KEY CONCEPT

1.3 Gases in the atmosphere absorb radiation.

BEFORE, you learned

- Solar radiation heats Earth's surface and atmosphere
- Earth's surface and atmosphere give off radiation
- The ozone layer is in the stratosphere

NOW, you will learn

- More about how radiation and gases affect each other
- About the ozone layer and ultraviolet radiation
- About the greenhouse effect

VOCABULARY

ultraviolet radiation p. 23
infrared radiation p. 23
ozone p. 23
greenhouse effect p. 24
greenhouse gas p. 24

EXPLORE Radiation

Can you feel radiation?

PROCEDURE

1. Turn on the lamp and wait for it to become warm. It gives off visible and infrared radiation.
2. Hold one hand a short distance from the bulb. Record your observations.
3. Turn the lamp off. The bulb continues to give off infrared radiation. Hold your other hand a short distance from the bulb.

WHAT DO YOU THINK?

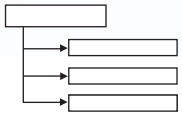
- What did you see and feel?
- How did radiation affect each hand?

MATERIALS

- lamp

Gases can absorb and give off radiation.

SUPPORTING MAIN IDEAS
Remember to make a chart for each main idea.



On a sunny day, objects around you look bright. Earth's atmosphere reflects or absorbs some sunlight, but allows most of the visible light to pass through to Earth's surface. A cloudy day is darker because clouds reflect and absorb much of the sunlight, so less light passes through to the ground.

The atmosphere can affect light in four ways. It can absorb light, reflect it, or let it pass through. Air can also emit, or give off, light. Although air does not emit much visible light, certain gases absorb and emit radiation that is similar to visible light.

CHECK YOUR READING List four ways that the atmosphere can affect light.

Just as there are sounds humans cannot hear, there are forms of radiation that humans cannot see. Sounds can be too high to hear. In a similar way, waves of **ultraviolet radiation** (UHL-truh-VY-uh-liht) have more energy than the light you can see. Ultraviolet radiation can cause sunburn and other types of damage. Sounds can also be too low for humans to hear. In a similar way, waves of **infrared radiation** (IHN-fruh-REHD) have less energy than visible light. Infrared radiation usually warms the materials that absorb it. Different gases in the atmosphere absorb these two different types of radiation.

The ozone layer protects life from harmful radiation.

In Section 1.2, you read about a gas called ozone that forms in the stratosphere. An **ozone** molecule (O_3) is made of three atoms of the element oxygen. Your body uses regular oxygen gas (O_2), which has two atoms of oxygen. In the stratosphere, ozone and regular oxygen gases break apart and form again in a complex cycle. The reactions that destroy and form ozone normally balance each other, so the cycle can repeat endlessly. Even though ozone is mixed with nitrogen and other gases, the ozone in the stratosphere is called the ozone layer.

The ozone layer protects life on Earth by absorbing harmful ultraviolet radiation from the Sun. Too much ultraviolet radiation can cause sunburn, skin cancer, and damaged eyesight. Ultraviolet radiation can harm crops and materials such as plastic or paint. Ozone absorbs ultraviolet radiation but lets other types of radiation, such as visible light, pass through.

READING TiP

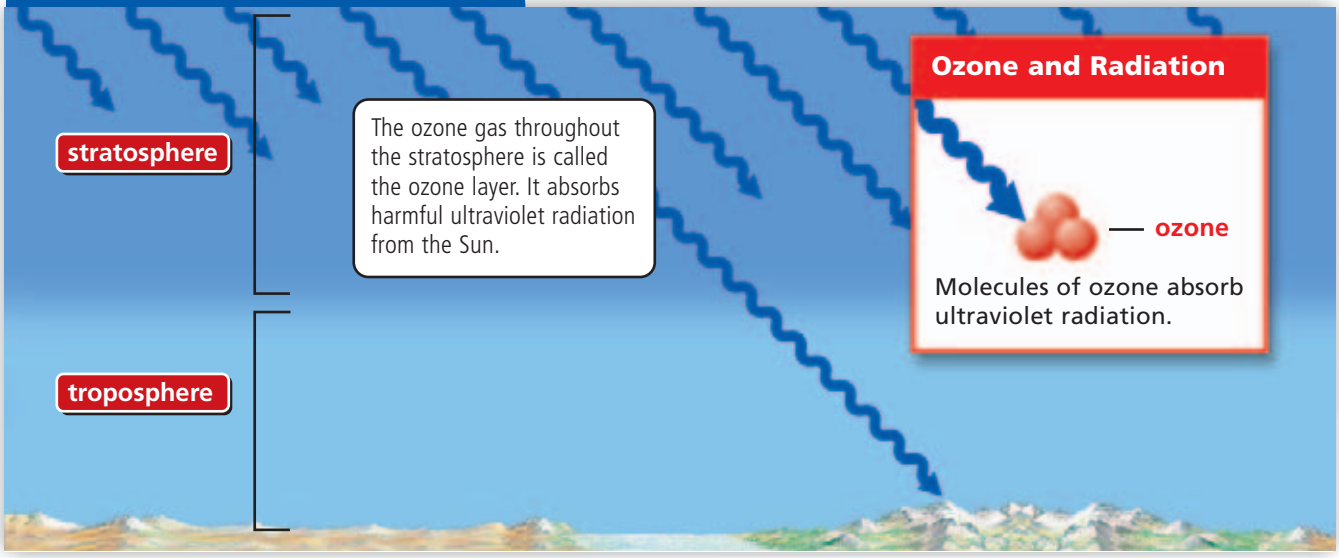
In this section, wavy arrows represent different types of radiation.

ultraviolet

visible

infrared

Ozone in the Stratosphere



The greenhouse effect keeps Earth warm.

VISUALIZATION
CLASSZONE.COM
See how the greenhouse effect works.

A jacket helps keep you warm on a cool day by slowing the movement of heat energy away from your body. In a similar way, certain gases in the atmosphere slow the movement of energy away from Earth's surface. The gases absorb and emit infrared radiation, which keeps energy in Earth's system for a while. This process was named the **greenhouse effect** because it reminded scientists of the way glass traps warmth inside a greenhouse.

Carbon dioxide, methane, water vapor, nitrous oxide, and other gases that absorb and give off infrared radiation are known as **greenhouse gases.** Unlike the glass roof and walls of a greenhouse, the greenhouse gases do not form a single layer. They are mixed together with nitrogen, oxygen, and other gases in the air. The atmosphere is densest in the troposphere—the lowest layer—so most of the greenhouse gas molecules are also in the troposphere.

REMINDER
Ozone absorbs ultraviolet radiation in the stratosphere. Greenhouse gases absorb and emit infrared radiation in the troposphere.

Radiation from the Sun, including visible light, warms Earth's surface, which then emits infrared radiation. If the atmosphere had no greenhouse gases, the infrared radiation would go straight through the atmosphere into outer space. Earth's average surface temperature would be only about –18°C (0°F). Water would freeze, and it would be too cold for most forms of life on Earth to survive.

INVESTIGATE Greenhouse Gases

How have levels of greenhouse gases changed?

Scientists have used ice cores from Antarctica to calculate prehistoric carbon dioxide levels and temperatures. The CO_2 data table has the results for you to plot.

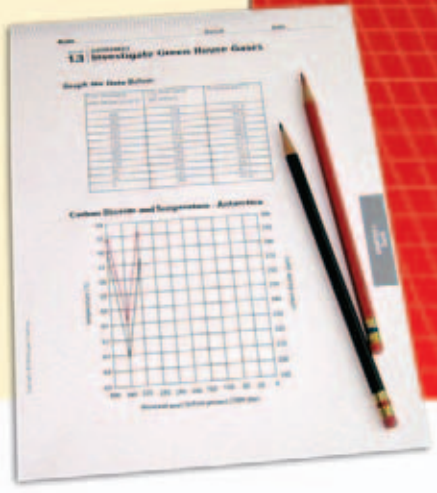
SKILL FOCUS
Graphing

MATERIALS
- CO_2 data table
- regular pencil
- red pencil

TIME
30 minutes

PROCEDURE

1. Plot the CO_2 levels on the graph sheet using a regular pencil. Draw line segments to connect the points.
2. Plot the temperatures on the same graph using a red pencil. Draw red line segments to connect the points.



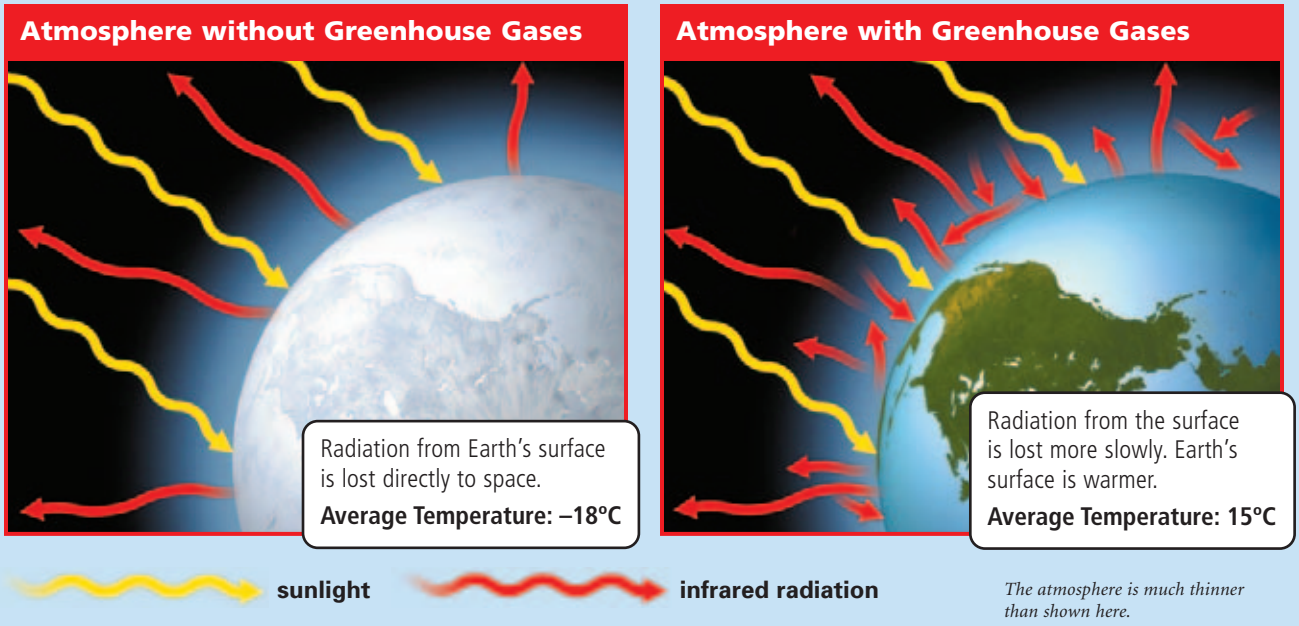
INTERPRET DATA

- How many times during the past 400,000 years were average temperatures in Antarctica above –56°C?
- Do these changes seem to be connected to changes in carbon dioxide? Explain.

CHALLENGE Is it possible to tell from the graph whether temperature affected carbon dioxide levels or carbon dioxide levels affected temperature? Why or why not?

The Greenhouse Effect

Greenhouse gas molecules absorb and emit infrared radiation.



Earth's atmosphere does have greenhouse gases. These gases absorb some of the infrared radiation emitted by Earth's surface. The greenhouse gases can then give off this energy as infrared radiation. Some of the energy is absorbed again by the surface, while some of the energy goes out into space. The greenhouse effect keeps Earth's average surface temperature around 15°C (59°F). The energy stays in Earth's system longer with greenhouse gases than without them. In time, all the energy ends up back in outer space. If it did not, Earth would grow warmer and warmer as it absorbed more and more solar radiation.

1.3 Review

KEY CONCEPTS

1. Name and describe two of the ways gases can affect radiation.
2. What type of radiation does the ozone layer affect?
3. How do greenhouse gases keep Earth warm?

CRITICAL THINKING

4. **Infer** What would happen if gases in the atmosphere absorbed visible light?
5. **Compare and Contrast** How are ozone and greenhouse gases alike? How are they different?

CHALLENGE

6. **Predict** How would the temperature on Earth be affected if the amount of greenhouse gases in the atmosphere changed?