The Sun and Its Energy

2012-2013

Hands-on investigations and explorations to introduce primary students to the basic concepts of solar energy.

ENERGY SOURCES

Grade Level:

- Primary

Subject Areas:

- Science
- Language Arts

NEED
National Energy Education Development Project

Teacher Advisory Board

NEED Mission Statement

The mission of The NEED Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs.

Teacher Advisory Board Statement

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

Permission to Copy

Energy Data Used in NEED Materials

NEED believes in providing the most recently reported energy data available to our teachers and students. Most statistics and data are derived from the U.S. Energy Information Administration's Annual Energy Review that is published in June of each year. Working in partnership with EIA, NEED includes easy to understand data in our curriculum materials. To do further research, visit the EIA web site at www.eia.gov. EIA's Energy Kids site has great lessons and activities for students at www.eia.gov/kids.

NEED
National Energy
Education Development

1.800.875.5029
www.NEED.org

The Sun and Its Energy

Table of Contents

PROUD MEMBER OF IREC Interstate Renewable Energy Council

Materials in Solar Kit

- 250 Solar beads and 100 pipe cleaners
- 1 Large demonstration thermometer
- 10 Student thermometers
- 2 Solar balloons with string
- 1 Solar oven with oven thermometer
- 1 Solar house kit
- 40-pack of NaturePrint® Paper
- 1 Radiometer

Student thermometers in the kit are safety thermometers containing alcohol, not mercury.

Materials Needed

- Shallow pan with water
- White and black construction paper
- 2 Similar small potted plants
- Tape
- Scissors
- Package of refrigerated cookie dough
- Plastic wrap
- Small cardboard box
- Dark pan
- Transparency film
- Rulers
- Clay
- Colored Pencils

Correlations to National Science Education Standards: Grades K-4

This book has been correlated to National Science Education Content Standards.
For correlations to individual state standards, visit **www.NEED.org**.

Primary Standard A | *SCIENCE AS INQUIRY*

- **Abilities Necessary to do Scientific Inquiry**
  - Ask a question about objects, organisms, and events in the environment.
  - Plan and conduct a simple investigation.
  - Employ simple equipment and tools to gather data and extend the senses.
  - Use data to construct a reasonable explanation.
  - Communicate investigations and explanations.
- **Understandings about Scientific Inquiry**
  - Simple instruments such as magnifiers, thermometers, and rulers provide more information than using only senses.

Primary Standard B | *PHYSICAL SCIENCE*

- **Properties of Objects and Materials**
  - Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools such as rulers, balances, and thermometers.
  - Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.
- **Light, Heat, Electricity, and Magnetism**
  - Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object.
  - Heat can be produced in many ways, such as burning, rubbing, or mixing one substance with another. Heat can move from one object to another by conduction.

Primary Standard D | *EARTH AND SPACE SCIENCE*

- **Objects in the Sky**
  - The sun provides the light and heat necessary to maintain the temperature of the Earth.

Primary Standard E | *SCIENCE AND TECHNOLOGY*

- **Understandings about Science and Technology**
  - People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
  - People have always had problems and invented tools and techniques to solve problems. Trying to determine the effects of solutions helps people avoid some new problems.
  - Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Teacher Guide

Background

The Sun and Its Energy is an inquiry-based unit for primary students. Hands-on investigations and explorations introduce primary students to the basic concepts of solar energy.

Concepts

- The sun produces radiant energy (light) that travels through space to the Earth.
- The sun's energy makes life possible on Earth.
- We use the sun's energy to see.
- Plants convert the sun's energy to sugars to provide food for growth and life.
- We use the sun's energy to produce heat.
- Radiant energy from the sun powers the water cycle and produces wind.
- It is difficult to capture the sun's energy because it is spread out—not concentrated in any one area. We can capture solar energy with solar collectors that convert the energy into heat.
- Photovoltaic (solar) cells convert radiant energy directly into electricity.

Time

Twelve 15-30 minute class periods.

Preparation

- Familiarize yourself with the information in the guide and with the materials in the kit. Highlight the information and discussion questions on pages 23, 27, 33, 38, and 41 that you want to use with your students.
- Make *Plant Investigation Science Notebooks* for each student using pages 43-46.
- Collect the materials that are not included in the kit. See the Materials Needed list on page 3 for a list of these materials. Prepare the cardboard box to look like a house before the *Solar House* activity (see page 40).
- Vocabulary cards related to solar energy are on pages 16-21. Copy onto card stock and use these on your word wall.

Science Notebooks

You are encouraged to have students record their thinking in science notebooks during this unit. There are many different looks to science notebooks, ways to use them, and ways to assess them. If you currently use student notebooks (or journals) in your classroom you may have your students continue using these as they learn about solar energy. If you are not using science notebooks, you can make them out of paper that your students are familiar using. If you would like more structure to your science notebooks, you can copy the worksheets included in this guide and staple them together, or have students glue these pages into their existing science notebooks.

A checklist for assessing science notebooks can be found on page 13. Carrying the checklist with you as you circulate among your students will allow you to make some notes for formative assessment and guide your conversation with students as you help them become stronger scientists. You may want to customize the checklist based on your state standards.

NEED Resources

The following guides can be used to enhance and extend your solar energy unit and can be downloaded from www.NEED.org:

- *Primary Energy Infobook*
- *Primary Energy Infobook Activities*
- *Energy Stories and More*

Online Resources

- Environmental Protection Agency www.epa.gov/sunwise

Photos on pages 22 and 40 courtesy of NASA.

Activity 1: Light is Energy

✪ Concepts

▪The sun gives us light to see.

▪Light is energy.

Materials

▪Sunny day

Time

▪20 minutes

☑ Procedure

1. Talk about day and night and how we must use artificial light at night to see. Compare cloudy and sunny days. Compare length of daylight in winter and summer. Explain how we can see when light bounces off objects and into our eyes. If we close our eyes, we can't see because no light can enter.
2. Turn off the lights in the classroom and observe the light from the sun. Close the blinds and observe how much harder it is to see clearly when there is less light.
3. Read pages 22-24 to the class and discuss the concepts with students using page 23 as a guide.

Activity 2: Plant Investigation

✪ Concepts

▪Plants require light.

▪Observations are made with our senses, and with tools.

Materials

▪2 Small potted plants of the same variety that require bright sunlight*
▪Water*
▪*Plant Investigation Science Notebooks*
▪Rulers*
▪Magnifying lenses (optional)*

Time

▪30 minutes + ongoing

*Not included in kit

Preparation

▪Make a *Plant Investigation Science Notebook* for each student using pages 43-46. Copy page 46 multiple times front to back to increase the number of observations your students will make.

☑ Procedure

1. Show the plants to the students. Ask them to describe the plants. Talk about color, shape, height, and other plant characteristics. Record descriptive vocabulary on the board.
2. Ask the students, "What will happen if we place one plant in sunlight and one plant in the dark? What do you think will happen to the plants?" Let students share what they think will happen with a partner.
3. Pass out the *Plant Investigation Science Notebooks*. Have students record their prediction on the first page. On the next page have students record Day 1 observations, drawing realistic pictures of the plants in their notebooks. Students should write individual words or complete sentences about their initial observations.
4. Put one of the plants in a location where it will receive direct sunlight. Put the other plant in a location where it will receive no light.
5. Explain to the students that the plants will be watered with the same amount of water, so the only thing different in the investigation is whether or not the plant is receiving light.

6. Students should record new observations in their *Plant Investigation Science Notebooks* every 2-3 days.
7. Once there is a noticeable difference between the plants, discuss with students what has happened and why they think this is. Have students write conclusions in their *Plant Investigation Science Notebooks*.
8. Read pages 25-31 to the class and discuss the concepts with students using page 27 as a guide.

Activity 3: The Radiometer

✪ Concepts

- The sun's energy can make things move.
- The position and motion of objects can be changed by pushing or pulling.

Materials

- Radiometer
- Sunny day
- *Top View of Radiometer,* page 30
- Copies of *Radiometer* worksheet on page 47 for each student

Time

- 20 minutes

☑ Procedure

1. Note: If weather does not permit doing this activity outside, you can use an artificial light such as an overhead or flashlight.
2. Show students the radiometer. Ask students, "What do you think will happen when we place the radiometer in the sun?"
3. Bring the class outside and have them observe what happens when the radiometer is in the sunlight.
4. Change the amount of sunlight hitting the radiometer and point out how the spinning slows as less energy hits the radiometer. Have students explain what is happening in their own words in their science notebooks, or using the *Radiometer* worksheet.
5. See page 30 for an explanation of how the radiometer works.

Activity 4: Reading a Thermometer

✪ Concepts

- Heat is energy.
- A change in temperature indicates a change in the amount of heat energy in a substance—the higher the temperature, the more energy.

Materials

- Large demonstration thermometer
- 10 Student thermometers
- Copies of *Reading a Thermometer* (page 48) for each student

Time

- 20 minutes

☑ Procedure

1. Divide the students into five groups.
2. Give each group two thermometers. Caution the students about taking care when working with glass.
3. Give each student a copy of the *Reading a Thermometer* worksheet.
4. Use the large demonstration thermometer to show the students how to read a thermometer. Explain that the thermometer works because the liquid inside expands as its temperature increases. Understanding and recording the exact numbers is not important—the concepts of being able to measure temperature and compare temperatures are what should be emphasized.
5. Have the students fill in the tubes of the thermometers on their worksheet to show the temperatures of their thermometers. All the thermometers should read the same room temperature. Discuss the possible causes of any discrepancies (faulty equipment, one in the sun and one in the shade, people handling the thermometer, etc.).

Activity 5: Light-to-Heat

✪ Concepts

- When light hits a substance, it is reflected or absorbed.
- Light often turns into heat when it hits a substance and is absorbed.
- Dark colors have a tendency to absorb light; lighter colors have a tendency to reflect light.
- Dark colors get hotter in sunlight than light colors.

Materials

- 10 Student thermometers
- Black and white construction paper*
- Scissors*
- Tape*
- Copies of *Black and White* (page 49) for each student
- Sunny day

Time

- 20 minutes

*Not included in kit

Preparation

- Label five thermometers "A" and five thermometers "B."

Question

- What will happen if one thermometer is placed in a black pouch and one thermometer is placed in a white pouch, and then both thermometers are placed in the sunlight?

☑ Procedure

1. Divide the students into five groups.
2. Give each group two thermometers, one A and one B, black and white construction paper, scissors, and tape.
3. Give each student a copy of the *Black and White* worksheet.
4. First, have students record the temperature of each thermometer.
5. Instruct the students to make small pouches with the construction paper and cover the bulbs of the thermometers as shown in the pictures on the worksheet.
6. Instruct the students to put the thermometers in a sunny place for five minutes, then record the temperatures on their worksheets.
7. Discuss as a class the change in temperature for A and B thermometers. Review the concepts above and allow students to record conclusions.

Activity 6: Solar Beads

✪ Concept

- The ultraviolet radiation in sunlight reacts with a chemical in the beads to cause a change in color.

Materials

- One solar bracelet for each student
- Sunny day
- Copies of *Color Changing Bracelet* (page 50) for each student
- Colored pencils or crayons*

Time

- 30 minutes

*Not included in kit

Preparation

- Make a solar bracelet for each student in your class. String approximately five beads onto a pipe cleaner and twist the ends together to make a loose fitting bracelet.

Procedure

1. Make sure the classroom blinds are slightly closed so that there is not too much sunlight entering the room.
2. Distribute a bracelet to each student. Say, "The beads on the bracelet change color, can you find out how to make them change colors?"
3. When some of the students have figured out that the beads change color in sunlight, open the blinds or take the students outside to observe the colors of the beads in sunlight.
4. Have students record their observations using color in their science notebooks, or use the *Color Changing Bracelet* worksheet.
5. Read page 32 to the class using page 33 as a guide.

Extensions

- Investigate how well your sunglasses block UV rays. Put two solar beads under your sunglasses. If the beads change to a bright color, UV rays are getting through the lens and not protecting your eyes from UV rays.
- Investigate how well your sunscreen protects your skin from UV rays. Place two beads in a closeable plastic sandwich bag. Coat the outside of the bag with sunscreen. If the beads change to a bright color, the sunscreen is not working. If the beads do not change colors the sunscreen is working. If your sunscreen is not working, check the expiration date. Sunscreen does expire.
- Track the UV report each day from your local news, or from EPA's UV Index page at www.epa.gov/sunwise/uvindex.html.

Activity 7: NaturePrint® Paper

Concept

- The energy in sunlight changes the color of the part of the paper exposed to the sun.

Materials

- 1 Piece of NaturePrint® Paper for each student
- Tub of water*
- Sunny day
- Copies of *NaturePrint® Paper* worksheet (page 51) for each student

Time

- 30 minutes

*Not included in kit

Procedure

1. Take the students outside on a bright, sunny day. Instruct each student to find a leaf with an interesting shape, a twig, or other small, flat natural object with which to make a print. (You can also have students cut designs from construction paper before going outside.)
2. Find a large, flat area. Distribute one piece of NaturePrint® Paper to each student. Instruct the students to place their paper flat on the ground and place their objects in the center of the paper—and then not to move them. Direct the students to observe the color of the paper that is exposed to the sun for two to three minutes, until it fades to a pale blue.
3. Take the papers inside quickly without further exposing them to direct sunlight. Soak the papers in a container of water for one minute and dry flat. Observe the image on the paper.
4. Students should describe how solar energy was used to make a design on their paper in their science notebooks, or using the *NaturePrint® Paper* worksheet. When NaturePrint® papers are dry, students can glue them into their science notebooks, or onto the worksheet in the space provided.

Activity 8: Solar Balloons

✪ Concepts

- Dark colors absorb light energy and turn it into heat.
- As substances get hotter, they expand.
- Less dense substances tend to rise, denser substances tend to fall.

Materials

- 1 Solar balloon with string
- Sunny day
- Copies of *Solar Balloon* worksheet (page 52) for each student

Time

- 30 minutes

☑ Procedure

1. Take the students outside on a bright, sunny day.
2. Tie off one end of the solar balloon with a small piece of the string.
3. Line up your class in two rows. Have them stand facing each other with their arms held out in front of them. Open the other end of the balloon and air will flow inside. When the balloon is full, tie off the open end of the balloon.
4. Tie two strings (each about four meters—or twelve feet—long) to the ends of the balloon and put the balloon in the sun. Secure the balloon to a stationary object, or let students hold onto the strings.
5. Watch as the balloon rises. Explain to the students that the air inside the balloon heats up and expands. It becomes less dense than the air around it, causing the balloon to rise.
6. Have students record their observations in their science notebooks, or on the *Solar Balloon* worksheet.

Activity 9: Solar Oven

✪ Concepts

- A shiny surface reflects light.
- Reflected light can be concentrated on an object.
- When sunlight shines on food, enough energy is changed to heat to cook the food.

Materials

- 1 Solar oven with oven thermometer
- 1 Package of refrigerated cookie dough*
- Dark pan*
- Plastic wrap*
- Sunny day
- Copies of *How to Use a Solar Oven* worksheet (page 53) for each student

Time

- 20+ minutes as needed

*Not included in kit

☑ Procedure

1. Read pages 34-37 to the class. Discuss concepts with students using page 38 as a guide.
2. Arrange small portions of cookie dough on the dark pan. (Making nachos by melting cheese on chips in the solar oven is a good alternative to cookies.)

3. Take the students outside on a bright, sunny day. Set up the solar oven and place the pan inside. Place the oven in the sun so that the light is focused on the food.
4. Cover the oven with plastic wrap and periodically observe the cookies as they bake. Use the thermometer to measure oven temperature. Allow the students to sample the cookies when they are finished.
5. Writing Integration: Have students write an expository piece explaining how to use a solar oven using the worksheet on page 53.

Extension

- Have your students make their own solar ovens. Use *How to Make a Pizza Box Solar Oven* on page 14 to lead your students in this activity.

Activity 10: Solar House

Concepts

- A solar cell is made of a thin piece of silicon with different chemicals on each side. When sunlight hits the solar cell, electricity is generated.

Materials

- *Solar House* kit
- Copies of *Solar House* worksheet (page 54) for each student
- Cardboard box*
- Sunny day
- Scissors*
- Transparency Film*
- Tape*
- Clay*

Time

- 20 minutes

*Not included in kit

Procedure

1. Read pages 39-42 to the class. Discuss the concepts using page 41 as a guide.
2. Show the students the solar cell and explain that it turns sunlight into electricity.
3. Put the solar cell on the cardboard box and hook it up to the fan motor and light, as shown in the diagram on the *Solar House* instructions on page 40.
4. Place the solar house in bright sunlight and allow the students to observe the fan turning and the light shining inside.
5. Vary the amount of sunlight hitting the solar cell and have the students observe the speed of the fan.
6. Discuss other electrical items that electricity from the solar cell might operate—at home and at school.
7. Have students write about the solar house in their science notebooks or the *Solar House* worksheet.

Extension

- Assign students to design and build their own solar home. Students will need to explain how their house will use as much solar energy as possible.

Activity 11: Solar Cells

Concept

- You can use electricity produced by solar cells to run machines or other appliances.

Procedure

- Take the students to see a working solar panel. If you have solar panels on your school, show the cells and monitoring equipment to the students and discuss what they do.

Review and Evaluation

Materials

- *Evaluation Form* (page 55)

Time

- 20 minutes

Procedure

1. Ask the students, "How do you know the sun is energy?"
2. Discuss that energy causes change and does work, and the types of change and work they learned about and observed the sun doing over the last two weeks.
3. Writing Integration: Have students write about what the sun's energy does. Compile the writings and make a class book about solar energy.
4. Complete the unit *Evaluation Form* with the students.
5. Send the Evaluation Form to The NEED Project at:

The NEED Project
P.O. Box 10101
Manassas, VA 20108
FAX: 800-847-1820

Science Notebook Skills Checklist

																													Student
																													Drawings
																													Picture is realistic (colors, shape, size).
																													Includes appropriate labels.
																													Notes and Observations
																													Uses senses to record observations.
																													Observations are "big picture."
																													Observations focus on details.
																													Graphs and Charts
																													Data is accurate.
																													Includes appropriate labels.
																													Clear presentation.
																													Communication
																													Communicates verbally.
																													Communicates in writing.
																													Makes predictions.
																													Makes predictions with reasoning.
																													Uses evidence to support reasoning.
																													Compares and contrasts.
																													Communication is personal.

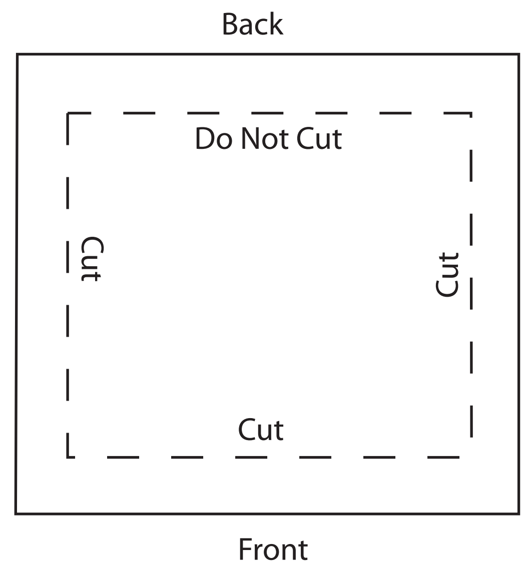
How to Make a Pizza Box Solar Oven

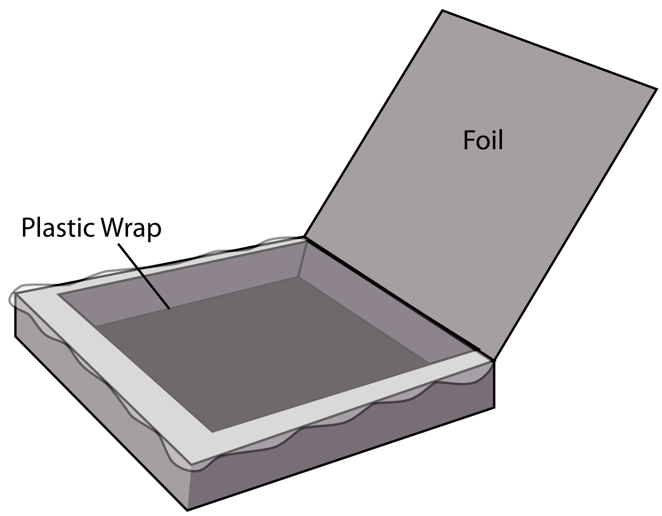
Materials

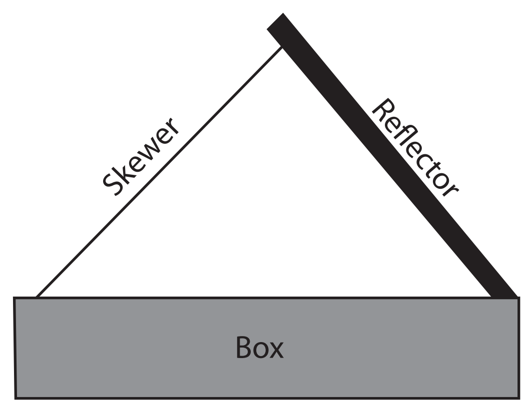
- 1 Medium pizza box
- 16” Plastic wrap
- 16” Aluminum foil
- 1 Wood skewer
- Marker
- Ruler
- Scissors
- Tape
- 1 Sheet black construction paper
- Food to cook
- Black paper plate

Procedure

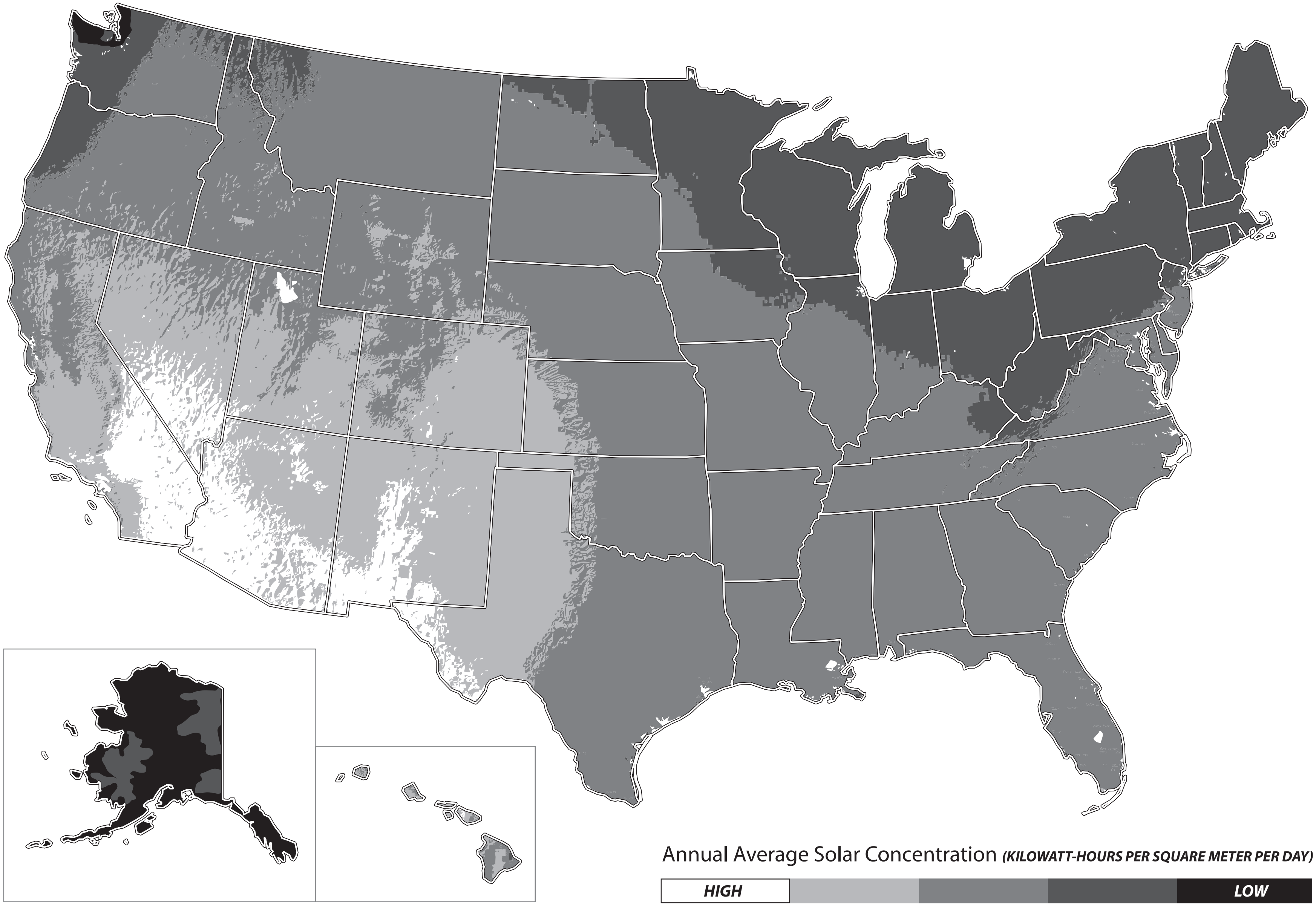
1. On the top of the pizza box, use a marker to draw a square one inch from all sides of the box.
2. Use scissors to cut along the front and sides of the square you just drew. Leave the fourth side along the box’s hinge uncut.
3. Tape aluminum foil to the inside surface of the new flap you just cut, leave the foil shiny side visible. Smooth out any wrinkles.
4. Tape plastic wrap over the hole you cut. Seal the edges with tape.
5. Tape black construction paper to the bottom of the box to help absorb the incoming sunlight.
6. Cover any air leaks around the box edges with tape. Make sure that the box can still be opened to place food inside the box and remove later.
7. Go outside in the sunlight and place the box on a flat, level surface.
8. Place food on a black paper plate and place inside the oven.
9. Tape one end of the skewer to the reflector lid, and attach the other end to the pizza box to adjust the reflector.
10. Let food cook, and check the reflector angle periodically to make sure sunlight is getting inside the solar oven.







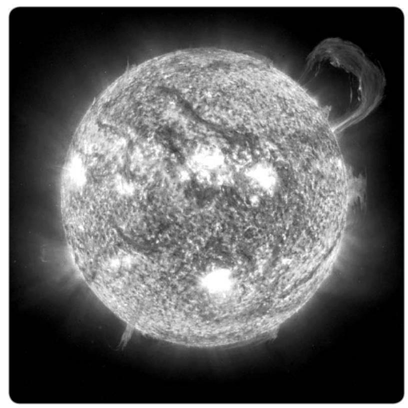
Annual Average Solar Concentration



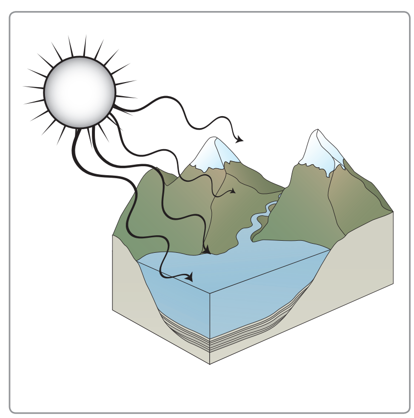
Note: Alaska and Hawaii not shown to scale
Data: NREL

sun

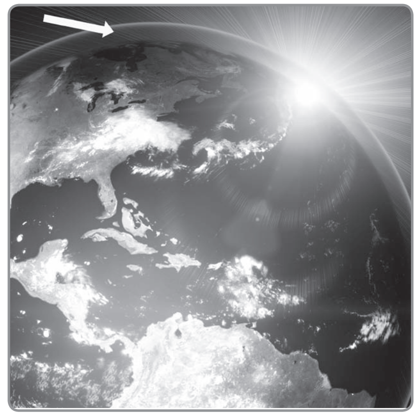
solar energy



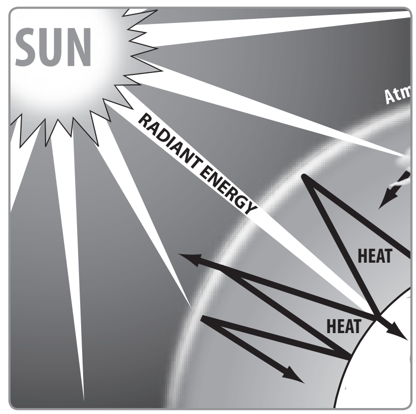
radiant energy



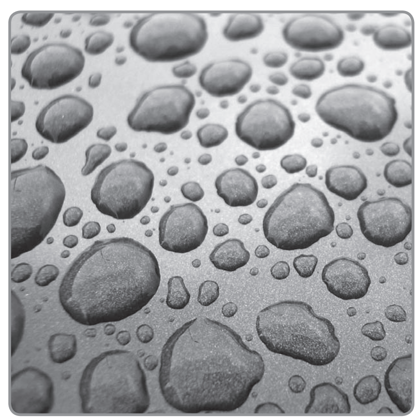
atmosphere



Greenhouse Effect



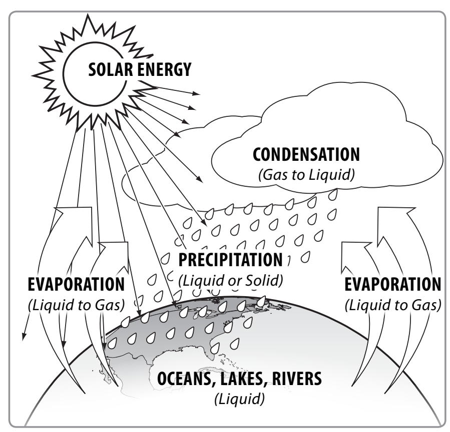
condensation



precipitation

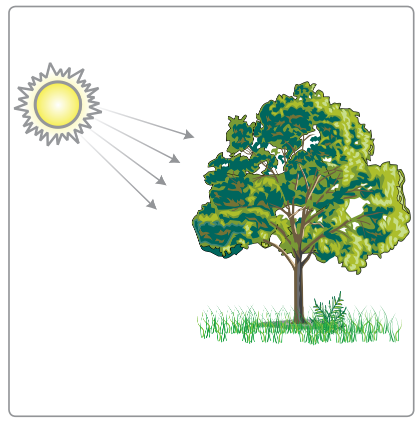
evaporation

water cycle

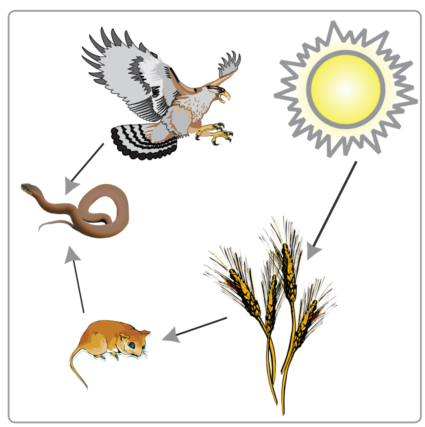


wind

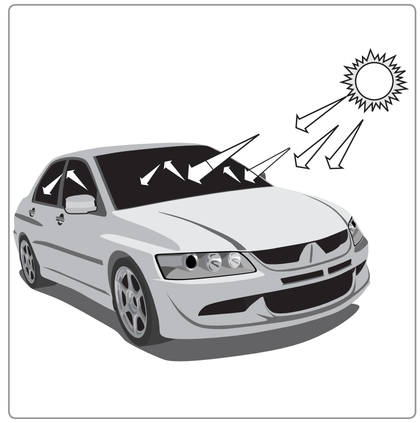
photosynthesis



food chain

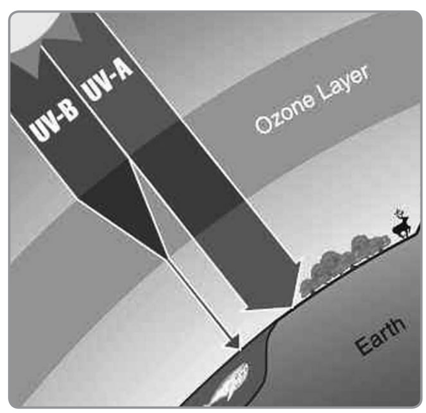


solar
collector

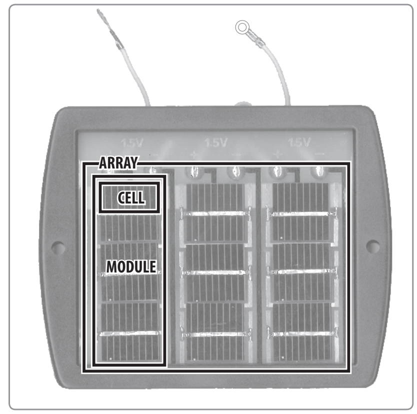


photovoltaic
(PV) cell

ultraviolet
radiation



PV module



PV panel

energy

The Sun and Its Energy

Some of the sun's energy reaches Earth. Most of it goes into space.

The sun sends out light all of the time. The sun’s light is called solar energy, or radiant energy.

Most of the sun’s energy goes into space. Some of the energy from the sun reaches Earth.

Solar Energy

The Earth gets most of its energy from the sun. We call this energy solar energy. *Sol* means sun. Solar energy travels from the sun to the Earth in rays. Some are light rays that we can see. Some are rays we cannot see, like x-rays. Energy that travels in rays is called radiant energy.

Like all stars, the sun is a giant ball of gas. It sends out huge amounts of radiant energy every day. Most of the rays travel into space. Only a small portion reaches the Earth.

When the rays reach the Earth, some bounce off clouds back into space—the rays are reflected. The Earth absorbs most of the solar energy and turns it into heat. This heat warms the Earth and the air around it—the atmosphere. Without the sun, we couldn't live on the Earth—it would be too cold.

The sun's energy can be converted, or changed, to heat. People, animals, and plants can live on Earth because it is just the right temperature for life.

More Information

Every day, the sun radiates (sends out) an enormous amount of energy. It radiates more energy in one second than the world has used since time began. This energy comes from within the sun itself. Like most stars, the sun is a big gas ball made up mostly of hydrogen and helium atoms. The sun makes energy in its inner core through a process called nuclear fusion.

During nuclear fusion, the high pressure and temperature in the sun's core cause hydrogen (H) atoms to come apart. Four hydrogen nuclei (the centers of the atoms) combine, or fuse, to form one helium atom. During the fusion process, radiant energy (light) is produced.

It takes thousands of years for the radiant energy in the sun's core to make its way to the solar surface, and then just a little over eight minutes to travel the 93 million miles to Earth. The radiant energy travels to the Earth at a speed of 186,000 miles per second, the speed of light.

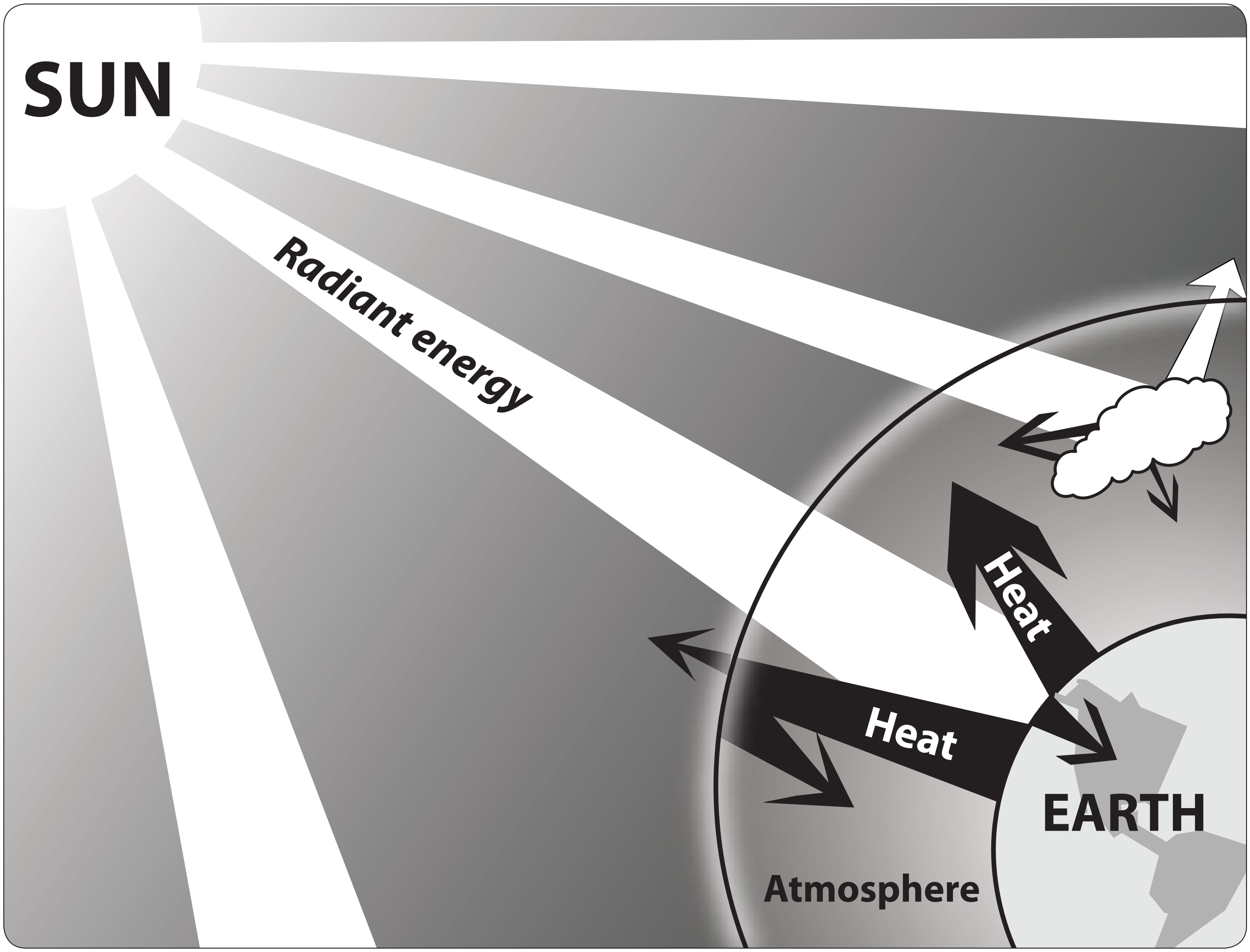
Only a small portion of the energy radiated by the sun into space strikes the Earth, one part in two billion. Yet this amount of energy is enormous. Every day enough energy strikes the United States to supply the nation's energy needs for one and a half years. About 30 percent of the radiant energy that reaches the Earth is reflected back into space. Another 25 percent is used to evaporate water, which is lifted into the atmosphere and produces rainfall. Radiant energy is also absorbed by plants, the land, and the oceans.

Discussion Questions

1. How do we know the light from the sun is energy? *(Energy makes change or gives us the ability to do work. The light from the sun allows us to see—without light it would be dark—light is a change—it is energy. We can feel it when it touches our skin—the light energy turns into heat—that is a change. We know it makes plants grow—growth is a change—plants die without the energy in sunlight.)*

2. What would the Earth be like without the sun? *(The Earth would be very cold with no living things. There would be no water cycle, no wind.)*

Greenhouse Effect

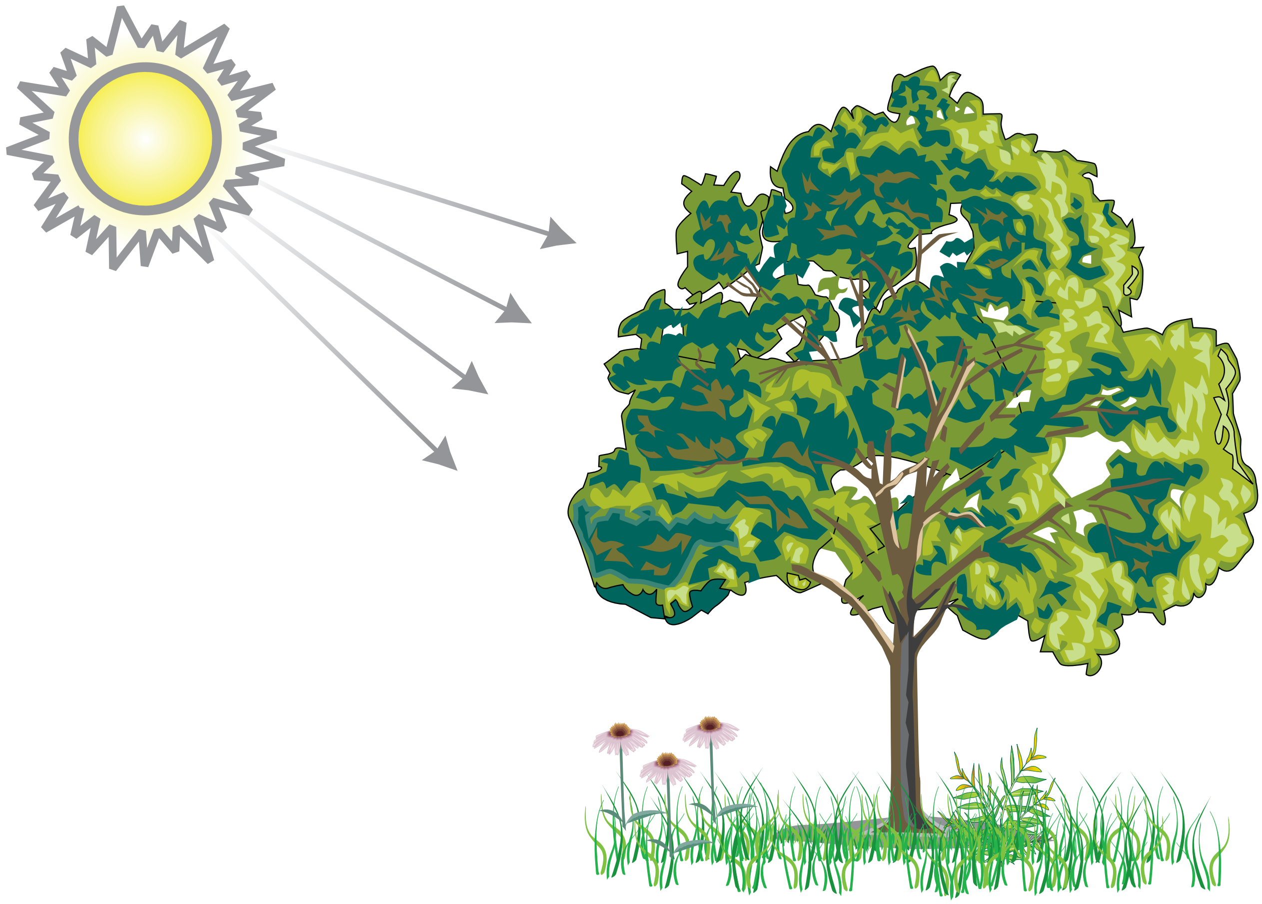


Some of the sun's energy that reaches Earth is transformed from light to heat. The atmosphere traps the heat and keeps our planet warm. This is called the Greenhouse Effect.

Nature Uses Solar Energy

The sun is very important to nature.

Photosynthesis



Plants turn sunlight into sugars. This provides energy for the plants to grow. Plants store the sugars in their leaves, stems, fruits, and roots.

Using Solar Energy

We Use Solar Energy In Many Ways

We use solar energy in many ways. During the day, we use sunlight to see what we are doing and where we are going.

Plants use the radiant energy (light) from the sun to grow. Plants absorb (take in) the radiant energy and turn it into glucose or simple sugars. The plants keep some of the sugars in their roots, stems, fruits, and leaves. It is chemical energy. The energy stored in plants feeds every living thing on the Earth. When we eat plants, and food made from plants, we store the energy in our bodies. We use the energy to grow and move. We use it to pump our blood, think, see, hear, taste, smell, and feel. We use the energy for everything we do.

The energy in the meat we eat also comes from plants. Animals eat plants to grow. They store the energy in their bodies.

We also use the energy stored in plants to make heat. We burn wood in campfires and fireplaces. Early humans used wood to cook food, scare away wild animals, and keep warm.

Solar energy turns into heat when it hits objects. That is why we feel warmer in the sun than in the shade. The light from the sun turns into heat when it hits our clothes or our skin. We use the sun's energy to cook food and dry our clothes.

Solar energy powers the water cycle. The water cycle is how water moves from clouds to the Earth and back again. The sun heats water on the Earth. The water evaporates—it turns into water vapor and rises into the air to form clouds. The water falls from the clouds as precipitation—rain, sleet, hail, or snow. When the precipitation falls to Earth, gravity pulls it to lower ground. There is energy in the moving water.

Solar energy makes the winds that blow over the Earth. The sun shines down on the land and water. The land heats up faster than the water. The air over the land gets warm. The warm air rises. The cooler air over the water moves in where the warm air was. This moving air is wind.

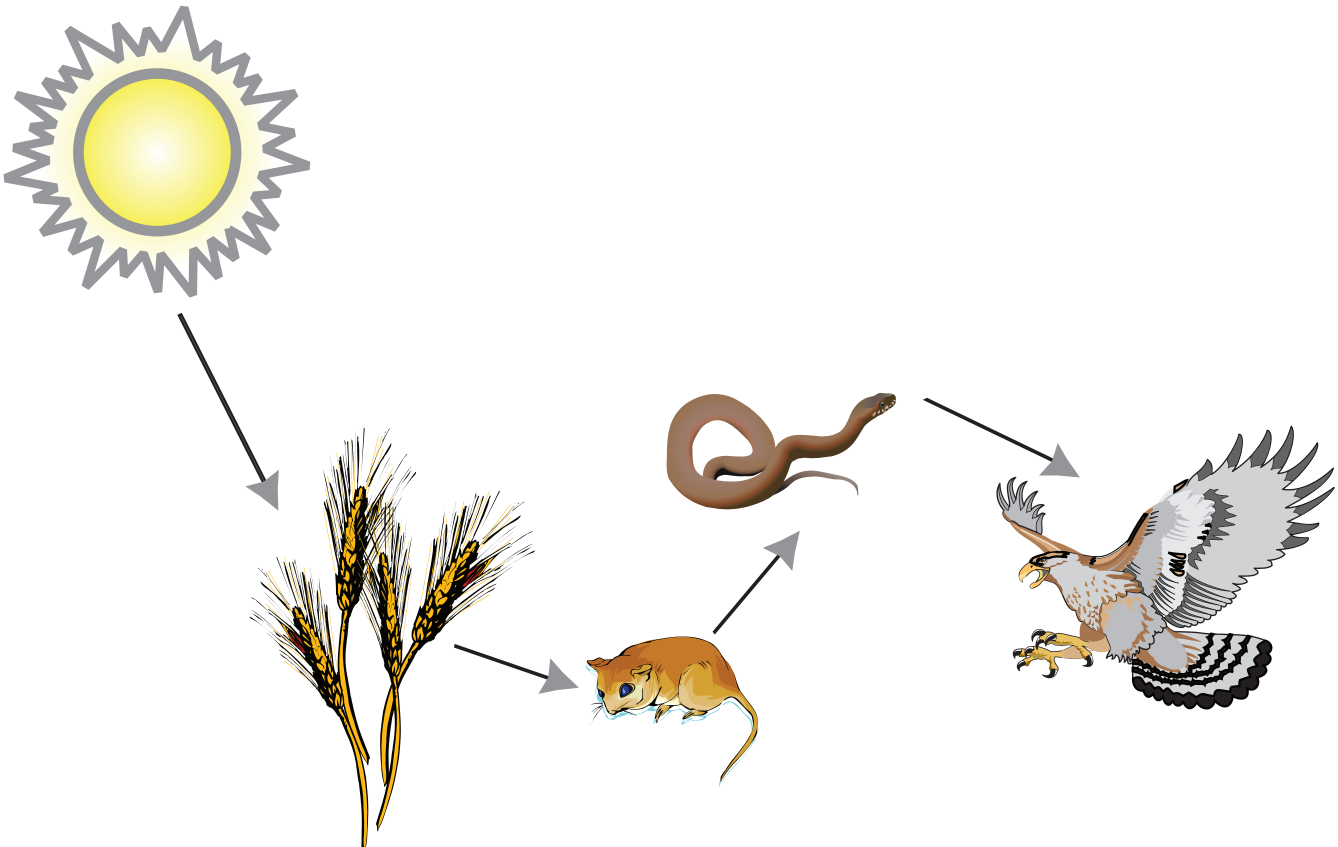
Discussion Questions

1. What are some foods made from plants? *(Breads, pastas, rice, vegetables, fruits, etc.)*

2. How does the energy in a hamburger come from the sun? *(A hamburger is made from beef from a cow that ate grass—the grass absorbed energy from the sun.)*

3. Should you wear a white shirt or a black shirt on a hot, sunny day? *(A white shirt—dark colors absorb more light energy and turn it into heat.)*

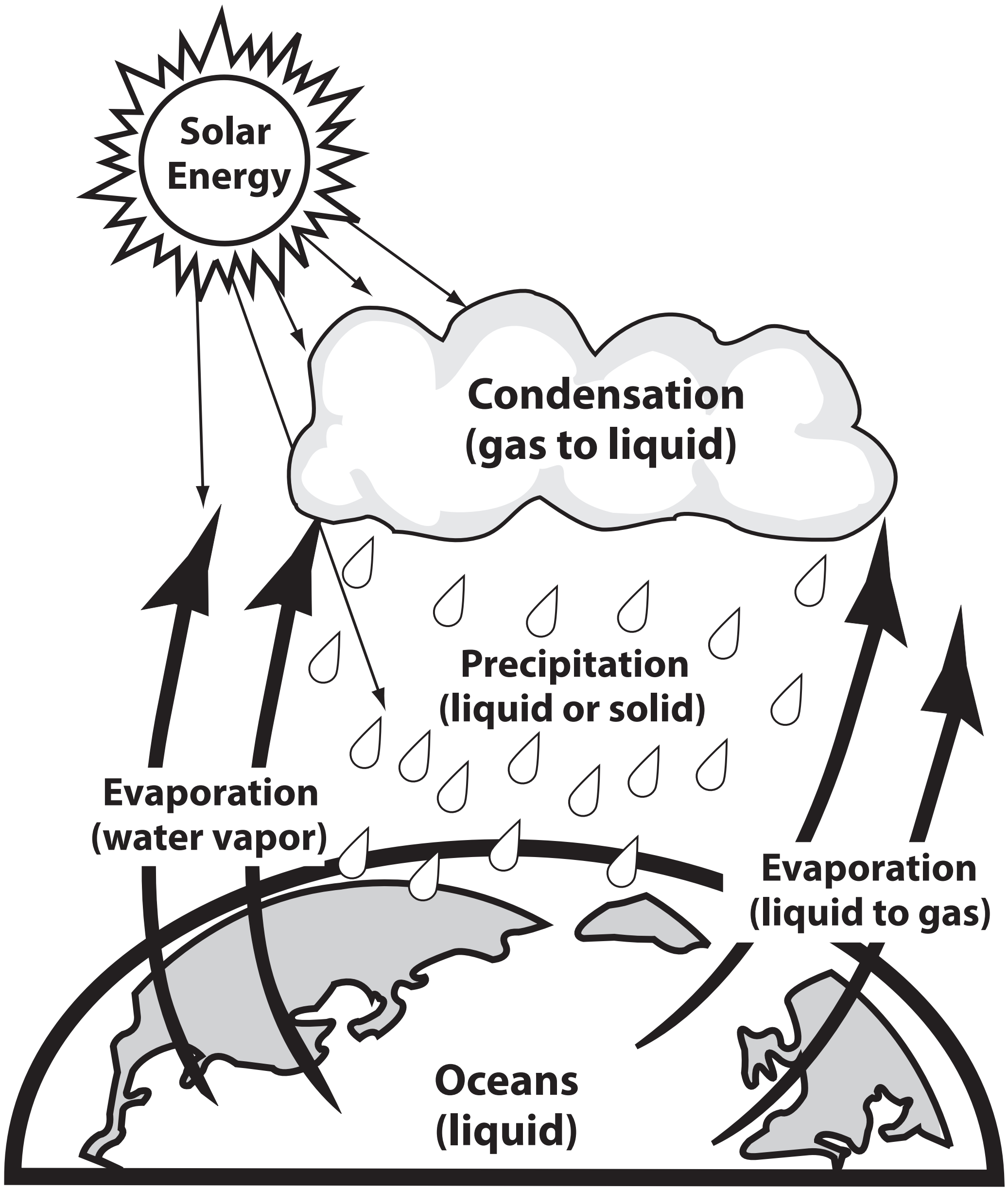
The Food Chain



The sun is part of the food chain. Plants can turn sunlight directly into food, but animals cannot.

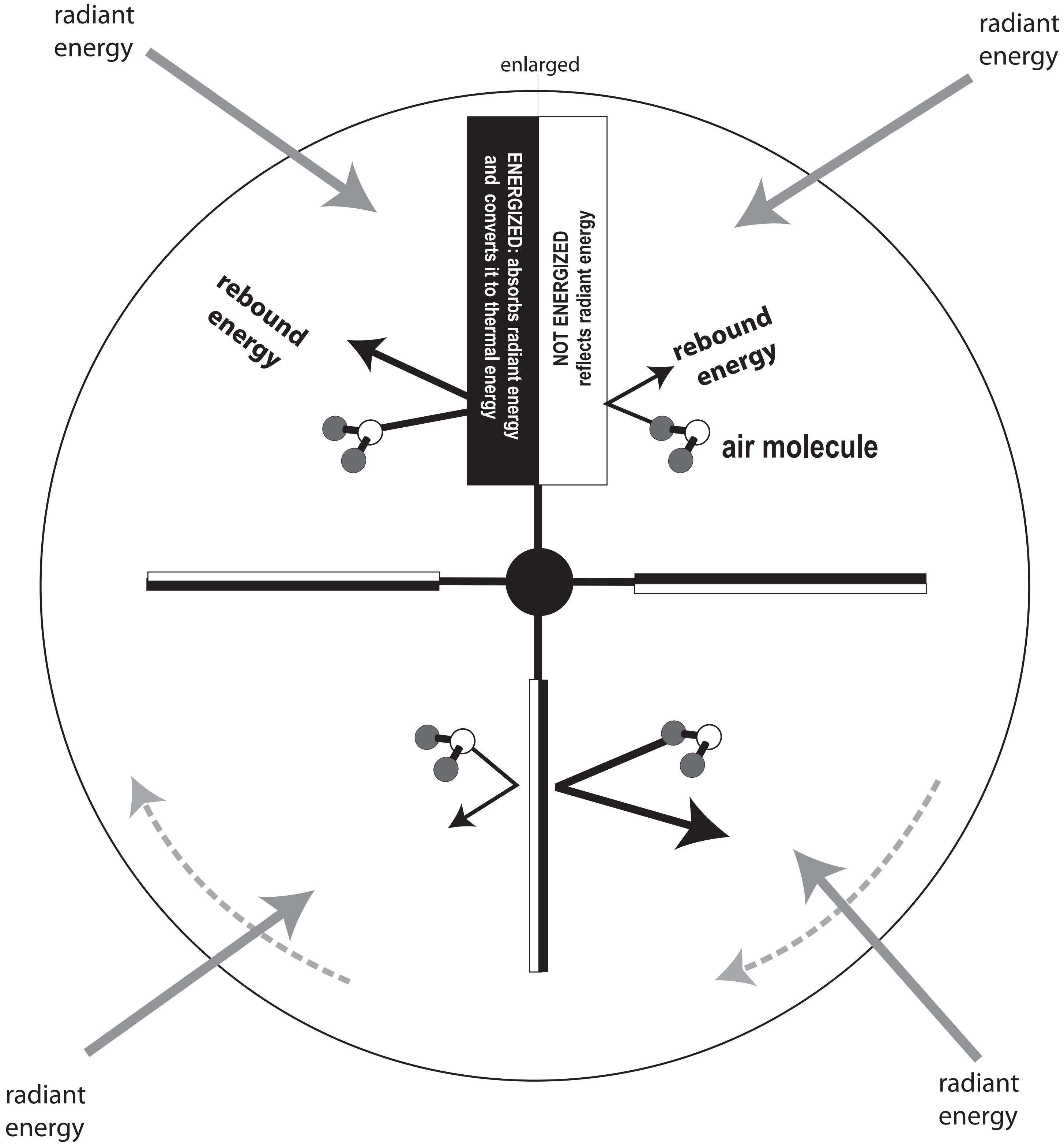
A mouse gets its energy from the plant, which got its energy from the sun. A snake gets its energy by eating the mouse. A hawk gets its energy by eating the snake. The sun's energy flows through them.

The Water Cycle

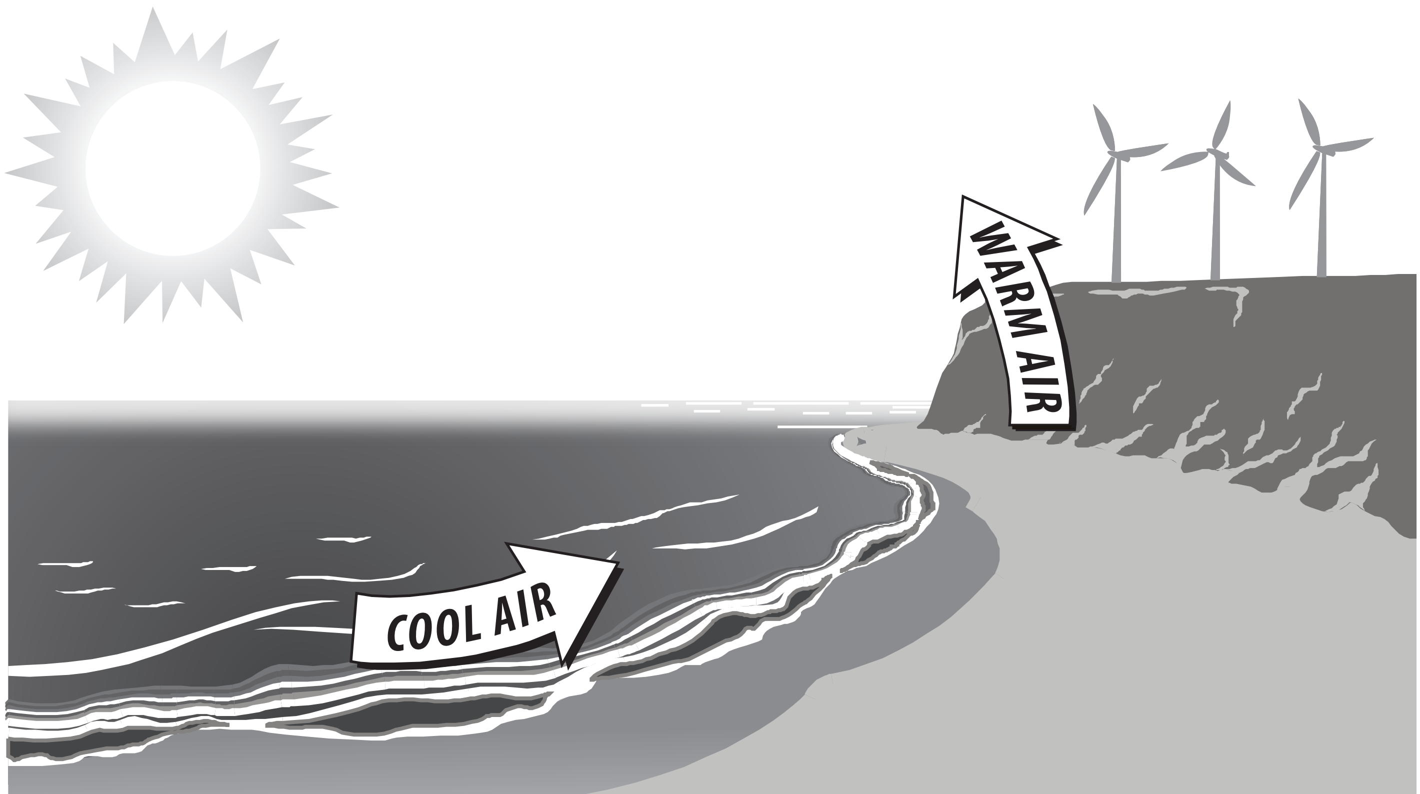


The sun is important to the water cycle. Solar energy causes water to evaporate.

Top View of Radiometer



How Wind is Formed



1. The sun shines on land and water.

2. Land heats up faster than water.

3. Warm air over the land rises.

4. Cool air over the water moves in.

Solar energy causes wind to form.

Ultraviolet Radiation

The sun's energy travels in waves. This is called radiation. The sun's waves have different lengths and different names. One type of wave is called ultraviolet, or UV, radiation.

Too much UV radiation is harmful. It can damage your eyes, cause your skin to burn, or make you sick. We need to protect ourselves from UV radiation.

Ultraviolet Radiation

The sun's energy travels in waves. The movement of energy in waves is called radiation. There are many types of radiation. Some radiation helps us see, some radiation you can feel, and some you cannot see or feel. One type of radiation is ultraviolet (UV) radiation. UV radiation has a shorter wavelength and higher energy than visible light. You cannot see or feel UV radiation.

More Information

There are three types of UV radiation—UVA, UVB, and UVC. The ozone layer absorbes some of the UV radiation before it reaches the Earth. UVC is completely absorbed by the ozone layer and atmosphere, so people don't need to worry about its effects. However, both UVA and UVB reach the Earth's surface. UVA radiation levels are more constant levels year round. The amount of UVB reaching the surface varies greatly depending on the time of day, time of year, latitude, altitude, weather conditions, and reflection of the surface in your location.

The National Weather Service and the Environmental Protection Agency developed the UV Index. This index indicates the strength of UV radiation on a scale from 1 to 11+, with 1 being low, and 11 being extremely high. UV Index forecasts are often published in newspapers in the weather section. You can also enter your zip code to obtain the UV forecast for your area at www.epa.gov/sunwise/uvindex.html.

Overexposure to UV radiation can cause skin damage, including skin cancer, eye damage, and other health problems. However, students, and adults, should not let concerns over UV radiation stop them from going outside. Proper protection from UVA and UVB radiation allows everyone to enjoy the outdoors without worry.

Steps you can take to protect yourself from overexposure to UV radiation are:

- Check the UV Index forecast. Even on cloudy days you can get a sunburn.
- Generously apply sunscreen so you do not burn.
- Wear protective clothing.
- Seek shade, especially when the sun's UV rays are strongest between 10 a.m. and 4 p.m.
- Be extra careful near water, snow, and sand, which have high reflective properties.

Discussion Question

What do you do to protect yourself from UV radiation? *(Wear sunscreen, sunglasses, hat, protective clothing, seek shade, etc.)*

Note: Information for this section has been taken from the U.S. Environmental Protection Agency. For more information, visit www.epa.gov/sunwise.

People Use Solar Energy

We use solar energy for many things.

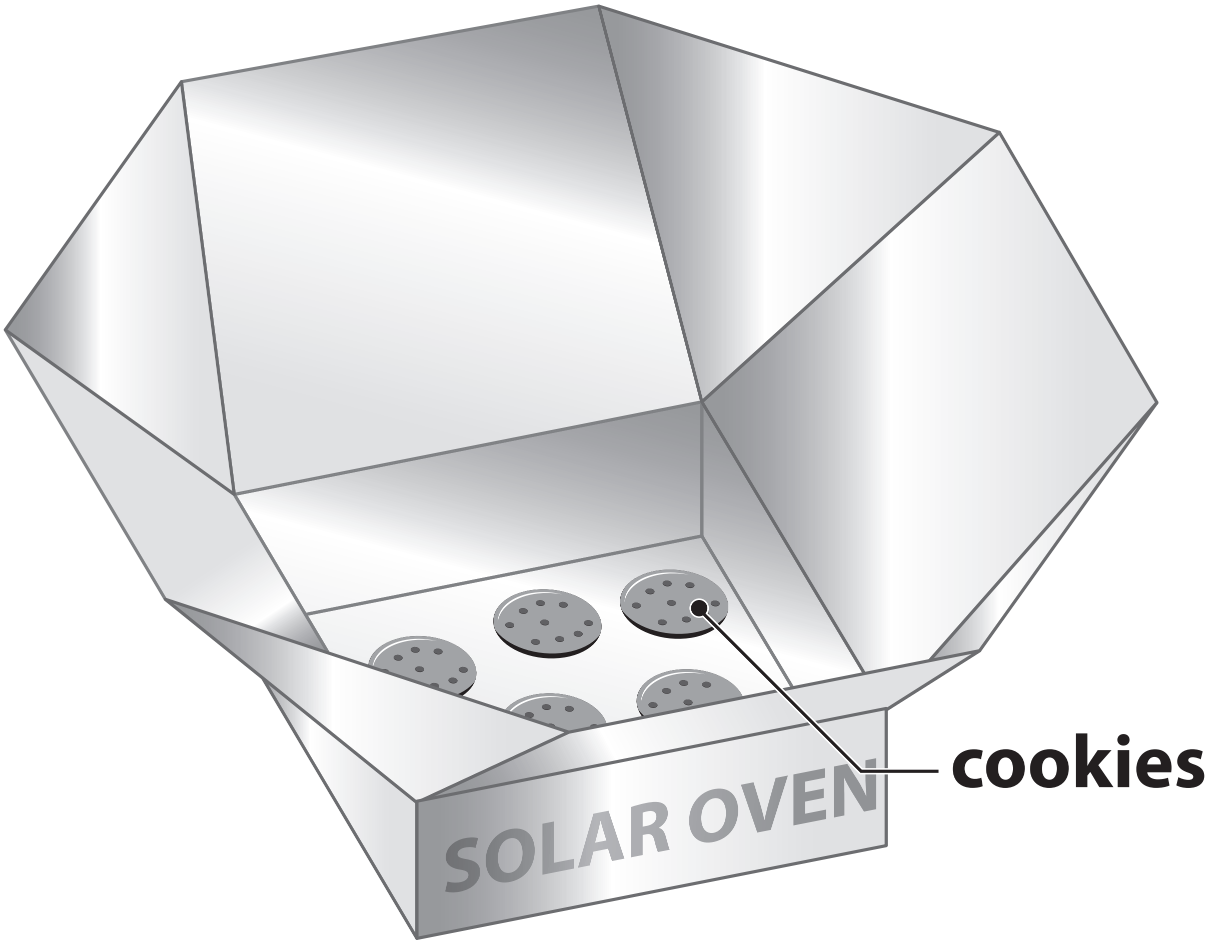
Solar energy provides light so we can see during the day.

We can dry clothes with solar energy.

We burn plants to turn their energy into heat.

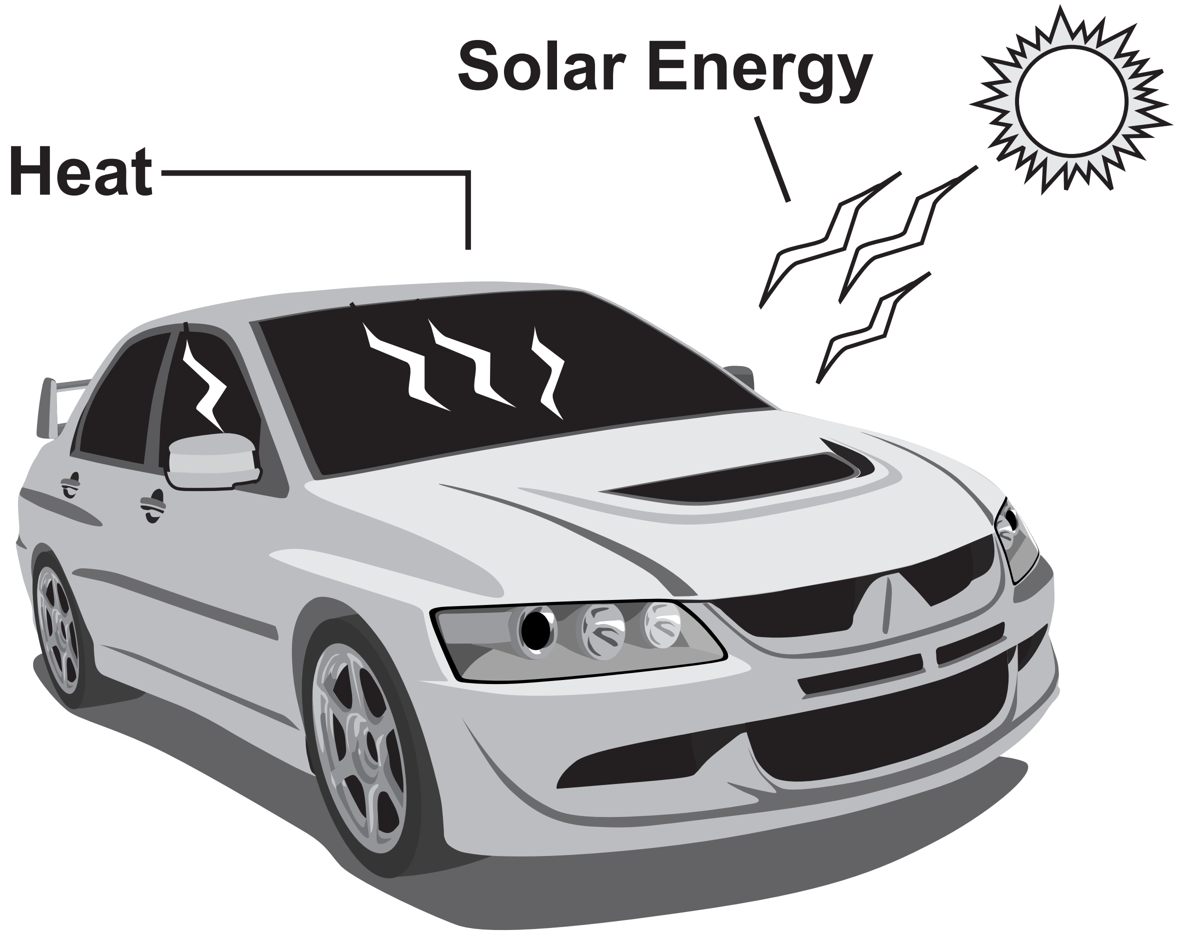
We eat plants that have stored solar energy.

Solar Oven



We can cook food with solar energy.

Solar Collector



Light passes through the window and hits the inside of the car. It turns into heat and is trapped inside.

Collecting Solar Energy

Why don't we use the sun for all our energy needs? We don't know how to yet. The hard part is capturing the energy. Only a little bit reaches any one place. On a cloudy day, most of the solar energy never reaches the ground at all.

Lots of people put solar collectors on their roofs. Solar collectors capture the energy from the sun and turn it into heat. People can heat their houses and water using solar energy.

More Information

Heating with solar energy is not as easy as you might think. Capturing sunlight and putting it to work is difficult because the solar energy that reaches the Earth is spread out over a large area. The amount of solar energy an area receives depends on the time of day, the season of the year, the cloudiness of the sky, and how close it is to the Earth's equator.

A solar collector is one way to capture sunlight and change it into usable heat energy. A closed car on a sunny day is like a solar collector. As sunlight passes through the car's windows, it is absorbed by the seat covers, walls, and floor of the car. The absorbed energy changes into heat. The car's windows let radiant energy in, but they do not let all the heat out.

Space heating means heating the space inside a building. Today, many homes use solar energy for space heating. A passive solar home is designed to let in as much sunlight as possible. It is like a big solar collector. Sunlight passes through the windows and heats the walls and floor inside the house. The light can get in, but the heat is trapped inside. A passive solar home does not depend on mechanical equipment, such as pumps and blowers, to heat the house.

An active solar home, on the other hand, uses special equipment to collect sunlight. An active solar home may use special collectors that look like boxes covered with glass. These collectors are mounted on the rooftop facing south to take advantage of the winter sun. Dark-colored metal plates inside the boxes absorb sunlight and change it into heat. (Black absorbs sunlight better than any other color.) Air or water flows through the collector and is warmed by the heat. The warm air or water is distributed to the rest of the house, just as it would be with an ordinary furnace system.

Solar energy can be used to heat water. Heating water for bathing, dishwashing, and clothes washing is the second biggest home energy cost. A solar water heater works a lot like solar space heating. In our hemisphere, a solar collector is mounted on the south side of a roof where it can capture sunlight. The sunlight heats the water and stores it in a tank. The hot water is piped to faucets throughout a house, just as it would be with an ordinary water heater. Installing a solar water heater can save 50 percent on water heating bills.

Discussion Question

Where on the Earth do you think it would be easy to capture solar energy? *(The desert, near the equator, any place where it is sunny most of the time.)*

Electricity

Scientists invented solar cells. Solar cells convert the sun's energy into electricity.

Many solar cells together make a module. Many modules connected together make a panel. Some people put solar panels on their homes so they can generate electricity from the sun.

Solar panels are expensive, but electricity from the sun is clean and free.

Solar House

A photovoltaic (PV) cell changes radiant energy into electricity. Electricity can run a motor to make motion and make light. A solar collector absorbs radiant energy and turns it into heat. A solar collector can heat water. A water storage tank painted black can store hot water and keep it hot by absorbing radiant energy.

Step 1: Use a cardboard box to make a house with big windows and a door in the front.

Step 2: Use clear transparency film to cover the windows.

Step 3: Use black construction paper to make a round water storage tank. Attach it to the side of the house with tape.

Step 4: Make two holes in the top of the box like in the drawing. Each hole should be about one centimeter (1 cm) in diameter.

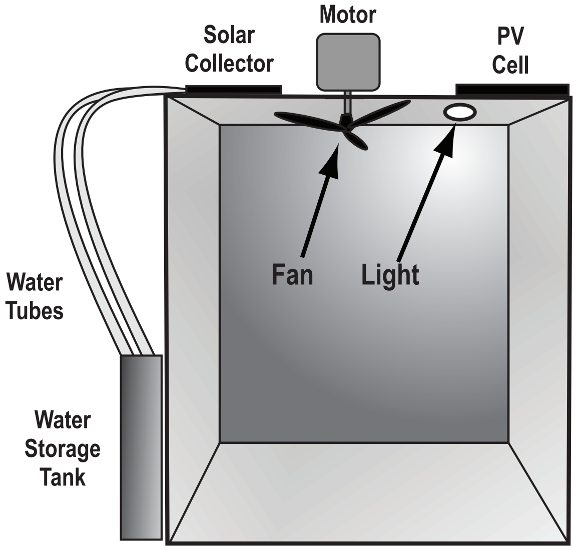
Step 5: Place the solar collector on top of the house as shown in the drawing. Put the tubing from the solar collector into the water storage tank.

Step 6: Place the PV cell on top of the house. Insert the light through the hole as shown in the diagram. Put the stem of the motor through the other hole for the motor stem.

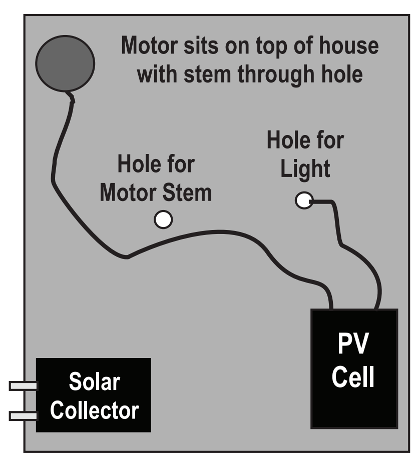
Step 7: Put a tiny bit of clay into the hole of the fan and push it onto the stem of the motor that is sticking through the ceiling.

Step 8: On a sunny day, place the house in the sun with the front facing south.

Step 9: Observe the light shine and the fan turn as the PV cell turns radiant energy from the sun into electricity. The solar collector shows how a real solar house could heat and store water. It doesn't really work.



Front View of House



Top View of House

Solar Energy Can Make Electricity

Photovoltaic (PV) cells turn the sun's energy into electricity. *Photo* means light and *volt* is a measure of electricity. PV cells are made of silicon, the main ingredient in sand. Each side of the silicon wafer has a different chemical added. When radiant energy hits the PV cell, the chemicals make electricity. Some toys and calculators use small PV cells instead of batteries. Big PV cells can make enough electricity for a house. They are expensive, but good for houses far away from power lines.

Some schools are adding PV cells to their roofs. The electricity helps lower the amount of money schools must pay for energy. The students learn about the PV cells on their school buildings. Today, solar energy provides only a tiny bit of the electricity we use. In the future, it could be a major source of energy. Scientists are looking for new ways to capture and use solar energy.

More Information

Photovoltaic cells are also called PV cells, or solar cells, for short. You are probably familiar with photovoltaic cells. Solar-powered toys, calculators, and roadside telephone call boxes all use solar cells to convert sunlight into electricity.

Solar cells are made of a thin piece of silicon—the substance that makes up sand and the second most common element on Earth. One side of the silicon wafer has a small amount of boron added to it, which gives it a tendency to attract electrons. It is called the p-type silicon because of its positive tendency. The other side of the silicon wafer has a small amount of phosphorous added to it, giving it an excess of free electrons. This is called the n-type silicon because of its tendency to give up electrons, a negative tendency. When the two sides have both been chemically modified, some electrons from the n-type silicon flow to the p-type silicon, forming an electric field between the layers. The p-type silicon now has a negative charge and the n-type silicon has a positive charge.

When the PV cell is placed in the sun, the radiant energy energizes the free electrons. If a circuit is made connecting the sides, electrons flow from the n-type silicon through the wire to the p-type silicon. The PV cell is producing electricity—the flow of electrons. If a load, such as a light bulb, is placed along the wire, the electricity will do work as it flows. The conversion of sunlight into electricity takes place silently and instantly. There are no mechanical parts to wear out.

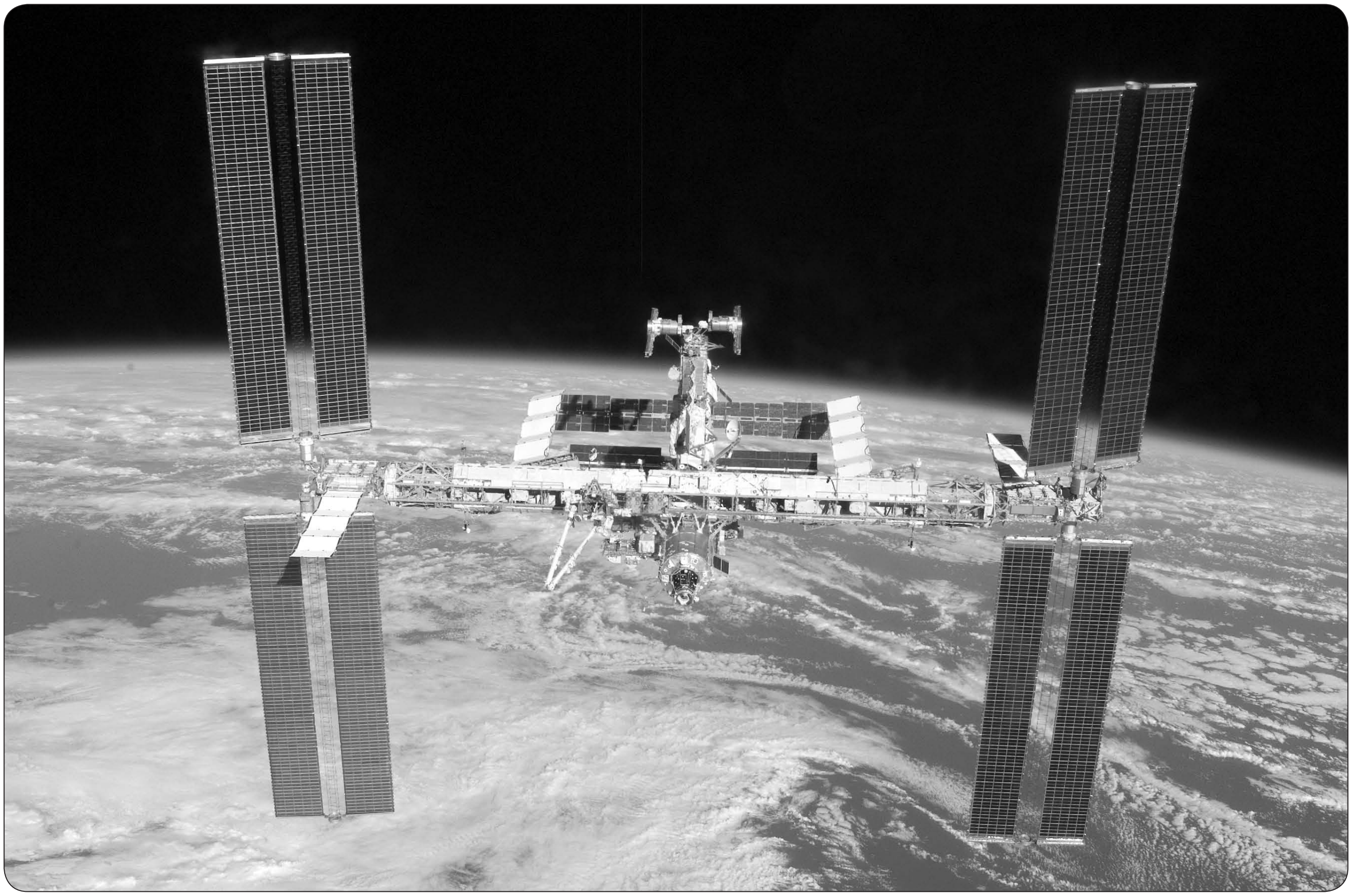
Compared to other ways of producing electricity, PV systems are expensive. It costs 10-20 cents a kilowatt-hour to produce electricity from solar cells. On average, people pay about 12 cents a kilowatt-hour for electricity from a power company using fuels like coal, uranium, or hydropower.

Discussion Questions

1. Have you seen a solar cell? Where did you see it?

2. What did it power?

Electricity in Space



Many solar panels make a solar array. Solar arrays are used to make electricity for cities. Solar arrays are used on the International Space Station to provide electricity for the astronauts.

Date ________________

Question:
What happened when we put one plant in the sunlight and one plant in the dark?

Draw a picture of the final result.

Sunlight *Dark*

Explain what you observed. What did you learn?

My Plant Investigation Science Notebook

Name

Date ____________________

Day _____

Observations:

Draw a picture of the plant in the sunlight and a picture of the plant in the dark.

Sunlight *Dark*

What do you notice about the plants? __________

Date ____________________

Question:

What will happen if we put one plant in the sunlight and one plant in the dark?

Prediction:

I predict ____________________

because ____________________

Date ______________________

Day _____

Observations:
Draw a picture of the plant in the sunlight and a picture of the plant in the dark.

Sunlight	*Dark*

What do you notice about the plants? __________

____

____

____

____

____

Date ______________________

Day _____

Observations:
Draw a picture of the plant in the sunlight and a picture of the plant in the dark.

Sunlight	*Dark*

What do you notice about the plants? __________

____

____

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____

Date ____________________

Day _____

Observations:
Draw a picture of the plant in the sunlight and a picture of the plant in the dark.

Sunlight	*Dark*

What do you notice about the plants? __________

____

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____

____

Date ____________________

Day _____

Observations:
Draw a picture of the plant in the sunlight and a picture of the plant in the dark.

Sunlight	*Dark*

What do you notice about the plants? __________

____

____

____

____

____

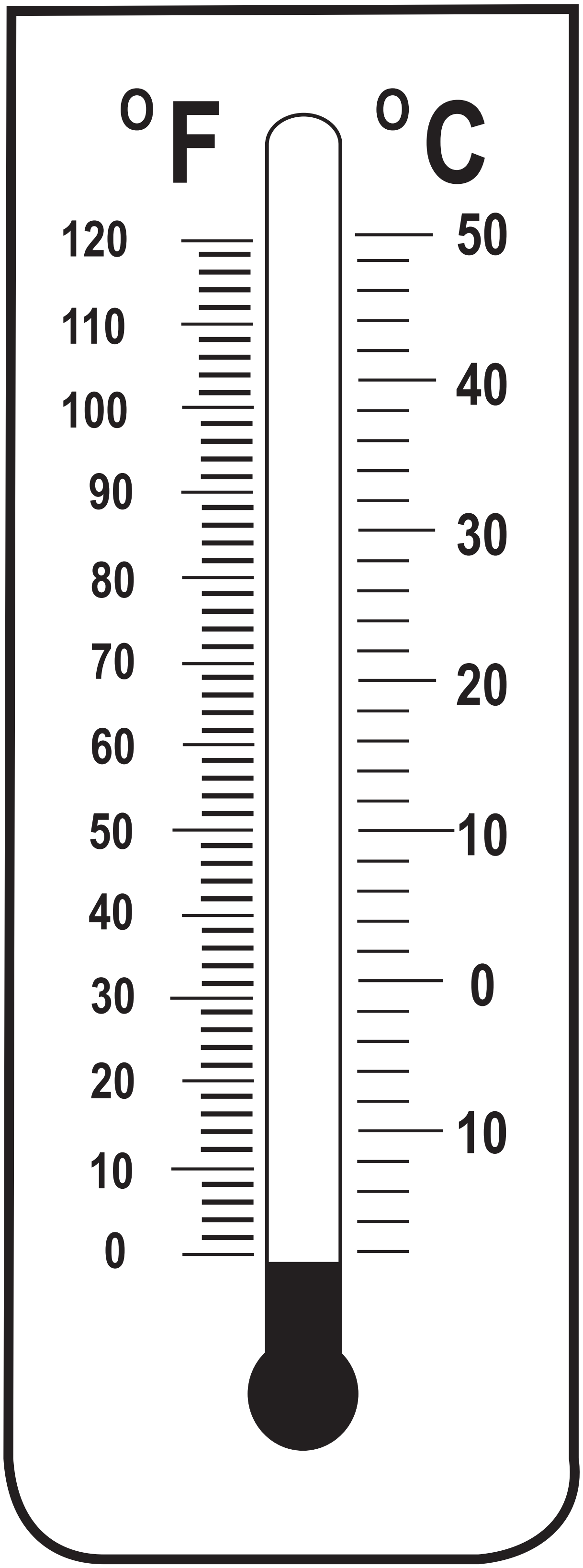
Name ______________________________ Date ____________________

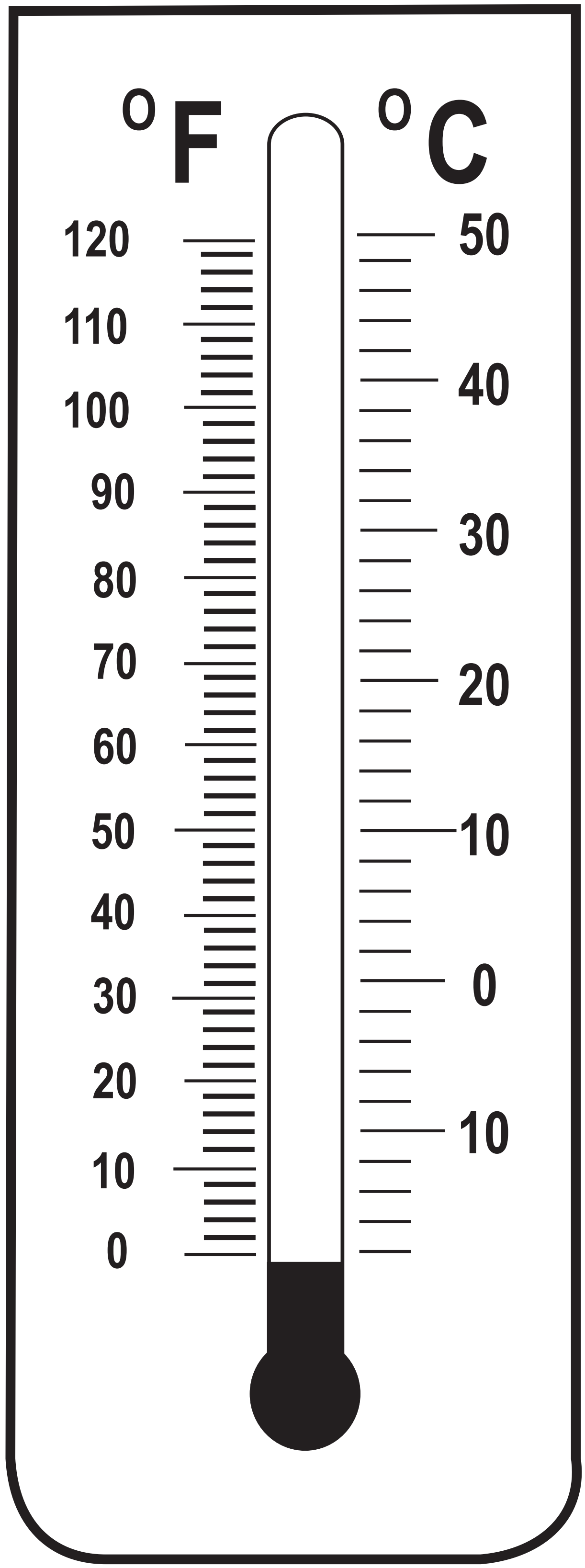
Radiometer

Draw a picture of the radiometer below and label the parts.

What happens when you put the radiometer in the sun?

Reading a Thermometer





Name ____________________ Date ____________________

Black and White

Question: What will happen to the temperature if we place one thermometer in a black pouch and one thermometer in a white pouch?

Prediction:

____

____

____

____

____

____

____

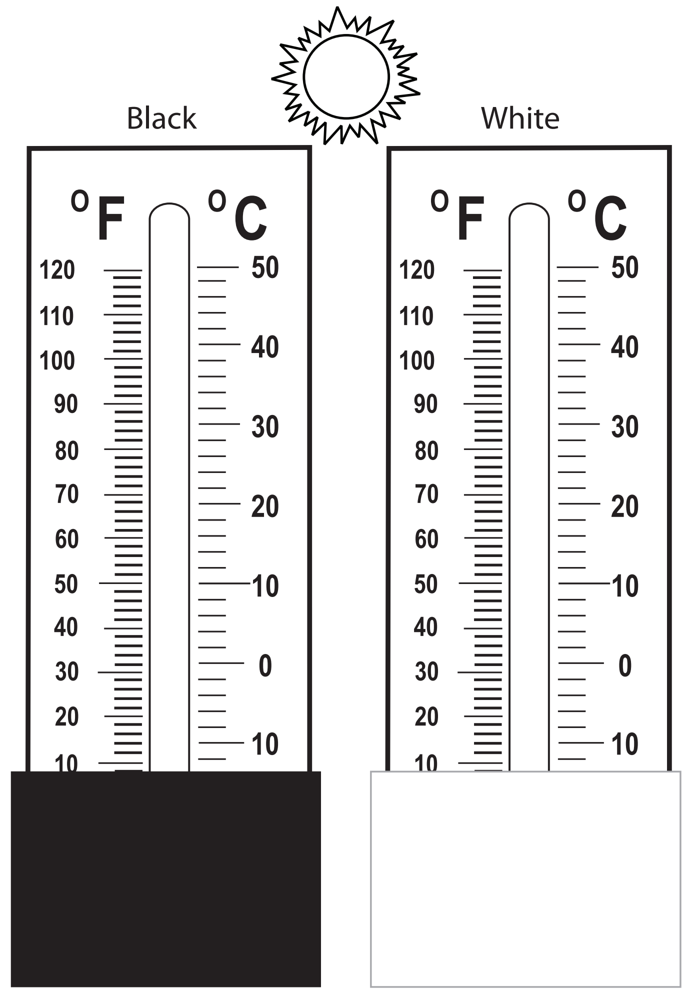
____

Starting Temperatures: ____________________
Thermometer A

____
Thermometer B

Ending Temperatures: ____________________
Thermometer A

____
Thermometer B



Thermometer A **Thermometer B**

Conclusion:

____

____

____

____

Name ______________________________ Date ____________________

Color Changing Bracelet

Before

After

Where were you when the beads were white? Where were you when the beads changed color? What makes the beads change color?

Name ______________________________ Date ________________

NaturePrint® Paper

How did solar energy make the design on your NaturePrint® Paper?

____

____

____

____

____

Name ______________________________ Date ____________________

Solar Balloon

Before

After

What happens when the solar balloon is left in the sun? Why?

Name ______________________________ Date ____________________

How to Use a Solar Oven

Name ______________________________ Date ____________________

Solar House

Draw a picture of the solar house and label the parts.

Explain how the house uses the sun's energy.

The Sun and Its Energy Evaluation Form

State: ____________ **Grade Level:** ____________ **Number of Students:** ___________

1. **Did you conduct the entire unit?**	❑ Yes	❑ No
2. **Were the instructions clear and easy to follow?**	❑ Yes	❑ No
3. **Did the activities meet your academic objectives?**	❑ Yes	❑ No
4. **Were the activities age appropriate?**	❑ Yes	❑ No
5. **Were the allotted times sufficient to conduct the activities?**	❑ Yes	❑ No
6. **Were the activities easy to use?**	❑ Yes	❑ No
7. **Was the preparation required acceptable for the activities?**	❑ Yes	❑ No
8. **Were the students interested and motivated?**	❑ Yes	❑ No
9. **Was the energy knowledge content age appropriate?**	❑ Yes	❑ No
10. **Would you teach this unit again?**	❑ Yes	❑ No

Please explain any 'no' statement below

How would you rate the unit overall?	❑ excellent	❑ good	❑ fair	❑ poor
How would your students rate the unit overall?	❑ excellent	❑ good	❑ fair	❑ poor

What would make the unit more useful to you?

Other Comments:

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Manassas, VA 20108
FAX: 1-800-847-1820

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National Fuel
National Grid
National Hydropower Association
National Ocean Industries Association
National Renewable Energy Laboratory
Nebraska Public Power District
New Mexico Oil Corporation
New Mexico Landman's Association
New Orleans Solar Schools Initiative
New York Power Authority
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