



ACTIVITY 1: RACE TO SPACE

NJ Standards Correlation

MATH:

4.4 Data Analysis, Probability, and Discrete Math

- A.1 Collect, generate, organize, and display data in response to questions, claims, or curiosity.
- A.2 Read, interpret, construct, analyze, generate questions about, and draw inferences from displays of data.

SOCIAL STUDIES:

6.2 Civics

- E.5 Identify current issues that may have a global impact and discuss ways to address them.

6.6 Geography

- B.2 Explain changes in places and regions over time and the consequences of those changes.
- E.2 Explain the nature, characteristics, and distribution of renewable and non-renewable resources.

SCIENCE:

5.1 Scientific Process

- A.1 Raise questions about the world around them and be willing to seek answers through making careful observations and experimentation.
- B.2 Identify the evidence used in an explanation.

5.5 Characteristics of Life

- A.2 Differentiate between the needs of plants and those of animals.

5.10 Environmental Studies

- B.1 Explain how meeting human requirements affect the environment.



NY Standards Correlation

SCIENCE:

3.1 d The Physical Setting

Measurements can be made with standard and metric units and nonstandard units.

4.1 g The Physical Setting

Interactions with forms of energy can be either helpful or harmful.

5.2 a The Living Environment

Plants respond to changes in their environment.

5.2 b The Living Environment

Animals respond to change in their environment.

5.2 g The Living Environment

The health, growth, and development of organisms are affected by environmental conditions such as the availability of food, air, water, space, shelter, heat, and sunlight.

6.1 f The Living Environment

When the environment changes, some plants and animals survive and reproduce, and others die or move to new locations.

7.1 a The Living Environment

Humans depend on their natural and constructed environments

7.1 b The Living Environment

Over time humans have changed their environment by cultivating crops and raising animals, creating shelter, using energy, manufacturing goods, developing means of transportation, changing populations, and carrying out other activities.

7.2 c The Living Environment

Humans, as individuals or communities, change environments in ways that can be either helpful or harmful for themselves and other organisms.



A delicate balance of gases in the air helps keep our planet at the right temperature for life to flourish here. But today, certain human activities are causing some of those gases, such as carbon dioxide, to build up, and things on planet Earth are heating up.

In this activity, students will learn the basics of how the greenhouse effect works, and how things are getting out of balance with a build-up of carbon dioxide. They'll take part in a game that simulates our atmosphere and the way that greenhouse gases trap heat. They'll graph the results of different scenarios to learn the effect of increasing amounts of greenhouse gases in the atmosphere.

OBJECTIVES:

After participating in this activity, students will be able to:

- explain the greenhouse effect
- identify carbon dioxide as a main greenhouse gas
- use a graph to describe the relationship between levels of carbon dioxide in the atmosphere and temperature

TIME:

One hour

MATERIALS:

The materials needed for this activity depend on how and where you'll play the simulation game. See "Getting Ready" for more information. Materials you may need include: sheets of paper (one sheet per student), masking tape, poster board or flip chart, and markers.

GETTING READY:

You should either prepare the area for the simulation game before the activity, or have a plan for how you'll lay out the space when you play the game.

You'll need an open area large enough for the students to run, an area approximately 30 feet long and 20 feet wide. You can adjust the dimensions to fit your space and the size of your group. You'll be recreating the diagram* provided at the end of the activity, with students running from an area designated as the surface of the sun, through open space,



into the atmosphere, and to the surface of the Earth. You can delineate these areas in the way that makes the most sense where you are. (For example, if you're indoors, one wall might represent the surface of the Earth while an opposite wall represents the surface of the sun. A piece of tape on the floor could designate the start of the Earth's atmosphere. Alternatively, you could do this outside, using cones, flags, or other markers to show the different areas.)

The atmosphere should begin about two-thirds of the distance from the sun to the Earth. For example, if the length of your playing area is 30 feet long, ten feet of the area should represent space and 20 feet of the area should represent the atmosphere.

You'll need a way to distinguish the students representing the sun from those representing carbon dioxide. You could do this by preparing pieces of paper with pictures of the sun on half of the papers and the words "carbon dioxide" on the other half. Have tape ready that students can use to attach the papers to their shirts. You could also substitute many other items if you like (students could wear hats, armbands, colored tape, or other items to help distinguish one group from the other group).

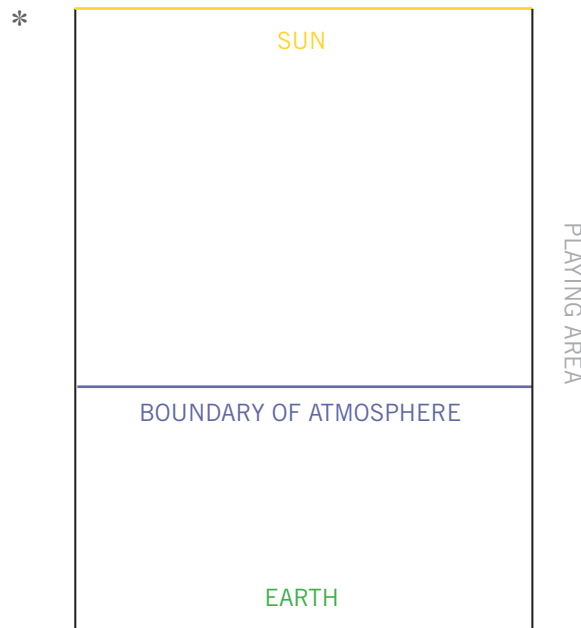
Finally, if you play the game outdoors, you may need a poster board or flip chart and markers to create a graph of the results.

THE ACTIVITY:

1. Ask students if they've ever been in a greenhouse. If so, what was it like? If students haven't been in a greenhouse, you could also ask if they've ever gotten into a car on a hot summer day. How did the car feel? (Explain that in greenhouses and in cars, the sun comes in through the windows and warms the air inside. But the windows don't let the heat back out, so the heat builds up and it gets hot inside. The students might recall that when you get into a car parked in the sun on a summer day, it feels very hot.)
2. Explain that our atmosphere—the air that surrounds the Earth—is a lot like the glass in a greenhouse (or the windows of a car). The light from the sun comes in, and some of the heat stays in the atmosphere. If we didn't have a way to keep some of the sun's warmth near the surface of the Earth, it'd be very cold here.

You can show this visually by recreating the diagram* attached. Show students the sun and the Earth and the Earth's atmosphere. Draw arrows to show the rays of the sun coming to Earth, reflecting off the surface, and draw some of the rays escaping back into space and some staying within the atmosphere. Explain that you're going to play a game that'll help explain how our atmosphere works like a greenhouse, keeping in some of the sun's heat energy.

3. Show the students the area you've designated for the game (or have them help you create it). Point out the areas that represent the sun, space, the atmosphere, and the surface of the Earth.





4. Standing in the area that represents the atmosphere, ask students what kinds of gases are in the atmosphere. Probably, most students know that there's oxygen in the air, because that's what we breathe. Ask them what we breathe out. (Carbon dioxide.) Trees "breathe" in the opposite way that people do, taking in carbon dioxide and releasing oxygen.

Explain that there are lots of different gases in the air, but oxygen and carbon dioxide are two gases that are very important to living things. Carbon dioxide also plays another important role in the atmosphere: it's able to trap the sun's heat. In this game, they'll see how it works. Divide the students in half and explain that one group will represent the heat of the sun and the other group will represent carbon dioxide.

5. Explain that you'll use a graph to track the results of the game. Lay out the axes of a graph large enough for the students to see (use poster board or a flip chart if you're outdoors). The y-axis should represent the amount of heat in the atmosphere and the x-axis should represent the amount of carbon dioxide. Number each axis so that it extends from 0 to the total number of students that represent that feature. For example, if you have 30 students, 15 students represent the sun's energy (heat) and 15 students represent carbon dioxide, so each axis should be numbered from 0 to 15.
6. Ask all of the students that represent the sun's energy to line up on the surface of the sun. Explain that, like they saw in the diagram, the sun's energy leaves the sun, travels through space and the Earth's atmosphere, then bounces off the Earth. In this game, the students representing the sun's energy must run to the surface of the Earth, quickly touch the line, and then try to run back out to space.
7. Explain that you'll play the first round without any carbon dioxide in the atmosphere to see what happens. Play the first round and discuss the results. (All of the sun's heat energy escaped to space.) How would it feel on Earth? (Cold!) Graph the results. (The first point should indicate 0 for both the x and y axes.)
8. But we know that there is carbon dioxide in the air, so play the simulation again with one-third of the students representing carbon dioxide playing. (For example, if you have 15 students representing carbon dioxide, ask 5 to play the next round.) Ask them to scatter around the area that represents the atmosphere. Explain that carbon dioxide is able to trap the sun's heat. So, in this simulation, the students representing carbon dioxide must allow the sun's energy to pass by them as it enters the atmosphere, but once it hits the Earth and tries to return to space, it can be captured. Stu-



dents representing carbon dioxide should try to capture, or tag, students representing the sun's energy. If a student representing carbon dioxide captures the sun's energy, he should stand still with the student representing the sun's energy until the end of the simulation. They can't capture anyone else.

Remind the students that since carbon dioxide is part of our atmosphere, it must remain there. Students who represent carbon dioxide can't leave the atmosphere as they chase the sun's energy. Once the sun's energy leaves the atmosphere and enters space, it's "safe," and can't return to the atmosphere.

9. When the students understand the rules, begin the simulation, and discuss the results when all the sun's energy has either escaped or been captured. What happened? (Some of the sun's heat was captured and remained in the atmosphere, but some escaped.) How would this affect our atmosphere? (It would make it warm.)

Place a point on the graph that indicates the results of the first round (the point should indicate the number of students who represented carbon dioxide in this round and the number of students captured).

10. Next, explain that people exhaling isn't the only source of carbon dioxide. Certain human activities, such as burning gasoline to drive cars or burning coal to make electricity, also create carbon dioxide. Ask students what effect more carbon dioxide from human activities could this have on the atmosphere.

After students discuss what they think would happen if we added more carbon dioxide to the atmosphere, do the simulation again with more carbon dioxide to see what effect it has. This time, ask two-thirds of the students representing carbon dioxide to participate. (For example, if 15 students represent carbon dioxide, ask 10 to participate in this round.) Play the game the same way, and discuss the results, noting the amount of heat trapped on the graph.

11. Finally, explain that if we keep driving cars and using electricity at the same rate that we are today, the amount of carbon dioxide in the air will increase even more. What effect will even higher levels of carbon dioxide have? Do the simulation a third time, with all of the students representing carbon dioxide participating. Discuss the results and note the amount of heat trapped on the graph.



Connect the points on the graph to see the relationship between the amount of carbon dioxide in the atmosphere and the amount of heat in the atmosphere. What did you find? (Probably, your students found that as more carbon dioxide was added to the atmosphere, the more heat was trapped.)

12. Ask the students how this might affect the atmosphere in real life. (As more carbon dioxide is added to the atmosphere, temperatures start to rise. Just like a greenhouse, or car on a summer day, the sun's energy comes into our atmosphere and becomes trapped, warming things up. As you saw in the demonstration, a small amount of carbon dioxide is helpful in keeping things warm enough for life, but a large amount can cause the temperature to rise higher.)
13. Finally, explain that generating electricity with fuels like coal and petroleum are one of the biggest sources of carbon dioxide. Driving cars is another major source. End the activity by asking students for some ideas of things we can do to help lower the amount of carbon dioxide in the air. (The students should share a variety of ideas.)

Explain that one way to help is to use less electricity. It's almost impossible to live without electricity, but we can do things to help cut down on how much we use. Compact fluorescent light bulbs (CFLs) are one way that we can easily cut down on our electricity use. They use just a quarter of the energy of regular bulbs, but still give you all the light you need. It's an easy change that can have a big impact, and that's why your school is participating in the Junior Energy fundraiser.