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# Weather Basics

Curriculum Unit 94.05.05
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## PHILOSOPHY OF UNIT

The intent of this unit is for the student to have fun while learning some basics about weather and climate.

Because most students enjoy “hands-on” activities, the unit will address this interest by having them construct simple weather instruments as they learn about the weather element. The construction of the instrument will help the student understand and retain this knowledge about the element by learning the basic operating principle of the instrument.

For best results, use peer learning groups to perform this activity. This allows the students to interact and socialize with one another in a positive manner. It provides an opportunity for them to challenge and defend each other in performing certain activities and answering thought provoking questions.

The study of weather is a topic that is part of the New Haven’s eighth grade science curriculum and since the teaching of science is going in the direction of “hands-on” activities, this unit is addressing both of these interests.

The construction of the instruments is done several ways . One way is to have the students all make the instrument the same way. The way I would suggest that you perform the activity is to have different groups construct different varieties of the same instrument whenever possible. This will help reinforce the idea that there is more than one way to solve a problem The main focus of the construction activity will be to have the student explain how and why their instrument works.

## INTRODUCTION

This unit will emphasize topics in meteorology and oceanography and how they relate to the various climates of the earth. We are suggesting various activities to be performed by the student throughout this unit in order to keep the student interested and motivated. We should point out at this tine that we are not striving for the student to construct perfect instruments, but they should be able to understand the basic principles of how they operate. Whenever possible, we will introduce topics to make the unit even more relevant.

All activity on earth is the result of energy from the sun. Because the earth is a sphere, not all places on earth receive the same amount of solar energy. There are other factors which also play a part in the heat exchange and we will suggest activities that can help the student understand this.

A good starting point will be for the student to get an understanding of the meaning heat and differentiate heat from temperature. We define heat as the energy in moving particles of matter measured in calories and temperature as the average kinetic energy of the particles of a substance measured in degrees.

Heat can move from one place to another by conduction, convection and radiation. One way to show conduction is to fill one cup with hot water and another filled with an equal amount of cold water. Use styrofoam cups and covers to insulate each container. Place a thermometer in each container and record the starting temperature. Connect the two containers with a metal bar and record the temperatures at set intervals.

The use of a lamp and containers containing water and a thermometer will show how bodies are heated by radiation. We can also show that the color of an object has a bearing on heat absorption. Place equal amounts of water of the same temperature in a dark container and a shiny container. Place an insulated cover with a thermometer over each and record the temperature at set intervals . The student will understand that objects can be heated by radiation and that darker colors absorb more heat than light objects.

Convection will be shown two ways. Convection in the atmosphere will be demonstrated with the use of a convection box. Using something that will give off smoke will show how the cool air falls and hot air rises. If you choose to show convection movement in a liquid, place the heat source to one side of a large beaker of water and heat. Add a drop of food coloring to the cool side of the water and observe how the food coloring sinks, moves across to the heated side and rises .

The student will now have a better understanding of heat exchange as we continue to study this unit.

As weather takes place in the layer of the atmosphere called the troposphere, we should learn about the atmosphere at this time.

The atmosphere is important to us as it filters out harmful radiation, moderates temperature, and allows life to exist as we know it. The layers of the atmosphere are divided into layers according to major changes in temperature. The main layers are the troposphere, stratosphere, mesosphere and thermosphere.

The troposphere is the layer that we live in. It consists mainly of nitrogen (78%) and oxygen(21%). Students enjoy the activity of putting steel wool in a test tube, and placing the open mouth of under water then observing the results the next day. The oxygen in the air combines with the steel wool causing the water to rise inside the test. The demonstration also leads to a good discussion on why it is good that nitrogen is plentiful in the air to dilute oxygen and lessen the effects of oxygen’s aggressive behavior.

The stratosphere is of interest to them because of the ozone layer and the jet stream. This can provide an opportunity to do extra credit work by writing a paper on the ozone layer. If you do not have a copy of the “Classroom Assessment List- Writing in Science- Middle School,” see your science representative. This document will provide the student with good organizational procedures and provide an opportunity for you to direct the student to what you are emphasizing.

Now that we know how heat travels and some characteristics of the atmosphere, we can try to understand the

water cycle. Most of the earth's surface is covered with salt water. This causes many students to wonder why rain water is not salty like ocean water. If you have the facilities to set up a distillation investigation, it will be very worthwhile. Have a saltwater mixture made up for this exercise. Have the student taste the water before and after distillation. Have them explain the two parts of the water cycle they witnessed. (evaporation and condensation) This exercise can also help the student understand how the salt content has increased over the years.

The third part of the water cycle will be understood by using the CEPUP module, "Investigating Ground water-The Fruitvale Story." The student uses his knowledge of how ground water travels to set up a plan to test the water from various areas on the map and pinpoint the source of ground water pollution.

Evaporation, condensation and precipitation will be shown by heating water in a beaker and placing a cold object over the mouth of the beaker. The rising warm air will condense on the cool object, become heavy and fall.

## WEATHER BASICS

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We can define weather as the condition of the atmosphere at a particular time and a particular place. As this condition determines what we will wear and what we will do for activities, we should understand something about the basic weather elements and their bearing on the total weather picture.

The basic symbol on the weather map is a circle where numbers and symbols are organized around. Each element has a particular position around the circle to place their value. The center of the cycle will tell a person how much of the sky is covered with clouds. This makes clouds the logical element to investigate first.

**Clouds**

We are familiar with the water cycle so the student should understand that clouds form from condensation in the atmosphere. The student will first observe the cloud cover and record this observation using the appropriate method on a station model. As for the clouds themselves, we will concern ourselves with the basics and their base elevations. Cumulus clouds, puffy, will use a base height of +1 mile and the symbol . Stratus clouds, layered , will use a base height of +1 mile and the symbol —-. Cirrus clouds, wispy, will use a base height of +3 miles, but are generally higher, and the symbol . We are interested in clouds as their size, shape and location give a key to what is happening with the water vapor in the atmosphere and air movement.

A simple way to show cloud formation is to use a cloud forming apparatus. If you do not have one, your science representative can probably track one down for you to borrow to demonstrate cloud formation for your class. The device consists of a glass flask, rubber bulb and inlet tube. Compressing and releasing the rubber bulb causes condensation and cloud formation. When performing this demonstration it is best to have a little smoke or dust particles inside the chamber to serve as a nuclei for the water vapor.

**Winds**

Winds are defined as air in motion. On a station model, the direction the wind is blowing from is represented by a staff. Barbs are placed on this staff to show wind speed.

Winds basically blow from high pressure areas to low pressure areas. The greater the differences in pressure, the stronger the wind. There are other influences that play a part in wind direction. One is Earth rotation which causes the Coriolis effect. This causes the winds in the northern hemisphere to deflect to the right and just the opposite in the southern hemisphere. The other factor is the heating and cooling of water vs. land. The temperature of water is more stable than that of land. This causes the air to have different densities at different times of day and seasons. This difference in their densities causes air movement.

There are places on Earth that winds blow with predictable regularity. They are the trade winds. The prevailing westerlies and the polar easterlies are not as regular. Basically, the cold air over the poles moves towards the equator. At the equator, the warm air rises, moves back toward the north pole, cools and falls back to earth to start the cycle again.

During World War II, the jet were discovered by airplanes doing high altitude bombing raids. They found that between the altitudes of 6 Km and 12Km a belt of high speed winds existed that moved at speeds upward to 500 Km/hr. Further investigations of this phenomena show that the jet stream plays an important part with weather determination. Students could do a research paper on the jet stream.

At this time, the student will construct two instruments for measuring wind. A wind vane for wind duration and an anemometer for measuring wind speed.

As mentioned earlier, there are a variety of ways to make weather instruments. I will briefly tell one method for the wind vane. You will need a 3’ by 5’ file card, a test tube, 2 drinking straws, 3 paper clips, sharpened pencil and a stapler You will first staple the straws to the index card, next bend the straws around the test tube and clip them together in front using the paper clips. Finally, place the test tube over the point of the pencil and it is ready for operation.

An anemometer can be constructed using 4 paper cups, wood strips, coat wire, medicine dropper and a block of wood for the base. Place a straight piece of coat hanger wire into the wood base. Connect the wood strips together forming right angles and attach the four cups to each end of a wood strip. Color one cup different from the rest of the cups. Drill a hole in the center of the wood strips and place the medicine dropper in the hole. Place the wood strips with the cups over the wire hanger wire. The cups can now turn freely in the wind and can be used as an anemometer.

To calibrate the anemometer have the student take it home and have a parent or relative ride them in a car at speeds of 5 mph and 10 mph. Count the number of times the colored cup rotates in a minute at this speed and use this as your speed guide.

**Air Pressure**

Because air is matter, it has weight and takes up space. Different examples can be used to show this. We can blow up a balloon to show that it has volume. Weight can be a little more difficult to demonstrate. One way is to do the can crushing demonstration. The student should be aware that warm air and cold air have different densities making them weigh different for the same volume as discussed from earlier units.

The procedure is to place a small amount of water in a can that can be sealed. You heat the can and water. When the water starts to boil you remove the can from the heat source and seal the container. As the container cools, it begins to buckle. At this time you will ask the student why this is happening. At least one student will probably say that the pressure on the on the outside is greater than the pressure on the inside

You can then ask them what causes pressure. If you want to go one step further, ask the student what they think will happen if you reheat the can. The can will take the original shape. This demonstration will also support the idea of more room for water vapor in warm air the cold air.

The rising or falling of barometric pressure is an indicator for the type of weather that is expected. When the barometric reading starts to fall, this usually indicates the air that was closer to the earth's surface is rising. This layer of air is warmer and contains more water vapor than it can hold at high altitudes. As this air rises, the barometric reading goes down and the water vapor condenses and may form clouds or cause precipitation. This is why a falling barometer indicates cloudy or stormy weather.

Just the opposite happens with a high pressure reading. The air from above descends and causes the barometric reading to rise. The air from above generally doesn't contain enough water vapor to cause precipitation and we can safely say we will experience good weather.

The barometric reading is located in the upper right of the station model. Standard air pressure is about 760mm

A barometer can be constructed by using a thin sheet of rubber (part of a balloon) , a jar, masking tape, quick drying cement, needle, paper soda straw and shoe box.

Place the thin sheet of rubber over the jar and secure it so that no air can enter or exit. Attach the needle to the straw and attach the straw to the rubber sheet. Draw 10 lines on an index card and number them form one to ten. Note the weather conditions and the position of the pointer on your homemade barometer. Monitor if the needle or falls and relate it to the weather conditions.

**Temperature**

We will refer back to our definition of temperature as the average kinetic energy of a substance that is measured in degrees. The scale that the student will use in this science unit is the Celsius scale. They should be aware that water freezes at 0 and boils at 100 degrees. You can measure the temperature of ice water to show the freezing point. The boiling point is found by heating the water and taking the temperature of water when it starts to bubble vigorously.

We are aware that the temperature, the lower the air pressure as molecules move farther apart leaving more room between them. At the same time, we must realize that because there is more room between the molecules of air, more water vapor can enter the air. The demonstration I like to use to show that there are spaces between the molecules is to mix equal amounts of water and ditto fund. I place 50 ml of water in one graduated cylinder and 50 ml of ditto fluid in another cylinder. I then ask the class what will happen if I mix the two together. They are very surprised when the combined volume does not equal 100 ml. This demonstration illustrates to them that there are spaces between molecules and not all molecules are the same size.

Construction of a thermometer can be done by using an Erlenmeyer flask, 30 cm length of glass tubing, one hole rubber stopper and colored water. Insert the glass tube into the one hole stopper. Put a plug of colored water, about one inch, into the tube and have it at rest about half way up the tube. Place the stopper and tube into the flask and allow it to stabilize. Place a string at the upper level of the plug of water and then appear to squeeze the flask. Ask the students why the plug moved up the tube. Do not answer the question. Use something that will insulate the heat from your hands against the flask- and repeat the "squeezing" of the

flask. Ask the students why the plug did not move this time. Ask and perform any other reasonable investigation they might want to perform with the apparatus. Finally decide what practical use this apparatus could be used for. (thermometer)

.Another type of thermometer that could be constructed is by using a 250 ml flask, a 125 ml flask, 2 rubber stoppers, a 30cm glass tube, and colored water. Fill the flask with colored water. Place the glass tube into the one hole stopper and gently put the stopper into the flask. Water will rise up into the glass tube. Gently heat the top portion of the tube to lower the air pressure. Now place the 125 ml flask and stopper onto the glass tubing. This is your expansion chamber. Heat the water very slowly and observe the water level. Do not overheat.

These two types of student and/or teacher constructed thermometers make the student understand the principle of how a thermometer operates and clarifies the definition of temperature.

To find the temperature on a weather map, you look in the upper left of the station model.

**Dew point**

The dew point is the point at which water vapor in the air will condense at that temperature and pressure. If the temperature is above freezing, dew forms on the ground when the air that comes in contact with the ground cools to that temperature. If the temperature is below freezing, frost forms.

The simplest way to find the dew point in the classroom is to use a thermometer, ice, water and a container that will allow moisture to form on the outside. Place the ice and thermometer into the container of water and stir gently. When moisture begins to form on the outside of the container, read and record the temperature. This is the dew point.

**Precipitation**

Precipitation is moisture that falls to earth from the sky. It is classified as rain, snow, sleet and hail. Precipitation starts as snow high up in the atmosphere. The temperature of the atmosphere will determine whether it will remain as snow or change to another form as it travels to earth.

The rain gauge is the instrument used to measure the amount of precipitation. I have found that it is best to purchase this instrument as precipitation generally does not come in large quantities.

Inches of precipitation over the last 3 hours are located m the lower left of the station model.

**Relative Humidity**

Although the relative humidity is not found on a station model it is a basic weather element.

Relative humidity refers to the amount of water vapor in the air compared to the amount that it can hold at that temperature and pressure.

Changes m temperature result in changes in relative humidity.

One way to measure relative humidity is to use a sling psychrometer. This device uses a wet bulb and a dry bulb thermometer. You swing these instruments around until the temperature does not go any lower. You then use a chart that will allow you to find the relative humidity. You can construct a sling psychrometer by

connecting two plastic backed thermometers with double backed foam tape. For best results, have the bulb of the thermometer you will use for the wet bulb open to the air. This will allow for a better air flow for evaporation to occur when the wet gauze is applied to the thermometer.

You can also construct a hygrometer to measure relative humidity. You still use a wet bulb and dry bulb thermometer but you fan the thermometers instead of spinning them around. The same chart is still used to find the relative humidity.

**Weather Map**

These weather elements are taken at specific times each day and the readings sent to the National Weather Bureau. The information then is used to construct a weather map. Plotting this information on a map allows the meteorologist to make weather predictions for the coming days.

The map shows the location of high and low pressure regions, types of fronts, and the basic weather elements.

Collect the daily weather map from the local paper and place it in your bulletin board. Have the students trace the weather patterns for about two weeks. After the first week, have the students try to guess what the weather will be like at various places in the United States the next day by looking at the weather map.

## CLIMATE

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Climate is defined as the average weather conditions of an area over very long periods of time. This means hundreds of years.

There are three major climate regions on the earth. Each based on the average weather conditions of the area.

These regions are:

Polar—60 to 90 degrees north or south of the equator.

These are the coldest of the zones as they do not receive radiation in the same amounts and intensity as the other zones. They also contain the ice caps that reflect sunlight.

Temperate—30 to 60 degrees north or south of the equator.

The temperate zone is affected by both tropical and polar air masses. This means that if a location is nearer the polar zone, during the winter season snow will fall. If nearer the tropical region, they will receive rain during the same season.

This region also has a wider range of weather conditions during the year because of the location of the other two zones.

Tropical—0 degrees to 30 degrees north or south of the equator.

This zone has the highest temperature as it receives the most solar radiation throughout the year.

**Climatic Change**

Thanks to nature, we have learned that the climate of the earth has changed over time. Radioactive dating, tree rings, fossils, ice cores, ocean floor samples and corals have supplied information for climatic change time frames .

We believe that these changes were due to a variety of reasons:

1. Cyclic of the earth's orbit from round to elliptical every 100,000 years.

2. Change in tilt of the earth's axis.

3. Precession—Wobbling that operates on a 20,000 year cycle.

4. Continental Drift.

5. Evolution of life forms.

The early climate of the earth is hard to follow because of the lack of a rock record. Due to the movement of the earth's lithosphere the rocks have been recycled destroying any evidence that might have existed.

It is believed that the early atmosphere a contained a plentiful amount of carbon dioxide for the greenhouse effect. The earth' s interior was warmer and contributed to a great deal of volcanic activity. These volcanic eruptions put water vapor and other particles into the atmosphere that formed clouds and blocked out solar radiation. The earth then began to cool allowing rain to fall. As time went on, oceans began to form and store heat. The water cycle then began.

There was no free oxygen in the atmosphere at this time. Ozone could not be formed to filter out the radiation that is harmful to life. Eventually primitive life began and started to add oxygen to the atmosphere.

Our present atmosphere contains mainly of nitrogen and oxygen. However, there are small amounts of other gases that play a major part in climate production.

Carbon dioxide is needed by organisms for photosynthesis and the greenhouse effect. Water vapor plays an important part by absorbing energy from the sun and pollutants may effect the amount of solar radiation that reaches the earth.

As for future climates, we will continue to have change due to continental drift and other natural factors that will continue to interact.

## Summary

As was stated at the beginning of this unit, we are not trying to make meteorologist of our students but make them aware of the various weather phenomena if students are interested in certain areas of weather, they should be encouraged to do research papers and give oral reports to the class. If possible, a field trip should be arranged to a weather station.

Again, let the student have fun while they learn.

***PROBLEM:***
How do we read a station model?

***GOAL.***
Upon completion of this lesson, 80% of the students will be able to:

1. identify the weather element on a station model by its' location.
2. plot correctly on the station model the basic element when given and/or measured.

***PROCEDURE:***

1. Review the seven basic weather elements and the instruments used to measure each
2. Review the position of each element on the station model.
3. Give students information to plot on the station model.
4. Critique results.

***APPLICATION: (Groups)***

1. For one week, have each group record and plot weather data using their group made instruments and data tables.
2. The group will then compare their data with other groups and classes and discuss why the similarities and differences.

***EVALUATION:***

1. Made observations safely using all appropriate senses.
2. Observations were quantitatively accurate as possible measurements were labeled properly.
3. Used appropriate tools and materials to make observations.
4. Data was recorded and organized appropriately and neatly.

***PROBLEM:***
Where is the temperature range the greatest, near large bodies of water or inland away from large bodies of water.

***GOAL:***
Upon completion of this lesson 90% of the students will be able to explain the role large bodies of water play in climate determination.

***PROCEDURE:***

1. Use two beakers of equal size and in one beaker place sand and in the other fill with an equal amount of water.
2. Record their temperatures.
3 Place the two beakers an equal distance from a heat source. Turn on the light.
4. Record the temperature every 5 minutes for a total of 20 minutes.
5. Turn-off the light and repeat data gathering for another 20 minutes.

***APPLICATION:***

1. Construct a data table for the heating and cooling data.
2. Construct a graph using the results from the data table. Use different colors for the sand and water.
3. Make a written summary of this graph.
4. Formulate an hypothesis of the original problem

***EVALUATION***
1. The hypothesis reflects the observations.

2. The student justifies the hypothesis through thoughtful evaluation of data.

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