Pressure and Density of the Atmosphere

Dana Desonie, Ph.D.

AUTHOR
Dana Desonie, Ph.D.

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Printed: August 8, 2016

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CHAPTER 1 Pressure and Density of the Atmosphere

- Define air density and air pressure.
- Explain how they change with increasing altitude.

Have your ears ever popped?

If your ears have ever "popped," you have experienced a change in air pressure. Ears "pop" because the air pressure is different on the inside and the outside of your ears.

Properties of Air

We usually can't sense the air around us unless it is moving. But air has the same basic properties as other matter. For example, air has mass, volume, and, of course, density.

Density of Air

Density is mass per unit volume. Density is a measure of how closely molecules are packed together. The closer together they are, the greater the density. Since air is a gas, the molecules can pack tightly or spread out.

The density of air varies from place to place. Air density depends on several factors. One is temperature. Like other materials, warm air is less dense than cool air. Since warmer molecules have more energy, they are more active. The molecules bounce off each other and spread apart. Another factor that affects the density of air is altitude.

Altitude and Density

Altitude is height above sea level. The density of air decreases with height. There are two reasons: at higher altitudes, there is less air pushing down from above, and gravity is weaker farther from Earth's center. So at higher altitudes, air molecules can spread out more, and air density decreases (**Figure** 1.1).

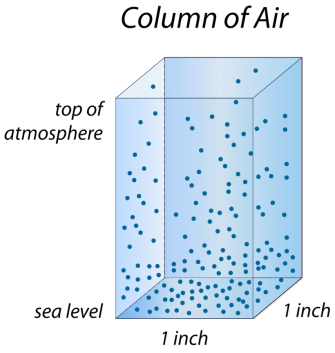

FIGURE 1.1

This drawing represents a column of air. The column rises from sea level to the top of the atmosphere. Where does air have the greatest density?

Air Pressure

Because air is a gas, its molecules have a lot of energy. Air molecules move a lot and bump into things. For this reason, they exert pressure. **Air pressure** is defined as the weight of the air pressing against a given area.

At sea level, the atmosphere presses down with a force of about 1 kilogram per square centimeter (14.76 pounds per square inch). If you are standing at sea level, you have more than a ton of air pressing against you. Why doesn't the pressure crush you? Air presses in all directions at once. Other molecules of air are pushing back.

Altitude and Air Pressure

Like density, the pressure of the air decreases with altitude. There is less air pressing down from above the higher up you go. Look at the bottle pictured below (**Figure** 1.2). It was drained by a hiker at the top of a mountain. Then the hiker screwed the cap on the bottle and carried it down to sea level. At the lower altitude, air pressure crushed it. Can you explain why?

Summary

- Air density and pressure decrease with increasing altitude.
- Ears pop as air pressures inside and outside of the ear equalize.
- Gravity pulls more air molecules toward the center of the planet.

Review

1. Why does air density decrease with increasing altitude?
2. Why does temperature decrease with increasing altitude in the troposphere?

FIGURE 1.2

At high altitude the air pressure is the same inside and outside the bottle. At sea level, the pressure is greater outside than inside the bottle. The greater outside pressure crushes the bottle.

3. Why are we not crushed by the weight of the atmosphere on our shoulders?

Explore More

Use the resource below to answer the questions that follow.

MEDIA

Click image to the left or use the URL below.
URL: https://www.ck12.org/flx/render/embeddedobject/1574

1. What is pressure?
2. What causes air molecules to have pressure?
3. Where does the atmosphere end? What is out past the atmosphere?
4. What is air pressure?
5. What is the elevation and air pressure in Key West, Florida?
6. What is the elevation on Mt. Everest? Why do climbers often use extra oxygen up there?
7. Why does air pressure change with altitude?

References

1. Hana Zavadska. Drawing of a column of air . CC BY-NC 3.0
2. User:Quantockgoblin/Wikimedia Commons. Water bottle collapsing due to greater air pressure at lower altitudes . Public Domain