Section 1

Energy in Earth's Atmosphere

Reading Preview

Key Concepts

- In what forms does energy from the sun travel to Earth?
- What happens to the sun's energy when it reaches Earth?

Key Terms

- electromagnetic waves
- radiation
- infrared radiation
- ultraviolet radiation
- scattering
- greenhouse effect

Target Reading Skill

Sequencing As you read, make a flowchart that shows how the sun's energy reaches Earth's surface. Put each step of the process in a separate box in the order in which it occurs.

How Earth's Atmosphere Gets Energy

Sun gives off energy.

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Energy travels to Earth as electromagnetic radiation.

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Lab zone Discover Activity

Does a Plastic Bag Trap Heat?

1. Record the initial temperatures on two thermometers. (You should get the same readings.)
2. Place one of the thermometers in a plastic bag. Put a small piece of paper in the bag so that it shades the bulb of the thermometer. Seal the bag.
3. Place both thermometers on a sunny window ledge or near a light bulb. Cover the bulb of the second thermometer with a small piece of paper. Predict what you think will happen.
4. Wait five minutes. Then record the temperatures on the two thermometers.

Think It Over

Measuring Were the two temperatures the same? How could you explain any difference?

In the deserts of Arizona, summer nights can be chilly. In the morning, the sun is low in the sky and the air is cool. As the sun rises, the temperature increases. By noon it is quite hot. As you will learn in this chapter, heat is a major factor in the weather. The movement of heat in the atmosphere causes temperatures to change, winds to blow, and rain to fall.

Energy From the Sun

Where does this heat come from? Nearly all the energy in Earth's atmosphere comes from the sun. This energy travels to Earth as **electromagnetic waves**, a form of energy that can move through the vacuum of space. Electromagnetic waves are classified according to wavelength, or distance between waves. **Radiation** is the direct transfer of energy by electromagnetic waves.

What kinds of energy do we receive from the sun? Is all of the energy the same? **Most of the energy from the sun travels to Earth in the form of visible light and infrared radiation. A small amount arrives as ultraviolet radiation.**

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As the sun rises, energy in the form of electromagnetic waves reaches Earth's surface.

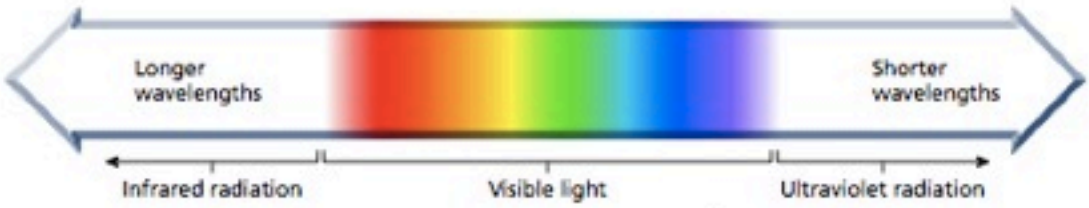

FIGURE 1
Radiation From the Sun
Energy from the sun travels to Earth as infrared radiation, visible light, and ultraviolet radiation.
Interpreting Diagrams *What type of radiation has wavelengths that are shorter than visible light?*

Visible Light Visible light includes all of the colors that you see in a rainbow: red, orange, yellow, green, blue, and violet. The different colors are the result of different wavelengths. Red and orange light have the longest wavelengths, while blue and violet light have the shortest wavelengths, as shown in Figure 1.

Non-Visible Radiation One form of electromagnetic energy, **infrared radiation,** has wavelengths that are longer than red light. Infrared radiation is not visible, but can be felt as heat. The sun also gives off **ultraviolet radiation,** which is an invisible form of energy with wavelengths that are shorter than violet light. Ultraviolet radiation can cause sunburns. This radiation can also cause skin cancer and eye damage.

Reading Checkpoint **Which color of visible light has the longest wavelengths?**

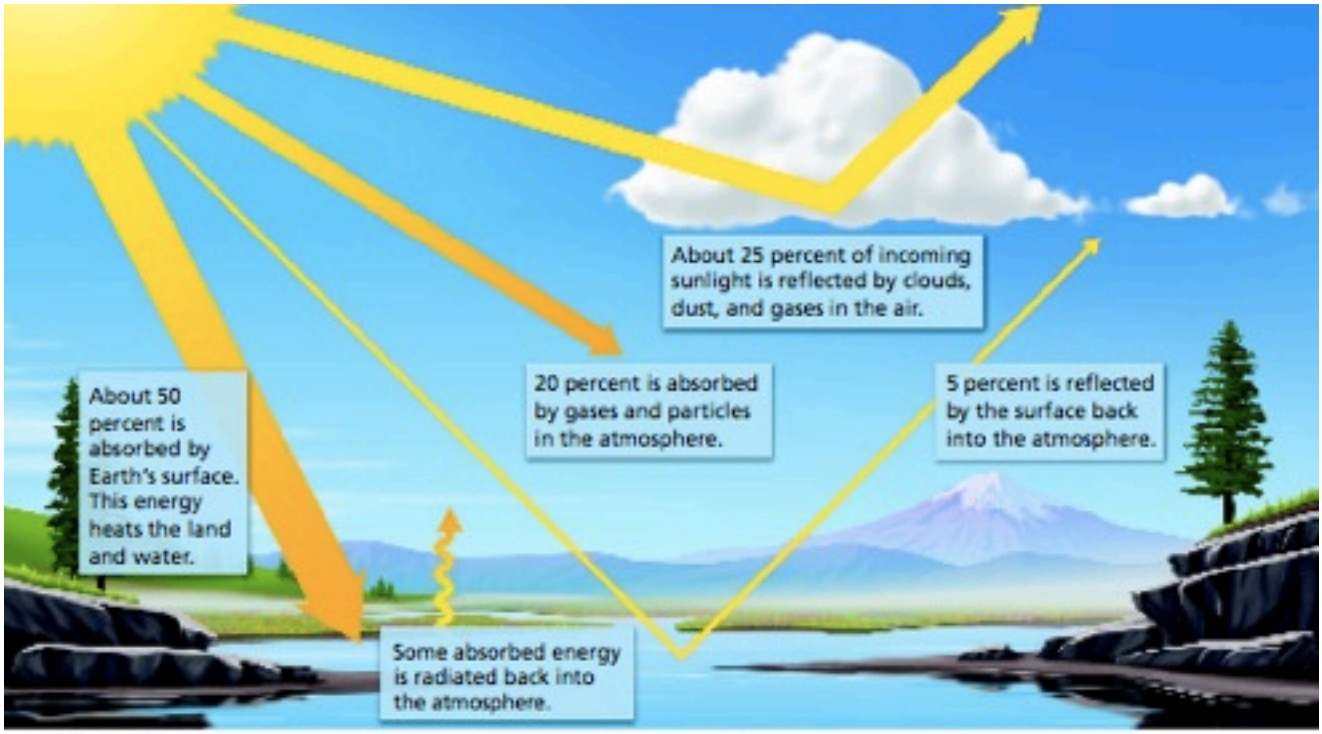

FIGURE 2
Energy in the Atmosphere
The sun's energy interacts with Earth's atmosphere and surface in several ways. About half is either reflected back into space or absorbed by the atmosphere. The rest reaches Earth's surface.

Energy in the Atmosphere

Before reaching Earth's surface, sunlight must pass through the atmosphere. The path of the sun's rays is shown in Figure 2. **Some sunlight is absorbed or reflected by the atmosphere before it can reach the surface. The rest passes through the atmosphere to the surface.**

Part of the sun's energy is absorbed by the atmosphere. The ozone layer in the stratosphere absorbs most of the ultraviolet radiation. Water vapor and carbon dioxide absorb some infrared radiation. Clouds, dust, and other gases also absorb energy.

Some sunlight is reflected. Clouds act like mirrors, reflecting sunlight back into space. Dust particles and gases in the atmosphere reflect light in all directions, a process called **scattering.** When you look at the sky, the light you see has been scattered by gas molecules in the atmosphere. Gas molecules scatter short wavelengths of visible light (blue and violet) more than long wavelengths (red and orange). Scattered light therefore looks bluer than ordinary sunlight. This is why the daytime sky looks blue.

When the sun is rising or setting, its light passes through a greater thickness of the atmosphere than when the sun is higher in the sky. More light from the blue end of the spectrum is removed by scattering before it reaches your eyes. The remaining light contains mostly red and orange light. The sun looks red, and clouds around it become very colorful.

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Energy at Earth's Surface

Some of the sun's energy reaches Earth's surface and is reflected back into the atmosphere. About half of the sun's energy, however, is absorbed by the land and water and changed into heat.

When Earth's surface is heated, it radiates most of the energy back into the atmosphere as infrared radiation. As shown in Figure 3, much of this infrared radiation cannot travel all the way through the atmosphere back into space. Instead, it is absorbed by water vapor, carbon dioxide, methane, and other gases in the air. The energy from the absorbed radiation heats the gases in the air. These gases form a "blanket" around Earth that holds heat in the atmosphere. The process by which gases hold heat in the air is called the **greenhouse effect.**

The greenhouse effect is a natural process that keeps Earth's atmosphere at a temperature that is comfortable for most living things. Over time, the amount of energy absorbed by the atmosphere and Earth's surface is in balance with the amount of energy radiated into space. In this way, Earth's average temperatures remain fairly constant. However, as you will learn later, emissions from human activities may be altering this process.

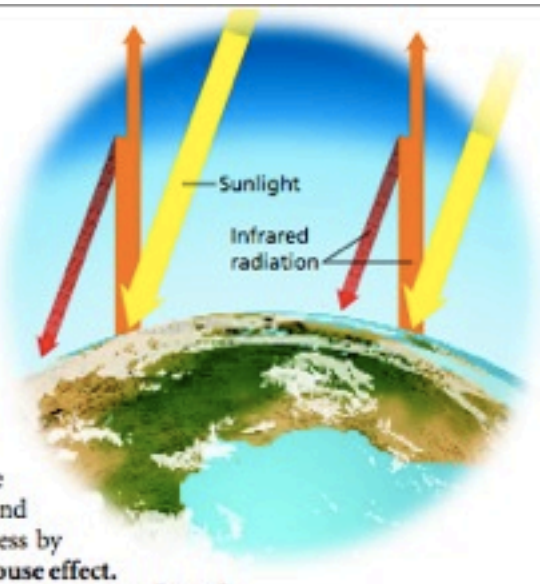

FIGURE 3
Greenhouse Effect
Sunlight travels through the atmosphere to Earth's surface. Earth's surface then gives off infrared radiation. Much of this energy is held by the atmosphere, warming it.

Reading Checkpoint **What is the greenhouse effect?**

Section 1 Assessment

Target Reading Skill

Sequencing Refer to your flowchart about how the sun's energy reaches Earth's surface as you answer Question 2.

Reviewing Key Concepts

1. a. Listing List three forms of radiation from the sun.
   b. Comparing and Contrasting Which form of radiation from the sun has the longest wavelength? The shortest wavelength?
2. a. Summarizing What happens to most of the sunlight that reaches Earth?
   b. Interpreting Diagrams What percentage of incoming sunlight is reflected by clouds, dust, and gases in the atmosphere?
   c. Applying Concepts Why are sunsets red?
3. a. Describing What happens to the energy from the sun that is absorbed by Earth's surface?
   b. Predicting How might conditions on Earth be different without the greenhouse effect?

Lab zone At-Home Activity

Heating Your Home With an adult family member, explore the role radiation from the sun plays in heating your home. Does it make some rooms warmer in the morning? Are other rooms warmer in the afternoon? How does opening and closing curtains or blinds affect the temperature of a room? Explain your observations to your family.