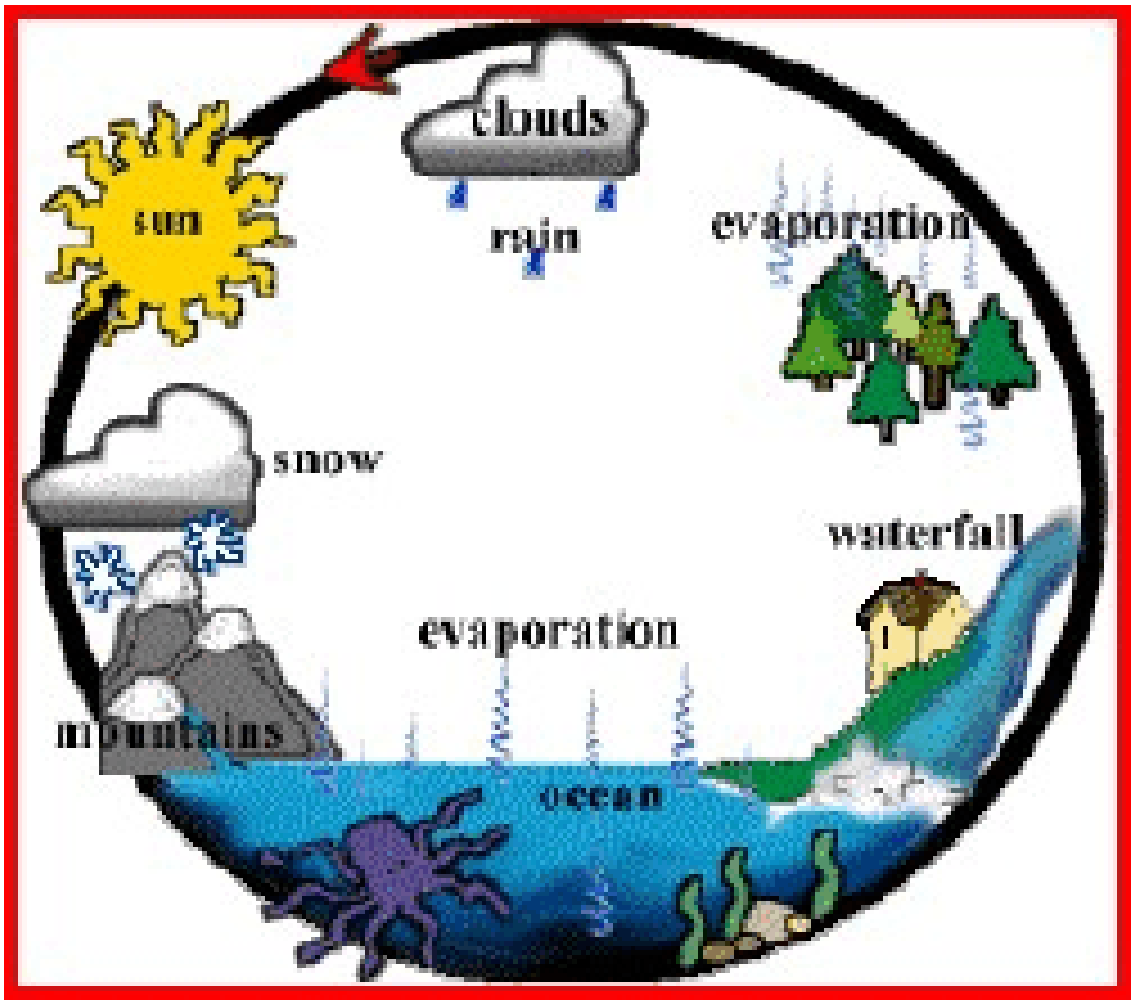
Wind, Water & Weather
A teacher's guide



Courtesy of
National Weather Service
Missoula, MT

BASICS OF WEATHER:

LOW PRESSURE
HIGH PRESSURE
COLD FRONT
WARM FRONT
STATIONARY FRONT
JET STREAM

If you can understand the basics of weather, you can put all of the pieces of this massive puzzle together. Then you may be able to make your own forecast. Understanding weather can be done easiest by breaking down a weather map into its individual parts. The most important parts of a weather map are: areas of Low pressure, High pressure, Cold fronts, Warm fronts, and the Jet stream.

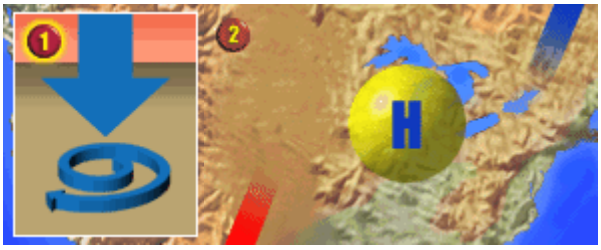
PRESSURE SYSTEMS- Air is continually flowing around the earth. Some air is light. Some air is heavier. The weight of the air usually depends on its temperatures and amount of moisture. Cold air and dry air are heavier than warm air and moist air. Since the atmosphere is not totally stirred up for evenness, masses of air will form cold, dry, heavy pockets and warm, moist, light pockets. These different pockets of air form pressure systems.

The atmosphere is always searching for a state of balance, and one of the ways it tries to accomplish this is to form pressure systems and wind to stir up the atmospheric differences. The center of a pressure system is located where the air pressure is the lowest (in low pressure) or highest (in high pressure). This is where you see the red L and blue H on a weather map.

LOW PRESSURE – Areas of low pressure are formed by light (less weighing) air. The air is usually somewhat warmer and more moist than air surrounding it. The light air starts to rise, and low pressure forms at the ground. It's called low pressure because there is less air and less weight above that given point on the ground. The most important point about low pressure is RISING AIR. The air is light and rises. When the air rises, it expands in volume. Expanding air cools. The amount of moisture air can hold is dependant on temperature. Warm air can hold more water in the form in invisible water vapor than cold air can. So as the air cools, it can't hold the moisture in the form of water vapor. Clouds form, and if there's enough moisture in all layers of the atmosphere, here comes the rain or snow!

Source: USA TODAY research by Chad Palmer, Graphic by Kevin A. Kepple

HIGH PRESSURE – Areas of high pressure are formed by heavy air. The air is usually colder and drier than surrounding air. The heavy air sinks and puts more force on the earth. That's why the air pressure goes up usually with colder, drier air. The most important point about high pressure is SINKING AIR. Sinking air is compressed and warmed to a certain degree. This warmer air can hold the moisture it already had, and more. So there is no need for the atmosphere to produce clouds and precipitation to get rid of the excess moisture. The center of a high pressure system usually brings sunshine, and a change to cooler air and lower humidity.

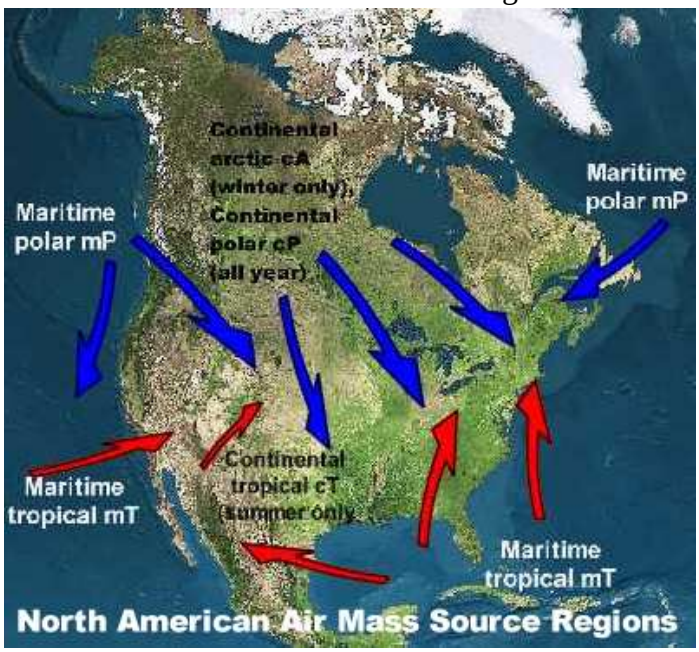


Source: USA TODAY research by Chad Palmer, Graphic by Kevin A. Kepple

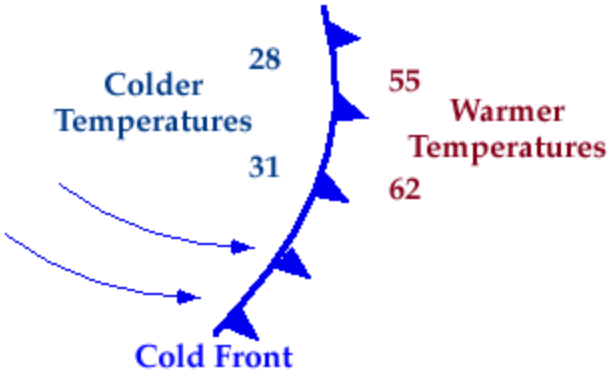
One location is not always under the center of a pressure system. In fact, most the time one location is transitioning from low to high pressure or high to low pressure. So the weather changes from the characteristics with one pressure system to the other.

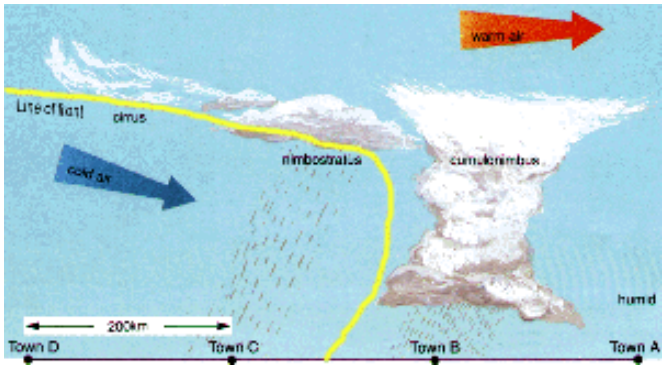
AIR MASSES/FRONTS – These are dividing lines between different types of air masses. An air mass is a large area of air that has come from a certain part of the globe. The different air masses of North Central Idaho and Western Montana are Maritime polar, Maritime tropical, and Continental polar/Tropical, Continental arctic (Winter only). A front is located between two of these different air masses. The interaction between two air masses will determine the characteristics of the front. Weather can change dramatically, in a short time when a front moves through. There is no such term as a low or high front.

Photo courtesy of
"The weather Doctor"



A **COLD FRONT** is the dividing line between warmer, more moist air ahead of the front, and colder, drier air behind the front. Cold air is heavier than warm air, nudges under the warm air, and forces the warm air upward. REMEMBER, RISING AIR CAUSED COOLING AND CLOUDS AND EVENTUALLY PRECIPITATION. The interaction at a cold front is abrupt, and change happens quickly. The typical weather scenario for a cold front is: Clouding up in 2 to 12 hours, intermittent precipitation and possibly sever thunderstorms (during the summer) then quickly-clearing. The precipitation to clearing after a cold front usually brings more clouds and precipitation to western Montana as the atmosphere remains unsettled and the sun acts to create more rising air and cloud/precipitation development. When a cold front moves over western Montana from the east (over the Continental Divide) there is usually a lot of clearing behind the front as most of the moisture is wrung out over the mountains and the east winds continue to further dry the lower levels of the atmosphere. A cold front is designated as a blue line with blue triangles attached to the front. The triangles point in the direction the front is moving.

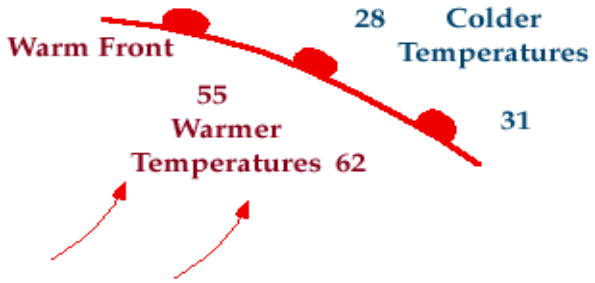


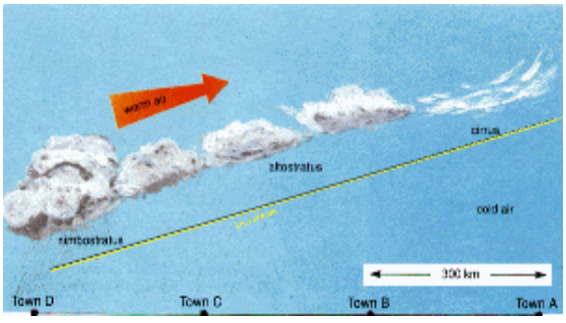


Source:http://ww2010.atmos.uiuc.edu/(Gh)/home.rxml

Source:http://www.ckkc.co.uk/html/stories/metrolgy.html

A **WARM FRONT** is the dividing line between colder air ahead of the front and warmer air behind the front. The warm air gradually slides up over the heavier cold air. That's the rising air that will produce clouds and precipitation. The typical weather is a gradual thickening and lowering of the clouds over a 24 hour period. A steady precipitation then forms, and can continue, light or heavy, for up to 24 hours. After a warm front moves through a location, the sky usually clear and temperatures warm up. This warm up is sometimes quite rapid because two warming factors appear at once; sunshine and south winds. A warm front is designated as a red line with red semi-circles on the side of the front that the front is moving.





Source: http://ww2010.atmos.uiuc.edu/(Gh)/home.rxml

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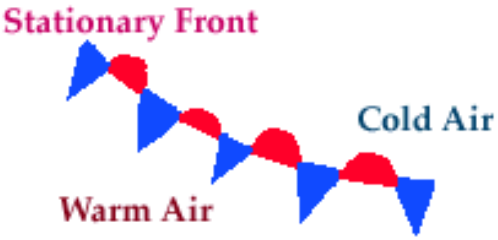
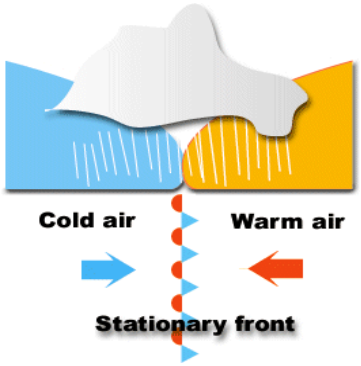
A **STATIONARY FRONT** has the characteristics of both a cold front and a warm front. The movement of the front overall is minimal. The cold air can't displace the warm air, and the warm air can't displace the cold; the stationary front waivers back and forth. As the front moves small distances north, it takes on the characteristics of a warm front. As the front snakes back south, it acts like a cold front. The stationary front doesn't move entirely until a low pressure system moving along the front can produce enough air movement to cause one air mass to take over the other.





Source: http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/af/frnts/sfdef.rxml
Source: http://fozzy.wvstateu.edu/~weatherlink/ams/images/front_stationary_en.gif

Here are some other facts about pressure systems and fronts:

- Winds blow clockwise around high pressure and counterclockwise around low pressure.
- With your back to the wind, low pressure is on your left and high pressure is on your right.
- Wind changing from south to southwest usually signals the approach of a cold front. Watch for warmer temperatures, and showery rain or snow, and even thunderstorms.
- Wind changing from south to west to north signals the passage of a cold front, with showers and then clearing and cooler.
- Wind changing from northeast or east to south signals a warm front passage. Steady clouds and precipitation may have occurred, and now look for more sun and warming temperatures.
- The stronger the pressure system, the stronger the winds.
- Winds are nature's way of equalizing air pressure and stirring up the atmosphere to a state of equilibrium. This equilibrium never happens, thankfully. If it did, meteorologists would be out of a job!
- Low pressure systems generally form in three areas; Colorado (east of the Continental Divide), the Texas panhandle or southern Canada.

THE JET STREAM – Winds are caused basically by temperature and thus air pressure differences. Wind is used to stir up those differences. But temperature and pressure differences not only happen here at the ground, the also occur at any level in the atmosphere. Generally the higher the altitude, the higher the wind speed. When we speak of the "jet stream', we are usually speaking of the winds at 20,000 to 40,000 feet above the ground. Winds at the jet stream level can blow up to 200 mph. The fastest rushing air at the jet stream level can influence our weather here on earth. The fast moving air lifts air from the surface. The rising air causes low pressure to develop. The stronger the jet stream, the stronger the low pressure system.

Source: http://images.usatoday.com/weather/resources/askjack/jetstream.jpg

Here are some possible exercises you can do with your students:

- Draw the current weather map daily for a week, and watch the movement of the systems and fronts. You can obtain the current weather map from the National Weather Service Missoula home page (http://www.weather.gov/missoula) by typing this address: http://www.hpc.ncep.noaa.gov/dailywxmap/, or typing daily weather map in the search at the top of the page.

- Watch the clouds change through the day. Look at height, type, thickness, movement, and number of different types of clouds in the sky at once.

- Watch the wind direction and speed change with time.

- Watch the barometer change with time.

- Log the daily weather (Max T/Min T, Precipitation)

- Combine all of these to get a complete picture of the weather.

All of these things can be done by either making a weather station in your classroom, or by going to the www.weather.gov/missoula and under **Current Conditions** on the left had side of the screen, click on **Local** (http://www.wrh.noaa.gov/mso/newlcl.php) and find the station nearest your school to monitor these changes.

What is Wind Chill

Wind chill is the term used to describe the rate of heat loss on the human body resulting from the combined effect of low temperature and wind. As winds increase, heat is carried away from the body at a faster rate, driving down both the skin temperature and eventually the internal body temperature. While exposure to low wind chills can be life threatening to both humans and animals alike, the only effect that wind chill has on inanimate objects such as vehicles, is that it shortens the time that it takes the object to cool to the actual air temperature (it cannot cool the object down below that temperature).

How do I calculate it?

To use the chart, find the approximate temperature on the top of the chart, read down until you are opposite the appropriate wind speed. The number which appears at the intersection of the temperature and wind speed is the wind chill index.

WIND CHILL CHART

Temperature (EF)

Wind (mph)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm																		
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98
FROSTBITE OCCURS IN:							30 MINUTES		10 MINUTES		5 MINUTES							

The National Weather Service in Missoula will issue a **Wind Chill Advisory** when wind chills are expected to reach 10 degrees below zero. A **Wind Chill Warning** will be issued when wind chills are expected to be 20 degrees below zero or less.

_____' S WEATHER MAP FOR _____200_'

WEATHER RIGHT NOW:

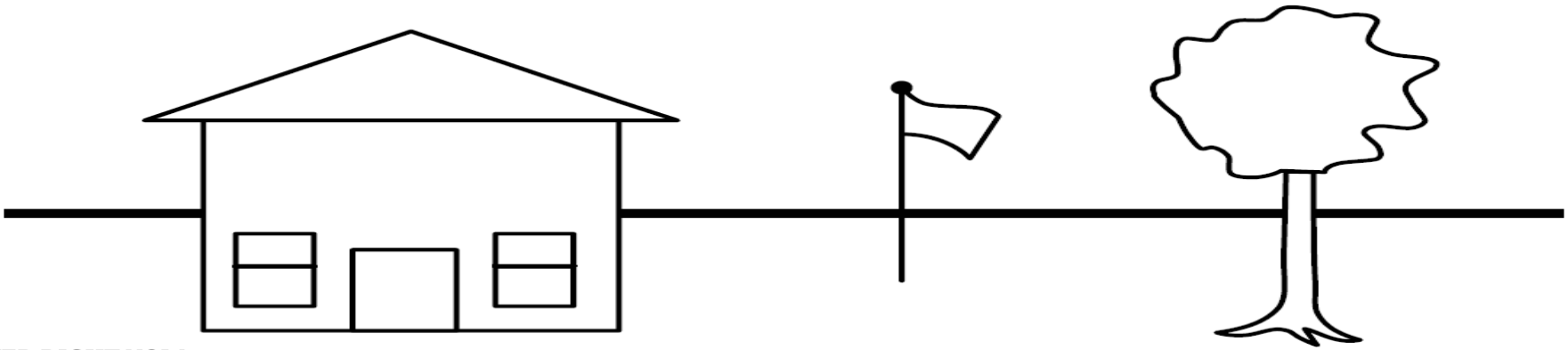
Wind Speed:_____ Temperature:_____˚F

Wind Direction:_____ Wind Chill:_____˚F Barometer:_____inches

_____Sun _____Clouds _____Rain

_____Rain _____Sleet _____Thunderstorm

_____‘S CLOUD COLORING CHART FOR _____200_‘



WEATHER RIGHT NOW:

Wind Speed:_____ Temperature:_____˚F Wind Direction:_____ Wind Chill:_____˚F Barometer:_____inches

Sun _____Clouds _____Rain _____Snow _____Sleet _____Thunderstorm

STATION *(Climatological)*	*(River Station, If different)*	MONTH	20 00
STATE	COUNTY	RIVER	
TIME (local) OF OBSERVATION	TEMP. | PRECIPITATION	STANDARD TIME IN USE	
TYPE OF RIVER GAGE	ELEVATION OF RIVER GAGE ZERO *Ft* / FLOOD STAGE *Ft.*	NORMAL POOL STAGE *Ft.*	

WS FORM B-91
(12-93)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

DATE	TEMPERATURE F.			PRECIPITATION				WEATHER							RIVER STAGE			
	24 HRS ENDING AT OBSERVATION			24-HR AMOUNTS		At ob.	*Type the letter Y through hours precipitation was observed, and a letter P through hours precipitation probably occurred unobserved.)* A.M. NOON P.M. 1 2 3 4 5 6 7 8 9 10 11 1 2 3 4 5 6 7 8 9 10 11							Time of observation if different from above	CONDITION	GAGE READING AT __A.M.	TENDENCY	REMARKS (Special obeservations, etc.)
	MAX.	MIN.	AT OBSN.	Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets (Ins. And tenths)	Snow, ice pellets hail, ice on ground (Ins.)		Fog	Ice pellets	Glaze	Thunder	Hail	Damaging Winds					
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CONDITION OF RIVER AT GAGE						X	READING DATE											

MAKING A WEATHER STATION

Instruments:
Thermometer
Barometer
Wind Vane/ Anemometer
Rain Gauge

Use items around the home to make a weather station that lets you measure the most important weather conditions.

The weather station should be placed outside away from buildings. The barometer however, can remain inside.

Record the weather conditions for at least a week to see how the weather varies with different weather conditions.

Thermometer – buy one, they are inexpensive and more accurate than a homemade one.

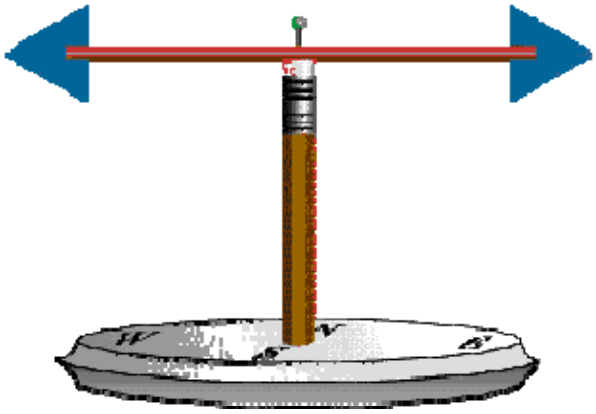
Make a Barometer

Do you know what the air pressure is today? You can find out for yourself by measuring the air pressure on a barometer.

Materials
small coffee can
plastic wrap
scissors
straw
index card
rubber band
Instructions
COVER the top of the can with plastic wrap. USE a rubber band to hold the plastic wrap in place. The cover should be taut making the can airtight.
PLACE the straw horizontally on the plastic wrap so that two-thirds of the straw is on the can.

TAPE the straw to the middle of the plastic wrap.
TAPE the index card to the can behind the straw.
Carefully RECORD the location of the straw on the index card.
After 15 minutes, RECORD the new location of the straw on the index card.
Continue CHECKING and RECORDING the straw location as often as desired.
Be careful not to place your barometer near a window, as the barometer is sensitive to temperature as well as air pressure.
What's happening
High pressure will make the plastic wrap cave in, and the straw go up. Low pressure will make the plastic wrap puff up, and the straw go down. Check your measurements with a real barometer.
What happens to your barometer when a big storm comes? Can you use your barometer to predict a storm?

Wind Vane



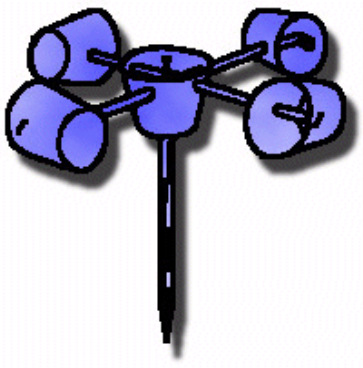
What You Need

- two heavy-weight paper plates
- crayon or a colored marker
- ruler
- pointed scissors
- clay
- small stones
- tape
- unsharpened pencil with an eraser
- 4-inch piece of yarn
- straight drinking straw
- oak tag
- straight pin

What To Do

1. On the bottom of one of the plates, use a ruler to draw two lines perpendicular to each other. The lines should cross in the center of the plate. Then, going in a clockwise direction, mark N, E, S, and W at the ends of the lines.
2. With the point of a scissors, punch a hole in the center of the plate. (You may want to do this for students.)
3. Place a small mound of clay in the center of the other plate. Surround the clay with a few small stones. Then place the first plate upside down on top of the plate holding the clay, and tape the edges of the plates together.
4. Push the pencil through the hole and set its end into the clay. The pencil's eraser should be at the top.
5. Tape one end of the yarn to the pencil, about 2 inches down from the eraser. (This will help you see the direction the wind is blowing.)
6. Cut two triangles, about 1 inch on each side, from oak tag. Cut a slit in each end of the straw and push one triangle into each slit. Tape the triangles in place.
7. Push the pin through the straw halfway along its length and press the pin into the pencil eraser.
8. Put the wind vane on a flat surface outside. Use a compass to find north, and position the wind vane with the “N” pointing north.

Anemometer



Materials

five 3 ounce paper Dixie cups
two straight plastic soda straws
a pin
scissors
paper punch
small stapler
sharp pencil with an eraser

Procedure

Take four of the Dixie cups. Using the paper punch, punch one hole in each, about a half inch below the rim.

Take the fifth cup. Punch four equally spaced holes about a quarter inch below the rim. Then punch a hole in the center of the bottom of the cup.

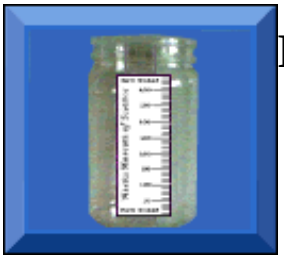
Take one of the four cups and push a soda straw through the hole. Fold the end of the straw, and staple it to the side of the cup across from the hole. Repeat this procedure for another one-hole cup and the second straw.

Now slide one cup and straw assembly through two opposite holes in the cup with four holes. Push another one-hole cup onto the end of the straw just pushed through the four-hole cup. Bend the straw and staple it to the one-hole cup, making certain that the cup faces in the opposite direction from the first cup. Repeat this procedure using the other cup and straw assembly and the remaining one-hole cup.

Align the four cups so that their open ends face in the same direction (clockwise or counterclockwise) around the center cup. Push the straight pin through the two straws where they intersect. Push the eraser end of the pencil through the bottom hole in the center cup. Push the pin into the end of the pencil eraser as far as it will go. Your anemometer is ready to use.

Your anemometer is useful because it rotates with the wind. To calculate the velocity at which your anemometer spins, determine the number of revolutions per minute (RPM). Next calculate the circumference (in feet) of the circle made by the rotating paper cups. Multiply your RPM value by the circumference of the circle, and you will have an approximation of the velocity of at which your anemometer spins (in feet per minute). (Note: Other forces, including drag and friction, influence the calculation but are being ignored for this elementary illustration. The velocity at which your anemometer spins is not the same as wind speed.)

The anemometer is an example of a vertical-axis wind collector. It need not be pointed into the wind to spin. (Note: This paper cup anemometer will produce a reasonable approximation of circumferential velocity, but should not be used for any purpose other than elementary illustration.)



Rain Gauge

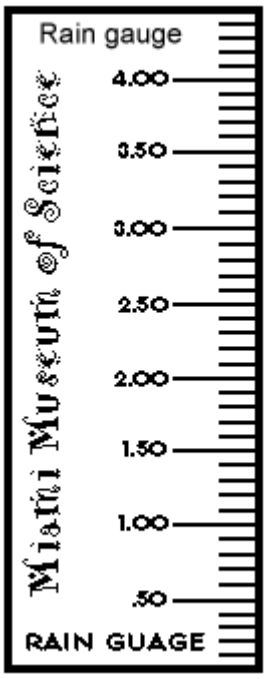
Materials

- a printed copy of the "Rain Gauge Ruler", below
- a straight-sided glass container, such as a bottle for olives
- scissors
- clear cellophane or plastic sandwich bag
- tape
- rainy day

Instructions

1. CUT out the Rain Guage Ruler.
2. COVER the ruler with clear cellophane, front and back. This will protect it from the rain, and make it sturdy so that the ruler can stand straight.
3. STAND the ruler inside the glass container so that the ruler rests on the bottom of the container.
4. TAPE it at the top, to the inside of the jar, so that the ruler does not fall.
5. PLACE your rain gauge outside.
6. MEASURE the amount of rainfall each day.

Rain Gauge Ruler



Acknowledgements:

www.epa.gov/region7/ kids/images/wtrcycle.gif (water cycle cover)

USA TODAY Graphic by Kevin A. Kepple (high and low pressure)

Photo courtesy of “The weather Doctor”  (air mass regions)

http://ww2010.atmos.uiuc.edu/(Gh)/home.rxml (cold front)

http://www.ckkc.co.uk/html/stories/metrolgy.html (cold front conceptual)

http://ww2010.atmos.uiuc.edu/(Gh)/home.rxml (warm front)

http://www.ckkc.co.uk/html/stories/metrolgy.html (warm front conceptual)

http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/af/frnts/sfdef.rxml (stationary front)

http://fozzy.wvstateu.edu/~weatherlink/ams/images/front_stationary_en.gif(stationary front conceptual)

http://www.eduplace.com/rdg/gen_act/weather/direct.html (wind Vane)

http://www.miamisci.org/hurricane/barometer.html (barometer, rain gauge) (Miami Museum of Science)

http://sln.fi.edu/tfi/units/energy/dixie.html (Anemometer) (The Franklin institute)

http://images.usatoday.com/weather/resources/askjack/jetstream.jpg (Jet Stream)