

3.2 Reading (Air Pressure: pages. 78 – 83)

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78 The Atmosphere

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LESSON 3.2 Air Pressure

Establish Learning Objectives
After this lesson, students will be able to:


- Identify some properties of air.
- Describe how barometers can be used to measure air pressure.
- Explain how altitude affects air pressure and density.

Engage

Activate Prior Knowledge
MY PLANET DIARY Read *Flying High* with the class. Have students discuss what they know about space suits worn by astronauts. Help students understand that the suits provide the astronauts with an "atmosphere" like that on Earth. Ask: **What condition would cause a pilot's blood to boil?** (The absence of air pressure) **How does a high-altitude pilot overcome the lack of air pressure?** (By wearing a pressure suit that keeps air pressure stable for the pilot)

BIG IDEAS OF SCIENCE REFERENCE LIBRARY DK
Have students look up the following topic: Altitude.

Explore

Lab Resource: Inquiry Warm-Up 
DOES AIR HAVE MASS? Students will weigh a balloon that is full of air.

LESSON 2 Air Pressure

UNLOCK THE BIG ?

- What Are Some Properties of Air?
- What Instruments Measure Air Pressure?
- How Does Altitude Affect Air Pressure and Density?

my planet DiARY

Flying High
Astronauts aren't the only people who go into space. High-altitude pilots who fly above 15,250 meters are in a zone with conditions similar to deep space. At these heights, air pressure is so low that blood can boil. A pilot can also pass out in less than a minute from lack of oxygen. To survive, pilots wear pressure suits. These suits weigh about 16 kilograms and are custom-built for each pilot. They inflate in an emergency, keeping air pressure stable for the pilot. The suits are "very, very restrictive," says pilot David Wright. "But it saves your life, so you're able to put up with that."

DISCOVERY
Discuss your answer with a classmate. Pilots wear pressure suits in addition to flying in a pressurized plane. Why do you think this is so?
If one system fails,
the other serves as a
backup.

PLANET DIARY Go to Planet Diary to learn more about air pressure.

Lab 2016 Do the Inquiry Warm-Up Does Air Have Mass?

What Are Some Properties of Air?

How do you know air exists? You can't see it. Instead, you have to understand what air does. It may seem to you that air has no mass. But the air in the atmosphere consists of atoms and molecules, which have mass. **Because air has mass, it also has other properties, including density and pressure.**




Properties of Air

- * density * air pressure
- * barometer * mercury barometer
- * aneroid barometer * altitude

🎯 Reading: Relate Cause and Effect
📌 Inquiry: Develop Hypotheses

As **Figure 1** shows, there is a column of air above you that extends all the way up through the entire atmosphere. In fact, the weight of the column of air above your desk is about the same as the weight of a large school bus. So why doesn't air pressure crush your desk? The reason is that the molecules in air push in all directions—down, up, and sideways. The air pushing down on top of your desk is balanced by the air pushing up on the bottom of your desk.

 Answer the questions below.

- ### Air Column
- The weight of the column of air above you puts pressure on you.
-  **Answer the questions below.**
- 1. Describe** What's an air column?
The air above you going up through the atmosphere
 - 2. Apply Concepts** Add arrows to the diagram below to indicate how the pressure from air molecules keeps you from being crushed.
- 
- 
- AIR COLUMN**

got it?

☐ I need extra help with See TE note.

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Evaluate

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Teach With Visuals

MERCURY BAROMETERS Direct students to look at the mercury barometer shown in **Figure 2**. Discuss the fact that the open end of the tube rests in a dish of mercury. Point out that the closed end is almost a vacuum. Help students understand that a space that is almost a vacuum is a space that contains almost no air. Ask: **How does a mercury barometer work?** (Air pressing down on the surface of the mercury in the dish is equal to the pressure exerted by the column of mercury in the tube that is inverted in the dish. When the air pressure increases, it presses down more on the surface of the mercury in the dish). **What does this increase in pressure do to the mercury?** (The increased pressure forces the column of mercury higher in the tube. This rise of the mercury in the tube indicates what the air pressure is at that time.)

Mercury Barometers Look at Figure 2 to see a mercury barometer model. A **mercury barometer** consists of a long glass tube that is closed at one end and open at the other. The open end of the tube rests in a dish of mercury. The closed end of the tube is almost a vacuum—the space above the mercury contains very little air. The air pressing down on the surface of the mercury in the dish is equal to the pressure exerted by the weight of the column of mercury in the tube. When the air pressure increases, it presses down more on the surface of the mercury. Greater air pressure forces the column of mercury higher. So, the level of the mercury in the tube shows you the pressure of the air that day.

Apply Concepts Use the drawing of the barometer on the right to show what a low air pressure reading looks like.

1. Shade in the level of the mercury in the tube and in the dish.
2. Describe what is happening.



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MY SCIENCE

Measuring Air Pressure



INTERACTIVE ART

MY SCIENCE COACH

Aneroid Barometers If you have a barometer at home, it's probably an aneroid barometer. The word *aneroid* means "without liquid." An **aneroid barometer** (AN uh royd) has an airtight metal chamber, as shown in Figure 3. The metal chamber is sensitive to changes in air pressure. When air pressure increases, the thin walls of the chamber are pushed in. When the pressure drops, the walls bulge out. The chamber is connected to a dial by a series of springs and levers. As the shape of the chamber changes, the needle on the dial moves.

Units of Air Pressure Weather reports use several different units for air pressure. Most weather reports for the general public use inches of mercury. For example, if the column of mercury in a mercury barometer is 30 inches high, the air pressure is "30 inches of mercury" or "30 inches." National Weather Service maps indicate air pressure in millibars. The pressure of the atmosphere is equal to one bar. One inch of mercury is about 33.86 millibars, so 30 inches of mercury is equal to about 1,016 millibars.

FIGURE 3
Inside an Aneroid Barometer
An aneroid barometer has an airtight metal chamber, shown in red, below.
Identify Label the diagram that shows the aneroid barometer under high pressure and the diagram that shows it under low pressure.



Low

High

Lab Zone Do the Quick Lab Soda Bottle Barometer.

Assess Your Understanding

1a. **Name** What two instruments are commonly used to measure air pressure?
Mercury and aneroid barometers

b. **Identify** What units are used to measure air pressure?
Inches of mercury and millibars

c. **CHALLENGE** How many millibars are equal to 27.23 inches of mercury?
922 millibars

got it?
☐ I get it! Now I know that air pressure can be measured by using two kinds of barometers.
☐ I need extra help with See TE note.

Go to MY SCIENCE COACH online for help

Explain

Teach With Visuals

ANEROID BAROMETERS Tell students to look at Figure 3. Point out that the object shown in red is the metal container inside the barometer. Ask: **What does the word aneroid mean?** (It means "without liquid.") **How does the shape of the metal container shown in the two images change?** (On the left, it is bulging. On the right, its walls are pushed in.) **How does an aneroid barometer work?** (The airtight metal chamber of an aneroid barometer is sensitive to changes in air pressure. When air pressure decreases, the thin chamber walls push in. When the pressure drops, the walls bulge out. The chamber wall is connected to a needle on a dial. As the shape of the chamber changes, the needle on the dial moves, indicating the air pressure.)

Lead a Discussion

UNITS OF AIR PRESSURE Review the different units of air pressure students are likely to hear on weather reports. Students will most likely recognize inches of mercury as the unit of air pressure. If the column of mercury in a mercury barometer measures 30 inches high, then the air pressure is reported as 30 inches. Ask: **What unit does the National Weather Service use on weather maps to indicate air pressure?** (Millibars) **How many millibars does 1 inch of mercury equal?** (33.86 millibars) **How many does 30 inches of mercury equal?** (1,016 millibars)

Elaborate

Lab Resource: Quick Lab
SODA BOTTLE BAROMETER Students will use a soda bottle to make a barometer.

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Altitude Also Affects Density As you go up through the atmosphere, the density of the air decreases. This means the gas molecules that make up the atmosphere are farther apart at high altitudes than they are at sea level. If you were near the top of a tall mountain and tried to run, you would quickly get out of breath. Why? The air contains 21 percent oxygen, whether you are at sea level or on top of a mountain. However, since the air is less dense at a high altitude, each cubic meter of air you breathe has fewer oxygen molecules than at sea level. So you would become short of breath more quickly at a high altitude.

FIGURE 4 EFFECT OF ALTITUDE ON PRESSURE AND DENSITY

1. **Relate Evidence and Explanation** Draw the air column above each hiker on the mountain. Then answer the question below the hikers.

2. **Make Models** In the empty circles below, draw how densely packed you think the molecules would be at the altitudes shown.

2a. **Define** What is altitude?
Distance above sea level

b. **Summarize** How does air pressure change as altitude increases?
Air pressure decreases with increasing altitude.

c. **Predict** What changes in air pressure would you expect if you carried a barometer down a mine shaft?
Air pressure would increase because the amount of air above you increases.

got it? ☐ I get it! Now I know the properties of air change with altitude.

☐ I need extra help with See TE note.

Go to MY SCIENCE COACH online for help with this subject.

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Explain

Lead a Discussion

ALTITUDE AND DENSITY Review the idea that the density of air depends on the number of molecules of gas in a given volume of space. Ask: **Are there more molecules in a sample of air at sea level or at great altitudes?** (There are more molecules in air at sea level than at great altitudes.) Compare what breathing would be like for a person on a high mountain with what breathing would be like for a high-altitude pilot. (In both cases breathing would be difficult because of the small amount of oxygen present and an extra oxygen supply would likely be needed by both people.)

Elaborate

Lab Resource: Quick Lab

EFFECTS OF ALTITUDE ON THE ATMOSPHERE Students will explore how altitude can affect the pressure and density of the atmosphere.

Evaluate

Assess Your Understanding

After students answer the questions, have them evaluate their understanding by completing the appropriate sentence.

RTI Response to Intervention

2a. If students have trouble defining *altitude*, then have them locate the highlighted term and read the definition.

b, c. If students need help describing changes in air pressure, then have them reread the paragraphs under the red head *Altitude Affects Air Pressure* and look at **Figure 4**.

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