chapter 15

Atmosphere

section 1 Earth's Atmosphere

What You'll Learn

- the gases in Earth's atmosphere
- the structure of Earth's atmosphere
- what causes air pressure

Before You Read

Imagine you are on a spaceship looking down at Earth. Would the view be perfectly clear? What do you think you might see surrounding Earth? Write your thoughts on the lines below.

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_____

Read to Learn

Importance of the Atmosphere

Earth's **atmosphere** is a thin layer of gases, solids, and liquids that surround the planet forming a protective covering. The covering keeps Earth from getting too hot or too cold. The atmosphere keeps Earth from absorbing too much heat from the Sun. It also keeps too much heat from escaping into space. Without protection from the atmosphere, life on Earth could not exist.

Makeup of the Atmosphere

Viewed from space Earth's atmosphere today has a thin layer of gases. White clouds usually cover at least half the planet. Between gaps in the clouds, the blue color of the ocean waters shows through.

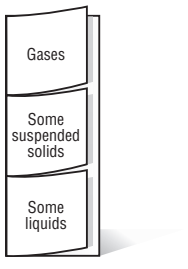
Earth's early atmosphere was very different from the atmosphere we know today. The early atmosphere was produced by erupting volcanoes. They released nitrogen and carbon dioxide, but little oxygen. Then, about 2 billion years ago, the amount of oxygen in the atmosphere began to increase.

Study Coach

Flash Cards Make flash cards to help you learn more about this section. Write the question on one side of the flash card and the answer on the other. Keep quizzing yourself until you know all the answers.

FOLDABLES™

A Organize Make a three-tab Foldable to help you learn about gases, solids, and liquids in Earth's atmosphere.



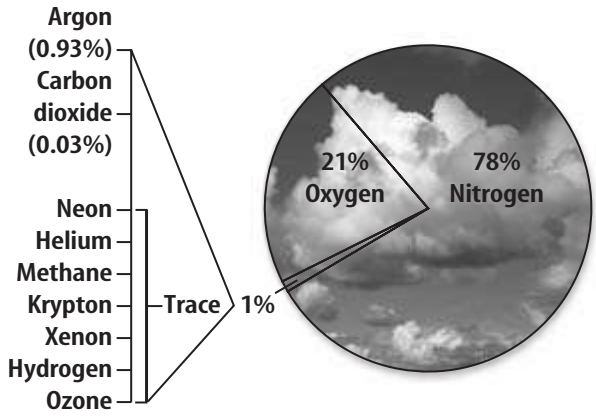
What caused the atmosphere to change?

Early organisms that lived in the ocean used sunlight to make food. While making food, the organisms released oxygen into the atmosphere.

The oxygen formed a layer of ozone molecules around Earth. The ozone layer protects Earth from the Sun's harmful rays. Over time, this protective ozone layer enabled green plants to grow on land. The green plants released even more oxygen. Today, many living things on Earth, including humans, depend on oxygen to survive.

Applying Math

1. **Fractions** Which is the most accurate fraction for the amount of oxygen contained in Earth's atmosphere—about 1/5, about 2/3, about 3/4?



What gases make up Earth's atmosphere?

As shown in the figure above, 78 percent of Earth's atmosphere is made up of nitrogen. Oxygen makes up 21 percent of the atmosphere. Small amounts of other gases make up the remaining 1 percent.

The composition of the atmosphere is changing in small but important ways. For example, humans burn fuel for energy. As fuel is burned, carbon dioxide is released as a by-product into Earth's atmosphere. Increasing energy use may increase the amount of carbon dioxide in the atmosphere.

What solids and liquids are in Earth's atmosphere?

Reading Check

2. **List** three solids found in Earth's atmosphere.

In addition to gases, Earth's atmosphere contains small, solid particles such as dust, salt, and pollen. Dust particles get into the atmosphere when wind picks them up off the ground. Salt is picked up from ocean spray. Plants give off pollen that becomes mixed throughout part of the atmosphere. ☑

The atmosphere also contains small liquid droplets, other than water droplets in clouds. The atmosphere moves these liquid droplets and solids from one area to another.

Layers of the Atmosphere

What would happen if a glass of chocolate milk was left untouched on a kitchen counter? Eventually, a lower layer, heavy with chocolate, would separate and fall to the bottom of the glass.

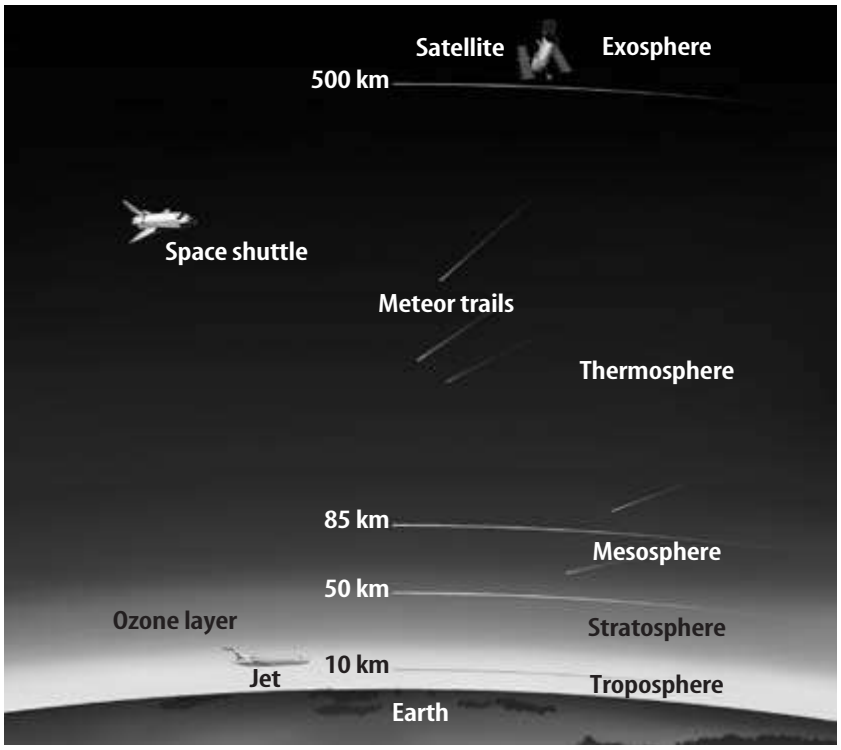
Like a glass of chocolate milk, Earth's atmosphere has layers. There are five layers in the atmosphere, as shown in the figure below. There are two lower layers: the troposphere (TRO puh sfihr) and the stratosphere (STRA tuh sfihr). The three upper layers of the atmosphere are: the mesosphere (MEZ uh sfihr), the thermosphere (THUR muh sfihr), and the exosphere (EK soh sfihr). Most of the air is contained in the troposphere and the stratosphere. ☑

What are the lower layers of the atmosphere?

The **troposphere** is the layer of Earth's atmosphere that is closest to the ground. It contains 99 percent of the water vapor and 75 percent of the atmospheric gases. The troposphere is where clouds and weather occur. It extends up to about 10 km from Earth's surface.

The **stratosphere** is the layer of Earth's atmosphere directly above the troposphere. As the figure shows, the ozone layer is found within the stratosphere.

Layers of the Atmosphere



Reading Check

3. **Identify** What are the two lower layers of the atmosphere?

_____

_____

Picture This

4. **Interpret** In what layer of the atmosphere do satellites orbit?

_____

What are the upper layers of the atmosphere?

The **mesosphere** is the third layer of the atmosphere. It extends from the top of the stratosphere to about 85 km above Earth.

The thermosphere is named for its high temperatures. The **thermosphere** is the fourth layer of the atmosphere and is its hottest and thickest layer. It is found between 85 km and 500 km above Earth's surface.

Reading Check

5. Identify Which of these is the hottest and thickest layer of the atmosphere: the mesosphere, the thermosphere, or the ionosphere?

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The ionosphere (I AH nuh sfihr) is within the mesosphere and thermosphere. The **ionosphere** is a layer of electrically charged particles that absorbs AM radio waves during the day and reflects them back at night. Because of this, daytime listeners cannot hear AM radio broadcasts from distant stations. When the ionosphere reflects radio waves at night, listeners can hear the distant stations they could not pick up during the day.

What causes this night and day difference between how far radio waves travel? During the day, energy from the Sun interacts with particles in the ionosphere. The interaction causes them to absorb AM radio frequencies. At night, the Sun's energy is not available and it does not interact with the particles in the ionosphere. This is why radio waves can travel greater distances at night as shown in the figure below.

The **exosphere** is the top layer of the atmosphere. The exosphere is very thin because it contains so few molecules. Beyond the exosphere is outer space.

Picture This

6. Determine What is reflected by the ionosphere at night but not during the day?

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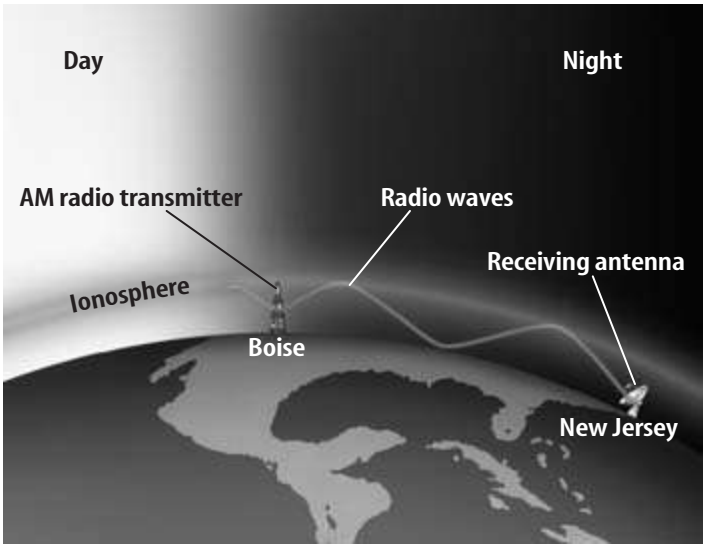
Radio Waves in the Ionosphere



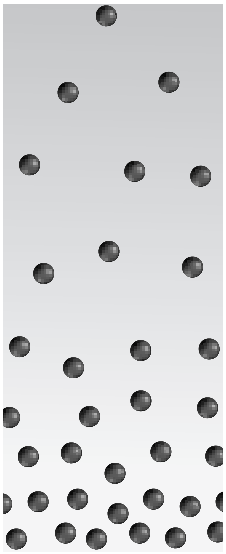
Atmospheric Pressure

Imagine a football player running with the ball. Suddenly, six other players tackle him. They pile one on top of the other. Who feels the weight more—the player on the bottom holding the ball, or the one on top? The player on the bottom, of course. Why? A great mass of bodies is pressing down on him.

What is pressure?

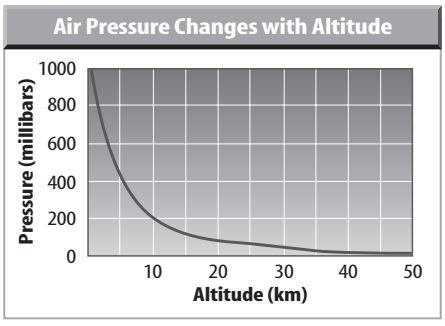
The molecules that make up human beings have mass. Atmospheric gases have mass, too. Atmospheric gases extend hundreds of kilometers above Earth's surface. Earth's gravity pulls these gases toward its surface. The weight of these gases presses down on the air below. As a result, the gas molecules nearer Earth's surface are closer together as shown in the figure to the right. This dense air close to the ground exerts more force than the less dense air near the top of the atmosphere. **Pressure** is the force exerted on an area.

Air Molecules



What affects air pressure?

Air pressure is greater near Earth's surface, where molecules are closer together. Air pressure decreases in air that is further from Earth's surface. In other words, air pressure decreases with altitude as shown in the graph below.



Because air pressure decreases with altitude, it is harder to breathe in the mountains than it is at the seashore. Jet airplanes maintain an inside air pressure that matches the air pressure on the ground. If the inside of the plane was not pressurized, people flying high above Earth's surface could not breathe.

Picture This

7. Interpret Why do the air molecules at the bottom of the figure exert more pressure than those at the top?

Picture This

8. Estimate What is the air pressure at an altitude of 5 km?

Think it Over

9. Explain Why do different layers of Earth's atmosphere have different temperatures?

Picture This

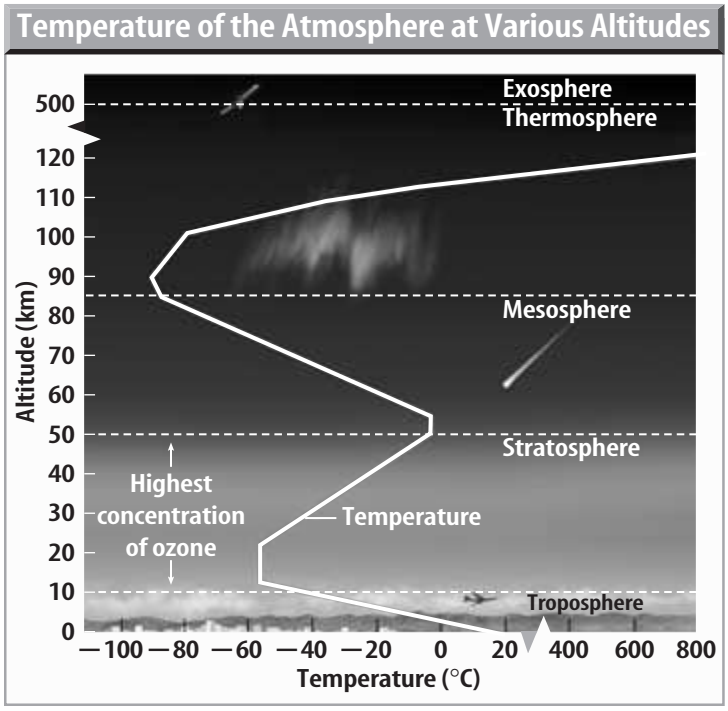
10. Interpret Look at the graph of atmospheric temperatures. Does the temperature in the thermosphere increase or decrease with altitude?

Reading Check

11. Compare Are the air molecules in the troposphere warmed mainly by the Sun's heat or by the heat from Earth's surface?

Temperature in Atmospheric Layers

Most of the energy on Earth comes from the Sun. This energy must pass through the atmosphere before it reaches Earth's surface. Some layers of the atmosphere contain gases that easily absorb the Sun's energy. Other layers do not contain these gases. As a result, different atmospheric layers have different temperatures as shown in the graph below.



Molecules that make up the air in the troposphere are warmed mostly by heat from Earth's surface. The Sun warms Earth's surface, which then warms the air right above it. For every kilometer above Earth's surface, the air temperature falls about 6.5°C. As a result, the air at the top of a mountain usually is cooler than the air at the bottom.

In the stratosphere, molecules of ozone absorb some of the Sun's energy. Energy absorbed by these molecules raises the temperature. The upper part of the stratosphere has more ozone molecules than the lower part does. Therefore, the temperature in this layer rises with increasing altitude.

Like the troposphere, the temperature in the mesosphere decreases with altitude. The thermosphere and the exosphere are closest to the Sun. These layers have fewer molecules, but each molecule has a lot of energy. Temperatures here are high.

The Ozone Layer

The **ozone layer** lies within the stratosphere about 19 km to 48 km above the ground. Ozone is made of oxygen. All life depends on the ozone layer.

The oxygen you breathe has two atoms per molecule. An ozone molecule is made up of three oxygen atoms. The ozone layer contains a high concentration of ozone and shields you from the Sun's harmful energy. How? Ozone absorbs most of the ultraviolet radiation that enters the atmosphere. **Ultraviolet radiation** is a type of energy that comes to Earth from the Sun. Too much exposure to ultraviolet radiation can damage your skin and cause cancer. ☑

Reading Check

12. Identify What does ozone absorb?

_____

_____

What are CFCs?

Chlorofluorocarbons (CFCs) are chemical compounds used in some refrigerators, air conditioners, aerosol sprays, and production of foam packaging. Evidence exists that CFCs are one type of air pollutant destroying Earth's protective ozone layer.

CFCs can enter the atmosphere in different ways. CFCs can leak from appliances. Sometimes CFCs escape when products containing them are not disposed of properly. ☑

Reading Check

13. Explain Name one way CFCs can enter the atmosphere.

_____

_____

Molecules from CFCs can break apart ozone molecules. Each ozone molecule is made up of three oxygen atoms bonded together. Each CFC molecule has three chlorine atoms. When a chlorine atom from a CFC molecule comes near a molecule of ozone, the ozone molecule breaks apart. One atom of chlorine can destroy about 100,000 ozone molecules. As a result, more harmful ultraviolet rays reach Earth's surface.

What is the ozone hole?

The destruction of ozone molecules by CFCs seems to cause a seasonal reduction in ozone over Antarctica called the ozone hole. Every year beginning in late August or early September the amount of ozone in the atmosphere over Antarctica begins to decrease. By October, the ozone concentration is at its lowest point. Then it begins to increase again. By December, the ozone hole disappears. ☑

Reading Check

14. Recall Where is the ozone hole located?

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In the mid-1990s, many governments banned the production and use of CFCs. As a result, there are fewer CFC molecules in the atmosphere today.

After You Read

Mini Glossary

atmosphere: Earth's air, which is made up of a thin layer of gases, solids, and liquids; forms a protective layer around the planet and is divided into five distinct layers

chlorofluorocarbons (CFCs): group of chemical compounds used in refrigerators, air conditioners, production of foam packaging, and aerosol sprays that may enter the atmosphere and destroy ozone

exosphere (EK soh sfihr): top layer of the atmosphere

ionosphere(I AH nuh sfihr): layer of electrically charged particles in the thermosphere that absorbs AM radio waves during the day and reflects them back at night

mesosphere (MEZ uh sfihr): third layer of the atmosphere that extends from the top of the stratosphere to about 85 km above Earth

ozone layer: layer of the stratosphere with a high concentration of ozone; absorbs most of the Sun's harmful ultraviolet radiation

pressure: the force exerted on a surface

stratosphere (STRA tuh sfihr): layer of Earth's atmosphere directly above the troposphere

thermosphere (THUR muh sfihr): fourth layer of Earth's atmosphere, and its thickest layer; has high temperatures

troposphere (TRO puh sfihr): layer of Earth's atmosphere that is closest to the ground

ultraviolet radiation: type of energy that comes to Earth from the Sun

1. Review the terms and definitions in the Mini Glossary. Write a sentence that explains why the ozone layer is important.

_____

_____

2. List the layers of the atmosphere in order. Begin with the top layer and end with the layer closest to Earth's surface.

1. _____
2. _____
3. _____
4. _____
5. _____

End of Section

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