_ghg_come_from

- | |
|------------------------------|
| a. CO ₂ : _____ % |
| b. Methane: _____ % |
| c. Nitrous oxide: _____ % |
5. Why is the fact that humans are adding to the usual amount of greenhouse gases in the atmosphere important?

Greenhouse Gas Emissions Diagram



Atmosphere



Ground (land & water)

In the diagram above, draw and label sources of natural and human-caused greenhouse gas emissions.
I add to greenhouse gas emissions by:

I can reduce my greenhouse gas emissions by:



TEACHER ANSWER KEY

Tim & Moby: What can you tell me about the carbon cycle?

Watch and listen carefully to what Tim & Moby have to say about the carbon cycle and answer the following questions about the sources of greenhouse gas emissions.

7. List three places you would find CO₂ on Earth.

- _____
- _____
- _____

8. List two sources of natural CO₂ in the atmosphere.

- _____
- _____

9. List three ways that humans put CO₂ into the atmosphere.

- _____
- _____
- _____

10. Since the Industrial Revolution, the amount of CO₂ in the atmosphere has increased by _____ percent.

11. Why is the fact that humans are adding to the usual amount of greenhouse gases in the atmosphere important?

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TEACHER ANSWER KEY

Where do Greenhouse Gases Come From?

Use the following sites and the resources provided by your teacher to answer the following questions about the sources of greenhouse gas emissions.

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- | | |
|----------|----------|
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| 3. _____ | |

7. List two sources of natural **CO₂** in the atmosphere. (Hint: remember the carbon cycle!)

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- | |
|----------|
| 1. _____ |
| 2. _____ |

8. List five sources of human-caused greenhouse gas emissions.

<http://www.epa.gov/climatechange/ghgemissions/sources.html>

<http://knowledge.allianz.com/search.cfm?651/fifteen-sources-of-greenhouse-gases-gallery>

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | |

9. What percentage of all of the human caused greenhouse gases is

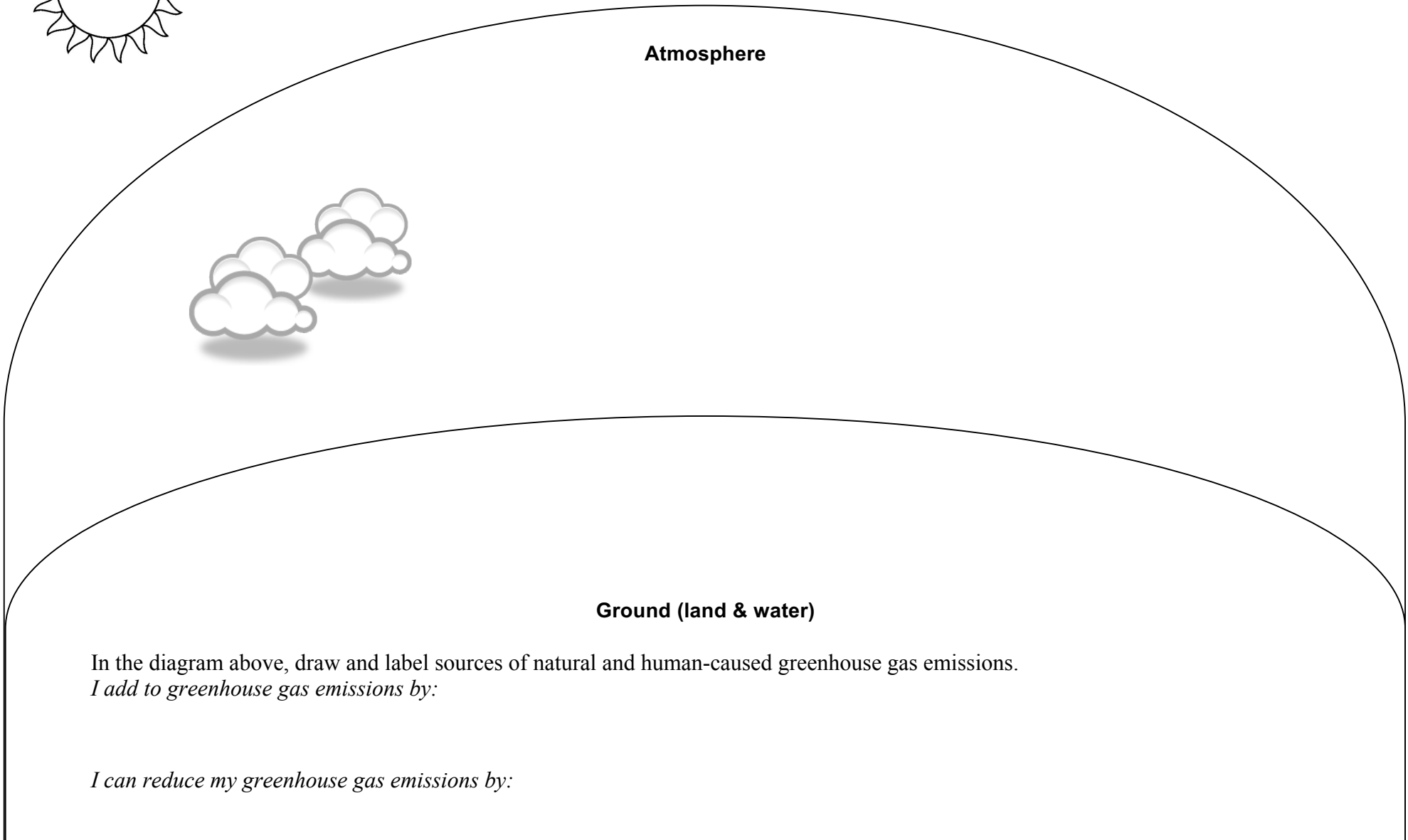
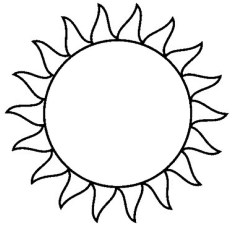
[http://www.eia.gov/energyexplained/index.cfm?page=environment where ghg come from](http://www.eia.gov/energyexplained/index.cfm?page=environment%20where%20ghg%20come%20from)

- | |
|------------------------------|
| a. CO ₂ : _____ % |
| b. Methane: _____ % |
| c. Nitrous oxide: _____ % |

Why is the fact that humans are adding to the usual amount of greenhouse gases in the atmosphere important?

TEACHER ANSWER KEY

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Atmosphere

Ground (land & water)

In the diagram above, draw and label sources of natural and human-caused greenhouse gas emissions.
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