Barometer

This material is about making your own barometer after which it can be tested and evaluated.

Air pressure, barometer, technical

12-13 years

Physics, mathematics

1 hour

TEACHER GUIDELINES

For upper grades, have students work in groups of two, which encourages them to better understand the activity. Allow students the freedom to redesign their barometers for more accurate measurements (such as increasing the number of lines on the upside down bottle). Have students graph the barometer measurement data that they collect and then explain any trends in the graph to the class.

For lower grades, use the permanent markers to draw symbols on the ketchup bottle that can help students remember what the different pressure values mean. Draw a cloud towards the bottom for low pressure, and a sun towards the top for high pressure.

MATERIALS

- Clear bottle
- Large drinking glass
- Ruler
- Permanent marker
- Barometer Analysis Worksheet

LEARNING OBJECTIVES/ STANDARDS

After this activity, students should be able to:

1. Describe a systems approach that engineers might use to address problems, such as weather forecasting.
2. Explain how engineered instrumentation, such as a barometer, can help predict changes in weather systems.
3. Relate how air pressure affects changes in weather systems.

BACKGROUND INFORMATION

Wouldn't it be great to be able to predict when a storm was going to arrive in your area? Of course, you could always look at the weather page in the newspaper or internet or watch the weather on the news, but what if you could just observe the clouds and make a prediction based on your own knowledge of the different types of clouds? Would you be able to make a prediction from this information? How accurate would your prediction be? What other types of things might you need to know to more accurately predict the weather? You may want to also look at the change in temperature, air pressure, wind speed and direction, and even humidity.

We have learned that much of our weather is caused by changes in air pressure. We know that hot air rises and cold air sinks. The rising hot air exerts less pressure on the Earth's surface, so air pressure decreases. Then cooler, dense air, that often carries moisture with it, comes in and replaces the hot air that has risen away. When the air fills with moisture, it releases that moisture in the form of rain, and we have a rainy day. Can we measure air pressure? How do we tell if the air around us is rising or falling?

Well, today we are going to design a weather forecasting instrument to help us predict one change in the system of weather around us. The instrument we are going to make is called a barometer, a device that measures air pressure. Our simple barometers consist of an empty bottle turned upside down in a cup. The wider sides of the bottle rest on the rim of the cup, so that the mouth of the bottle is not touching either the bottom or sides of the cup. Water that we put in the cup will rise to a certain level up the neck of the bottle. The reason that the water rises is that air is pushing down on the water in the cup and forcing it up into the bottle. We call this air pressure. If the air pressure goes up, then it pushes harder on the water in the cup and forces more water up into the bottle. We will be able to measure the change in air pressure by measuring how much the water level in the neck of the bottle goes up or down. If the air pressure goes down, then the air is not pushing as hard on the water in the cup and less water will be in the bottle. The water level in the bottle will go down. Falling air pressure usually indicates that a storm of some sort is approaching. Conversely, rising air pressure is usually an indication that the weather is clearing up. We will act like engineers as we analyze one individual component of our weather system. What might be our next step if we were trying to help predict the changes in weather around us? Using a systems approach, we might look at other factors affecting the weather system, such as temperature, humidity and wind speed.

CREATED BY:
Teach Engineering

PROCEDURE

Introduction
If a barometer shows that air pressure is decreasing, it indicates a chance for rain very soon. The more rapid the decrease in air pressure, the stormier it will be. The reason decreasing air pressure signals the arrival of a storm is that the decrease in air pressure indicates warm air is rising; the rising air carries moisture with it that forms clouds, and when the clouds fill with moisture, it rains. If the air pressure is increasing, the weather is going to clear up or stay fair.

Steps
1. Starting at the top of the neck of the ketchup bottle, have students make a mark every two centimeters, going all the way to the bottom of the bottle
2. Turn the bottle upside down and number the marks, starting with "1" at the upside down bottom of the bottle (or, the actual top of the bottle). These numbers do not represent an actual unit of pressure; they are simply to help students measure and compare values.
3. Fill the bottle about half-way with water; hold upright.
4. Place the glass upside-down over the bottle.
5. Quickly flip the bottle and glass over so that the glass is upright and the bottle is upside-down. Some water will spill out, but the water level inside the ketchup bottle should be higher than the level outside of it (that is, inside the glass). If it is not, repeat steps 3-5, using a little more water.
6. Add about an inch more of water into the cup. This ensures that if the pressure increases and pushes more water up the bottle, the bottle opening will remain submerged. Note: The water level in the cup should be just a little higher than the lip of the ketchup bottle. To take a barometer reading, take note of where the water level is inside the ketchup bottle.
7. Place the barometers in a safe place where the temperature stays fairly constant, and where they can be easily observed. They can be stored inside.
8. Record the current water level by using the numbered marks. Record the current weather conditions on your worksheet.
9. Take more barometer readings and weather observations once each day for at least a week. Record the information on your worksheet.
10. Compare any barometer changes to weather changes and look for trends. Were there any changes in weather during the week? Did the barometer change when the weather changed? Did the barometer change without a change in weather? How well did the barometer work? Was the design of your barometer effective? What would you change if you could design the barometer again? How does a barometer help us understand the system of weather around us?

RESULT