Section 1: Characteristics of the Atmosphere

Preview

Key Ideas

- **Describe** the composition of Earth's atmosphere.
- **Explain** how two types of barometers work.
- **Identify** the layers of the atmosphere.
- **Identify** two effects of air pollution.

Composition of the Atmosphere

- **atmosphere** a mixture of gases that surrounds a planet, such as Earth
- The most abundant elements in air are the gases nitrogen, oxygen, and argon.
- The two most abundant compounds in air are the gases carbon dioxide, CO_2, and water vapor, H_2O.
- In addition to containing gaseous elements and compounds, the atmosphere commonly carries various kinds of tiny solid particles, such as dust and pollen.

Composition of the Atmosphere, *continued*

Nitrogen in the Atmosphere

- Nitrogen makes up about 78% of Earth's atmosphere and is maintained through the *nitrogen cycle.*
- Nitrogen is removed from the air mainly by the action of nitrogen-fixing bacteria.
- The bacteria chemically change nitrogen from the air into nitrogen compounds that are vital to the growth of all plants.
- Decay releases nitrogen back into the atmosphere.

Composition of the Atmosphere, *continued*

Oxygen in the Atmosphere

- Oxygen makes up about 21% of Earth's atmosphere.
- Animals, bacteria, and plants remove oxygen from the air as part of their life processes.
- Land and ocean plants produce large quantities of oxygen in a process called *photosynthesis*.
- The amount of oxygen produced by plants each year is about equal to the amount consumed by all animal life processes.

Composition of the Atmosphere, *continued*

Water Vapor in the Atmosphere

- As water evaporates from oceans, lakes, streams, and soil, it enters air as the invisible gas *water vapor*.
- Plants and animals give off water vapor during transpiration or respiration. But as water vapor enters the atmosphere, it is removed by the processes of condensation and precipitation.
- The percentage of water vapor in the atmosphere varies depending on factors such as time of day, location, and season.

Reading Check

Does transpiration increase the amount of water vapor in the atmosphere or decrease the amount of water vapor in the atmosphere?

Transpiration increases the amount of water vapor in the atmosphere.

Composition of the Atmosphere, *continued*

Ozone in the Atmosphere

- **ozone** a gas molecule that is made up of three oxygen atoms
- Ozone in the upper atmosphere forms the *ozone layer*, which absorbs harmful ultraviolet radiation from the sun.
- Without the ozone layer, living organisms would be severely damaged by the sun's ultraviolet rays.
- Unfortunately, a number of human activities damage the ozone layer.

Composition of the Atmosphere, *continued*

Particulates in the Atmosphere

- The atmosphere contains various tiny solid and liquid particles, called *particulates*.
- Particulates can be volcanic dust, ash from fires, microscopic organisms, or mineral particles lifted from soil by winds. Pollen from plants and particles from meteors that have vaporized are also particulates.
- Large, heavy particles remain in the atmosphere only briefly, but tiny particles can remain suspended in the atmosphere for months or years.

Atmospheric Pressure

- Gravity holds the gases of the atmosphere near Earth's surface. As a result, the air molecules are compressed together and exert force on Earth's surface.
- **atmospheric pressure** the force per unit area that is exerted on a surface by the weight of the atmosphere
- Atmospheric pressure is exerted equally in all directions—up, down, and sideways.

Atmospheric Pressure, *continued*

- Earth's gravity keeps 99% of the total mass of the atmosphere within 32 km of Earth's surface.
- Because the pull of gravity is not as strong at higher altitudes, the air molecules are farther apart and exert less pressure on each other at higher altitudes.
- Thus, atmospheric pressure decreases as altitude increases.

Atmospheric Pressure, *continued*

- Atmospheric pressure also changes as a result of differences in temperature and in the amount of water vapor in the air.
- In general, as temperature increase, atmospheric pressure at sea level decreases.
- Similarly, air that contains a lot of water vapor is less dense than drier air because water vapor molecules have less mass than nitrogen or oxygen molecules do.

Measuring Atmospheric Pressure

- Meteorologists use three units for atmospheric pressure: atmospheres (atm), millimeters or inches of mercury, and millibars (mb).
- *Standard atmospheric pressure*, or 1 atm, is equal to 760 mm of mercury, or 1,000 mb. The average atmospheric pressure at sea level is 1 atm.
- Meteorologists measure atmospheric pressure by using an instrument called a *barometer*.

Measuring Atmospheric Pressure, *continued*

Mercurial Barometers

- One type of barometer is the *mercurial barometer*.
- Atmospheric pressure presses on the liquid mercury in the well at the base of the barometer.
- The height of the mercury inside the tube varies with the atmospheric pressure.
- The greater the atmospheric pressure is, the higher the mercury rises.

Measuring Atmospheric Pressure, *continued*

Aneroid Barometers

- Inside an aneroid barometer is a sealed metal container from which most of the air has been removed to form a partial vacuum.
- Changes in atmospheric pressure cause the sides of the container to bed inward or bulge out. These changes move a pointer on a scale.
- An aneroid barometer can also measure altitude above sea level. When used for this purpose, it is called an *altimeter.*

Reading Check

What is inside an aneroid barometer?

An aneroid barometer contains a sealed metal container that has a partial vacuum.

Layers of the Atmosphere

- Earth's atmosphere as a distinctive pattern of temperature changes with increasing altitude.
- The temperature differences mainly result from how solar energy is absorbed as it moves through the atmosphere.
- Scientists identify four main layers of the atmosphere based on these differences.

Layers of the Atmosphere, *continued*

The Troposphere

- **troposphere** the lowest layer of the atmosphere, in which temperature drops at a constant rate as altitude increases; the part of the atmosphere where weather conditions exist
- At an average altitude of 12 km, the temperature stops decreasing. This zone is called the *tropopause* and represents the upper boundary of the troposphere.

Layers of the Atmosphere, *continued*

The Stratosphere

- **stratosphere** the layer of the atmosphere that lies between the troposphere and the mesosphere and in which temperature increases as altitude increases; contains the ozone layer
- In the upper stratosphere, the temperature increases as altitude increases because air in the stratosphere is heated from above by absorption of solar radiation by ozone.
- The *stratopause,* about 50 km above Earth's surface, marks the upper boundary of the stratosphere.

Layers of the Atmosphere, *continued*

The Mesosphere

- **mesosphere** the coldest layer of the atmosphere, between the stratosphere and the thermosphere, in which the temperature decreases as altitude increases
- The mesosphere is located above the stratopause and extends to an altitude of about 80 km.
- The upper boundary of the mesosphere, called the *mesopause,* has an average temperature of nearly –90°C, which is the coldest temperature in the atmosphere.

Layers of the Atmosphere, *continued*

The Thermosphere

- **thermosphere** the uppermost layer of the atmosphere, in which temperature increase as altitude increases; includes the ionosphere
- Temperature increases as altitude increases because nitrogen and oxygen atoms absorb solar radiation.
- The lower region of the thermosphere, at an altitude of 80 to 400 km, is commonly called the *ionosphere*.
- Interactions between solar radiation and the ionosphere cause the phenomena known as *auroras*.

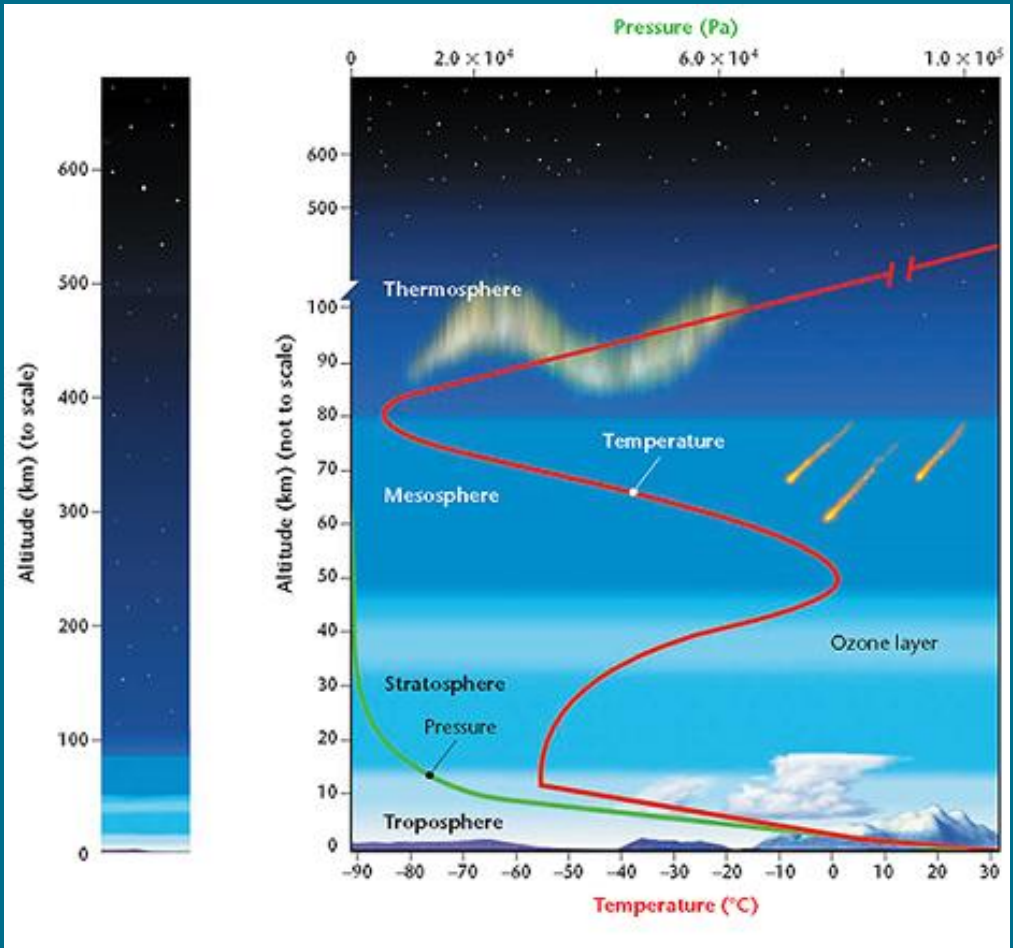
Layers of the Atmosphere, *continued*

The Thermosphere, *continued*

- There are not enough data about temperature changes in the thermosphere to determine its upper boundary.
- However, above the ionosphere is the region where Earth's atmosphere blends into the almost complete vacuum of space.
- This zone of indefinite altitude, called the *exosphere*, extends for thousands of kilometers above the ionosphere.

Layers of the Atmosphere, *continued*

This diagram shows the different layers of the atmosphere.



Reading Check

What is the lower region of the thermosphere called?

The lower region of the thermosphere is called the *ionosphere.*

Temperature Inversions

- Any substance in the atmosphere and that is harmful to people, animals, plants, or property is called an *air pollutant.*
- Today, the main source of air pollution is the burning of fossil fuels, such as coal and petroleum.
- Certain weather conditions can make air pollution worse.
- One such condition is a *temperature inversion*, the layering of warm air on top of cool air.

Temperature Inversions, *continued*

- In some areas, topography may make air pollution even worse by keeping the polluted inversion layer from dispersing.
- Under conditions in which air cannot circulate up and away from an area, trapped automobile exhaust can produce *smog,* a general term for air pollution that indicates a combination of smoke and fog.