Bronx River Alliance Education

Global Warming Game

GRADES K–10

Game time:
45 mins – 1 hour

Skills: Kinesthetic learning, Critical thinking, Worldview perspective

Materials:
4 cones (or 2 long ropes to designate the GHG layer), large Sun picture, large Earth picture, necklace-style hang signs depicting various Greenhouse Gases (**see pages 6–11**)

Standards:
PS3.D, ESS2.D, ESS3.D

OBJECTIVES:

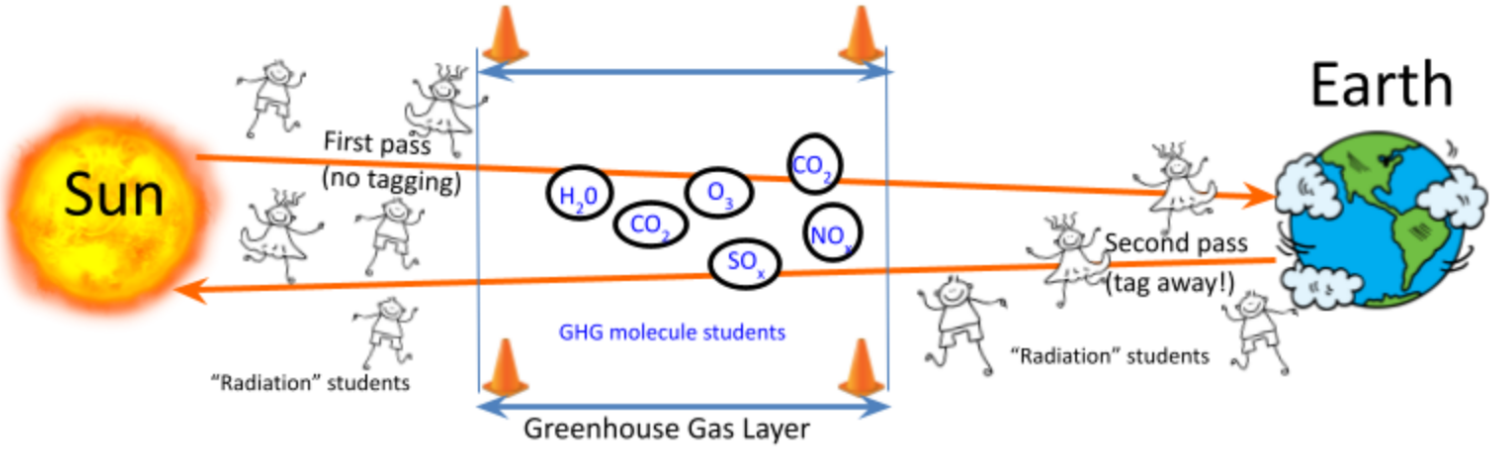
Students will gain an understanding of global warming and climate change through game play. By the end of this lesson, students should begin to understand:

- how the Greenhouse Gas layer works to keep the Earth warm enough for habitation
- the sources of carbon dioxide (CO_2) and other atmospheric pollutants
- why excess carbon (C) in the atmosphere causes warming
- how to articulate why excess Greenhouse Gas (GHG) molecules cause warming
- why the water on Earth also is changing from chemical reactions with atmospheric pollutants

MATERIALS:

4 cones (or 2 long ropes to designate the GHG layer), large Sun picture (p 6), large Earth picture (p 7), necklace-style hang signs depicting various Greenhouse Gases (pp 8–13)

Game Formation:
(to be played in a large space, like a gymnasium for indoor play or a park or school yard for outdoor play)



ACTIVITY SUMMARY:

Students play a movement-based tag game simulating sunlight as it travels from the Sun, through the Greenhouse Gas (GHG) layer, warming the Earth, returning back through the GHG layer, and back out into space. As more tagged students simulating GHG molecules begin to fill up the designated GHG layer area, it becomes more difficult for the sunlight students to make it back to the Sun, emphasizing the role fossil fuels are playing in global warming/climate change.

BACKGROUND INFORMATION:

Climate change is often thought to be the same as global warming, which has caused confusion in the general public about underlying causes and possible mitigation strategies. This game is designed to help tease apart the driving factors of global warming (i.e. excess Carbon Dioxide (CO_2) in the atmosphere) as an introduction to the larger issue of global climate change. Through play, the students learn why excess air pollutant molecules in the atmosphere inhibit radiation escape, thus causing warming. Once students understand the science behind the effects of burning fossil fuels and buildup of greenhouse gas (GHG) molecules, have a follow-up discussion with them, making connections to other climate change-related phenomena related to excess heat and/or build-up of particular GHG molecules (e.g. ocean acidification from excess CO_2, acid rain from excess SO_X and NO_X, desertification from excess heat, etc.).

ACTIVITY GUIDE:

1. Begin with 3 students in the designated “Greenhouse Gas” layer and give each one a GHG molecule necklace sign (1 CO_2, 1 O_3, and 1 H_2O). Explain that they are a normal Greenhouse Gas layer and important to make sure that the Earth is warm enough to have flowing water, not just be a big ball of ice.
2. The rest of the students will be sunlight/solar radiation[1] and start at the side with the large Sun. Their goal is to get to the Earth and back without getting caught in the GHG layer.
3. The GHG molecules have to stay between the 4 cones (or two ropes) and can only tag a sunlight/radiation student on the way back from the Earth to the Sun. (Therefore, the path from the Sun to the Earth is a “free” direction with no tagging possible.)

[1] Note: the option is being given to use the term sunlight or solar radiation interchangeably, depending on the age of the participants. Please use your discretion and select whichever term best fits your needs.

4. Start them by saying, “Okay, sunlight/radiation, warm up the Earth” and send them over to the Earth side. When it is time for them to run back to the Sun side, say, “Okay, Greenhouse gas molecules, are you ready? (Them: Yeah!) Are you ready sunlight/radiation? (Them: Yeah!) Okay, sunlight/radiation, see if you can make it back out of the atmosphere!”
5. Two adults can help facilitate the game. One adult is the referee, making announcements. The other adult will hold the necklace signs and distribute them.
6. As each person is tagged, they will receive a neck sign with another type of GHG molecule (start by handing out CO_2, H_2O, and O_3, then in subsequent rounds, add SO_x, NO_x). Tell each person where that particular gas comes from (i.e. SO_x, NO_x come from power plants, CO_2 from burning fossil fuels and cars, etc.).
7. Whomever is not tagged will go again, this time with more GHG molecules able to tag them on the way back from the Earth.
8. The round is over when all the sunlight/radiation students are trapped in the GHG layer.
9. Repeat rounds as desired. Switch students around to give each person a chance at both roles.

DISCUSSION QUESTIONS:

Following game play, have students sit in a circle and discuss the outcome of the round(s). Feel free to use one or more of the following questions to prompt discussion:

- For the sunlight/radiation students: Was it easier or harder to escape out of the atmosphere as the game went on? Why do you think that?
- For the greenhouse gas (GHG) molecule students: Was it easier or harder to tag a sunlight/radiation student as the game went on? Why do you think that?
- If it is harder for sunlight/radiation to escape the more GHG molecules in the atmosphere, does it make sense why the Earth is heating up underneath?
- What do you think this means for other parts of our Earth when we add more carbon into our atmosphere?
- How do current and/or past emissions (air pollution) impact global ecosystems?

VOCABULARY

Here are some suggested vocabulary words to get your students acquainted with the terms used in this lesson!

1. **Atmosphere:** the mass of air surrounding the Earth, also called the greenhouse gas (GHG) layer.
2. **Chemical formula:** A written symbol showing the proportions of elements making up a molecule.
3. **Climate:** the long-term pattern (>100 years) of weather conditions of an area.
4. **Climate change:** Significant and long-lasting change in the Earth's climate and weather patterns.
5. **Element:** Any substance that consists of atoms of only one kind that constitutes all matter.
6. **Fossil fuels:** Fuels like coal, oil, and natural gas formed in the Earth from plant or animal remains.
7. **Global Warming:** An increase in the Earth's temperatures due to an increase in the greenhouse effect resulting especially from pollution.
8. **Greenhouse effect:** Warming of the surface and lower atmosphere that is caused by conversion of solar radiation into heat in a process involving Sun's rays entering the atmosphere, absorbed by the Earth's surface, and reradiated back towards space, which is absorbed by greenhouse gases and partly reradiated back to the Earth.
9. **Molecule:** One or more atoms/elements combined together, forming different substances.
10. **Pollution:** Human-made waste that contaminates the environment.
11. **Weather:** How hot/cold, wet/dry, calm/storm, or clear/cloudy an area is.

CHEMICAL CORNER

- **Carbon dioxide:** chemical symbol **CO_2** — some naturally-occurring in GHG layer, excess results from burning fossil fuels
- **Ozone:** chemical symbol **O_3** — the foundation of the greenhouse gas (GHG) layer; not well-bonded in this state, so can easily be broken into more stable O_2 by pollutants
- **Methane:** chemical symbol **CH_4** — results from breakdown of organic matter, notoriously a by-product from cows
- **Nitrogen compounds:*** chemical symbol **NO_x** — usually occurs as Nitrogen dioxide (NO_2), typically from vehicle exhaust and industrial pollution
- **Sulphur compounds:*** chemical symbol **SO_x** — typically occurs as Sulphur dioxide (SO_2), results from burning coal — the term "clean coal," a misnomer, refers to lower levels of Sulphur (S)
- **Water:** chemical symbol **H_2O** — naturally-occurring as water vapor in the atmosphere

*Note: the subscript x is used as a catch-all term for multiple forms, like NO and NO_2, as in algebra when the numerical value is unknown

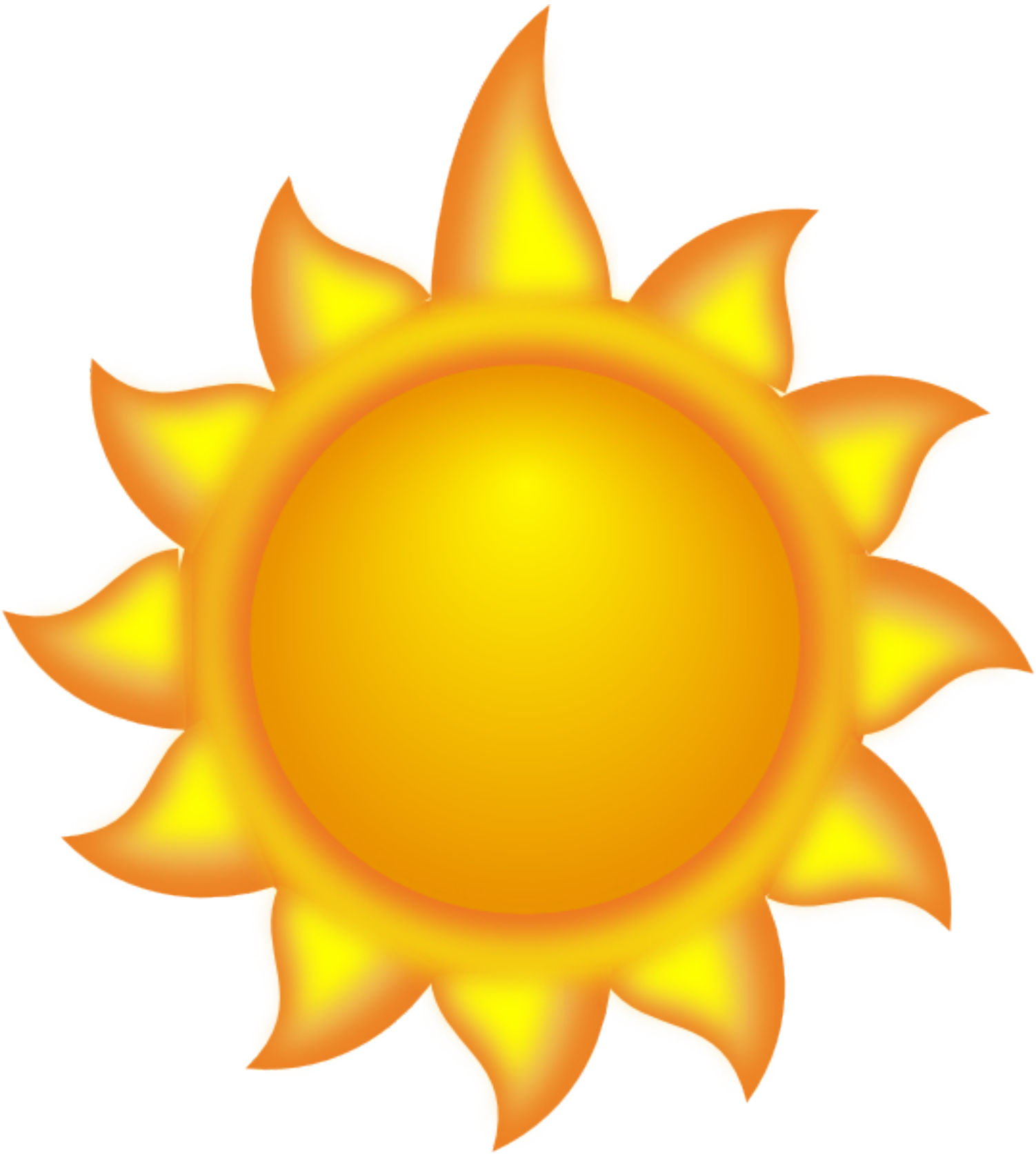
REFERENCE PAGE

For more information about climate change, there are a number of youth-oriented pages online:

- **American Museum of Natural History (AMNH):** https://www.amnh.org/explore/ology/climate-change
- **The Climate Reality Project:** https://www.climaterealityproject.org/blog/just-kids-what-climate-change-and-what-can-i-do
- **National Aeronautics and Space Administration (NASA):** https://climatekids.nasa.gov/climate-change-meaning/
- **National Geographic:** https://kids.nationalgeographic.com/science/article/climate-change

For parents or teachers, here is a guide from Natural Resources Defense Council (NRDC) about age-appropriate concepts when talking with youth about climate change:
https://www.nrdc.org/stories/your-guide-talking-kids-all-ages-about-climate-change

Sun and Earth signs (pp 6–7) – used for marking the long ends of the game field – recommend laminating and affixed to a wall (if inside), cones, or other objects that will not cause harm if collided with during game play
Student necklace-style hang signs (pp 8–13) – recommend laminating multiple copies of each sheet, punching two holes along the top edge, and threading yarn or string through for each sign




CO_2


NO_x

CH_4

(Methane)


SO_x


H_2O


OZONE LAYER
OZONE LAYER
OZONE LAYER
OZONE LAYER
OZONE LAYER
OZONE LAYER

O_3