

11-5 What is air pressure?

INVESTIGATE

Observing Air Pressure HANDS-ON ACTIVITY

1. Place a drinking straw in a cup of water.
2. Put your finger over the top end of the straw.
3. Take the straw out of the water. Observe the water inside the straw.
4. Hold the straw over the cup and remove your finger. Observe what happens.

THINK ABOUT IT: What happened when you removed the straw from the water with your finger on top of it? What holds the water in the straw? Why does the water fall out when you take your finger away? How is this activity related to air pressure?



STEP 3

Objective

Explain air pressure and describe what affects it.

Key Terms

newton: metric unit of force
pressure: amount of force per unit of area

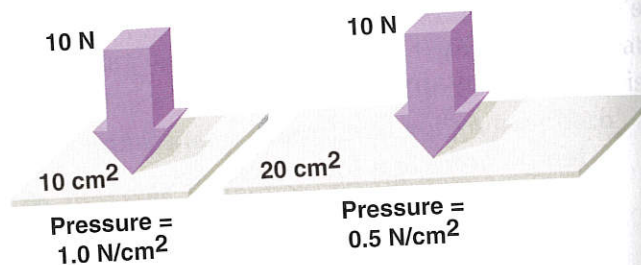
Weight and Pressure Weight is a force. If you hold a book in the palm of your hand, you feel the weight of the book pressing down. This force is measured in units called **newtons (N)**. A 1-kg mass has a force of about 10 N.

The amount of force per unit of area is called **pressure**. When you hold the book in the palm of your hand, the book's weight is spread over your hand. Suppose the book's force is 10 N, and your hand has an area of 100 square cm, or 100 cm². The force on each square centimeter is then 10 N divided by 100 cm², or 0.1 N/cm². The pressure of the book on your hand is 0.1 N/cm².

$$\frac{\text{Force}}{\text{Area}} = \text{Pressure}$$

$$\frac{10 \text{ N}}{100 \text{ cm}^2} = 0.1 \text{ N/cm}^2$$

A force exerted over a small area causes more pressure than the same force applied over a large area. See Figure 11-12 for an example of this.

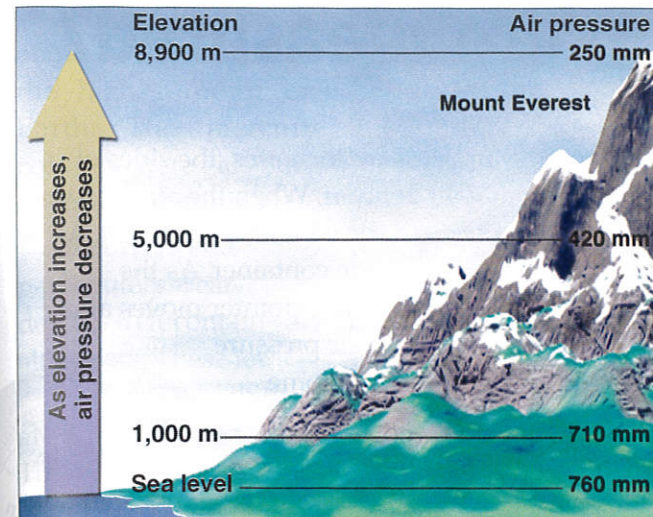


▲ **Figure 11-12** The same force exerted over a smaller area causes more pressure.

Air has weight. One liter of air weighs about 0.01 N at sea level. This is about the weight of a paper clip. The surface of Earth is at the bottom of the atmosphere. Air molecules are in constant motion and are pulled towards Earth's center by gravity. The force of all these moving molecules causes air pressure. Most of the air in the atmosphere is concentrated near Earth's surface. So air pressure is greatest near Earth's surface and decreases as altitude increases.

- 1 **EXPLAIN:** Why does air exert pressure on Earth's surface?

Elevation Air pressure changes with elevation, or height above sea level. The atmosphere is hundreds of kilometers thick. The weight of all this air causes more pressure near the ground. This pushes the air molecules closer together. Near the top of the atmosphere, the air molecules remain farther apart. There is very little weight of air pressing down. Therefore, the air pressure is lower. The higher the elevation, the lower the air pressure.

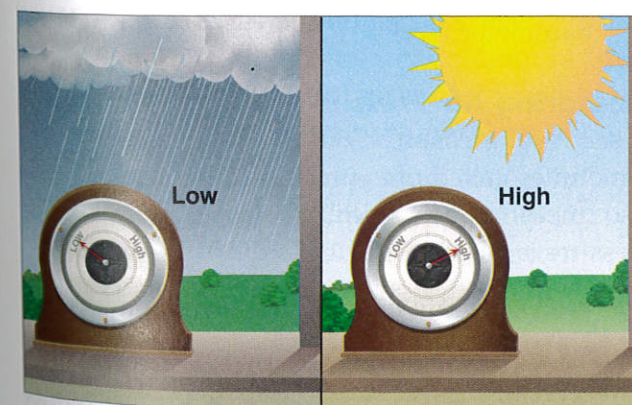


▲ **Figure 11-13** Elevation affects air pressure, which is measured in millimeters of mercury.

Air pressure decreases as distance above the surface increases. The air pressure on top of a mountain is less than the air pressure at sea level. Air pressure at sea level is about 10 N/cm².

- 2 **DESCRIBE:** How does elevation affect air pressure?

Water Vapor The more water vapor in the air, the lower the air pressure. Water evaporates from lakes, rivers, and oceans. Living things give off water vapor. All of this water vapor goes into the air. The lighter molecules of water vapor replace some of the other gas molecules in air. Air with a lot of water vapor weighs less than dry air with less water vapor. Thus, moist air exerts less pressure. Air pressure goes down as the amount of water vapor in the air goes up.



▲ **Figure 11-14** The weather conditions outside influence the air pressure.

- 3 **DESCRIBE:** How does water vapor affect air pressure?

Temperature Under ordinary conditions, the higher the temperature, the lower the air pressure. Heat makes air molecules move faster. As the molecules move faster, they spread apart. This makes the air less dense.

So warm air is less dense than cool air. In summer, when temperatures are higher, the air pressure is usually lower.

- 4 **RELATE:** How is temperature related to air pressure?

CHECKING CONCEPTS

1. Pressure is the amount of _____ on a unit of area.
2. Air pressure at sea level is _____ than air pressure on top of a mountain.
3. Air pressure _____ as elevation increases.
4. Warm air weighs _____ than cool air.

THINKING CRITICALLY

5. **CALCULATE:** A 5-N force pushes down on an area that is 10 cm². How much pressure does the force have?
6. **HYPOTHESIZE:** Why do ears "pop" in an airplane?

Web InfoSearch

The Magdeburg Hemispheres In 1654, Otto von Guericke, the mayor of a small German town called Magdeburg, did an experiment. He made a hollow metal sphere with two halves, or hemispheres, fitted tightly together. Air was pumped out of the sphere through a valve. This lowered the air pressure inside. The higher outside air pressure held the sphere together.

SEARCH: Use the Internet to find out more about this experiment. Why couldn't horses pull the two hemispheres apart? Start your search at www.conceptsandchallenges.com. Some key search words are **air pressure**, **Von Guericke**, and **Magdeburg**.