

GASES AND THEIR PROPERTIES

Overview:

In this lesson, students examine multimedia to learn about properties of matter and apply this knowledge to look at gases in the atmosphere. Students explore multimedia tools to learn about the greenhouse effect and then model the process kinesthetically. Finally, students explore temperature projections for their community in the next century, consider the effects of these temperature changes and discuss actions their community can take to address this issue.

Objectives:

The student will:

- differentiate among atmospheric gases that do, and do not, exhibit properties contributing to the greenhouse effect;
- model the greenhouse effect;
- identify some local impacts of increasing greenhouse gases; and
- discuss community action to address climate change related to increased greenhouse gases.

Targeted Alaska Grade Level Expectations:

Science

- [7-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [7] SB1.1 The student demonstrates an understanding of the structure and properties of matter by using physical properties (e.g., density, boiling point, freezing point, conductivity) to differentiate among and/or separate materials (i.e., elements, compounds, and mixtures).
- [8] SB1.1 The student demonstrates an understanding of the structure and properties of matter by using physical and chemical properties (i.e., density, boiling point, freezing point, conductivity, flammability) to differentiate among materials (i.e., elements, compounds, and mixtures).

Vocabulary:

fossil fuel—carbon-based fuels that formed over millions of years from the remains of dead plants and animals; burning fossil fuels releases greenhouse gases into the atmosphere

greenhouse effect—the process of heating the surface of a planet due to the presence of atmospheric gases that absorb and emit infrared radiation (heat)

greenhouse gas—an atmospheric gas that absorbs and emits heat, trapping it close to a planet's surface; greenhouse gases include: water vapor, carbon dioxide and methane

Whole Picture:

Earth's surface is warmed by the sun's energy. As this energy enters the atmosphere and reaches the surface, most of it is absorbed. Some energy is reflected back into the atmosphere where it may be absorbed and reradiated in all directions by atmospheric gases. This is called the greenhouse effect. The greenhouse effect is a naturally occurring phenomenon that has created a hospitable climate and made life on Earth possible.

Not all atmospheric gases are able to trap and emit heat this way. The physical properties of atmospheric gases (specifically related to heat transfer) and their relative abundance in the atmosphere have a profound effect on Earth's climate. Nitrogen and oxygen make up over 99% of the atmosphere and are not greenhouse gases. The molecules of these gases are too tightly bound together to absorb heat and contribute to the greenhouse effect. The "greenhouse gases" (water vapor, carbon dioxide, methane, nitrous oxide and others) compose less than one percent of Earth's atmosphere. The molecules of these gases are composed of more than two atoms



GASES AND THEIR PROPERTIES

that are only loosely bound together allowing them to vibrate, absorb and reradiate heat. A commonly held misconception about greenhouse gases is that they “reflect” heat back to Earth. Greenhouse gases do not reflect heat. They absorb heat that radiates off Earth’s surface and reradiate it in all directions. Some of it will return to Earth while most will be radiated into space.

Throughout its history, Earth’s surface temperatures have fluctuated considerably. There have been many ice ages and warm periods (called interglacial periods). In the Mesozoic period (225 million to 65 million years ago) dinosaurs roamed and temperatures were much warmer than they are today. How does Earth’s atmosphere change so dramatically? Changes in greenhouse gas concentrations are just one way. Other known drivers of climate change include: changes in Earth’s orbit, changes in the sun’s intensity and volcanic eruptions.

In the last two centuries human beings have drastically increased the amount of greenhouse gases released into Earth’s atmosphere. A significant cause is the carbon dioxide released from burning fossil fuels like coal, oil and natural gas. Earth’s systems are complex, interrelated and variable, making the impact of these changes difficult to predict. Although scientists agree that temperatures increase from processes that release more greenhouse gases into the atmosphere, ideas differ when considering what the implications will be for life on Earth. One idea is that higher temperatures will cause cloud cover to increase and temperatures to decrease. Another idea is that higher temperatures will stop the global circulation of warm and cold ocean currents. This could cause an ice age because warm currents won’t be able to reach the polar regions of the planet.

Materials:

- Container (enough to fit the soft foam balls)
- Soft foam balls (approximately 36)
- Masking tape
- Paper (one sheet per student, plus at least three extra)
- Marker
- Clipboard with data sheet
- VIDEO: “Properties of Gases and Climate Change”
- TEACHER INFORMATION SHEET: “Sample Data Sheet”
- VISUAL AID: “Big Delta Projected Temperatures”
- STUDENT WORKSHEET: “Greenhouse Gas Scavenger Hunt”
- STUDENT WORKSHEET: “Values and Choices”

Activity Preparation:

1. Access the greenhouse gas emissions chart for your community at the Scenarios Network for Alaska Planning (SNAP) website: <http://www.snap.uaf.edu/community-charts>. These charts display temperature and precipitation projections for Alaskan communities. They display values for three possible scenarios: low, medium and high greenhouse gas emissions. Have this information on hand for class discussion in steps 11-13 of the Activity Procedure.
2. Prepare for the greenhouse modeling game. First choose a location. A gym would be ideal. An alternative could be outside along the school building. (The game requires a wall to toss the balls against.) Establish a boundary line with masking tape approximately 10-15 feet from the wall. Students will need room to move around between the wall and the masking tape. Mark each blank piece of paper with the name of an atmospheric gas. Most should be nitrogen or oxygen. Be sure you have at least one for each major greenhouse gas: water vapor, carbon dioxide, methane, nitrous oxide, and CFCs. (It is also possible to have students make these labels as part of the lesson.) Use the TEACHER INFORMATION SHEET: “Sample data sheet” as a model to make a data sheet for the game. Place the data sheet on a clipboard.

Activity Procedure:

1. Ask students what air is comprised of. Explain air is a word used to describe Earth's atmosphere. It is comprised of many different gases including nitrogen, oxygen, carbon dioxide, water vapor and methane. These gases have different characteristics or properties. Explain students will explore how the properties of gases in the air affect life on Earth.
2. Distribute STUDENT WORKSHEET: "Greenhouse Gas Scavenger Hunt." Direct students to watch the VIDEO: "Properties of Gases and Climate Change." Allow time for completion of the worksheet. After students have completed the worksheet, review as a class and discuss responses.
3. Explain students will model the greenhouse effect. See Activity Preparation for more detailed notes on setting up. In this model, one student will represent the sun and one student will be a data recorder. The remaining students will represent gas molecules in Earth's atmosphere. In this game, the area between the wall and the masking tape line represents Earth's atmosphere.
4. Pass out one piece of paper and a small piece of masking tape to each student (except for the student representing the sun and the data recorder). Students should tape the paper to the front of their shirt to identify themselves as a particular atmospheric gas. In the first round, students should be mostly oxygen and nitrogen, with only one student representing carbon dioxide and one student representing water vapor. Do not use the other greenhouse gases yet.
5. The sun should stand outside the masking tape line with the bucket full of foam balls. The balls represent the sun's radiation (heat). Before beginning, review safety guidelines. These may include: no running, stay within designated area, only the sun may throw the balls, etc.
6. When the game begins, the gas molecules should mill about in the atmosphere. The sun will throw the balls (heat) at Earth's surface (the wall). After the balls bounce or "reflect" off the wall (Earth's surface), the atmospheric gases (the other students) can catch the balls. It doesn't matter if the balls touch the ground. If a greenhouse gas like water vapor (H_2O) or carbon dioxide (CO_2) catches a ball they hold onto it. If a non-greenhouse gas like nitrogen (N_2) or oxygen (O_2) catches a ball, they toss it back to the bucket. Most balls should be returned to the bucket. The recorder should note the number of balls caught by oxygen and nitrogen (and returned) versus the number caught by a greenhouse gas (and held).
7. Play for a few minutes, or until the recorder has logged at least 50 data points. Repeat two more times. Students may change rolls after each.
8. After the third round, switch a few students from nitrogen and oxygen to the other greenhouse gases. Repeat for a total of three more rounds.
9. After the game, return to the classroom and discuss the results. Ask students what processes (natural and human-caused) might add greenhouse gases to the atmosphere (thereby enhancing the greenhouse effect).
10. Ask students to return to their computers. Aid them in finding the SNAP website (<https://snap.uaf.edu/tools/community-charts>) and in opening the graph for their community.
11. Use the VISUAL AID: "Big Delta Projected Temperatures" to help students understand their community graph. Explain this is a graph of projected temperatures for Big Delta based on greenhouse gas emissions. Be sure to describe each of the columns and what the colors represent. Show students the historical range (1961-1990) of months with temperatures above 30°F (May to September) and explain this is an approximation of ice-free months. Write this information on the board. Then guide students in determining the projected range of months with temperatures above 30°F in 2091-2100 (April to October). This shows a longer ice-free time.

GASES AND THEIR PROPERTIES

12. Instruct students to look carefully at the temperature graph for their community. Pose each of the critical thinking questions below. Allow time for students to share their ideas with the class.
 - What is the historical range (1961-1990) of months with temperatures above 30°F?
 - What is the projected range of months with temperatures above 30°F in 2091-2095?
 - What does this mean for hunting seasons in the future? Possible answers include: Preparing meat will be more of a challenge at warmer temperatures. Animal migration patterns might change. Warmer temperatures could change plant communities thereby affecting where animals are found. (For example, willows could begin to grow in increasing numbers on tundra causing caribou herds to change their paths.)
 - How might other seasonal activities like gardening, fishing, and even forest fires be affected? Possible answers include: The gardening season will be longer allowing humans to grow more crops. Fishing runs may happen earlier in the year. Warmer temperatures may mean more diseases for fish. Warmer temperatures also often result in more intense and frequent forest fires.
13. Distribute STUDENT WORKSHEET: "Values and Choices." Complete this worksheet as a class, discussing student ideas about alternative energy sources in their community.

Answers:

STUDENT WORKSHEET: Greenhouse Gas Scavenger Hunt

1. Use the boiling or freezing point. Pure water (H_2O) will boil at 100°C (212°F) and freeze at 0°C (32°F). The boiling point of the saltwater will be higher and the freezing point will be lower.
2. greenhouse gases
3. nitrogen and oxygen
4. Greenhouse gases: Water Vapor (H_2O), Carbon Dioxide (CO_2), Methane (CH_4) and CFCs.
Not Greenhouse gases: Oxygen (O_2), Nitrogen (N_2)
5. water vapor (H_2O)
6. Students should list three of the following: burning of fossil fuels, respiration from animals, forest fires, erupting volcanoes, organic soil decay
7. Students should list three of the following: diesel, heating oil, gasoline, propane, kerosene, petroleum, coal, natural gas
8. Earth's surface temperature will increase (which could change Earth's climate)
9. B. absorbs
10. B. more precipitation, more evaporation, and drier land

STUDENT WORKSHEET: Values and Choices

Answers will vary.

SAMPLE DATA SHEET

Directions: This data sheet (or a hand made version of it) can be used for the greenhouse gas modeling game described in Activity Procedure. The student recorder should make a tally mark for each ball that is caught and returned (by a student representing nitrogen or oxygen) and for each ball that is caught and kept (by a student representing a greenhouse gas). The recorder should then add up the total tally marks and circle it in each box.

	Greenhouse Effect		Enhanced Greenhouse Effect	
1	balls caught and returned:	balls kept:	balls caught and returned:	balls kept:
2	balls caught and returned:	balls kept:	balls caught and returned:	balls kept:
3	balls caught and returned:	balls kept:	balls caught and returned:	balls kept:

BIG DELTA PROJECTED TEMPERATURES

Community Charts: Big Delta

[« change community](#)

Temperature

Precipitation

Future Greenhouse Gas Emissions:

[Low](#)

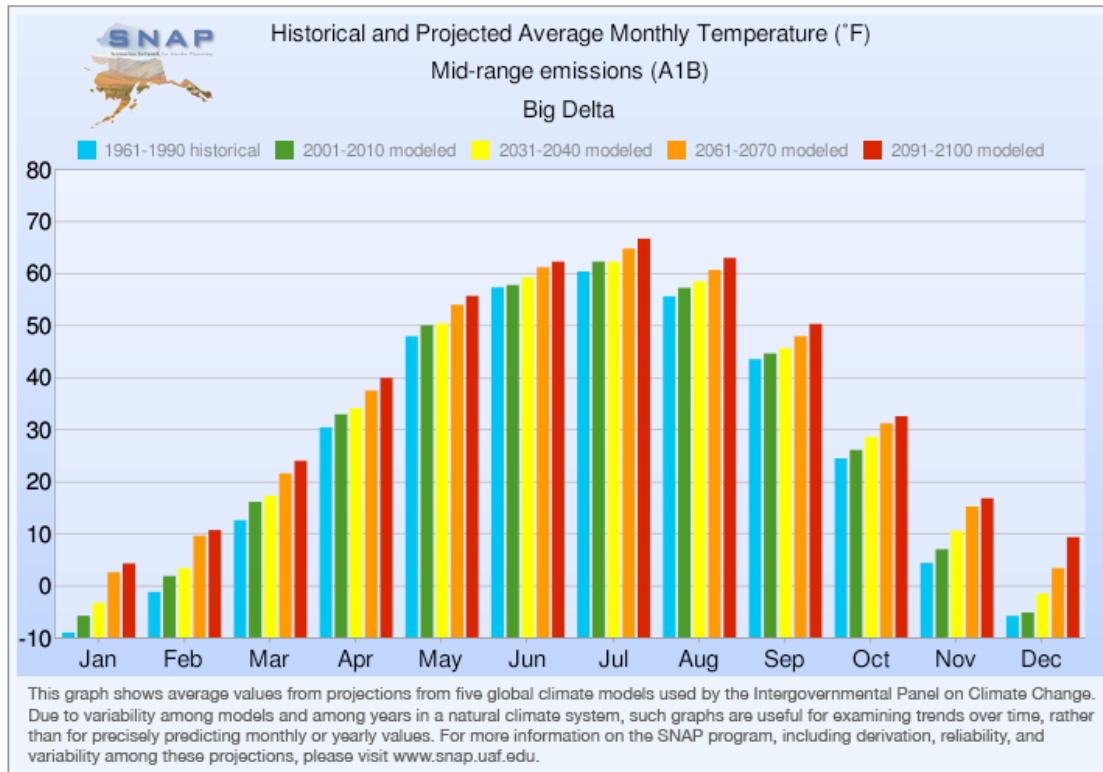
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NAME: _____

GREENHOUSE GAS SCAVENGER HUNT

Directions: Watch the VIDEO: "Properties of Gases and Climate Change."
Navigate through the information to answer the questions below.

1. How can you use properties to distinguish a cup of water (H₂O) from saltwater without tasting it?

2. Earth's atmosphere is made up of a mixture of gases, including gases that can absorb heat called _____.

3. 99% of Earth's atmosphere is composed of these two gases:

A. _____ B. _____

4. Which of the following gases has greenhouse property? Which do not? Sort the following gases into the appropriate column.

Carbon Dioxide (CO₂)

Methane (CH₄)

Oxygen (O₂)

Water Vapor (H₂O)

CFCs

Nitrogen (N₂)

Greenhouse Gas	Not a Greenhouse Gas

5. Which greenhouse gas is the most common in Earth's atmosphere? _____

6. List three sources of carbon dioxide.

_____, _____, and _____.

7. Give three examples of fossil fuels.

_____, _____, and _____.

8. What is the result of the enhanced greenhouse effect? _____

9. A gas in the atmosphere is a greenhouse gas if it _____ the heat radiated off Earth's surface.

A. reflects B. absorbs C. dissolves D. cools

10. Which statement is the correct prediction of the higher temperatures of climate change in Interior Alaska?

A. no change in precipitation and drier land C. higher sea levels, wetter land
B. more precipitation, more evaporation and drier land D. more snow, more runoff

NAME: _____
VALUES AND CHOICES

Think about what you have learned about greenhouse gases.

1. List two possible effects of more greenhouse gases in your community.

2. Look at the list of Athabaskan Cultural values. Select **one value** and **explain** how that value relates to the decision to seek alternative energy sources (wind, hydropower, solar, wood, etc.).

Athabaskan Cultural Values

Self-sufficiency and Hard Work

Care and Provision for the Family

Family Relations and Unity

Love for Children

Village Cooperation and Responsibility to Village

Humor

Honesty and Fairness

Sharing and Caring

Respect for Elders and Others

Respect for Knowledge & Wisdom from Life Experiences

Respect for Land and Nature

Practice of Native Traditions

Honoring Ancestors

Spirituality
