Safety Science Tools

The Power of Solar Energy

Open your students' eyes to the importance of scientific literacy. As a Science Educator, you can help them draw connections between science, engineering, math, and language. These lessons can help build their confidence, strengthen their interest, and apply their knowledge to solve new problems.

The sun is a vital part of our earth's environment. The sun provides warmth, daylight, and sun rays that help humans, animals, and plants thrive. The sun's energy, called **solar energy**, can be captured and turned into electricity. In this experiment, students will see how they can influence the amount of energy captured from the light, using different-colored surfaces. They will also observe the different waves that make up white ("visible") light. And finally, experience how light energy can be converted into electricity.

There are three different parts to this activity.

A. Observe how solar energy produces heat;
B. Break light down into its different-colored waves; and
C. Investigate how solar energy is converted into electricity.

PART A – OBSERVING HOW SOLAR ENERGY PRODUCES HEAT

MATERIALS

- Clamp-on shop lamp (or similar)
- 100-watt incandescent light bulb
- 2 four-inch-by-four-inch cards (one black, one white)
- Ice cubes of equal size (optional: add food coloring to make the results more obvious)
- Toothpicks
- Ruler

PREDICTIONS AND OBSERVATIONS

Share with your students that in this experiment they are going to be learning about how light energy produces heat.

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EXPERIMENT STEPS

1. Position the lamp so it is 6 inches (15 cm) from the table surface. Put the two cards under the lamp, evenly positioned as shown.
2. Select two ice cubes of the same size.
3. Lay each ice cube on a toothpick, one on each card. The toothpick should raise the edge of the ice cube off the card just slightly. This makes it easier to detect the melting water.
4. Turn on the lamp. In about 5 minutes the ice will start to react.
5. Draw the chart below on the board Ask the students to make their predictions - will both ice cubes melt at the same rate? If not, which color will melt faster?

	WHICH ICE CUBE WILL MELT FASTER?		
	BLACK CARD	WHITE CARD	NO DIFFERENCE
PREDICT			
OBSERVE			

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PART B — BREAK LIGHT DOWN INTO ITS DIFFERENT-COLORED WAVES

MATERIALS

- Flashlight with strong beam
- Prism (can be purchased at a teacher supply store or online; search for "optical prism")
- Large box such as a paper case box, inside painted black
- Piece of white paper, set inside the box

PREDICTIONS AND OBSERVATIONS

Ask students if they knew that white light is made up of different colors? Explain that our eyes can't see the different colors in white light. But white light is actually made up of all the colors in the visible light spectrum. While showing students the prism, ask them to speculate about what might happen if you were to send the white light through the prism?

Draw the chart below on the board and use it to record their predictions.

Part B	What Colors Can You See from the Prism?						
	Red	Orange	Yellow	Green	Blue	Purple	Black
Predict							
Observe							

EXPERIMENT STEPS

Position the flashlight so the beam shines through the prism onto the white paper inside the box. The box will help keep extra light out of the experiment. You may need to adjust the prism or flashlight to see a spectrum. Record the observations on the chart.

THE SCIENCE

The light we see is actually made up of many different colors of light. The human eye sees "white light"—that's when all the colors that make up the visible spectrum are combined. But in fact, each color has a different **wavelength**.

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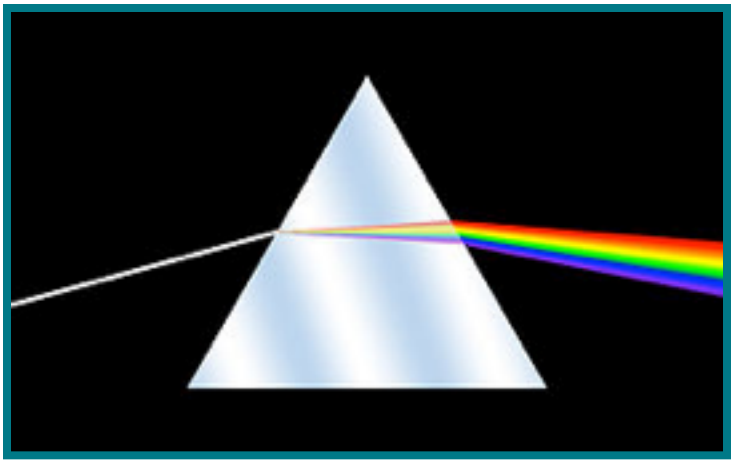
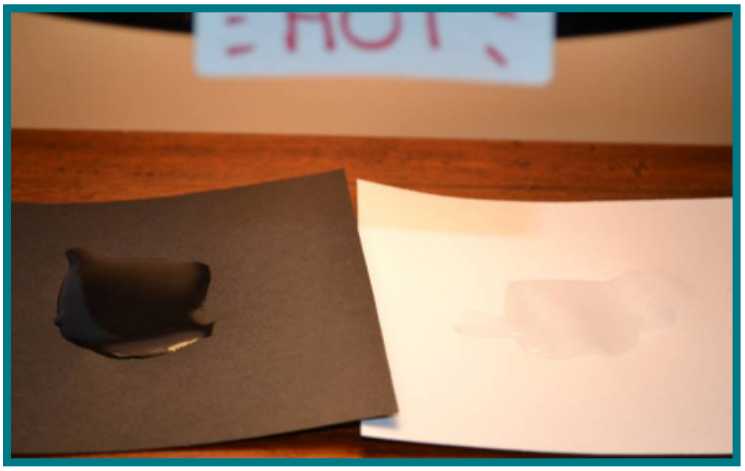
The different wavelengths of light travel at different speeds, but that isn't noticeable when light moves through air. When light travels through the angle of the glass prism, however, the waves are slowed down, causing the white single beam to split into different colors. This range of colors is called the "spectrum of visible light." Traditionally, the spectrum contains seven colors: red, orange, yellow, green, blue, indigo, and violet A rainbow is produced when sunlight travels through raindrops, which act like millions of tiny prisms.



After a few minutes, examine the ice cubes and the water underneath each one.

Ask students to verify which ice cube has melted more? Record their observations on the chart. Ask students if they can explain why one ice cube melt faster than the other when both ice cubes were the same size, and the same distance from the lamp?



Light is a form of energy. We can turn light into heat energy by absorbing the light.
The black card absorbs all wavelengths (all the colors) in the light. In fact, that's why the card appears black to our eyes. The white card, by contrast, reflects all wavelengths in the light.
The more wavelengths the paper absorbs, the more heat it produces. The black card heated up more than the white card, making the ice cube melt faster. This is why people wear white in the summer!

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PART C — INVESTIGATE HOW SOLAR ENERGY IS TURNED INTO ELECTRICITY

For hundreds of years, scientists and inventors have developed different ways to harness the power of the sun's energy. Today, the sun's light can be captured in solar cells that convert the energy into electricity. Sunlight is free to use and renewable, making it a safe and efficient source of energy for our planet.

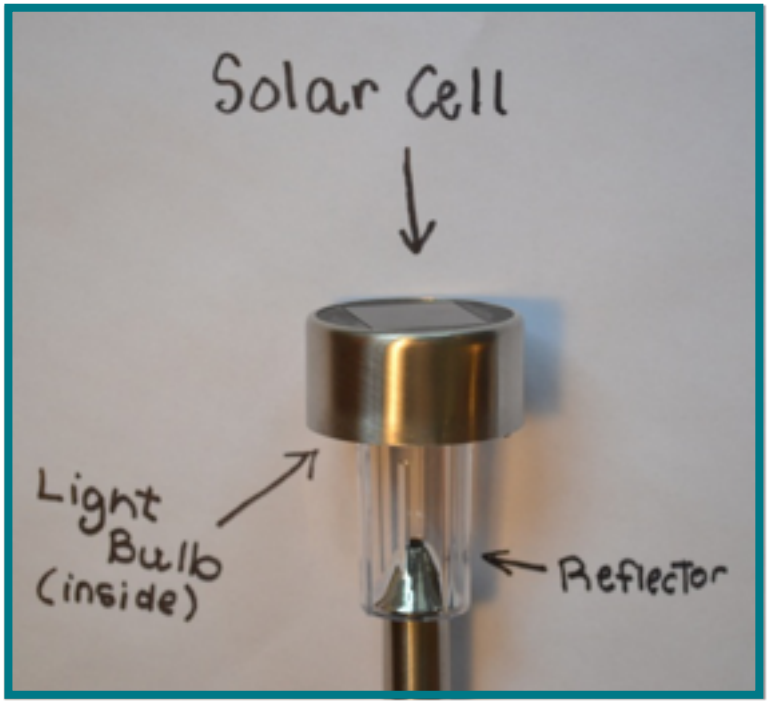
MATERIALS

- 2 solar-powered garden lights (available at garden stores or dollar stores)
- Large box with lid such as a paper case box, the inside lined with white paper or painted white

PREDICTIONS AND OBSERVATIONS

Be sure to fully charge one solar light outside before beginning the activity.

Carefully take the second light apart and show students the internal components



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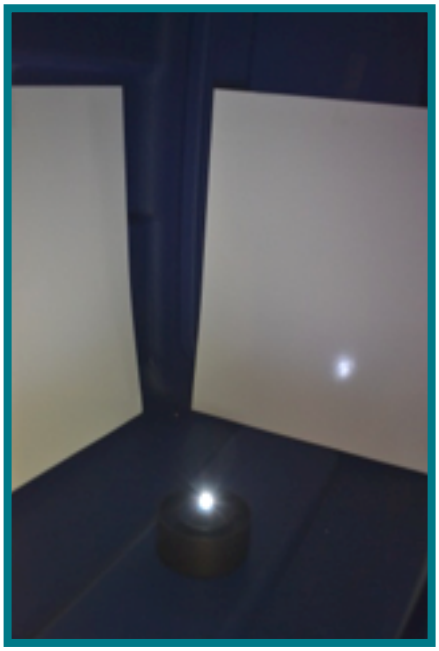
EXPERIMENT STEPS

1. Hold the working light by its base and ask students:
   - Is the light on?
   - How the light be turned on?
   - Put the light inside the box with the lid partially closed. Is the light on now?
   - If the clear light casing comes apart, remove it. Have students notice the intensity of the light with the bulb fully exposed. The light is like a pin-dot.
   - Now put the outside glass/plastic light diffuser back on. What does the light look like now? Does it seem as bright? Why would the manufacturer add the diffuser?



2. Look at the internal components of the second light and ask students to think about:
   - Where the light get its electricity from?
   - If this is a "solar" light, why is there a battery inside?
   - Why doesn't the light bulb stay lit all the time when the sun is shining?

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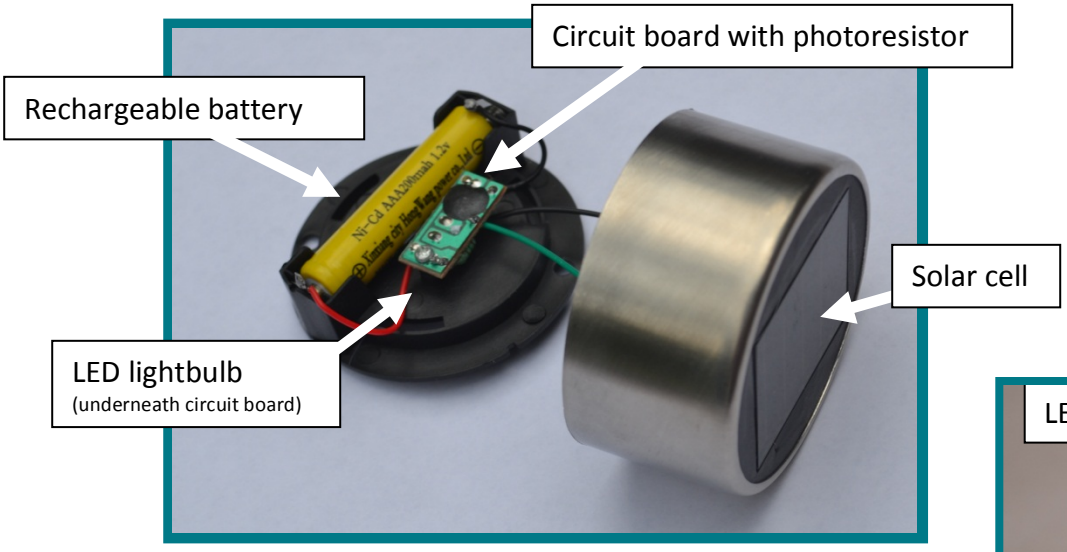
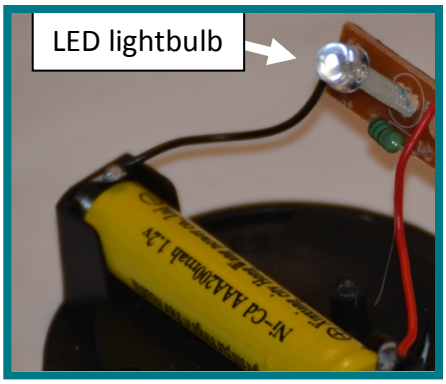
THE SCIENCE

Look at the top of the outside of the light unit. See the smooth dark glass square? That is the "photovoltaic cell," also called the solar cell. This plate of special materials absorbs the energy from the sun and captures it in the rechargeable battery. The more solar cells, the more energy collected. This one is 1.5-inch-by-1.5-inch (approximately 4 cm x 4 cm).





This solar-powered light DOES have a battery. But unlike regular batteries that wear out over time, the battery in this unit is rechargeable. Every day, the sunlight, captured by the solar cell, recharges the battery. And every night, the light bulb glows until the electricity in the battery is drained. This is a great demonstration of renewable energy.

Inside the unit is a miniature electrical circuit board (green). The circuit board connects the solar cell, the rechargeable battery, and the tiny LED (light-emitting diode) light bulb. The circuit board is smart enough to "step up" the voltage provided by the battery to a level needed to illuminate the LED. It also includes a sensor called a "photoresistor" that controls when the light bulb actually turns on. If you cover the sensor with your hand, or put the whole unit inside a dark box, the photoresistor thinks it's nighttime and the electrical circuit is completed. This allows electricity from the battery to illuminate the light bulb. When it is daylight, the photoresistor disconnects the electrical circuit, so the light bulb turns off. During the day, the solar cell collects energy from the sun, and recharges the battery...over and over, day in and day out.

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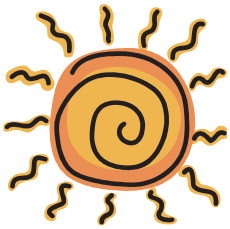
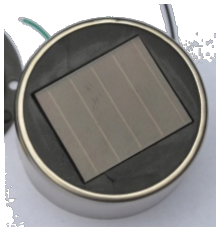
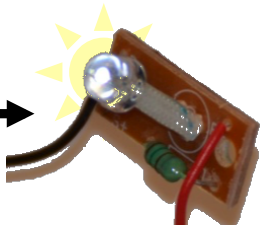


Sunlight is absorbed by the solar cell and converted to electricity



The solar cell recharges the battery

The battery powers the light bulb



A typical garden light will collect about 1.8 volts of electricity each day, which is more than enough to fully charge the 1.2-volt AAA NiCad battery in the unit. The light will glow for as many as 15 hours on a fully charged battery.

Ask your students if they know how to make sure a solar light will work as well as possible and as long as possible?

Answer: Put it out where it will get full sunlight, and keep the solar cell clean and uncovered. Also, make sure the parts are connected securely so water doesn't get into the battery compartment, which could cause it to corrode.

Free electricity from the sun, every day—that's renewable energy!