Why Angle Changes Intensity

Summary

This hands-on activity will help students understand why summer is hotter than winter.

Group Size

Small Groups

Materials

- Flashlight
- Centimeter Grid overhead transparency
- Centimeter Grid paper (pdf)
- Darkened room (Taping black paper over the windows helps.)
- Piece of cardboard or clipboard
- Clear tape
- Markers
- Protractors

Background for Teachers

There are two ways Earth's tilt causes seasons. The first is that there are more daylight hours when we are tilted toward the sun in summer, and fewer in the winter when we are tilted away. The second reason is that when the sun is high overhead, we receive more direct sunlight; in the winter the opposite is true. Therefore, the reason that summer is hotter than winter is two-fold. First, the days are longer, so the sun has longer to heat Earth. Second, the sun's rays are more directly overhead, delivering more heat to Earth.

Intended Learning Outcomes

1. Use Science Process and Thinking Skills
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning

Instructional Procedures

Invitation to Learn

Ask students why they think we have seasons. Many will say because we are closer to the sun in summer than in winter. To help overcome this misconception, tell students that we are actually closest to the sun in January. Then tell them that there is a space heater at the back of the classroom. Imagine you are really cold and want to get warmer. Ask for suggestions on how to get warmer. They will probably tell you that they need to get closer to the heater. Take a baby step forward and ask if this will help warm you up. They say no. Point out that the difference between Earth’s farthest distance from the sun and its closest is comparable to that baby step. Therefore, Earth’s distance from the sun plays a very small role in its temperature variation.

Instructional Procedures

- Cut the *Centimeter Grid* transparency so that it will cover the flashlight with a little overlap. Tape the transparency over the lens of the flashlight.
- Place the flashlight so that it is parallel to the floor and perpendicular to the wall; turn it on.
- Ask students what the grid looks like. Are all the grids the same size? If some are smaller, which ones?
- Tilt a poster board at a 45° angle to demonstrate the tilt of Earth.

Ask students how the gridlines have changed. Are all the grids the same size? Which ones are larger? Which ones are smaller? Why do you think they changed? If each square has the same amount of heat, which squares do you think will get the hottest? Why? Which ones will not heat up as quickly? Why?

Have the students try this on their own in groups of three to four. Have them tape a piece of graph paper to a piece of cardboard or on a clipboard.

Give each group a flashlight. Have them place the flashlight on a pile of books so that the flashlight is parallel to the floor.

Place the graph paper so that it is perpendicular to the flashlight about 1 1/2 to 2 feet away (if you have mirror stands, they help keep the cardboard upright). Aim the flashlight at the graph paper then turn it on.

Have students trace the area illuminated by the flashlight.

Have students change the angle of the cardboard so that it is leaning back away from the flashlight at an angle of 23.5°. Have students trace the new area illuminated by the flashlight in a different color.

Have students change the angle again to 45° or 60° and trace the illuminated area in a different color.

Make sure that students keep the flashlights at exactly the same distance from the cardboard throughout the activity.

Assessment Plan

Students may answer the following questions individually, in groups, or as a whole class:

Does the quantity of heat in the flashlight change as you change the angle?

Of the three angles you tried, which one will heat up the cardboard the most?

Why do you think that one angle will heat up the cardboard more than another?

Note to teachers: No matter what the angle is, the amount of light energy from the flashlight remains the same. Therefore, the greater the angle, the less intense the light energy on each square will be and it will not heat up as much, due to the angle increasing the size of the square, while the amount of light remains consistent.

Authors

Utah LessonPlans