

Cool Surfaces Experiment

Experiment Overview

Students will create simulated “buildings” out of cardboard boxes and observe the effect of different colored exteriors on the air temperature inside the boxes when placed under heat lamps, simulating direct sunlight.

Materials Needed

1. Two open-top boxes
 - a. The boxes should be about the size of a file/bankers box or smaller
2. Two (2) thermometers (e.g., alcohol thermometers or thermometers with a probe/extension wire)
3. White paint or white construction paper
4. Black paint or black construction paper
5. Clear Packing Tape
6. Paint brush (unless using spray paint or construction paper)
7. One infrared thermometer to measure surface temperature (*optional*)
8. Two (2) heat lamps
9. Two (2) heat bulbs (250 watts)
10. Writing utensil
11. Box cutter
12. Paper or computer to record results

Safety Note

This experiment involves the use of infrared heat lamps and other equipment. Ensure that all equipment is used in accordance with the manufacturer’s instructions and recommended safety protocols.

Instructions

1. Gather all of the required materials
2. If preparing the boxes using paint:
 - a. Place the box open side down on a protected surface
 - b. Paint the sides and bottom of each box; one white box and one black box
 - c. Let dry overnight



3. If preparing the boxes using construction paper:
 - a. Place the box open side down on a surface
 - b. Tape construction paper to the sides and bottom of each box (one black and one white), ensuring that the entire box surface is covered
4. If using alcohol or similar thermometers, turn the boxes on their sides (open side facing you). Use a pen or other writing utensil to trace an outline of the thermometer on one side of each box
 - a. If the box is not square, choose one of the longer sides of the box
 - b. The side of the box with the thermometer should not directly face the heat lamp



5. Cut a rectangle out of the side of each box where you traced the thermometer, so you will be able to read the temperature from the thermometer once it is installed
6. Secure the thermometer to the inside of the box using tape so that the front of the thermometer is visible through the cut rectangle



7. On the outside of the box, over the thermometer hole with one or more pieces of clear packing tape, ensuring that the hole is completely covered on all sides



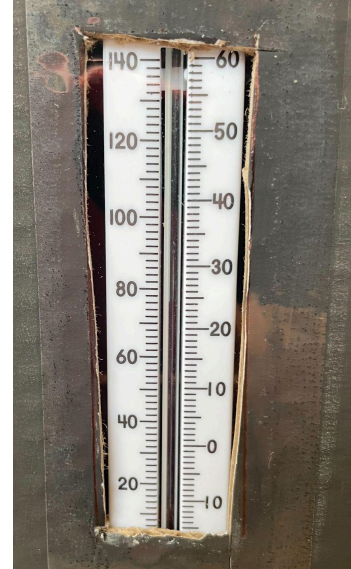
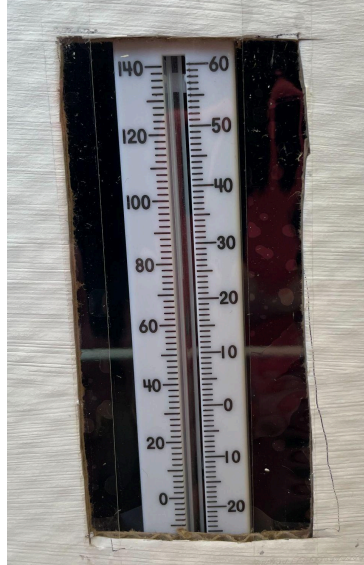
8. If using thermometers with a probe or extension wire, poke a very small hole in the bottom (i.e., the “roof”) of the box and insert the sensor so that it is suspended in the middle of the box.
9. Find a suitable indoor area and set up two heat lamps to simulate direct sunlight. The heat lamps should be directly above the boxes, as shown in the photo below. The bulb guard should be roughly 11 inches away from the boxes (do not turn on the lamps yet)
 - a. **Safety Notes:**
 - i. **Do not leave heat lamps unattended when turned on, and turn the lamps off directly after use.**
 - ii. **Handle the lamps carefully. Do not touch the bulb or the metal guard after they have been turned on, as they will be very hot.**



10. Place the boxes open side down under the heat lamps
11. If available, use an infrared thermometer to measure the surface temperature of the top of each box and record (*optional*)



12. Record the initial temperatures of each thermometer attached to the boxes
 - a. Please note that it can be difficult to read the alcohol thermometers due to the lack of light inside the boxes. If you cannot clearly read the thermometers, we suggest taking photos of them with an iPhone or another good camera and zooming in to read them. For example, in the photos below, the white box is reading at approx. 75° F, and the black box is reading at approx. 76° F.



13. Turn on the heat lamps and set a timer for 30 minutes (do not leave unattended while turned on, and do not touch the hot bulbs or guards). If there is enough time in the class period, consider setting the timer for an hour instead.



14. When the time is up, read the thermometers and document the new interior air temperatures
15. Turn off the heat lamps
16. For each box, subtract the initial interior air temperature from the 30-minute (or one-hour) interior air temperature to determine how the interior air temperature has changed. Compare the change in air temperature for each box.
 - a. It's important to compare the change in temperature, as opposed to just directly comparing the 30-minute (or one-hour) temperatures, since the boxes may not have started at the same temperature.
17. If available, use an infrared thermometer to measure the surface temperature of the top of the boxes and document the findings (*optional*)
18. Clean up all materials