Weather Stations

Students will use everyday objects to build instruments to monitor the weather at their school.

Students will make a barometer to measure air pressure and a hair hygrometer to measure air moisture. They will equip their station with a thermometer and make visual observations of local clouds and weather.

AIR PRESSURE:

Air pressure measures the weight of air pressing down on an object. The weight of the air is related to the number of air molecules in the area. More molecules mean more pressure. Air pressure is an important measurement because changing air pressure is an indication of changing weather conditions. Pressure gradients create wind as air molecules from areas of high pressure move to areas of low pressure.

Imagine that the room you're in is the atmosphere and each student represents a molecule of air. Have most of the students crowd into one corner of the room and have a few students stand in the other corner. The corner with lots of students would be an area of high pressure and the corner with only a few students would be an area of low pressure. People (and air molecules) don't like to be crowded, especially when there is an area with only a few people a few feet away. Have some of the students in the 'high pressure' corner move toward the less crowded corner until the students are roughly evenly distributed between the two corners.

The movement of students from the crowded corner to the less crowded corner is like air molecules moving from an area of high pressure to an area of low pressure. This phenomenon creates wind.

BAROMETER:

Barometers measure the air pressure and help people plan for changes in the weather. Not all barometers are created equal, so have the students split into teams of two to make the barometers. We have provided you with a variety of different containers. Once the barometers have been made the club can determine which style of barometer best records changes in local air pressure. Local newspapers print air pressure on the weather page. If you could save the weather page every day the week after the club meeting where you make the barometers, students can discuss how well their barometers are recording changes in pressure and how changes in pressure correlate with changing temperature and/or precipitation patterns in their community.

Before we make the barometers we should understand how and why they work. The barometer we're going to make is going to trap air molecules in a container with a flexible lid. So the number of molecules in the jar will stay the same but the pressure will change based on the pressure of the air around it.

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The scientific formula for air pressure is:

PV = nRT

P = pressure
V = volume
n = number of molecules
R = constant for gases
T = temperature

The temperature of the air will remain pretty constant in the classroom, but we'll put a thermometer next to the barometers so we can see if the temperature is constant or not. The constant won't change, and the number of molecules in the container won't change since we sealed them in. The only two things left to change are pressure and volume

We can rewrite the equation:

P = nRT/V
Since n, R, and T remain constant the equation can be simplified even further:

$P \propto 1/V$ ($\propto$ means is proportional to)
OR, as P increases V decreases, and as V increases, P decreases.

Materials:

Straw
Container
Plastic wrap
Rubber bands
Scissors
Index card
Baby food container
Balloon
Tape

Procedure:

First we will perform an experiment where we will change the temperature in a small jar.

1) Take a baby food container and cover the opening with a piece of a balloon and secure it with a rubber band.

2) Hold the jar in your hands to warm up the air inside. Watch as the air expands and the piece of balloon puffs out as the air expands.

Now we're ready to start on the barometers.

3) Cover the top of the can tightly with the plastic wrap and secure it with the rubber band. (The cover should be taut and airtight.)

4) Place the straw on top of the can so that a bit is hanging off the side. You can cut the straw if necessary. Tape the straw in place.

5) Tape your index card to the wall, with the long end perpendicular to the floor, so the straw is roughly in the middle of the card.

6) Record the level of the straw on the index card and write down the date.

7) Check the pressure at the beginning of the next few SMILE club meetings.

Discussion:

By sealing the can students have sealed air under a certain pressure in the can. As the pressure changes outside the can the volume of the air in the can will expand or contract as the pressure changes. This can be recorded by the height of the straw on the index card. Students should compare their results with pressure measurements in the local paper and see if their barometers are recording the same thing the paper is reporting. Discuss what they think makes some of their barometers work better than others.

HUMIDITY:

Humidity is the measure of the amount of water vapor in the air. Have you ever wondered what it would be like to walk through a cloud? If you're picturing something light, fluffy and generally pleasant, think again. Clouds on the earth's surface have a special name: fog. As anyone who's been in the fog can tell you, it is not exactly fun. It's cold, damp and almost impossible to see. Air temperature determines how much water air can hold – cold air can hold much less water than warm air.

Hair Hygrometer:

Hair reacts to the amount of humidity in the air, as anyone with curly can tell you. Hair expands as humidity increases and contracts as humidity decreases. This expansion of hair when it's humid creates frizzy hair and 'bad hair days'. While this may bother hairdressers, it is good for science. We can measure the relative humidity of the air using human hair.

While the barometers should be placed away from the outside wall to minimize the temperature changes, the hygrometers should be placed close to the window to maximize the variability in humidity.

Materials:

10" x 4" piece of foam core board
Plastic plate
2 small nails
3 long strands of human hair (~ 8 inches long)
a coin, washer or paper clip for a weight
glue
tape
scissors

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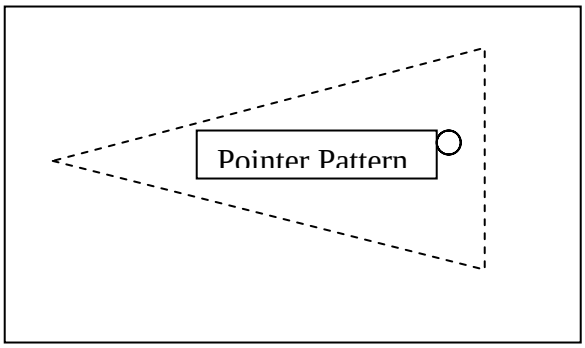
Directions:

1) Cut a plastic triangle to act as the pointer, groups should make pointers of different proportions and lengths to see what works best.

2) Poke one of the nails into the wide end of the plastic pointer (o on example). You may need to use a tack to start the hole on the plastic pointer.
Tape the weight (penny, washer, paper clip) to the pointy end of the plastic pointer.

3) Gather the 3 hairs together and glue one of the ends to the middle of the plastic pointer.



4) Position the pointer on the board about 2 inches from the bottom and attach it with the nail, but make sure that the pointer can still move.

5) Attach the other nail to the board about 1 inch from the top.

6) Pull the hair strands tight so the arrow points parallel to the ground (the pointer should be perpendicular to the hair).

7) Glue the free ends of the hair to the other nail maintaining the tightness.

8) Trim off excess hair once the glue is dry.

9) Mark where the arrow points on the piece of wood and record the local % humidity from the internet or the local newspaper.

10) Observe changes in the hygrometers from one week to the next.

Discussion:

The hair cells will expand when moisture is high making the pointer point down and will contract when it is dry making the pointer point up. How well do the hair hygrometers work? Which ones seem to be most sensitive and why? What are the factors that govern how the hygrometers work?