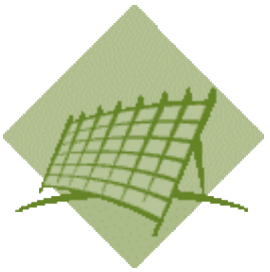
Summary: Students will learn how and why the sun heats different items.

Solar Explorations



Grade Level: K–4 (5–8)

Subject Area: English Language Arts, Mathematics, Science

Setting: Classroom and outdoor setting

Time:
Preparation: 50 minutes
Activity: Two to three 50-minute periods

Vocabulary: Energy, Heat, Solar energy, Temperature

Major Concept Areas:
Theme II
- Development of renewable energy resources
  - Solar energy

Standards Addressed:
Wisconsin Model Academic:
SC: A.8.6, A.8.8, B.8.4, C.8.1, C.8.2, C.8.4, C.8.6, C.8.7, C.8.9, C.8.10, D.8.4, D.8.8, D.8.9, G.8.7

Common Core ELA: L.K-5.4, L.3-5.3, L.4-5.6, RI.K-5.4, RI.3-4.3, RI.4.7, RI.5.1, RI.5.8, RL.K.4, RL.K.10, RL.1.1, RL.2-4.4, RL.3.1, RL.4.1, RL.5.1, SL.K.2, SL.K-1.6, W.K-1.5, W.2-5.7

Common Core Math: 1.MD.3, 2.MD.7

NGSS: K-PS3-1, 4-PS3-2, 4-ESS3-1, MS-PS3-3, MS-PS3-4, MS-PS4-2
SEP: Planning and Carrying Out Investigations, Obtaining, Evaluating, and Communicating Information
DCI: ESS3.A: Natural Resources, PS3.A: Definitions of Energy, PS3.B: Conservation of Energy and Energy Transfer
CCC: Cause and Effect, Connections to Engineering, Technology, and Applications of Science, Energy and Matter

Objectives
Students will be able to explain what role colors and/or materials play in solar energy production and energy efficiency.

Rationale
Understanding how different colors and/or materials are heated by the sun helps build a basis for understanding solar energy and the implications of solar energy as a potential heat source.

Materials
See materials listed under ***Sun Experiments***.

Getting Ready
Paint the insides of one shoebox white, another black, and line a third box with aluminum foil. Set up stations for students to fill the soup cans with sand/soil, water, shredded paper, and salt.

Background
For more information, see the ***Renewable Energy Fact Sheets*** on the KEEP website. Energy from the sun can be categorized in two ways: heat and light.

Solar energy is used to heat the air and water for applications such as space heating, pool heating, and water heating for homes and businesses. These technologies are solar thermal since they use the heating properties of solar energy. Solar thermal collectors are often mounted in a sunny spot like the roof of a building.

The color of the solar thermal collector plays an important part in collecting the sun's heat. Dark colors collect more energy than light colors. Therefore, a dark panel will collect more energy than a light panel. Darker colors are commonly used in the construction of solar panels.

Photovoltaic (PV) technology converts the sun's light energy directly into electrical current. The electrical current can be used right away or stored in a battery for future use. PV panels come in many shapes and sizes. You can see them on buildings or on roadside construction signs. Technologies are being developed to incorporate PV panels into building materials such as shingles.

Procedure
Orientation
Ask students which they would wear on a hot summer day—a black or a white shirt. Explain to students that they will be exploring how the sun affects materials and colors. Place an incandescent lamp so it shines on a piece of white paper and a piece of black paper for at least fifteen minutes. Ask students which paper will be hotter and why. Allow students to go feel the paper to see if they were correct. Optional: Check out infrared thermometers from KEEP to measure temperature differences.

Steps
1. Have students conduct the ***Sun Experiments***. NOTE: ***Sun Experiments*** includes a variety of ways students can explore different aspects of the sun and how sunlight is absorbed by other objects. You may want to conduct each experiment as a class or in small groups. Older students may conduct the experiments on their own at individual stations.
2. Tell students that they will be asked to figure out what happened in the experiments. They should think carefully about their answers and then discuss what they think with classmates.

Closure
Have students record and discuss the results.

Assessment

Formative

- Are students able to identify which colors absorb the most light?
- Why do students think it might be important to know which materials absorb light?
- Can students explain which substances retained heat the longest after being removed from the sun?

Summative

Show students pictures of different types and colors of roofing materials (black roof, tin roof, clay, etc). Have students discuss what type of roof would maintain cool temperatures in a house and why. Ask them what material collects the sun's energy most effectively and could be used to build solar panels.

Extension

Which will cool a building better – changing its black roof to white or adding a roof garden? Gather three identical cardboard boxes (copy paper boxes will work well), three thermometers, black and white paint, a bag of potting soil, several small plants, and aluminum foil. Paint the top of one box black and another box white. Plant a garden on the top of the third box by making a shallow pan with the aluminum foil. Fill pan with about an inch of potting soil and plant several small plants. Keep the soil moist, not wet, during this entire experiment. Place the three boxes in a sunny spot with a thermometer inside each one. Record the temperatures inside the box for one week as well as the weather outside (sunny, cloudy, raining, etc.). Check the temperature at 10:00 a.m. and at 2:00 p.m. Use the information gathered to determine which box stayed the coolest.

Photovoltaic panels mounted on the roof supply the household with electrical energy.

Solar panels collect thermal energy from the sun to heat water for household use. Picture from North Carolina Sustainable Energy Association.

Sun Experiments

Visit the KEEP website for more renewable energy investigations.

Solar Soup Cans

Materials:

16 soup cans	Black paint
Four shoeboxes and lids	White paint
At least four thermometers	Aluminum foil
Salt	Paint brush
Sand/soil	Plastic wrap
Water	Masking tape
Shredded paper	

* A data sheet for Solar Soup Cans is located on the KEEP website on the Doable Renewables Support Page.

Divide students into four groups: A, B, C, and D. Have each group fill up four soup cans with water, sand/soil, shredded paper, and salt. Give Group A the shoebox with a black painted interior, Group B the box painted white inside, Group C the box lined with aluminum foil, and Group D the box without a painted inside (should not be black or white). Have students place thermometers in each can. Take an initial reading for each substance. Have each group place the soup cans in their boxes and set them in a sunny window. Cover each box with plastic wrap and secure it with masking tape.

At 10-minute intervals, students should read and record the temperature of each substance. They can stop after they have taken four or five temperature readings. Put lids on the boxes and remove them from the sun. After 15 minutes and again after 30 minutes, take the temperatures of the substances by quickly removing the lids and checking the thermometers. Record data on data sheet.

NOTE: For younger grades, simplify the activity to test one aspect, either colors or materials.

Solar Balloon

Materials:

- 2 large, thin black garbage bags
- Scissors
- Tape

Select one bag, but do not open it. Lay the bag on a flat surface and, using scissors, cut open the sealed end of the bag. Get another plastic bag and do not cut off the end. Align the uncut bag with the first bag so that the cylinder will be closed off at one end. Tape the adjoining open ends of the two bags together (instead of using tape you can use a low setting on an iron to seal the ends of the bags). This should result in a two-bag cylinder or solar balloon with one closed end.

When it is sunny and the winds are calm, take the solar balloon into a large open area free of obstacles. While holding the bag open walk or run to inflate the balloon. Using kite string, tie off the open end of the bag leaving extra string to hold onto the solar balloon. If there is a breeze, stand upwind of the balloon. The balloon may start to slide across the ground. If it does, walk with the balloon until it starts to rise on its own. Ask students, what does the color of the bag have to do with absorbing heat? Why did the bag begin to rise? (Molecules in the bag started to heat up and move faster which then caused more pressure inside the bag). Before deflating the balloon, open one end and have students observe the temperature inside the bag.

Sun Prints

Materials:

- Light-sensitive photographic paper (available at a photography or craft store)
- Various objects to form negative images on paper (e.g., paper clips, pencils, combs)
- Cardboard (large enough to cover photographic paper)

Practice by putting objects on regular paper. When you find a pattern you like, sit in a dark area and arrange the objects on the light-sensitive paper (you'll need to prepare these in a dark room). Cover the arrangement and the light-sensitive paper with cardboard, and carry it into the sunlight. Remove the piece of cardboard and expose the arrangement to the sun for about two minutes. Take the objects off the light-sensitive paper. Quickly rinse the paper in developing liquid or water (this process should be done by an adult unless water only is used).

NOTE: A simpler version of this activity is to use dark construction paper and cover portions of it with designs and letters you've cut out. The uncovered portions will be bleached by the sun when left in the sun for at least four hours. The covered portions will retain the original color. Weigh down the designs and letters so they don't shift or blow away.