

Earth's Daylight

Summary

Students investigate the relationship between the amount of heat absorbed and the angle to the light source.

Time Frame

1 class periods of 30 minutes each

Group Size

Large Groups

Materials

- 2 Thermometers
- 2 Toilet Paper Tubes

Background for Teachers

A misconception that students often have is that because the Earth is closer to the sun in the summer and farther away in the winter, it is hotter in the summer. This answer seems to make perfect sense. If you are closer to a fire, you are warmer. But in relation to the Earth and the sun, this explanation is not correct, especially since the Earth is farther away from the sun in July than it is in January.

Why isn't the Earth's distance a factor in explaining the causes of the changing seasons? The most important reason is that the Earth's orbit or path around the sun is almost circular. The distance of the Earth from the sun does change, but it is so slight that it makes very little difference in the heat energy felt on the Earth. For example, if you were sitting 30 meters from the fireplace and moved 30 centimeters closer, you would not feel that much warmer than what you felt before. Therefore, it is not the Earth's distance from the sun that causes the change in our seasons.

What causes the changes in the seasons on Earth? The two things that make an impact on the seasons are the angle of the Sun above the horizon and how long the sun stays in the sky at a given latitude (the amount of daylight). When the sun is most nearly overhead, the ground gets the hottest. At noon, the sun is at an angle that is most nearly vertical. At sunrise or sunset, the angle from the horizon is smaller so the ground is cooler.

The angle above the horizon at noontime is important because it determines how much concentrated light and energy the Earth receives at a specific point. An area that receives more light more directly overhead, gets the hottest. Also, the longer the sun is above the horizon on a given day, the longer it will radiate light and energy. This factor is not nearly as important as the angle of the sun above the horizon. This lesson demonstrates how the angle of the sun above the horizon changes.

What causes the Earth to be at a different angle from the sun at different times of the year? The tilt of the Earth's axis is what makes this difference. The angle of the Earth's axis from the plane of its orbit is about 66.5° above the plane, which is 23.5° from being perpendicular to the plane of the Earth's orbit ($90^\circ - 66.5^\circ = 23.5^\circ$). The seasons are caused because the Earth is not perpendicular (90° angle) to the Earth's orbit around the sun.

If your students have either studied the celestial sphere or have done some observations of the sun then it will help them be more prepared for this activity. Students should be made aware that the sun moves across the sky always staying above the same latitude on a given day.

In summary, the reason for the seasons is the angle at which the sun's rays strike the earth, caused by the tilt of the Earth on its axis. The tilt of the Earth also causes the change in the number of daylight hours experienced throughout the year.

Intended Learning Outcomes

Observe simple objects, patterns, and events, and report their observations.
Plan and conduct simple experiments.
Demonstrate a sense of curiosity about nature.
Cite examples of how science affects life.

Instructional Procedures

Take two round, hollow toilet paper tubes.
Point one tube toward the sun at a 90° angle and the other tube at a 45° angle and allow the sunlight to strike the ground.
Place a thermometer on the ground beneath each tube.
Which ground will be hotter? The 90° angle tube will get more direct, concentrated heat and light energy.
With the 45° angle tube, the light is spread out over a larger area, so the light and heat energy is not as concentrated.

Extensions

Repeat the experiment with additional toilet paper tubes held at angles other than 90 and 45 degrees.

Assessment Plan

Have students answer the question, "What is the relationship between the tilt of the Earth and the Earth's seasons? Assess their answers to check for understanding and possible misconceptions.

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