

Can solar energy be concentrated?

Overview: Today you'll use a plain old light bulb to learn more about the special ways that the sun's energy is used and harnessed, and especially the implications that it has on our energy needs.

What to Learn: This experiment will teach you how the sun's rays interact with our planet, and how in turn we use this energy in a number of ways.

Materials

- Lamp with an incandescent bulb
- Magnifying lens

Lab Time

1. The results of this experiment may be easiest to observe if done at night in a dark room. Ask an adult to remove the lampshade from a lamp that uses a single incandescent bulb. An incandescent bulb is the type that gets quite hot when used. Turn on the lamp. Turn off all the other lights in the room.
2. Stand about two feet from the wall that is the greatest distance from the lamp. There should be nothing between you and the lamp bulb. Place the magnifying glass on the wall so that the lens is flat against the wall. Now, slowly move the lens away from the wall and toward the light. Keep the lens parallel to the surface of the wall. As you move the lens outward, watch the wall.
3. Record your observations on the worksheet.

Concentrated Solar Observations:

Describe or draw the image on the wall in the space below:

How bright is this image? How big?

What happens when you move the lens? The bulb? Why is this happening?

The United States Department of Energy's National Renewable Energy Laboratory in Colorado uses solar energy to operate a special furnace. This high-temperature solar furnace uses a lens to concentrate sunlight. A heliostat (a device used to track the motion of the sun across the sky) is used so that the image reflected from a mirror is always directed at the same spot. The lens is used to concentrate sunlight from a mirror to an area about the size of a penny. This concentrated sunlight has the energy of 20,000 suns shining in one spot.

In less than half a second, the temperature can be raised to 1,720° C (3,128° F), which is hot enough to melt sand. This high-temperature solar furnace is being used to harden steel and to make ceramic materials that must be heated to extremely high temperatures.

Concentrated sunlight also has been used to purify polluted ground water. The ultraviolet radiation in sunlight can break down organic pollutants into carbon dioxide, water, and harmless chlorine ions. This procedure has been successfully carried out at the Lawrence Livermore Laboratory in California. In the laboratory, up to 100,000 gallons of contaminated water could be treated in one day.

The curved shape of the magnifying lens we used in this experiment causes light rays to bend and focus on an image. When we look through the lens, we can use it to make writing or some other object appear larger. However, the magnifying lens can also be used to make something smaller. The light from the bulb is bent and focused on the wall when the lens is held far from the lamp and close to the wall. The image is much brighter than the surroundings. This is because all the light falling on the surface of the lens is concentrated into a much smaller area.

When sunlight is concentrated by passing it through a lens, the result can be an intensely bright and hot spot of light. Even a small magnifying glass can increase the intensity of the sun enough to set wood and paper on fire. We are using a light bulb rather than sunlight for this experiment because concentrated sunlight can be very harmful to your eyes. NEVER LOOK AT A CONCENTRATED IMAGE OF THE SUN.

Do you know of any common ways that solar energy can be concentrated for our use? What about heating homes? Even cooling homes in hotter climates? Providing electricity? Did you know that solar energy can even be used to break down pollutants to clean water? Any others?

Exercises Answer the questions below:

1. Name three uses for solar energy:
 - a.
 - b.
 - c.
2. What type of heat energy is transmitted by the sun?
 - a. Conduction
 - b. Convection
 - c. Plasma
 - d. Radiation
3. Circle the following phenomena influenced by the sun:
 - a. Pressure
 - b. Climate
 - c. Weather
 - d. Wind

Answers to Exercises: Can solar energy be concentrated?

1. Name three uses for solar energy: (electricity, air conditioning/climate control, water treatment, solar furnace, oven)
2. What type of heat energy is transmitted by the sun? (radiation)
3. Circle all the following phenomena influenced by the sun: (wind, climate, weather)