

# 16.1

## KEY CONCEPT

# The atmosphere's air pressure changes.

### BEFORE, you learned

- Density is the amount of mass in a given volume of a substance
- Air becomes less dense as altitude increases
- Differences in density cause air to rise and sink

### NOW, you will learn

- How the movement of air molecules causes air pressure
- How air pressure varies
- How differences in air pressure affect the atmosphere

## VOCABULARY

air pressure p. 539  
barometer p. 542

## EXPLORE Air Pressure

### What does air do to the egg?

#### PROCEDURE

- 1 Set a peeled hard-boiled egg in the mouth of a bottle. Make sure that the egg can't slip through.
- 2 Light the matches. Remove the egg, and drop the matches into the bottle. Quickly replace the egg.
- 3 Watch carefully, and record your observations.

#### MATERIALS

- peeled hard-boiled egg
- glass bottle
- 2 wooden matches



#### WHAT DO YOU THINK?

- What happened when you placed the egg back on top of the bottle?
- What can your observations tell you about the air in the bottle?

## Air exerts pressure.

Air molecules move constantly. As they move, they bounce off each other like rubber balls. They also bounce off every surface they hit. As you read this book, billions of air molecules are bouncing off your body, the book, and everything else around you.

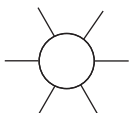
Each time an air molecule bounces off an object, it pushes, or exerts a force, on that object. When billions of air molecules bounce off a surface, the force is spread over the area of that surface. **Air pressure** is the force of air molecules pushing on an area. The greater the force, the higher the air pressure. Because air molecules move in all directions, air pressure pushes in all directions.



**CHECK YOUR READING** How does the number of air molecules relate to air pressure?

## VOCABULARY

Add a description wheel for *air pressure* to your notebook.



## Air pressure is related to altitude and density.

### COMBINATION NOTES

Record details about how air pressure varies.

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### REMINDER

Density is the amount of mass in a given volume of a substance.

The air pressure at any area on Earth depends on the weight of the air above that area. If you hold out your hand, the force of air pushing down on your hand is greater than the weight of a bowling ball. So why don't you feel the air pushing down on your hand? Remember that air pushes in all directions. The pressure of air pushing down is balanced by the pressure of air pushing up from below.

Air pressure decreases as you move higher in the atmosphere. Think of a column of air directly over your body. If you stood at sea level, this column would stretch from where you stood to the top of the atmosphere. The air pressure on your body would be equal to the weight of all the air in the column. But if you stood on a mountain, the column of air would be shorter. With less air above you, the pressure would be lower. At an altitude of 5.5 kilometers (3.4 mi), air pressure is about half what it is at sea level.

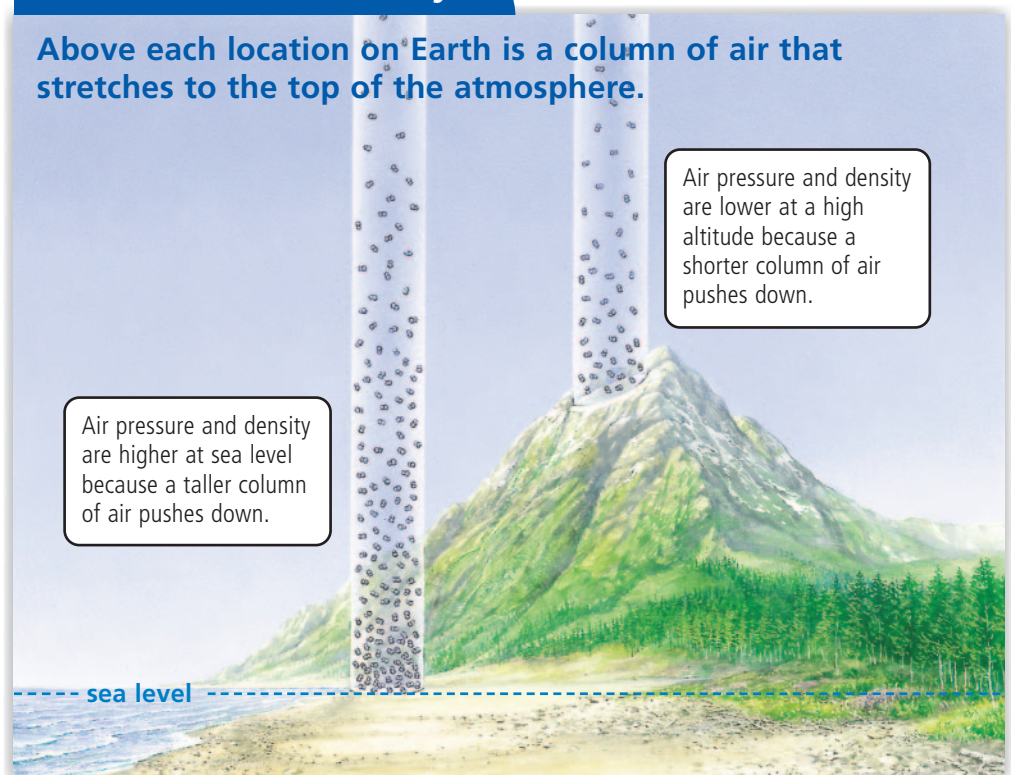
Air pressure and density are related. Just as air pressure decreases with altitude, so does the density of air. Notice in the illustration that air molecules at sea level are closer together than air molecules over the mountain. Since the pressure is greater at sea level, the air molecules are pushed closer together. Therefore, the air at sea level is denser than air at high altitudes.

### Air Pressure and Density

Above each location on Earth is a column of air that stretches to the top of the atmosphere.

Air pressure and density are lower at a high altitude because a shorter column of air pushes down.

Air pressure and density are higher at sea level because a taller column of air pushes down.



## Pressure and Air Motion

You've read that air pressure decreases as you move to higher altitudes. Air pressure also often varies in two locations at the same altitude. You can observe how such pressure differences affect air when you open a new can of tennis balls. You may hear a hiss as air rushes into the can. The air inside the sealed can of tennis balls is at a lower pressure than the air outside the can. When you break the seal, air moves from outside the can toward the lower pressure inside it.

Air pressure differences in the atmosphere affect air in a similar way. If the air pressure were the same at all locations, air wouldn't move much. Because of differences in pressure, air starts to move from areas of higher pressure toward areas of lower pressure. The air may move only a short distance, or it may travel many kilometers. You will learn more about how air moves in response to pressure differences in Section 16.2.



Find out more about air pressure.



How do differences in air pressure affect the movement of air?

## INVESTIGATE Air Pressure

### How can you measure changes in air pressure?

#### PROCEDURE

- 1 Cut open a balloon along one side until you get close to the end. Stretch the balloon across the open top of the can. Secure it tightly in place with a rubber band.
- 2 Cut the straw on an angle to make a pointer. Tape the other end of the straw to the center of the balloon.
- 3 Tape a ruler against a wall or a box so that the end of the pointer almost touches the ruler. Record the position of the pointer against the ruler.
- 4 Record the position of the pointer at least once a day for the next five days. Look for small changes in its position. For each day, record the air pressure printed in a local newspaper.

#### WHAT DO YOU THINK?

- In what direction did the pointer move when the air pressure went up?  
when the air pressure went down?
- Explain how your instrument worked.

**CHALLENGE** Predict what would happen to the pointer if you repeated this experiment but poked some small holes in the balloon.

#### SKILL FOCUS

Collecting data



#### MATERIALS

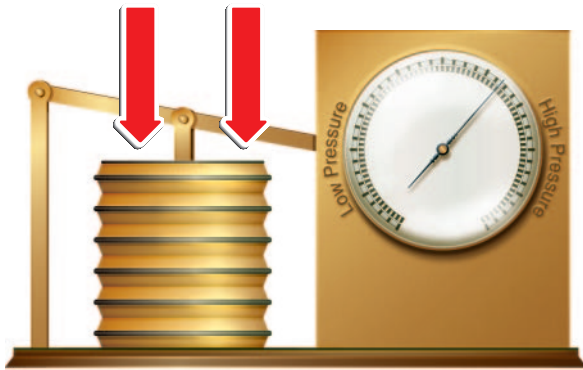
- scissors
- round balloon
- metal can
- rubber band
- thin straw
- tape
- ruler

**TIME**  
15 minutes



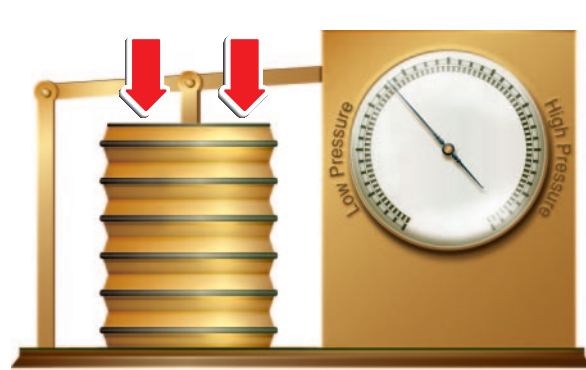
## How a Barometer Works

### High Air Pressure



The flexible chamber on the barometer contracts when the air pressure increases.

### Low Air Pressure



The chamber expands when the air pressure decreases.



Which of these barometer readings would be the more likely one on a mountain? Explain why.

## Barometers and Air Pressure

Air pressure can be measured in different ways. A **barometer** is any instrument that measures air pressure. The illustrations above show a simplified version of a common type of barometer. This type contains a sealed flexible chamber that has little air inside. The chamber contracts when the outside air pressure is high and expands when the air pressure is low. A series of levers or other devices turns the motion of the chamber into something that can be read—the movement of a needle on a dial or a jagged line on a strip of graph paper.

## 16.1 Review

### KEY CONCEPTS

1. How does the movement of air molecules cause pressure?
2. How does altitude affect air pressure?
3. How is air density related to air pressure?

### CRITICAL THINKING

4. **Apply** Would you expect the air pressure in a valley that's below sea level to be higher or lower than air pressure at sea level? Explain.
5. **Predict** Two barometers are placed one kilometer apart. One shows higher pressure than the other. What will happen to air between them?

### CHALLENGE

6. **Infer** The eardrum is a thin sheet of tissue that separates air in the middle part of your ear from air outside your ear. What could cause your eardrum to make a popping sound as you ride up a tall building in an elevator?