



Greenhouse in a Bottle

How do the color of the surface that sunlight encounters and cloud cover affect greenhouse warming?

Key Concept

Dark surfaces absorb more sunlight than light surfaces and thus reach higher temperatures. Cloud cover reduces incoming sunlight, keeping the Earth cooler.

What You Should Know

- Sunlight striking the Earth's surface warms our planet.
- Dark surfaces absorb more solar radiation and contribute significantly to heating the Earth's surface and lower atmosphere.
- Thick cloud cover prevents some of the sunlight from penetrating to the Earth's surface.

Materials (per student or group of students)

- 4 empty two liter plastic soda bottles, washed and dried
- 4 thermometers
- 4 wooden skewers
- white acrylic paint
- 2 cups white sand
- 2 cups black sand
- transparent tape
- light source (or direct sunlight)

The Prediction

How will the temperatures vary between the painted bottle (cloudy sky) and the clear bottle (cloudless sky) with the same colored substrate? How will the substrate color affect the temperatures?

Investigation

- 1) Paint the upper third of two of the bottles white (referred to as bottles B and D).
- 2) Leave the other two bottles clear (referred to as bottles A and C).
- 3) Fill the base of bottles A and B with 1 cup white sand.
- 4) Fill the base of bottles C and D with 1 cup black sand.
- 5) Tape each thermometer to a wooden skewer so that the bulb of the thermometer is at the bottom of the skewer.
- 6) Poke a small hole in each of the four bottle caps.
- 7) Insert the top of the skewered thermometer into each bottle cap.
- 8) Holding the bottle cap, lower the thermometer into each bottle until the thermometer bulb is just above the sand.
- 9) Secure all four bottle tops.
- 10) Place the bottles evenly under a light source with the thermometers facing outwards. Record the baseline temperatures.
- 11) Turn on the light and begin recording the temperatures every 5 minutes. Continue for at least 30 minutes.

Discussion

- 1) Compare your predictions to the final data. Did you choose the coolest bottle? The hottest bottle?
- 2) There are many factors involved in this demonstration. What might be affecting the amount of heat reaching each bottle?
- 3) If you were to redesign this demonstration to create the lowest temperature rise, what would you do (without changing the light source)?

What's Happening?

The Earth's atmospheric greenhouse effect is much more complex than this simple greenhouse experiment. The type of surface that sunlight first encounters is one of the most important factors. Forests, grasslands, ocean surfaces, ice caps, deserts and cities all absorb and reflect the sunlight differently. Cloud cover also affects greenhouse warming both by reducing the amount of solar radiation reaching the Earth's surface and by reducing the amount of heat energy emitted back into space.



Prediction

Temperature

[illegible]

Plot the temperatures of bottles A, B, C and D over time.
(Remember to label the axes and identify the set of points for each bottle).

