Weather & Climate

# The Weight of Air and Air Pressure

Students will learn about air weight and pressure; the students will see the effect of the air pressure on two sheets of paper and an example of the weight of the air around us.

Air pressure, weight, and atmosphere

10-12 years

Math, Earth Science

30 minutes

## TEACHER GUIDELINES

Show students examples of air pressure and discuss them in a hands-on-way.

## MATERIALS

- 1 ruler
- 1 sheet of printer paper
- 1 newspaper
- 2 balloons
- 1 meter stick
- String
- Scotch tape

## LEARNING OBJECTIVES/ STANDARDS

1. Demonstrate that air has weight and how air pressure works. (Reproducing)
2. Understand the physics of why air has a different weight. (Understanding)
3. Design a new example to demonstrate air pressure. (Creating)

## BACKGROUND INFORMATION

We typically do not "feel" atmospheric air pressure. Why? Since air surrounds our bodies, and all things, the pressure, as a result of the air, is applied equally on all sides. But, air has weight; if someone holds an 8½x11" sheet of paper flat in their hands, the weight of the air directly above the sheet is over 1,300 pounds.
Obviously the paper does not weight that much. Why? That same pressure (14.7 pounds per square inch) is also pressing up on the bottom side of the paper. The equal pressure on all sides cancel each other out so all that is left is the weight of the material that comprises the paper.

**Units of Pressure**
We often speak of pressure in terms of atmospheres. One atmosphere is equal to the weight of the earth's atmosphere at sea level, about 14.7 pounds per square inch. If you are at sea level, each square inch of your surface is subjected to a force of 14.7 pounds.
In water, the pressure increases about one atmosphere (14.7 pounds per square inch) for every 10 meters of water depth. At the deepest part of all the earth's oceans, Marianas Trench's (east of the Philippine Islands) depth is about 35,800 feet (7 miles/11 kilometers). The pressure of nearly 7 miles of water overhead is about 1080 atmospheres or 16,000 pound per square inch.

**Moist vs. Dry Air**
Baseballs travel farther in moist air than in dry air. For any given volume of air, moist air (at the same temperature and pressure) has exactly the same number of molecules as dry air. Dry air is composed of mostly of heavy oxygen (O2) and nitrogen (N2) molecules. However in moist air, some molecules are the lighter weight water molecules (H2O), rather than heavier O2 or N2 molecules. Therefore, the air is less dense in moist air and this decrease in density equates to less resistance to the ball's motion through air. So, for two baseballs hit with equal force, the one in the moist air would travel farther than the one hit in dry air.

CREATED BY:
Leah Tai,
TAHMO

## PROCEDURE

The weight of air in balloons:

1. Blow up both balloons so they are the same size.
2. Tape one balloon to each end of the yard/meter stick.
3. Tie a string to the center of the stick and adjust it so the stick balances when held by the string. Tape the sting in place to prevent it from slipping.
4. Ask the students, "If one end were heavier, would the heavier end move up or down?"
5. Supporting one balloon, have someone carefully deflate the other balloon. Try poking the balloon with a pin in its neck to prevent the balloon from tearing apart as it pops.
6. Release the remaining balloon and ask the students to explain what happens.

Air pressure under paper:

1. Lay a ruler or stick on a table with about 8 cm hanging over the edge.
2. Lay a sheet of printer paper on the part of the ruler in direct contact with the table.
3. Press the paper against the table until it is flat as possible.
4. Press down on part of the ruler hanging over the edge.
5. Repeat the above steps except replace the printer paper with a large sheet of opened newspaper in the second step.

## RESULT

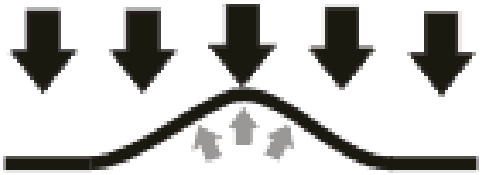
**Weight of Air:** Since the inflated balloon weighs more than the deflated one, the side of the inflated balloon will drop. Imagine the weight of air if that balloon were now 24 km tall, as tall as the atmosphere. This is actually what is occurring around you all the time. When we measure air pressure, we are measuring the weight of a column of air 24 km high directly over us.

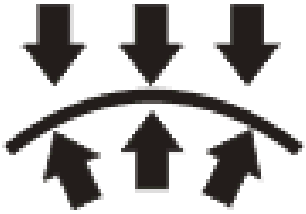
**Pressure of air on paper:** The students will discover the newspaper was much harder to lift than the printer paper. As the ruler lifted the printer paper, air rush in under the rising paper and thereby quickly allowed the air pressure to equalize on all sides. Essentially, the weight of the air above the paper had no effect on the difficulty in lifting the paper.
As the ruler lifted the newspaper, the edges of the newspaper remained in contact with the desk. Very little air was allowed to rush in and equalize the pressure on the bottom side of the newspaper. Since there is less air below the paper the pressure is less as well. Now the weight of all the air above the paper now becomes more evident.

## DISCUSSION

Draw the following diagrams on the board.

Which of the images describes each paper and the pressure on it?





What happens to the weight of air, and air pressure, at high elevations?

Have students design a simple demonstration, similar to those done in class, to show evidence of air pressure or the weight of air.