HOW'S THE WEATHER (1-2 HOURS)

Students will make their own weather station, consisting of several home-made versions of real weather measurement equipment and use that equipment to make observations about the local weather.

Overview

Topic: **Weather**

Real World Science Topics:

- An exploration of the different tools used to measure meteorological properties
- An exploration of the effect that meteorological variables can have on the comfort of people.

Objective

Students will gain an understanding of how meteorologists observe and analyze the weather.

Materials Needed for Each Team of 2-4 students:

two thermometers
gauze
rubber bands
shoe box
two paper plates
crepe paper
small coffee can
plastic wrap
straw
an index card

Additional Materials

Compass

Preparation

Before class you should scout the location that your students will be taking measurements. This location should be as far away from building as possible. Once you are there use a compass to find north, and find a good reference which students can use to identify north.

Standards Met

National Science Standards Addressed
Content Standard A: Science as Inquiry
Students: Will employ simple equipment and tools to gather data and extend the senses
Content Standard F: Earth Science
Students: Will understand that clouds, formed by the condensation of water vapor, affect weather and climate.

National Math Standards Addressed
Measurement: Carry out simple unit conversions within a system of measurement
National Technology Standards Addressed
Process data and report results

Sources:

National Science Teachers Association
http://books.nap.edu/html/nses/overview.html#content
National Council of Teachers of Mathematics
http://standards.nctm.org/document
National Educational Technology Standards
http://cnets.iste.org/currstands/cstands-netss.html

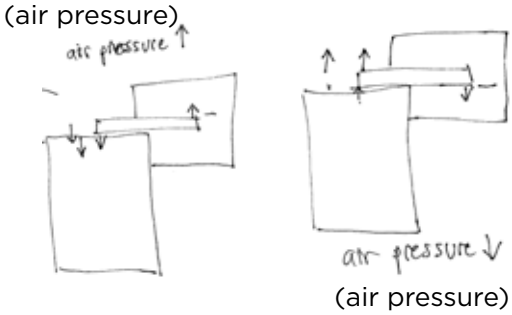
STEPS FOR *HOW'S THE WEATHER*

1. Warm-up Activity: Begin the class by asking students what are the most common weather properties they see when they see the current weather conditions broadcast on TV or on the internet. Temperature and precipitation are the most likely answers, but others that they are probably familiar with may include pressure, humidity, wind speed and direction, as well as cloudiness and recent precipitation amount. Ask students which instruments are used to measure these various properties. Students will probably know that a thermometer measures temperature, but they may not know many of the others, like an anemometer for measuring wind speed or a barometer for measuring pressure. Tell the students that in this activity they will create instruments for measuring these properties out of common materials.

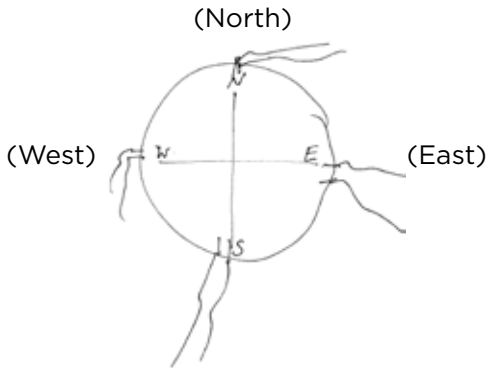
2. Divide students into groups of 4 and distribute the materials needed for this lab, as well as the *How's the Weather* handout.

3. Students should be supplied with two thermometers. Explain to them that they will use one to measure air temperature, and one to measure humidity. Students will use the two thermometers to make a piece of equipment called a sling psychrometer. This piece of equipment is used to measure the amount of moisture in air. To build the psychrometer, soak a piece of gauze in water and wrap it around the liquid filled end of one of the thermometers. When the class is ready to take observations, have the start fanning the gauze with a paper plate. They should keep fanning the gauze until the temperature stops falling. Instruct students to record the temperature on both the wet and the dry thermometers on the handout, then subtract the wet temperature from the dry temperature. The wet temperature is called the dew point. Tell students to use the table given on the handout to calculate relative humidity. Higher dew points and relative humidity mean that there is more moisture in the air.

4. Next students will make a barometer. A barometer measures air pressure. Ask the students to describe air pressure. Guide them to the correct answer by asking what pressure is (When something is pushing on something else). Air pressure is the pressure of air molecules pushing against us. To make the barometer, students should take the coffee can, stretch a piece of plastic wrap across the mouth, using rubber bands to hold the plastic wrap tightly in place. They should then tape the straw to the plastic wrap so that about half of it is hanging off of the top of the can. Lastly they should tape an index card to the back of the can as shown in the diagram. When it is time to take observations they should simply draw a line on the index card at the top of the straw. A normal barometer would give a numeric reading, but for this lab it is acceptable to simply note whether the pressure went up or down during the course of the activity. Pressure changes very slowly, so there may be no noticeable change during the short time of this activity. If you are interested you could have the students construct the barometer several days before the rest of the experiment and take daily pressure readings over several days.



5. Students will use the Beaufort Wind Scale provided on the handout to assess the wind speed and will make a wind vane to find wind direction. To make a rudimentary wind vane, students can simply take a paper plate and draw two perpendicular lines across the top of it, crossing in the middle. At the end of each line they should tape a streamer. The ends of the lines should be labeled N, S, E, and W. To use the wind vane they just hold the plate so that the N is facing North. Before class you should use a compass to find North for the class, and find a reference object in that direction for the class to refer to. Then all they have to do is look at the streamers. If they are blowing towards the south then the wind is coming from the north. Have them record the wind speed and direction on the handout.



6. If the class is not already outside then they should take their newly made weather stations outside, and place them in an appropriate location. A lot of consideration is given by real meteorologists as to where to place a weather station. The primary considerations are accurately measuring wind, rain, and precipitation. Ask students some things that might make the measured air temperature erroneous. This could include sun shining directly on the thermometer, or the thermometer being close to another source of heat, like a building. Buildings can also block the flow of wind, making it difficult to accurately measure its speed and direction. Meteorologist weather stations are frequently in small shelters in the middle of a field. Have your students place their stations as far from buildings as possible. They can use a cardboard box, or other methods for creating a screen or shelter for the thermometers.

7. Students should first make basic observations about the atmospheric conditions. Is it sunny or cloudy? Is it raining? Spend the next 15 minutes taking measurements of each property, except humidity, every five minutes, which they should record on the Weather handout. During the downtime, lead a discussion of why meteorologists measure these different properties. Temperature and precipitation are fairly obvious – people like to know what kind of clothes they need to wear and whether they will need to keep their windows open or closed. How comfortable you are at a certain temperature is related to how much moisture is in the air. Ask students whether they feel more uncomfortable when it is humid outside or drier. (Usually humid) Ask students to explain what happens when a low pressure system moves into the area. (Low pressure is associated with rainy weather).

8. Wrap-Up Activity: When you return to the classroom, have each group write their results on tables on the board. Have the class average the results together. Ask the class why is it important average the numbers? (Because it helps to reduce errors). Have each group speak about a specific aspect of the activity. For example, have one group explain what they think the relative humidity tells you about the local weather conditions.

***How's the Weather* Extension Activity**

If students are interested they could present their results in the form of a short news weather segment. This should include not just a description of the data, but it should be presented in an interesting and informational manner. If the internet is available to students then they should be allowed to use it to research upcoming or national weather, so they could add a forecast segment or a national weather segment to their presentation. The chalkboard can stand in for the normal green screen that meteorologists use to present the weather to the public.

HOW'S THE WEATHER
BACKGROUND INFORMATION

How do meteorologists measure humidity?

The atmosphere can only hold so much water vapor at any given temperature before the water vapor starts condensing into liquid water in the form of cloud droplets. Meteorologists measure humidity in three ways. The first is the absolute humidity. This is simply a measure of the mass of water vapor per mass of air.

The human body feels humidity when we sweat. The closer the atmosphere is to its saturation point the harder it is for sweat to evaporate and the stickier it feels outside. This is why meteorologists use a measure called relative humidity. Relative humidity is the amount of water vapor that is actually present in the atmosphere compared to the amount it could theoretically hold at a given temperature. When relative humidity is at 100% at the surface, fog will form. The dew point is another measurement of humidity. When the dew point and the air temperature are the same, the relative humidity is 100%. The lower the dew point, the lower the humidity in the air.

What is air pressure?

Air pressure is the pressure of air molecules flying into our bodies. At the bottom of the atmosphere there are many air particles, so air pressure is relatively high. The higher up you go into the atmosphere, the fewer air molecules there are, so air pressure is lower. Air pressure at the surface is not constant across the Earth. When the sun heats the Earth the air starts to rise, so there are fewer air molecules bumping into your body. This is called low pressure. When there is high pressure, air is sinking, so there are more air molecules bumping into your body.

How are storms related to air pressure?

Storms form when water vapor condenses into clouds. One way for this to happen is for the air to get colder. Cold air holds less moisture than warm air, so the moisture will condense. The air further from Earth's surface is cooler than the air at the surface. Warm air however is less dense than cold air. Warm air rises into the upper atmosphere where it cools, and condenses to form clouds. Remember that rising air and low pressure are related. This is why storms are usually accompanied by falling pressures. Conversely, high pressure is normally accompanied by large scale sinking air. This is warm as it descends, which lowers the relative humidity and reduces the chances of clouds and rain forming.

Key Vocabulary:
Relative humidity: the amount of moisture presently in the air divided by the amount that the air could theoretically hold at a given temperature
Dew point: the temperature to which air must be cooled in order for water vapor to start condensing.
Air pressure: the pressure exerted by the air molecules around you
Precipitation: liquid or solid water that falls from clouds
Barometer: a device that measures changes in air pressure
Psychrometer: a device that measures humidity in the air

STUDENT HANDOUT FOR *HOW'S THE WEATHER*

Name _____ **Date** _____

Is it sunny, mostly sunny, mostly cloudy or completely overcast?

Wet bulb temperature (°C):

Dry bulb temperature (°C):

Difference:

Relative humidity (from chart below):

°C	1	2	3	4	5	6	7	8	9	10
10	88	77	66	55	44	34	24	15	6	
11	89	78	67	56	46	36	27	18	9	
12	89	78	68	58	48	39	29	21	12	
13	89	79	69	59	50	41	32	22	15	7
14	90	79	70	60	51	42	34	25	18	10
15	90	81	71	61	53	44	36	27	20	13
16	90	81	71	63	54	46	38	30	23	15
17	90	81	72	64	55	47	40	32	25	18
18	91	82	73	65	57	49	41	34	27	20
19	91	82	74	65	58	50	43	36	29	22
20	91	83	74	67	59	53	46	39	32	26
21	91	83	75	67	60	53	46	39	32	26
22	91	83	76	68	61	54	47	40	34	28
23	92	84	76	69	62	55	48	42	36	30
24	92	84	77	69	62	56	49	43	37	31
25	92	84	77	70	63	57	50	44	39	33

STUDENT HANDOUT FOR *HOW'S THE WEATHER*

Did the air pressure go up or down during the course of the activity?

What direction is the wind blowing in?

What is the approximate wind speed in miles per hour according to the Beaufort Scale shown below? One knot is equal to 1.15 miles per hour.

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects
0	Less than 1	Calm	Calm, smoke rises vertically
1	1-3	Light Air	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Whole trees in motion, resistance felt walking against wind
9	41-47	Strong Gale	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	
12	64+	Hurricane	