Lesson 1

Describing Earth's Atmosphere

Reading Guide

Key Concepts

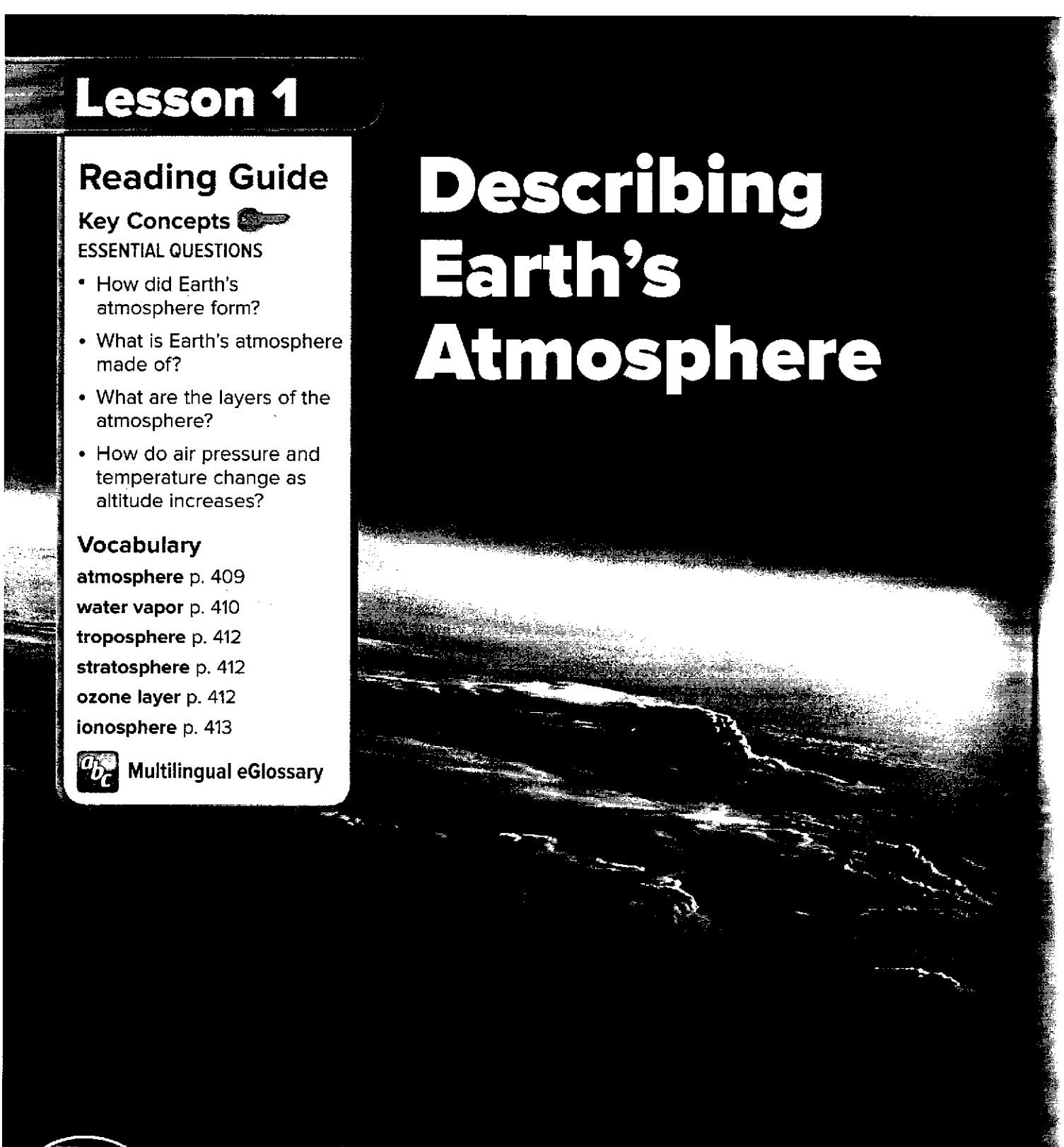
ESSENTIAL QUESTIONS

- How did Earth's atmosphere form?
- What is Earth's atmosphere made of?
- What are the layers of the atmosphere?
- How do air pressure and temperature change as altitude increases?

Vocabulary

atmosphere p. 409
water vapor p. 410
troposphere p. 412
stratosphere p. 412
ozone layer p. 412
ionosphere p. 413

Multilingual eGlossary



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Inquiry Why is the atmosphere important?

What would Earth be like without its atmosphere? Earth's surface would be scarred with craters created from the impact of meteorites. Earth would experience extreme daytime-to-nighttime temperature changes. How would changes in the atmosphere affect life? What effect would atmospheric changes have on weather and climate?

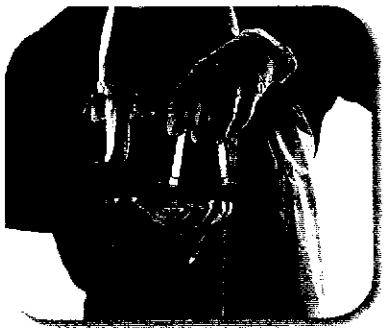
Launch Lab

20 minutes

Where does air apply pressure?

With the exception of Mercury, most planets in the solar system have some type of atmosphere. However, Earth's atmosphere provides what the atmospheres of other planets cannot: oxygen and water. Oxygen, water vapor, and other gases make up the gaseous mixture in the atmosphere called air. In this activity, you will explore air's effect on objects on Earth's surface.

1. Read and complete a lab safety form.
2. Add **water** to a **cup** until it is two-thirds full.
3. Place a large **index card** over the opening of the cup so that it is completely covered.
4. Hold the cup over a tub or a large bowl.
5. Place one hand on the index card to hold it in place as you quickly turn the cup upside down. Remove your hand.



Think About This

1. What happened when you turned the cup over?
2. How did air play a part in your observation?
3. **Key Concept** How do you think these results might differ if you repeated the activity in a vacuum?

Importance of Earth's Atmosphere

The photo on the previous page shows Earth's atmosphere as seen from space. How would you describe the atmosphere? *The* **atmosphere** (AT muh sfihr) *is a thin layer of gases surrounding Earth.* Earth's atmosphere is divided into five layers. The first four layers extend to about 600 km, and the outermost layer extends to about 10,000 km above Earth.

WORD ORIGIN

atmosphere
from Greek *atmos,* means "vapor"; and Latin *sphaera,* means "sphere"

The atmosphere contains the oxygen, carbon dioxide, and water necessary for life on Earth. Earth's atmosphere also acts like insulation on a house. It helps keep temperatures on Earth within a range in which living organisms can survive. Without it, daytime temperatures would be extremely high and nighttime temperatures would be extremely low.

The atmosphere helps protect living organisms from some of the Sun's harmful rays. It also helps protect Earth's surface from being struck by asteroids. Most asteroids that fall toward Earth burn up before reaching Earth's surface. Friction with the atmosphere causes them to burn. Only the very largest asteroids strike Earth.

Reading Check Why is Earth's atmosphere important to life on Earth?

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Origins of Earth's Atmosphere

Most scientists agree that when Earth formed, it was a ball of molten rock. As Earth slowly cooled, its outer surface hardened. Erupting volcanoes emitted hot gases from Earth's interior. These gases surrounded Earth, forming its atmosphere.

Ancient Earth's atmosphere was thought to be water vapor with a little carbon dioxide (CO_2) and nitrogen. **Water vapor** *is water in its gaseous form.* This ancient atmosphere did not have enough oxygen to support life as we know it. As Earth and its atmosphere cooled, the water vapor condensed into liquid. Rain fell and then evaporated from Earth's surface repeatedly for thousands of years. Eventually, water accumulated on Earth's surface, forming oceans. Most of the original CO_2 that dissolved in rain is in rocks on the ocean floor. Today the atmosphere has more nitrogen than CO_2.

REVIEW VOCABULARY

liquid
matter with a definite volume but no definite shape that can flow from one place to another

Earth's first organisms could undergo photosynthesis, which changed the atmosphere. Recall that photosynthesis uses light energy to produce sugar and oxygen from carbon dioxide and water. The organisms removed CO_2 from the atmosphere and released oxygen into it. Eventually the levels of CO_2 and oxygen supported the development of other organisms.

Key Concept Check How did Earth's present atmosphere form?

MiniLab

20 minutes

Why does the furniture get dusty?

Have you ever noticed that furniture gets dusty? The atmosphere is one source for dirt and dust particles. Where can you find dust in your classroom?

1. Read and complete a lab safety form.
2. Choose a place in your classroom to collect a sample of dust.
3. Using a **duster,** collect dust from about a 50-cm^2 area.
4. Examine the duster with a **magnifying lens.** Observe any dust particles. Some might be so small that they only make the duster look gray.
5. Record your observations in your Science Journal.
6. Compare your findings with those of other members of your class.

Analyze and Conclude

1. **Analyze** how the area surrounding your collection site might have influenced how much dust you observed on the duster.

2. **Infer** the source of the dust.
3. **Key Concept** Other than gases and water droplets, predict what Earth's atmosphere might contain.

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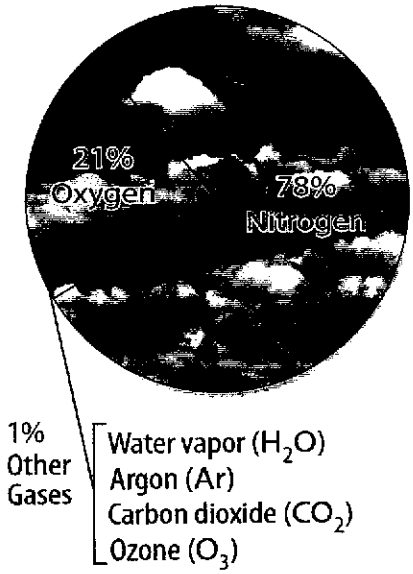
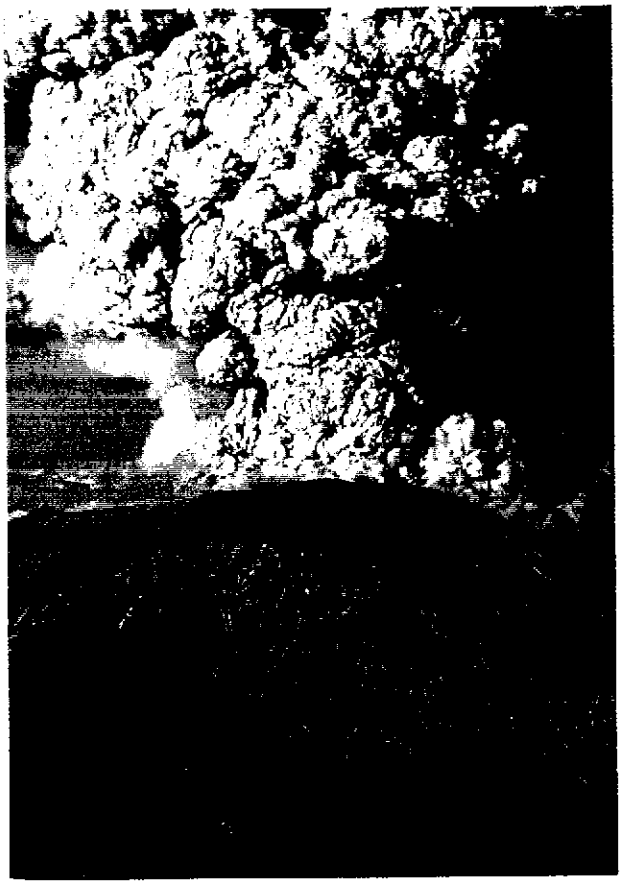
Figure 1 Oxygen and nitrogen make up most of the atmosphere, with the other gases making up only 1 percent. ▼



Visual Check What percent of the atmosphere is made up of oxygen and nitrogen?



▲ **Figure 2** One way solid particles enter the atmosphere is from volcanic eruptions.

Composition of the Atmosphere

Today's atmosphere is mostly made up of invisible gases, including nitrogen, oxygen, and carbon dioxide. Some solid and liquid particles, such as ash from volcanic eruptions and water droplets, are also present.

Gases in the Atmosphere

Study **Figure 1.** Which gas is the most abundant in Earth's atmosphere? Nitrogen makes up about 78 percent of Earth's atmosphere. About 21 percent of Earth's atmosphere is oxygen. Other gases, including argon, carbon dioxide, and water vapor, make up the remaining 1 percent of the atmosphere.

The amounts of water vapor, carbon dioxide, and ozone vary. The concentration of water vapor in the atmosphere ranges from 0 to 4 percent. Carbon dioxide is 0.038 percent of the atmosphere. A small amount of ozone is at high altitudes. Ozone also occurs near Earth's surface in urban areas.

Solids and Liquids in the Atmosphere

Tiny solid particles are also in Earth's atmosphere. Many of these, such as pollen, dust, and salt, can enter the atmosphere through natural processes. **Figure 2** shows another natural source of particles in the atmosphere–ash from volcanic eruptions. Some solid particles enter the atmosphere because of human activities, such as driving vehicles that release soot.

The most common liquid particles in the atmosphere are water droplets. Although microscopic in size, water droplets are visible when they form clouds. Other atmospheric liquids include acids that result when volcanoes erupt and fossil fuels are burned. Sulfur dioxide and nitrous oxide combine with water vapor in the air and form the acids.

Key Concept Check What is Earth's atmosphere made of?

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Animation

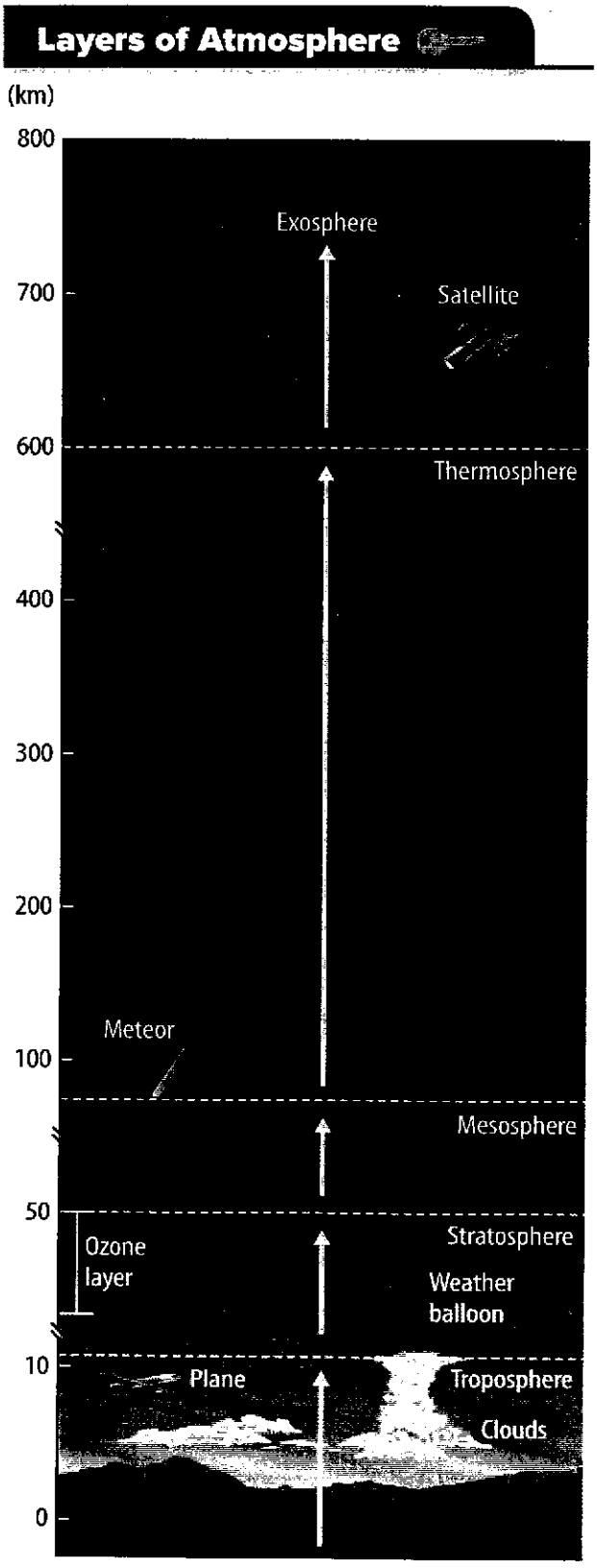


Figure 3 Scientists divide Earth's atmosphere into different layers.

Visual Check In which layer of the atmosphere do planes fly?

Layers of the Atmosphere

The atmosphere has several different layers, as shown in **Figure 3.** Each layer has unique properties, including the composition of gases and how temperature changes with altitude. Notice that the scale varies in **Figure 3.** This is so all the layers can be shown in one image.

Troposphere

The atmospheric layer closest to Earth's surface is called the **troposphere** (TRO puh sfihr). Most people spend their entire lives within the troposphere. It extends from Earth's surface to altitudes between 8–15 km. Its name comes from the Greek word *tropos,* which means "change." The temperature in the troposphere decreases as you move away from Earth. The warmest part of the troposphere is near Earth's surface. This is because most sunlight passes through the atmosphere and warms Earth's surface. The warmth is radiated to the troposphere, causing weather.

Reading Check Describe the troposphere.

Stratosphere

The atmospheric layer directly above the troposphere is the **stratosphere** (STRA tuh sfihr). The stratosphere extends from about 15 km to about 50 km above Earth's surface. The upper half of the stratosphere contains the greatest amount of ozone gas. *The area of the stratosphere with a high concentration of ozone* is referred to as the **ozone layer.** The presence of the ozone layer causes increasing stratospheric temperatures with increasing altitude.

An ozone (O_3) molecule differs from an oxygen (O_2) molecule. Ozone has three oxygen atoms instead of two. This difference is important because ozone absorbs the Sun's ultraviolet rays more effectively than oxygen does. Ozone protects Earth from ultraviolet rays that can kill plants, animals, and other organisms and cause skin cancer in humans.

Per Breiehagen/Getty Images

Mesosphere and Thermosphere

As shown in **Figure 3,** the mesosphere extends from the stratosphere to about 85 km above Earth. The thermosphere can extend from the mesopshere to more than 600 km above Earth. Combined, these layers are much broader than the troposphere and the stratosphere, yet only 1 percent of the atmosphere's gas molecules are found in the mesosphere and the thermosphere. Most meteors burn up in these layers instead of striking Earth.

Ionosphere *The* **ionosphere** *is a region within the mesosphere and thermosphere that contains ions.* Between 60 km and 300 km above Earth's surface, the ionosphere's ions reflect AM radio waves transmitted at ground level. After sunset when ions recombine, this reflection increases. **Figure 4** shows how AM radio waves can travel long distances, especially at night, by bouncing off Earth and the ionosphere.

FOLDABLES®

Make a vertical four-tab book using the titles shown. Use it to record similarities and differences among these four layers of the atmosphere. Fold the top half over the bottom and label the outside *Layers of the Atmosphere.*

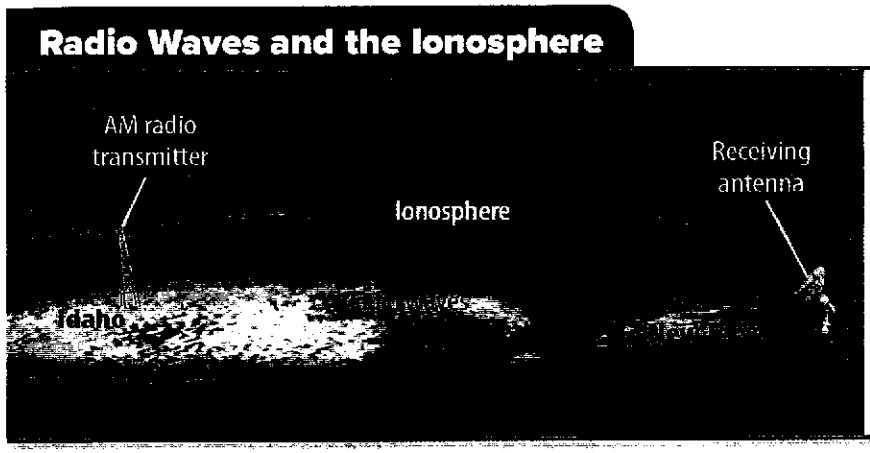


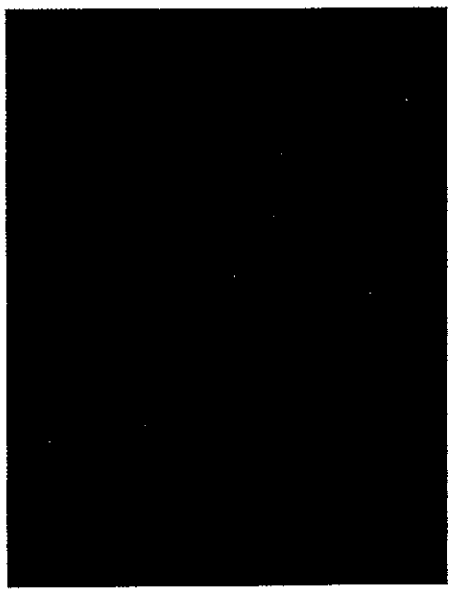
Figure 4 Radio waves can travel long distances in the atmosphere.

Auroras The ionosphere is where stunning displays of colored lights called auroras occur, as shown in **Figure 5.** Auroras are most frequent in the spring and fall, but are best seen when the winter skies are dark. Auroras occur when ions from the Sun strike air molecules, causing them to emit vivid colors of light. People who live in the higher latitudes, nearer to the North Pole and the South Pole, are most likely to see auroras.

Exosphere

The exosphere is the atmospheric layer farthest from Earth's surface. Here, pressure and density are so low that individual gas molecules rarely strike one another. The molecules move at incredibly fast speeds after absorbing the Sun's radiation. The atmosphere does not have a definite edge, and molecules that are part of it can escape the pull of gravity and travel into space.

Key Concept Check What are the layers of the atmosphere?



▲ **Figure 5** Auroras occur in the ionosphere.

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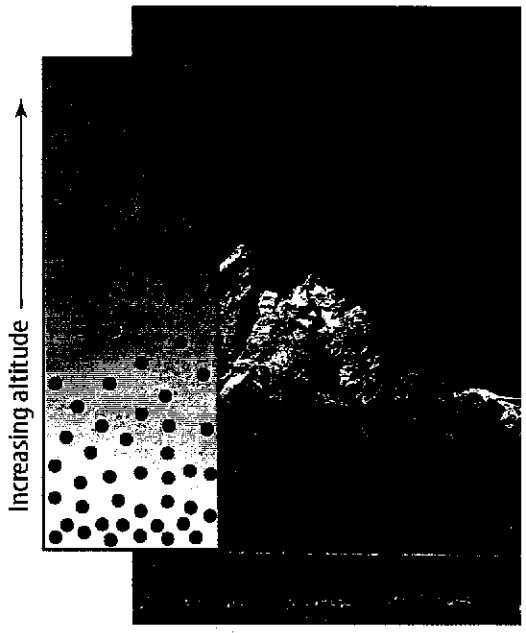
Figure 6 Molecules in the air are closer together near Earth's surface than they are at higher altitudes. ▼

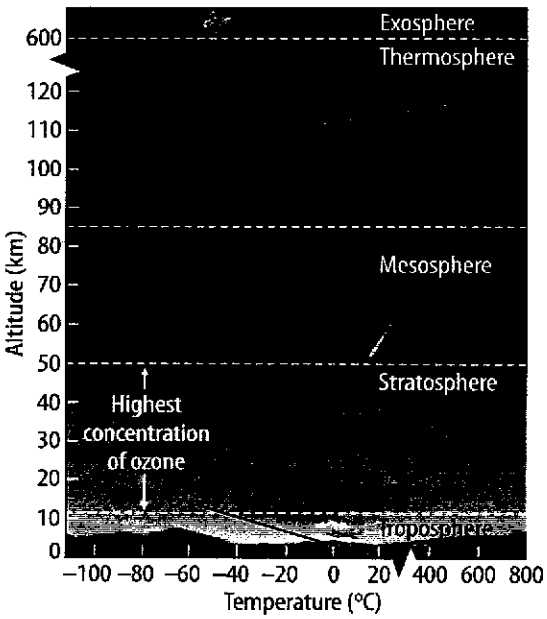


Air Pressure and Altitude

Gravity is the force that pulls all objects toward Earth. When you stand on a scale, you can read your weight. This is because gravity is pulling you toward Earth. Gravity also pulls the atmosphere toward Earth. The pressure that a column of air exerts on anything below it is called air pressure. Gravity's pull on air increases its density. At higher altitudes, the air is less dense. **Figure 6** shows that air pressure is greatest near Earth's surface because the air molecules are closer together. This dense air exerts more force than the less dense air near the top of the atmosphere. Mountain climbers sometimes carry oxygen tanks at high altitudes because fewer oxygen molecules are in the air at high altitudes.

Reading Check How does air pressure change as altitude increases?

Figure 7 Temperature differences occur within the layers of the atmosphere. ▼



Visual Check Which temperature pattern is most like the troposphere's?

Temperature and Altitude

Figure 7 shows how temperature changes with altitude in the different layers of the atmosphere. If you have ever been hiking in the mountains, you have experienced the temperature cooling as you hike to higher elevations. In the troposphere, temperature decreases as altitude increases. Notice that the opposite effect occurs in the stratosphere. As altitude increases, temperature increases. This is because of the high concentration of ozone in the stratosphere. Ozone absorbs energy from sunlight, which increases the temperature in the stratosphere.

In the mesosphere, as altitude increases, temperature again decreases. In the thermosphere and exosphere, temperatures increase as altitude increases. These layers receive large amounts of energy from the Sun. This energy is spread across a small number of particles, creating high temperatures.

Key Concept Check How does temperature change as altitude increases?

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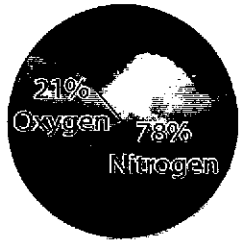
Lesson 1 Review

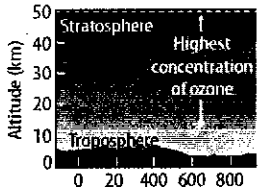
Online Quiz
Virtual Lab

Visual Summary



Earth's atmosphere consists of gases that make life possible.

Layers of the atmosphere include the troposphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere.



The ozone layer is the area in the stratosphere with a high concentration of ozone.

FOLDABLES

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

1. Air is empty space.
2. Earth's atmosphere is important to living organisms.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

1. The _____ is a thin layer of gases surrounding Earth.
2. The area of the stratosphere that helps protect Earth's surface from harmful ultraviolet rays is the _____.
3. **Define** Using your own words, define *water vapor.*

Understand Key Concepts

4. Which atmospheric layer is closest to Earth's surface?

   A. mesosphere **C.** thermosphere
   B. stratosphere **D.** troposphere

5. **Identify** the two atmospheric layers in which temperature decreases as altitude increases.

Interpret Graphics

6. **Contrast** Copy and fill in the graphic organizer below to contrast the composition of gases in Earth's early atmosphere and its present-day atmosphere.

Atmosphere	Gases
Early	
Present-day	

7. **Determine** the relationship between air pressure and the water in the glass in the photo below.

Critical Thinking

8. **Explain** three ways the atmosphere is important to living things.

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