Dark vs. Light-Colored Materials

Use the IR thermometers instead of liquid-crystal material to complete this mini-lab (called a "Snack") from the Exploratorium. Simply substitute an index card for the liquid-crystal material and observe the temperature changes with the IR Thermometer.

Source: https://www.exploratorium.edu/snacks/give-and-take

Give and Take

Dark-colored materials both absorb and emit energy more readily than light-colored materials.

Using an index card colored with Sharpies and an IR thermometer, you can monitor temperature changes. By observing these changes, you can show that dark-colored materials absorb and re-emit the energy contained in light more readily than light-colored materials.

Grade Bands: K-2, 3-5, 6-8, 9-12
Subject: Physics, Heat & Temperature, Light

NGSS and EP&Cs: PS, PS3, PS4, CCCs, Energy And Matter, EPCs, EPC2

Tools and Materials

- A black marking pen
- A metallic silver marking
- Index card
- Desk lamp with an incandescent bulb or

sunlight

Assembly

Use the marking pens to color one half of the index card black and the other half silver.

To Do and Notice

Hold up the card so the silver-and-black side that you colored with the marking pens is facing the light source. Hold the card a few inches away from the lamp. Or, if the sun is your light source, just hold the card in the sunlight. (*Note: this Snack does not work with LED or (Is “Snack” a typo?)fluorescent lights. In sunlight, it works best when it's bright out but not too hot or too cold.)*

Watch the liquid crystal side of the card. Use the IR thermometer to measure the temperature of the 2 sides of the card. Notice that the side with black on the back changes temperature faster than the side with silver on the back.

Remove the card from the light source and measure the temperature as it cools. The black side should cool faster than the silver side.

What’s Going On?

Dark-colored materials absorb visible light better than light-colored materials. That’s why the dark side of the card heats up first. The lighter side absorbs less of the incident light, reflecting some of the energy. Darker materials also emit radiation more readily than light-colored materials, so they cool faster.

You may be tempted to skip coating half of the card with the silver marker. After all, that half is probably white, which indicates that it reflects light in the visible portion of the electromagnetic spectrum. But, although the white paper reflects visible light, it also absorbs infrared light. If you could see infrared light, the white paper would look black when illuminated with infrared.

Unlike plain white paper, silver paint reflects infrared light as well as visible light. The white paper is an infrared absorber, and so it is also a good infrared emitter: It will cool almost as fast as the blackened paper. The silver is a good infrared reflector and a poor infrared emitter: It will cool more slowly than the blackened side. Therefore, the heating experiment with visible light will work with black-and-white halves of the card, but the cooling experiment will not!

Even with the silvered coating, the cooling effect is harder to observe because the card is cooled by conduction and convection in addition to radiation. This is in contrast to the heating experiment, where the only heating is from radiation.

Going Further

The reflective power of a given surface is called the *albedo (*"whiteness" in Latin), which is the ratio of reflected energy compared to the amount hitting the surface. An opaque object that reflects 80% of the electromagnetic energy has an 80% albedo and absorbs 20%.

Albedo is an important concept related to climate change. Snow and ice have a high albedo and reflect most of the sun's energy back into space. Water, soil, and plants have a lower albedo, and absorb more solar energy, which contributes to warming and heating in the atmosphere. This, in turn, leads to more melting of snow and ice, which leads to more warming, especially in polar regions. This cycle is an example of a positive feedback loop.