Air Pressure

Background

All around us, there is a thin layer of air that presses down on the Earth. The air surrounding the Earth is called the atmosphere. The weight of air that presses or pushes down per unit area is called air pressure. On average, the atmosphere presses down on us with a force of 14.7 pounds per square inch!

Sometimes, often depending on the temperature of the air, there is more air on top of us, and the air pressure is higher. This condition is called a "high." If there is less air on top of us, the condition is called a "low." The skies are usually clear where there is a high pressure system, and cloudy when there is low pressure.

High pressure and low pressure masses of air interact to help generate the weather we observe. A large amount of air that has approximately the same temperature, pressure, and humidity is called an air mass. The place where two different air masses meet is called a front. A cold front represents a zone where cold, dry air is moving to replace warmer, moist air. When a cold front is approaching, the pressure typically drops steadily until it reaches a minimum. When the front passes, the pressure begins to rise sharply, and then steadily rises after the front passes. When a warm front (when warm air is replacing cool air) is approaching, the air pressure usually falls. As the warm front passes, the pressure levels off. After the front has passed, there is usually a slight rise in pressure, followed by a fall.

One way to predict the comings and goings of warm and cold fronts is to observe clouds. Clouds form when water vapor cools and condenses, and depending on the atmospheric conditions, different cloud formations develop. In the case of approaching cold fronts, cirrus ("sear-us") clouds, which are located high in the sky and are very wispy, are generally observed, followed by towering cumulus ("kewm-you-lus") or cumulonimbus ("kewm-you-low-nim-bus") clouds. Towering cumulus clouds are tall, large and puffy, whereas cumulonimbus clouds are huge thunderstorm-bearing clouds. Once the cold front has passed, smaller cumulus clouds are typically seen.

Warm fronts usually display the following progression of cloud development: cirrus; cirrostratus ("sear-oh-strah-tus," high), altostratus, nimbostratus, and stratus, which are clouds at varying altitudes that take on a sheet-like, sky-covering appearance; and fog.

The tool meteorologists use to measure air pressure is called a barometer. By measuring air pressure in different places, we can better predict the progression of weather systems.

Topic

Atmosphere

Objectives

Students will:

- Investigate the relationship between air pressure and the weather.
- Construct an instrument to measure air pressure.
- Identify types of clouds.

Overview

Students will identify causes of air pressure, design and use a barometer (a tool that measures air pressure), and compare how it relates to air temperature and weather conditions.

Key Question

How does air pressure relate to the weather?

Key Concepts

- Often atmospheric air temperature is related to air pressure.
- Warm air masses are generally associated with low pressure.
- Cold air masses are generally associated with high air pressure.
- There are three general types of clouds: cirrus, cumulus, and stratus.

Materials & Preparation

For the teacher demonstration, you will need:

- 8 oz. glass of water
- Index cards
- Bowl to collect any spilt water

To make the barometer, each team will need:

- Thermometer
- Latex glove or balloon
- Baby food jar
- Rubber band
- Ruler
- Heavy paper or cardboard, approximately 4" x 11"
- Brick
- Toothpick
- Straw (paper straw preferred)
- Glue or tape

1. Teacher Demonstration: Fill an 8oz. glass or smaller with water to the rim.
2. With one hand, slide an index card across the top of the glass and hold it there. (The index card and your hand must be dry.)
3. Over a bowl, turn the glass upside down and remove your hand from the index card. The index card should hold the water inside the upside-down glass because the pressure from the air presses up against the rim of the glass.
4. Move the glass back and forth. The card should stay in place because the air pressure remains the same throughout the room.
5. **After demonstration: whole group discussion.** Why did the water stay in the glass? Have students share thoughts and record them on board or overhead.
6. Divide the class into cooperative groups and facilitate their production of a barometer.
7. Have students place a thermometer with their barometer outdoors in a tamper-free environment.
8. Students will check and record the temperature, air pressure, and cloud cover for the next five days. If available, have a cloud identification chart available for their use.
9. Review the information provided in the Background section with the students. Use this information to help the students answer the Reflection & Discussion questions.

Management

- Two 50-minute class periods, plus five days of observation.
- Look in Earth science books for a cloud identification chart, or call your local branch of the National Weather Service to see if they have an extra one they might be willing to donate.

Reflection & Discussion

1. Were all of the observations of the teams the same? What do you think may have been the reason for any differences in observations?
2. Did the types of clouds you observed match the changes in atmospheric conditions?
3. What would you expect to happen to your barometer if you took it someplace high in altitude, like Denver, Colorado? What if you took it someplace that was lower than sea level, like Death Valley, California?

Transfer/Extension

1. Extend the observations to span a larger time period, such as an entire month. Note the daily observations of air pressure for each team on a class-wide chart.
2. Look into partnering with the National Weather Service to provide them with local weather observations on a regular basis.
3. Look into acquiring other weather-monitoring equipment, such as a rain gauge or an anemometer (which measures wind speed).

STUDENT WORKSHEET

Air Pressure

Student Procedures

1. Take the glove or balloon and cut it so that you have a smooth piece that is large enough to stretch over the lid of the jar.
2. Stretch the glove or balloon over the opening of the empty jar.
3. Stretch the rubber band over the jar to secure the rubber or latex tightly.
4. Cut off the excess rubber or latex from around the jar.
5. Tape or glue the toothpick parallel to the end of the straw so that the toothpick sticks out of the end, like a pointer.
6. Glue or tape the cardboard or heavy paper to the brick so that the skinny end of the paper lines up evenly with the thin end of the brick. You should be able to stand the brick on its end without the paper getting in the way, and so that the paper extends at least a few inches higher than the top of the jar.
7. Tape the end of the straw that does not have the toothpick on it to the center of the glove or balloon. This is your barometer.
8. Place the barometer next to the brick so that the toothpick points to a place on the paper. Use your ruler to draw a straight horizontal line on the paper where the end of your barometer points.
9. Place the barometer system in a tamper-free environment away from moisture. Also, place a thermometer near your barometer.
10. Check your barometer every 24 hours for the next five days. With a pencil, mark the place where the toothpick points, and write the date or day of the week beside it. If the pointer moves above the last line you drew, the air pressure outside the jar has increased. If the pointer is below the line, the air pressure outside the jar has decreased.
11. Record your observations of the air pressure as well as the air temperature and any observed clouds on your data log.
12. After completing your study, answer the following questions.

Air Pressure

Barometer Data Log

Daily Weather Measurements

Day	Air Pressure Up/Down	Temperature (°C)	Type of Cloud Cover
1			
2			
3			
4			
5			
6			

Questions & Conclusions

1. Explain how your barometer measures air pressure.
2. Do you see a relationship between air pressure and temperature? Explain.
3. Did you notice any changes in air pressure just before some general changes in the weather, such as a storm? Explain.