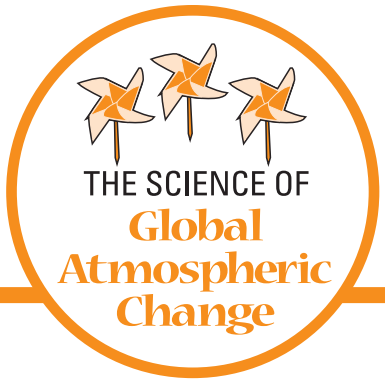

Using Heat from the Sun

Activity from *The Science of Global Atmospheric Change Teacher's Guide* and for *Mr. Slaptail's Curious Contraption*

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Teacher Resources from the
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Teacher Resources from the Center for Educational Outreach at Baylor College of Medicine.

The activities described in this book are intended for school-age children under direct supervision of adults. The authors and Baylor College of Medicine cannot be responsible for any accidents or injuries that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text.

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
sis.nlm.nih.gov/enviro/climatechange.html

U.S. GEOLOGICAL SURVEY, OFFICE OF GLOBAL CHANGE
usgs.gov/global_change

U.S. GLOBAL CHANGE RESEARCH PROGRAM
globalchange.gov

GRAY WATSON
http://en.wikipedia.org/wiki/File:Solar_panels_on_house_roof.jpg

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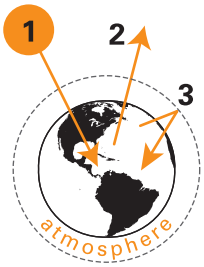
http://www.bath.ac.uk/bio-sci/research/profiles/wheals-a.html

WORLD HEALTH ORGANIZATION who.int/global-change/environment

People and Climate Changes

Environment and Health Basics

WHAT IS THE GREENHOUSE EFFECT?



1. Sunlight passes through the clear atmosphere and warms the Earth's surface.
2. The warm surface reflects heat back into the atmosphere.
3. Greenhouse gases and water vapor trap some of the heat and send it back toward the Earth.

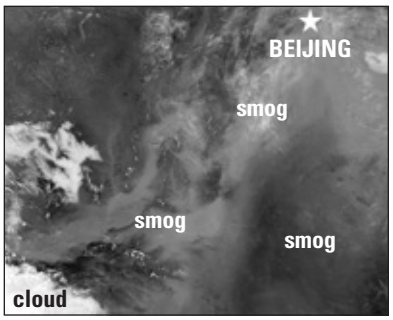
CFSs AND OZONE

The release of chemicals known as CFCs (chlorofluorocarbons) is contributing to changes in the atmosphere that will affect climate and human health and well-being. Freon and other CFCs are greenhouse gases that increase the amount of heat trapped near the surface of Earth. In addition, chlorine molecules released by these chemicals in the stratosphere break apart the ozone molecules responsible for shielding Earth from ultraviolet radiation.

Over the last decade, the amount of ozone in the stratosphere has decreased (especially in the polar regions)—leading to greater risks of skin cancer for people and also damaging vital populations of plants, animals and marine life.

Life on Earth has been possible because of the very special characteristics of our atmosphere. The planet is warm enough to support life, thanks to the presence of certain gases in the lower atmosphere. The atmosphere also absorbs almost all of the potentially damaging radiation produced by the sun before it reaches the surface. Our atmosphere contains elements necessary for life—nitrogen, carbon and oxygen—as well as abundant water vapor to maintain the water cycle.

Human actions, particularly during the last several decades, are changing the composition of Earth's atmosphere. Since the industrial revolution, people have been removing stored carbon from Earth in the forms of coal, crude oil and natural gas, and burning it to make heat. In the process, water vapor, carbon dioxide and small amounts of other substances are produced. Other activities, such as clearing land (by burning) for agriculture, also have added CO_2 to the atmosphere. As a result, levels of carbon dioxide in the lower atmosphere have increased from around 260 parts per million (ppm) by weight to more than 350 ppm.



The dense smog over China in the above image likely results from pollution held in place by a temperature inversion. Air high in the atmosphere is usually cooler than the air near the ground. As warm air rises through the atmosphere, it disperses its pollutants, but when cold air is trapped under a layer of warm air, it cannot rise.

Winter temperature inversions are not uncommon as residents rely on coal for electricity and heat. These conditions lead to frequent build-ups of smog.

Photo courtesy of NASA Earth Observatory.

Carbon dioxide is one of the gases responsible for trapping heat near Earth's surface and lower atmosphere. Many scientists believe that increases in the amounts of CO_2 and other greenhouse gases, such as methane (CH_4), will lead to warmer temperatures on Earth. Even minor increases in the surface temperature of the planet could have far-reaching effects. Major climactic patterns of winds, temperature and rainfall could change drastically. This would impact water resources, coastlines, agriculture, forests, energy production and patterns of disease.

Climate, the characteristics of weather in a particular region over long periods of time, determines which kinds of plant and animal life are present, which crops can be grown, how people construct their houses and, to a great extent, people's clothing and diet. The climate of any given region depends on its distance from the equator, altitude and rainfall patterns.

Even slight changes in the world's climate affect human health and well-being in countless ways.

Using Heat From the Sun

Environment and Health

We seldom think about the sun's importance to our planet. It is the ultimate source of almost all the energy we use. Besides the sun, the only other sources of energy on the planet are radioactive rocks and the molten core deep below Earth's surface. The sun keeps us warm. It is responsible for weather, which is caused by uneven heating of large masses of air. Our food and common fuel sources depend or depended on solar energy trapped by producers, such as plants.

This activity is designed to build student awareness of the importance of the sun as the ultimate source of almost all energy on Earth. It also provides insight into harnessing the sun's power directly as a source of energy, as Mr. Slaptail does with his solar water heater in the adventure story that accompanies this unit.

Unit Links

Mr. Slaptail's Curious Contraption
Story, pp. 22–24; Science box, p. 20

Explorations
Sun Power, p. 4; We Can Make a Difference, p. 5

CONCEPTS

- Some of the energy given off by the sun can be felt as heat.
- Heat from the sun can be used as a source of energy.

OVERVIEW

Students conduct a discovery activity that allows them to observe how energy from sunlight can heat water.

SCIENCE, HEALTH & MATH SKILLS

- Measuring liquids
- Predicting
- Observing
- Comparing
- Drawing conclusions

TIME

Preparation: 10 minutes
Class: 30–60 minutes

MATERIALS

Each group will need:

- 2 cups, 9-oz clear plastic
- Graduated cylinder, 100-mL (or metric measuring cup)
- Student thermometer, plastic
- Copies of "Sunlight Observations" sheet

SETUP

Place all materials in a central area for Materials Managers to collect for their groups. Have students work in groups of 4 to conduct the activity.

If you are teaching this activity during the winter, you will need to conduct it indoors in a sunny window. When the weather is warm, students may conduct the experiment outside.

PROCEDURE

1. Ask students, *How do we get hot water in our homes? Does the water come that way or do we have to heat it?* Lead students into a discussion about different energy sources, such as electricity or gas, that usually are used to heat water for houses.
2. Follow the discussion by asking, *What if we didn't have any electricity or fuel to burn? Are there other ways to heat water?* Guide students into a discussion of the sun's importance as a source of heat and other energy for Earth. Ask, *How could we find out if the sun provides energy to heat water?* Tell students they will be investigating this question.
3. Have each group of students label two identical cups—one as "light" and one as "dark." Next, have them measure 50 mL of water into each cup.
4. Direct students to measure the temperature of the water in each cup and to record the temperature on their student sheets. Have each group place the cup labeled "light" in direct sunlight (outside or inside the classroom). The other cup should be left

Did you know that heat energy is measured in calories? One calorie represents the amount of heat required to raise the temperature of 1 cubic centimeter of water (10 milliliters) one degree.

RENEWABLE ENERGY SOURCES

Some homes have solar panels to generate their own heat and electricity.

Photo courtesy of Gray Watson, Wikipedia.

Energy from the sun creates the air currents used to generate electricity from "wind power."

Photo courtesy of the U.S. Global Change Research Program. *Our Changing Planet.* 2011.

inside the classroom, preferably in a dark area, away from any heating vents or radiators.

5. Have students predict the final temperature of the water in each cup and write their predictions in the appropriate spaces on the "Sunlight Observations" sheet.
6. If possible, have students wait at least one hour before checking the "light" cup. Have them measure the temperature of the water in the cup and record it on their sheet. Afterward, have them measure and record the temperature of the water in the "dark" cup.
7. Ask, *What happened to the water in the cup that you placed in the sun? Did it become warmer or colder, or stay the same? What about the water in the cup you left inside?* Help students understand that energy from the sun warmed the water in the "light" cup. Ask, *Where are other places that we can observe energy from the sun?*

Even fossil fuels, energy sources that we use every day, owe their existence to the sun. They formed from plants and tiny living organisms that were buried at intense pressures for millions of years.

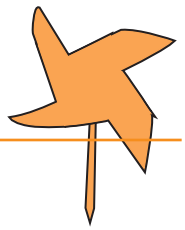
VARIATIONS

- Have students compare how different colored cups absorb heat from sunlight, or examine the effects of placing the cups on a reflector made of aluminum foil, or on black paper (which absorbs heat). Students also may want to compare results from cups placed on a grassy surface to those with cups sitting on a paved surface.
- Challenge students to come up with their own designs for solar water heaters. Let them draw their designs and/or build their heaters from recycled materials.

QUESTIONS FOR STUDENTS TO THINK ABOUT

In the story, *Mr. Slaptail's Curious Contraption*, Mr. Slaptail builds a solar water heater to supply his house with hot water. Ask students, *Do you think this is a practical use of solar power?* Encourage them to visit the library or search the Internet to learn what they can about houses that use power from the sun for heat, electricity or hot water.

Sunlight Observations



Name _____

You will need:

2 cups	water
thermometer	graduated cylinder or measuring cup

1. Label one cup "Light." Label the other cup "Dark."

2. Measure 50 mL of water into each cup.

3. Take the temperature of the water in each cup using the thermometer. Write the temperatures in the boxes.

Light	Dark
°	°

4. Put the "Light" cup in bright sunlight. Put the "Dark" cup in a dark place. Wait about one hour.

5. Predict the temperature that will be reached by the water in each cup after one hour. Write your prediction in the top half of each box below. Now, measure the temperature of the water in both cups again. Write the temperatures in the boxes.

	Light	Dark
Predict	°	°
Actual	°	°

6. What happened to the temperature of the water in the "Light" cup?

7. What happened to the temperature of the water in the "Dark" cup?

8. Why do you think this happened?

Observaciones Solares

Mi Nombre _____

Vas a necesitar:

2 vasos	agua
un termómetro	una taza o un cilíndro para medir

1. Marca un vaso "Luz." Marca el otro "Sombra."

2. Mide 50 mL de agua en cada vaso.

3. Mide la temperatura en cada vaso usando el termómetro. Escribe las temperaturas en los cuadros.

Luz	Sombra
°	°

4. Pon el vaso "Luz" en el sol. Pon el vaso "Sombra" en algun lugar obscuro. Espera una hora.

5. Predice la temperatura que alcanzará el agua en ambos vasos. Escribe tu predicción en la parte superior de cada cuadro. Ahora, mide la temperatura del agua en ambos vasos otra vez. Escribe las temperaturas en los cuadros.

	Luz	Sombra
Predicción	°	°
Actual	°	°

6. ¿Que pasó con la temperatura del agua en el vaso "Luz"?

7. ¿Que pasó con la temperatura del agua en el vaso "Sombra"?

8. ¿Que crees que pasó?