Temperature Experiment: Teacher Guide

Purpose

- Learn that darker colors absorb more light, and lighter colors reflect more light (therefore darker colored objects heat up more).
- Conduct a scientific experiment following the steps of the scientific process.

Guiding Question

- How does paper color affect temperature?

Estimated Time

- 45 minutes

Pre-requisites

- Experience making bar graphs (Gr.3-5)
- Experience reading a thermometer

Materials and Tools

- Thermometers (2 per student pair or group)
- Black paper envelopes (1 per student pair or group)
- White paper envelopes (1 per student pair or group)
- Lamps or heat source (2-6), or a sunny window
- Handouts (1 per student)

Preparation

- Make handout copies.
- Make paper envelopes (or have students make them). Fold a piece of paper in half and tape two sides closed. Depending on size of thermometers, you could use a half or quarter piece of paper.
- Set up lamps with clear space underneath them. Turn lamps on at beginning of lesson to let them heat up.

Teacher Background Information

This lesson gives students experience with scientific experiments and using scientific tools. It also gives students the basis for understanding energy balance and albedo, important concepts in climate change.

Wearing dark colored clothing on a summer day makes individuals feel much warmer than if they were wearing light colored clothing. This is because of a property called albedo. Albedo is the fraction of incoming solar radiation (sunlight) that is reflected back into space. Because it is expressed as a fraction, albedo values do not have units.

Objects that are very dark in color absorb most of the incoming solar radiation (causing them to heat up) and have a low albedo, while objects that are very light in color reflect most of the incoming radiation and have a higher albedo.

Albedo can have a large influence on the Earth's climate. The more energy that is reflected back in to space, instead of absorbed, the less warming there is likely to be. Humans can impact albedo through changes in land use. Altering what is on the surface of the Earth through deforestation, urbanization, agriculture, etc. will change the albedo of that location, and therefore either increase or decrease the potential for warming.

What to do and how to do it (Grades 3-5)

Explain to students that you will be doing an experiment to see how the color of an object affects its temperature. Have they noticed that different colored objects feel warmer or cooler in the sun?

Ask students if they can think of the science tool you will need for this experiment (a thermometer!). Review how to read the thermometer: read the number at the top of the red line, what units they are measuring in, what each line on the thermometer means (are they counting by 1's, 2's, 5's?).

Students will be working in pairs or groups. Give each student a handout, and each team two thermometers, one black paper envelope and one white paper envelope. Have them write their name, or their team name, on the envelope. Have students record the initial temperature in their data table and then put a thermometer in each envelope. Have one team member place the envelopes under one of the hot lamps (be careful not to touch the lamp!).

Explain that they will be waiting 5 minutes before they check the temperature. While they wait, have students write a prediction of which colored envelope will have the higher temperature? Have them record their prediction (including *why* they think that) on their worksheet. Remind students that scientists are interested in all ideas, so their predictions do not have to be correct, or the same as their neighbor's.

After 5 minutes, they will retrieve their envelopes and use the thermometers to measure the temperature. Remind students to record their temperature data in the data table, including units!

When they are done, they can return the materials and begin working on their bar graph. Depending on their graphing experience, this can be done as a class or individually. Be sure that they first write their graph title (have them use the investigative question as a model! For example, "How Paper Color Affects Temperature"), and write in a scale (they may have to count by 10s). They should only graph the 'After' temperature data.

Once they have completed their graph, they can turn the worksheet over to begin answering the discussion questions. Remind them that scientists always back up their answers with **evidence**. What is the evidence in their experiment? The temperature data. So, you should see numbers (with units!) in their answers.

Once they have completed the writing portion of the experiment, have a few students share their outcome. How different were the temperatures? Was this what they expected? Discuss why the temperature was different. Elicit student responses, and make sure they understand that lighter colored objects *reflect* more light, so they don't heat up as much. Darker colored objects *absorb* more light, so they get warmer. Can they think of how this idea may be important in other aspects of their lives?

What to do and how to do it (Grades 1-3)

Explain to students that you will be doing an experiment to see whether black or white paper will have a higher temperature (be hotter) under the same lamp. Have they noticed that different colored objects feel warmer or cooler in the sun?

Ask students if they can think of the science tool you will need for this experiment (a thermometer!). Review how to read the thermometer: read the number at the top of the red line, what units they are measuring in, what each line on the thermometer means (are they counting by 1's, 2's, 5's?). Practice counting by 2's or 5's depending on the thermometers you are using. Have students act out the thermometer when it is a hot day (stand up with hands in the air) vs. a cold day (crouch down near the floor).

Students will be working in pairs or groups. Give each student a handout, and each team two thermometers, one black paper envelope and one white paper envelope. Have them write their name, or their team name, on the envelope. Have students record their initial temperature in their data table (in the 'before' column), and then put a thermometer in each envelope. Have one team member place the envelopes under one of the hot lamps (be careful not to touch the lamp!).

Explain that they will be waiting 5 minutes before they check the temperature. While they wait, have students write a prediction of which colored envelope will have the higher temperature? Have them record their prediction on their worksheet. Remind students that scientists are interested in all ideas, so their predictions do not have to be correct, or the same as their neighbor's. Have a few students share their predictions. Can anyone elaborate on why they think that might happen?

After 5 minutes, they will retrieve their envelopes and use the thermometers to measure the temperature. Remind students to write their temperature data in the data table (in the 'after' column)!

When they are done, they can return the materials and begin answering the discussion questions. Remind them that scientists always back up their answers with **evidence**. What is the evidence in their experiment? The temperature data!

Once they have completed the writing portion of the experiment, have a few students share their outcome. How different were the temperatures? Was this what they expected? Discuss why the temperature was different. Elicit student responses, and make sure they understand that lighter colored objects *reflect* more light (it bounces back off of them), so they don't heat up as much. Darker colored objects *absorb* ("suck up") more light, so they get warmer. How does it feel when they wear a black shirt on a hot day? What about a white shirt? Can they think of any other examples of this in their lives?