

# 11-3

## How is Earth's surface heated?

### INVESTIGATE



#### Modeling the Absorption of Light

##### HANDS-ON ACTIVITY

1. Place an aluminum plate under a lamp whose light is directed downward.
2. Fill half the plate with dry, dark soil and half with dry sand.
3. Insert a thermometer into each side. Record the temperatures.
4. Turn on the lamp and let the plate stand for a while. Compare the new temperatures with the starting ones.

**THINK ABOUT IT:** How do the temperatures change? Why is one higher than the other?



STEP 4

### Objective

Describe how energy from the Sun warms Earth's surface.

### Key Terms

**radiant** (RAY-dee-uhnt) **energy:** energy given off by the Sun that can travel through empty space

**radiation** (ray-dee-AY-shuhn): movement of the Sun's energy through empty space

**Radiant Energy** The Sun gives off **radiant energy**. If you go out into the sunlight, you can feel the radiant energy from the Sun warming your skin.

Light is a form of radiant energy. Radiant energy can travel across millions of kilometers of empty space. The movement of this energy through empty space is called **radiation**. Most of Earth's energy comes from the radiation given off by the Sun.

**1 NAME:** What kind of energy is sunlight?

**Absorption of Energy** Dark surfaces absorb light. When light is absorbed, or taken in, it is usually changed into heat.

Suppose you wrap two ice cubes with cloth. You wrap one ice cube in a dark-colored cloth and the other in light-colored cloth. You place both ice cubes in sunlight. Which one would melt first?

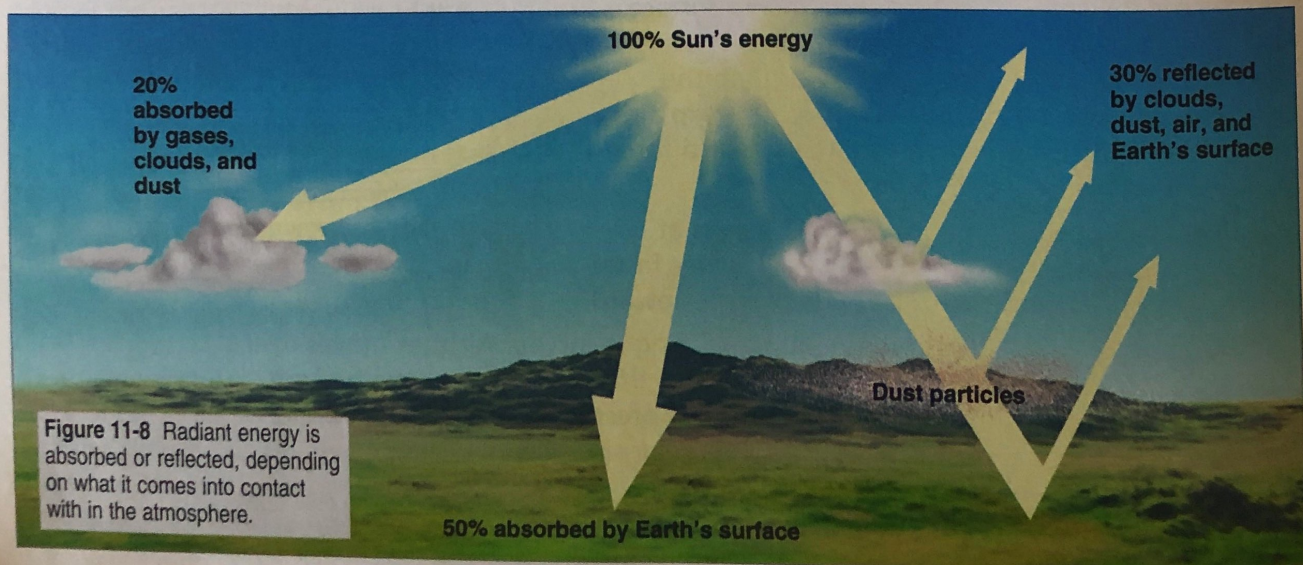


Figure 11-8 Radiant energy is absorbed or reflected, depending on what it comes into contact with in the atmosphere.

The ice cube wrapped in the dark cloth would melt faster. Surfaces that reflect light, such as white surfaces, remain cooler than surfaces that absorb light, such as dark surfaces.

2 **DESCRIBE:** What happens when light is absorbed by a surface?

**Energy from the Sun** Only a small part of the Sun's energy reaches Earth. Some of the Sun's energy is absorbed by the atmosphere. Clouds, dust particles, and water droplets in the atmosphere also absorb or reflect some of the Sun's energy. The energy that is reflected goes back into space. Some of the energy that passes through the atmosphere is absorbed by Earth's surface. This energy is changed into heat. As a result, Earth becomes warmer. The entire process is shown in Figure 11-10.

3 **STATE:** What happens when the Sun's energy is absorbed by Earth's surface?

### ✓ CHECKING CONCEPTS

1. Light is a type of \_\_\_\_\_.
2. The Sun's energy reaches Earth by \_\_\_\_\_.



## Science and Technology

### SOLAR ENERGY

The Sun is a potentially huge source of energy. It could be used to meet all of the world's energy needs. Scientists are working to develop efficient ways to use solar energy.

At one power plant in California's Mohave Desert, rings of huge mirrors capture sunlight and reflect it to a central tower. A liquid runs through pipes in the tower. The liquid becomes hot. The hot liquid is then used to boil water to make steam. The steam turns a turbine and a generator. In this way, solar energy can be converted to produce electricity when people need it, even after sunset.

Solar cells can also be used to turn solar energy directly into electricity. Solar cells are also called photovoltaic, or PV, cells. In the 1950s, solar cells were developed for use on U.S. spacecraft. Panels of solar cells power satellites in space. You might have a calculator or a watch that uses a solar cell. Some small, experimental cars are powered by solar cells.

**Thinking Critically** Why is it important to develop solar energy for heating homes?

3. When light is \_\_\_\_\_, it is changed into heat.
4. Clouds, \_\_\_\_\_, and water droplets can absorb or reflect the Sun's energy.



### THINKING CRITICALLY

5. **PREDICT:** If there was no wind, would it be cooler on a cloudy or on a clear day? Why?

### Web InfoSearch

**Electromagnetic Radiation** Electromagnetic radiation is energy in the form of waves of different frequencies. Frequency refers to how often the wave occurs in a given amount of time. Light is only one type of electromagnetic radiation.

**SEARCH:** Use the Internet to find out more about this. What are other types of electromagnetic radiation? In what technologies are they used? Start your search at [www.conceptsandchallenges.com](http://www.conceptsandchallenges.com). Some key search words are **electromagnetic radiation, light waves, and X-rays.**



▲ **Figure 11-9** On this artist's drawing of a communications satellite, the large blue panels contain the solar cells.

# 11-4 How does heat move through the atmosphere?

## Objective

Explain how the atmosphere is heated.

## Key Terms

**conduction** (kuhn-DUK-shuhn): transfer of heat through matter by direct contact

**convection** (kuhn-VEK-shuhn): process by which heat is transferred through a liquid or a gas

**Conduction** Heat moves through Earth's atmosphere in three main ways. These ways are conduction, radiation, and convection.

The troposphere, or lower layer of the atmosphere, is heated by a process that moves heat through matter. A metal pan placed over a flame will get hot. The metal molecules directly over the flame begin to move faster. They bump into the slower-moving molecules surrounding them and make them move faster. This is how heat moves through the metal pan.

Heat generally moves from an area of higher temperature to an area of lower temperature. This kind of movement of heat through matter is called **conduction**.

Sunlight absorbed by Earth's surface is changed into heat. This warms the surface. Air touches the warmed surface and is heated by conduction.

**1 NAME:** How does heat move through matter?

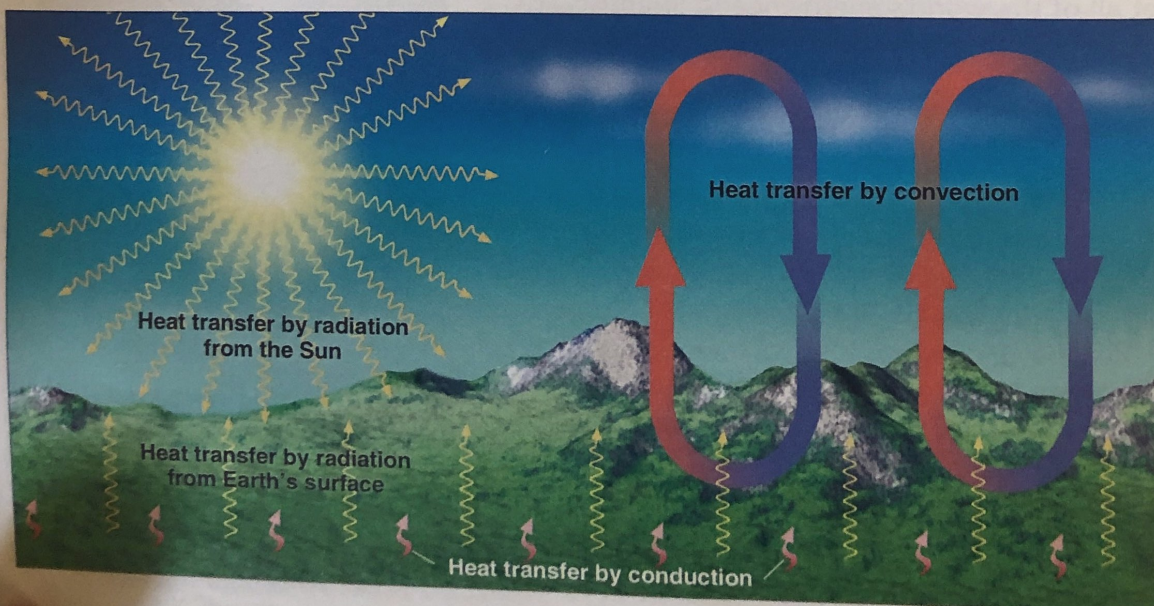
**Radiation** The atmosphere is also heated by the process of radiation. Radiant energy travels from the Sun through space in waves.

Most of the Sun's energy is short-wave radiation. This radiation passes easily through the atmosphere and strikes Earth's surface, where it is mostly absorbed and changed into heat energy. Heat energy is long-wave radiation. Earth's surface warms up and radiates most of the heat energy back into the atmosphere. There it is absorbed by gases. This warms the atmosphere.

**2 DESCRIBE:** What happens to the energy radiated by Earth?

**Convection** The process by which heat is transferred through a gas or a liquid is called **convection**. When air is heated, it expands. As the warm air expands, it becomes lighter because it becomes less dense. Warm air is lighter than cool air. Warm air rises. The cooler, denser air sinks.

**3 DEFINE:** What is convection?



◀ Figure 11-10  
There are three  
types of heat  
transfer:  
conduction,  
radiation, and  
convection.

## ✓ CHECKING CONCEPTS

1. When a solid is heated, its \_\_\_\_\_ move faster.
2. Solids are heated by \_\_\_\_\_.
3. Earth's radiant energy is \_\_\_\_\_-wave radiation.
4. Energy traveling in waves from the Sun is called \_\_\_\_\_ energy.
5. Heat moves through air by \_\_\_\_\_.

## 💡 THINKING CRITICALLY

6. **IDENTIFY:** Which of the following is conduction, which is radiation, and which is convection?
  - a. The water in a fish tank becomes warmer after the heater in it is turned on.
  - b. The Sun warms your skin on a summer day.
  - c. A glass bowl is warmed by the steaming rice it contains.
  - d. A burning log in a fireplace causes the temperature in a room to go up.

## INTERPRETING VISUALS

Use Figure 11-11 to answer the following questions.

7. **EXPLAIN:** Why does the balloon rise?
8. **INFER:** What does the flame do?



▲ Figure 11-11 Hot-air balloons

## HEALTH AND SAFETY TIP

Never grab the handle of a hot pot with your bare hands. Use a potholder. Metal is a good conductor of heat. The potholder is not. It keeps most of the heat from passing through to your hands.



## Hands-On Activity

### DETERMINING THE EFFECT OF TEMPERATURE ON AIR MOVEMENT

You will need scissors, a ruler, tissue paper, thread, cellophane tape, a desk lamp, and a partner.

1. Cut a 6-cm long spiral from the tissue paper.
  2. Cut a piece of thread 15 cm long.
  3. Tape one end of the thread to the center of the paper spiral.
  4. Turn on the desk lamp. Point the light up.
  5. Have your partner hold the end of the thread. Position the paper spiral about 10 cm above the light.
- ⚠ **CAUTION:** Do not allow the paper to touch the light bulb.



▲ **STEP 5** Be sure the spiral does not touch the light bulb.

### Practicing Your Skills

**DESCRIBE:** What happens to the spiral?

**INFER:** How do temperature differences affect what happens?

**CONCLUDE:** How is this an example of convection?