

Albedo Laboratory Guide

Driving Question: What effect does albedo have on surface temperature?

After completing this activity you will:

1. Understand how light reflection and absorption are related to albedo.
2. Understand that lightly colored surfaces have a higher albedo than darker colored surfaces.

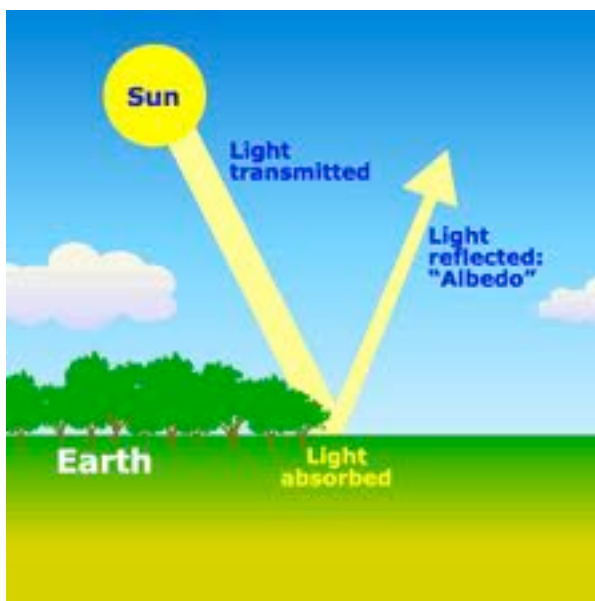


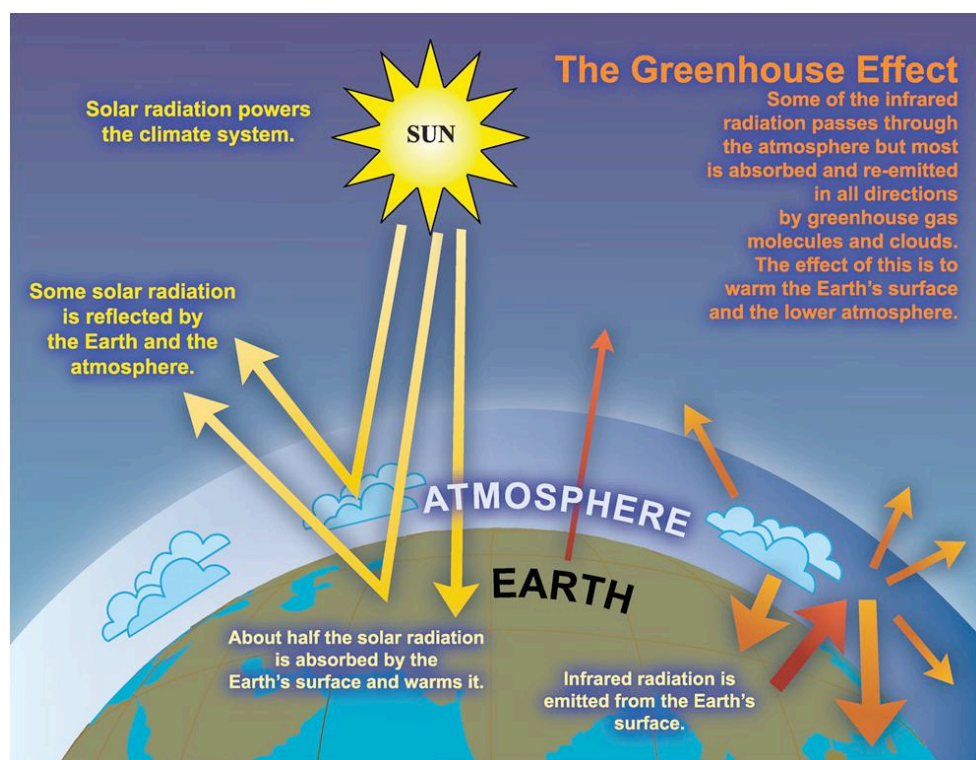
Background Information

The **albedo** of an object is a measure of how strongly it reflects light from light sources such as the Sun. Albedo is the percentage of incoming light that is reflected rather than absorbed. It is thought that the Earth's average albedo is around 30%. Energy in the form of visible radiation (light) from the Sun warms the earth. Some of the energy from the Sun is reflected back into space while some of the energy is absorbed. Clouds, snow, ice, land, and particles or pollutants in the atmosphere can all reflect energy back into space. The part that is absorbed by the Earth warms the surface, which then re-radiates energy (infrared) back out into space. The hotter the Earth's surface, the more energy is radiated out.

The diagram below help to explain what happens to the energy from the Sun:

In general lighter colored objects tend to have a higher albedo, while darker colored objects absorb the Sun's energy. If the Earth receives more energy from the Sun than it sends back to space, the Earth gets warmer. If the Earth reflects more of the Sun's energy than it absorbs, the Earth gets colder.





The classic example of albedo effect is the snow-temperature feedback. If a snow-covered area warms and the snow melts, the surface becomes darker and the albedo decreases. As a result more sunlight is absorbed, and the temperature tends to increase. In comparison if snow forms, the surface gets lighter, thus reflecting more light radiation. As result less sunlight is absorbed and temperatures tend to cool. This creates a “positive feedback” in which the more the surface warms, the darker it becomes, and the warmer it gets. This can be referred to as a “run-away” cycle.



Laboratory Description

In this experiment, you will investigate how the color of a surface influences its ability to reflect or absorb heat. You will place temperature probes (or thermometers) within envelopes made of black paper and white paper. You will measure and compare changes in temperature as the temperature probes (or thermometers) are heated with a high intensity lamp (or outdoors in sunlight).



Equipment List

For each laboratory team – You will work in teams of 4.

1. 2 thermometers or temperature probes
2. 1 piece of **Black** colored paper
3. 1 piece of **White** colored paper
4. 1 high intensity lamp
5. Albedo Laboratory Investigation Sheet



Team Work:

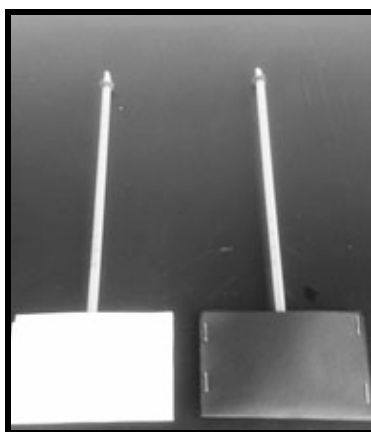
1. *Each student in your group will have a task. Select these before beginning the experiment.*
 - a. **Temperature monitors (2 students).** *The temperature monitors read the temperature for each apparatus when the timekeeper indicates.*

- b. **Timekeeper.** The timekeeper keeps track of the measurement intervals and tells the other group members when to take measurements.
- c. **Recorder.** The recorder writes the observations and temperature measurements provided by the group.



Step 2: Conducting the Experiment

1. Wrap the thermometers or temperature probes in paper.
 - a. Wrap one thermometer or temperature probe tightly in a black paper envelope.
 - b. Wrap one thermometer or temperature probe tightly in a white paper envelope.
 - c. How to make an envelope:
 - i. Take 4 1/4" by 5 1/2" square of paper.
 - ii. Fold each square in half twice
 - iii. Staple or tape the edges of each square to form a pocket.
 - iv. Place the bulb end of the thermometer or probe into the pocket.



2. Place the wrapped thermometers directly underneath the lamp (or out in the sun). The light should be about 24 centimeters above the thermometers/envelopes. Each item should be arranged an equal distance from the light source. (Note: The lamp is not turned on yet.)



3. Complete the **prediction section on your investigation sheet**. Which envelope do you predict will heat the fastest? Which envelope will reach the highest temperature?
4. **Measurement Overview:** The temperature readings for both thermometers (or probes) should be checked and recorded every 2 minutes for a total of 10 minutes. After the 6-minute measurement, you and your team should discuss and note which color paper (white or black) has the highest

temperature. After the 8-minute measurement has been taken, turn off the light. One more temperature reading is gathered at the 10-minute mark.

5. **Step-by-Step Procedure**

- a. **BEFORE:** Measure temperature prior to turning on the light bulb. Record the temperature in the **BEFORE** column.
 - i. It is important to know the temperature both before and after the light is turned on. This provides a starting point so changes in temperature can be discussed accurately.
- b. **TURNING THE BULB ON**
 - i. Begin timing immediately after turning the light on.
 - ii. Measure and record this temperature in the **0-minute** column on the worksheet.
- c. **2-MINUTE INTERVALS:** You will take and record temperature measurements on your Albedo Data Collection Table every 2 minutes for the first 8 minutes of the experiment with the light on. Reminder: The time labels at the top of the data chart are elapsed time.
 - i. For each timing period: Measure and record temperature in the correct time column.
- d. **6-MINUTE INTERVAL:** After your group has collected data for **6 minutes**, you and your team should discuss and note which color paper (white or black) has the lowest albedo (which envelope appears to have absorbed the most heat) and which color paper has the highest albedo (which envelope appears to have absorbed the least heat). Record this information as **“high”** or **“low”** in the **Albedo Ranking** row on your data table.
- e. **8-MINUTE INTERVAL: Turn off the light bulb immediately after the temperatures are recorded for the 8-minute interval.** (Do not turn off your temperature data recorder if you are using a temperature probe.)
- f. At the 10-minute mark, measure and record the temperature for each color.
- g. Calculate the **Heat Increase**. This is the difference between the **start measurement** and **the 8-minute** interval temperature. Record this value on your Albedo Data Collection Table.
- h. Calculate the **Heat Retention**. This is the difference between the **10-minute** and **8-minute intervals**. Record this value on your Albedo Data Collection Table.
- i. Complete the **Albedo Lab Analysis** section, questions #1-6 on your investigation sheet.