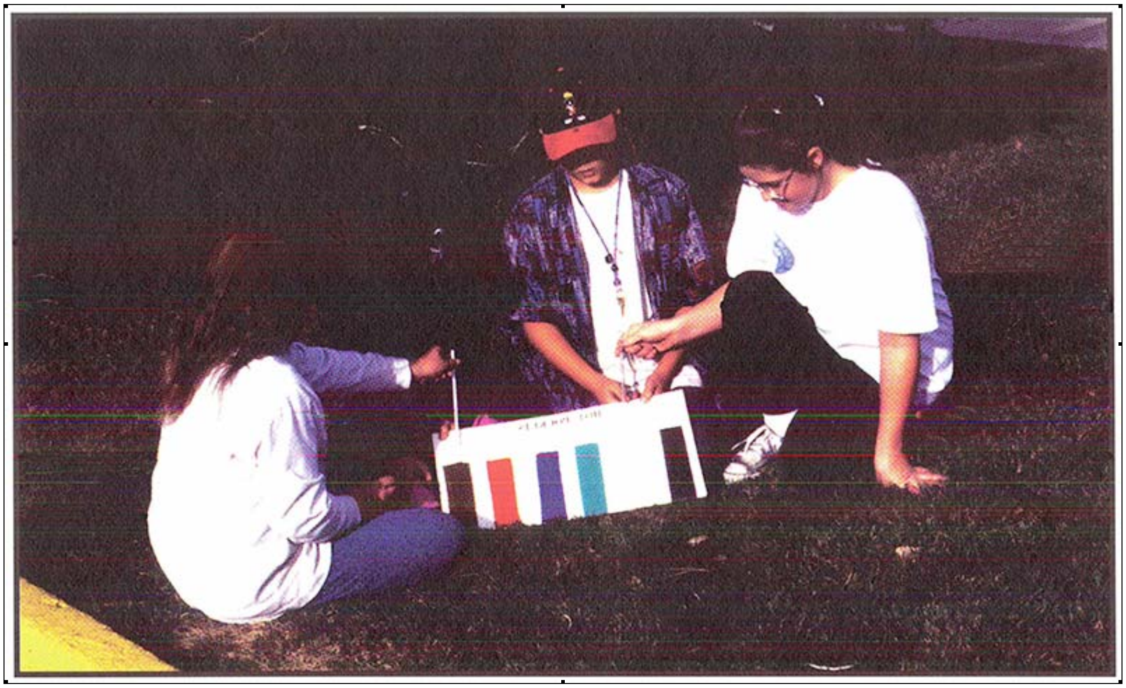
Hot Pockets

From Wyoming Energy Curriculum



Overview

By experimenting, students discover which colors of cloth absorb the most light and covert the light to heat. They are able to explain which colors conserve energy and design solar applications with these colors. Students learn about the heating of earth's surface and the atmosphere.

Objectives

Students will:

- discover which colors of cloth absorb the most solar energy.
- apply the knowledge of conversion of light to heat to explain how the sun heats earth's surface and the atmosphere.
- use materials to conserve or radiate the sun's energy and make designs that use solar energy.
- students learn to conduct a controlled experiment.

Goals and Concepts

B 1, **C** 13, **E** 13, 15

Grade Levels Adaptable for K-6
Time Needed 1 hour or more
Subjects to Integrate Science
Topics properties of light, solar heating and preventing solar heating, conversion of light energy to heat energy, alternate energy to conserve fossil fuels
Skills measuring, observation, communication, prediction, interpretation of data, graphing

Materials

Cardboard or poster board
Six thermometers
Fabric for pockets
Suggested fabric is a heavy material with a rough surface , such as linen, corduroy, or denim
Glue or tape

Background

With this activity the teacher has the opportunity to delve into the science of light, energy conversion, and solar application of light at some depth. The activity is also fun and very useful with younger children even if only the observations are made and the obvious applications of solar energy are discussed. In carrying out this activity students have the opportunity to learn about properties of light and how it is converted to heat. They learn how some pigments trap particular wavelengths of light and reflect others as colors. In this study of light, pigments, and heat, students also learn about our use of the conversion of light to heat in solar heating and solar reflection to prevent solar heating.

Energy from the sun comes to the earth in a varying assortment of wavelengths (the distance between crests of the energy wave). This entire assortment of wavelengths of energy is called the electromagnetic spectrum.

Visible light is only a small segment of the electromagnetic spectrum of energy that reaches the earth. Some rays, such as radio waves, have very long wavelengths, more than 1000 meters between crests. Other rays have very wavelengths of 10 billionths of a meter. For example, ultraviolet light has a short wavelength. The shorter the wavelength, the more intense the energy carried in the ray. Some of the short wavelength rays such as gamma rays and ultraviolet light rays are intense and damaging to cells of living organisms. Violet light has the shortest wavelength of light visible to our eyes (about 1/ 750 billionth of a centimeter in wavelength - crest to crest). Red light has the longest wavelength visible to our eyes (1/400 billionth of a centimeter wavelength).

When a ray of light energy strikes a surface, it may be absorbed or reflected. When we say it is absorbed, we really mean that the ray is converted to heat. When white light strikes a surface that appears red to us, the surface is absorbing all of the rays that make up white light and reflecting the red. The red wavelength strikes the retina of our eyes that detects the wavelength as red. The combination of the visible wavelengths of light appears as white light to us. If the surface absorbs the entire visible spectrum of rays, we say the surface is black. If it appears green, the other rays are being absorbed and the light with the wavelength that appears green to our retina is being reflected by the surface.

When scientists say a surface absorbs an energy ray, they mean the surface is converting the ray to another form of energy. The other form is usually heat. When molecules move they cause heat. If a surface appears black to our eyes, it is absorbing all of the visible light rays. The rays that strike its surface cause the molecules at the surface to move faster, which is heat. When molecules move, they give off heat.

If none of the wavelengths of light are absorbed by a surface (doesn't cause the molecules of the surface to move faster), the light is reflected and we call the surface white. The energy is reflected by the surface and the surface does not heat (the molecules are not caused to move faster).

When we say an object is very hot, we are saying the molecules of the object are moving fast and giving off energy. A rough, black surface that is not shiny is one that will absorb light better than most any other surface. Light energy of all wavelengths that strike the molecules of the surface moves the molecules of the material or pigment and they are not reflected. We say the object is black. It is not reflecting light of any wavelength. Instead, the energy of the rays striking it is being converted to heat.

We can detect which colors reflect the most energy by the amount of heat (total movement of molecules) caused by the light rays that are absorbed. Thermometers can give us this measurement of the average energy of the moving molecules.

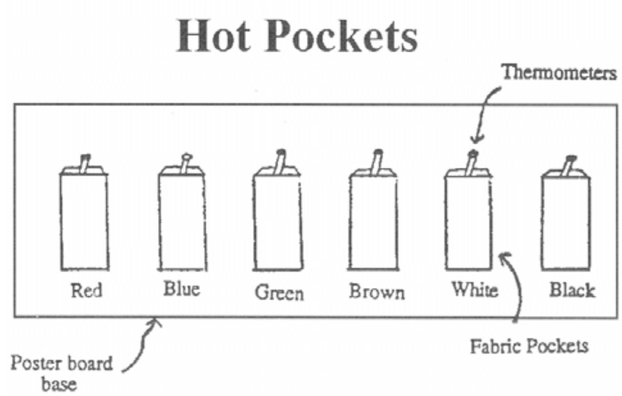
Procedure

The diagram below shows how to construct a "warm pocket' solar energy absorbing board.

18" by 10" piece of heavy cardboard

4" by 2" swatches of cloth

glue or tape edges to make pockets



Depending upon the age of the students, the teacher may let them construct the apparatus. One may be constructed for an entire class or one per group of four or five students. A thermometer is necessary for each swatch of cloth. The swatches of cloth can be purchased from a fabric shop. Try to get the varying colors from the same kind of material: linen, corduroy, etc., so that the only variable is the color.

The activity lets students see how a scientific experiment is designed: controls, variables, and uniformity of method. Place the board with the swatches face down on a dry lawn in an area bright with sunlight. When all thermometers are at the same temperature, turn the board over and insert the thermometers into the pockets so they may be read without touching them as the energy of the sun is converted to heat by the nature of the pigment in the cloth. Students record the temperatures at even intervals of time for each color: 5 min., 10 minutes, and so on. In less than thirty minutes the swatches usually plateau out and the maximum temperature for that time of the day is reached.

Students make a graph to show the absorption of light and the resulting heat by the varying colors. Some teachers use a colored marker to match the color of the swatch of cloth. Post the graphs on the wall of the classroom and see how they correspond. Are more boards more accurate than just one? This question shows the process of science. Experiments are more reliable with many repetitions. Use the results to explain a scientific experiment. What are the controls? What was the variable? Why is it best in a scientific experiment to have only one variable?

In a discussion, have students explore applications of their newfound knowledge in the real world.   Ask the class questions such as:

- Why are leaves green?
- Could you use our knowledge of colors to help conserve energy in heating or cooling a house?
- If you wanted to store the sun's energy in rocks, what color rocks would you choose?
- If you lived in a desert climate where it is warm in all seasons, what color might you paint your house?
- How could you use curtains to help cool your home in the summer and warm it in the winter?

Extending the Activity

1. Visit a solar home to see how colors can be used to regulate temperatures.

2. Have students do research to find out which colors of light are best used by plants to be converted to the energy stored in foods: sugars and other carbohydrates.

3. How did the energy of light ever get stored in fossil fuels: coal, natural gas, and oil?

4. Why are the big tanks for petroleum storage usually painted a very light color?

5. What are some reasons we must learn to use the sun and other alternate energy sources and conserve our fossil fuel reserve?

6. Ask students to apply what they have learned about absorption of light energy to the clothes they might wear during the seasons of the year.

Assessment

1. Ask students to observe their graphs generated from the experiment and write a conclusion.

2. Ask students to describe three ways they could use their knowledge about colors and heat absorption to conserve energy in their home or school, without using more money for fossil fuels.

Additional Resources

Science Projects in Renewable Energy and Energy Efficiency, copyright, 1991
National Energy Foundation
5160 Wiley Post Way, Suite 200
Salt Lake City, Utah 84116
(801) 539-1406

Good websites:

eia.doe.gov/kids/classactivities/wind_elemrev.pdf
This is an excellent collection of activities and readings from the U.S. Department of Energy.
They are grouped by grades: K-3, 4-7, and Intermediate, 6-9.

http://www1.eere.energy.gov/education/science_projects.html

wattsonschools.com/activities.htm

Wyoming Science Standards

CONTENT STANDARD

1. CONCEPTS AND PROCESSES
In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.

BENCHMARK Grade 4
7. Properties of Objects: Students classify objects by properties that can be observed, measured, and recorded, including color, shape, size, weight, volume, texture, and temperature.
9. Physical Phenomena: Students investigate physical phenomena commonly encountered in daily life, including light, heat, electricity, sound, and magnetism.

CONTENT STANDARD

2. SCIENCE AS INQUIRY
Students demonstrate knowledge, skills, and habits of mind necessary to safely perform scientific inquiry. Inquiry is the foundation for the development of content, teaching students the use of processes of science that enable them to construct and develop their own knowledge. Inquiry requires appropriate field, classroom, and laboratory experiences with suitable facilities and equipment.

BENCHMARK Grade 4
1. Students research answers to science questions and present findings through appropriate means.
2. Students use the inquiry process to conduct simple scientific investigations.
A. Collect and organize data
B. Use data to construct simple graphs, charts, diagrams, and/or models
C. Draw conclusions and accurately communicate results, making connections to daily life
D. Pose or identify questions and make predictions
E. Conduct investigations to answer questions and check predictions
3. Students identify and use appropriate scientific equipment.

CONTENT STANDARD

3. HISTORY AND NATURE OF SCIENCE IN PERSONAL AND SOCIAL DECISIONS
Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

BENCHMARK Grade 4
2. Students recognize how scientific information is used to make decisions.
A. Identify and describe local science issues, such as environmental hazards or resource management
B. Suggest feasible solutions and personal action plans to address an identified issue

Wyoming Math Standards

CONTENT STANDARD
3. MEASUREMENT Students use a variety of tools and techniques of measurement in a problem-solving situation.

BENCHMARK Grade 4
6. Students use time, in problem-solving situations to:
• compare relationships among seconds, minutes, and hours;
• use elapsed time to the nearest minute.

CONTENT STANDARD

5. DATA ANALYSIS AND PROBABILITY Students use data analysis and probability to analyze given situations and the results of experiments.

BENCHMARK Grade 4
1. Students collect, organize, and compare data in graphs, Venn diagrams, tables, and charts.
2. Students communicate conclusions about a set of data by interpreting information using graphs, Venn diagrams, tables, and charts.
3. Students predict, perform, and record results of probability experiments.
4. Students predict all possible outcomes of a given situation or event.