Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1988 Volume VI: An Introduction to Aerodynamics

Weather Awareness

Curriculum Unit 88.06.09
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Outline of Content

I. *Teacher's Introduction*

Objectives and Strategies. This unit is about weather. Its primary objective is to increase weather awareness. The basic structure used for doing so is to keep a weather log and develop answers to the following four questions. (1) How is our weather dependent on the Earth's gravity and the Sun's energy? (2) What are the four main components of weather? (3) How are storms created? (4) what can we learn from weather reports? The teacher's introduction is followed by a student text. A copy of it for each student will help save teacher preparation time and give students material to use. During the course of the unit each student is expected to read the text, keep a daily weather log, make illustrations, do an individual one or two page report, do several worksheets, work in a group to prepare and present a report on one of the topics given below, and take a final test. Four weeks of lesson plans, a weather log form and a unit test are included.

Project topics are as follows.

1. Clouds	6. Weather Forecasting
2. Thunderstorms and Lightning	7. Compare TV, Radio and Newspaper Weather Reports
3. Hurricanes and Tornadoes	8. Global Air and Water Currents
4. Weather Instruments Airplanes	9. Effects of Weather on
5. Connecticut Weather topics	10. Other related, approved

This unit has been designed for use as a four week unit in a consumer, applied or general math course. It also would be appropriate for some science classes. A lot of numbers are given with the idea that by doing so it may be more interesting to students and provide material for teachers to use in various ways. Depending on the class, middle and high school students can use this unit.

(figure available in print form)

II. Student Text

Weather Awareness

A. Student's Introduction

The purpose of this unit is to develop greater weather awareness by keeping a weather log and developing answers to the following four questions. (1) How is our weather dependent on the Earth's gravity and the Sun's energy? (2) What are the four major components of weather? (3) How are storms created? (4) What can we learn from weather reports?

B. Weather Log

One way to become more aware of the weather around us is to keep a weather log. Each day while doing this unit you are to make an entry in your weather log. Here is an example of how a day's log entry might look.

Today's Date	7/25/88
Temperature	73 F (22 C)
Humidity	80%
Air Pressure	low
Wind Direction	westerly
Speed	10 knots
Clouds	overcast
Other	1.7"
Information	rain yesterday

C. Four Questions

Question 1. *How is our weather dependent on Earth's gravity and the Sun's energy?* Here are some interesting facts about the Earth and other planets in our solar system that could be helpful in answering this and related questions.

Figure 1. Relative Distance of Planets to the sun (1)

(figure available in print form)

l AU = 1 Astronomical Unit = Distance Between Sun and Earth = 149.5 million Kilometers = 92.9 million miles

(figure available in print form)

Figure 2 Earth Compared with Moon, Mars, Jupiter, and the Sun (2)

The above data can help us understand various aspects of Earth's weather. we are interested in specifically answering "How is our weather dependent on the Earth's gravity and the Sun's energy? We will start by taking a look at the surface gravity of the various planets in Figure 2.

Earth's gravity is given the value 1.00. That means that the Earth's gravity is used as a standard unit of measure. By comparison the Moon's gravity is .16 or 16% that of Earth's, Mars' gravity is 38% that of Earth's, Jupiter's 287% that of Earth's, and the Sun's 2700% that of Earth's. In other words, the gravity values of the other planets are given in relation to Earth's gravity.

It is the force of gravity, this pull toward its center, that allows, or does not allow, a planet to hold a layer of air to its surface. For Earth, its gravity of 1.00 is sufficient to hold a massive layer of air, about 1000 miles deep, to its surface.(3) This mass of air is the Earth's atmosphere. The Moon's gravity of .16 is not sufficient to hold air to its surface, so the Moon has no atmosphere. Since the moon does not have an atmosphere, it does not have the atmospheric conditions needed to support life. The moon, therefore, is a lifeless planet.

The Earth's atmosphere, in which we live and all our weather takes place, can be thought of as a large insulating blanket that is wrapped around the Earth. During the day this insulating blanket of air screens out much of the Sun's rays and thus prevents Earth from getting extremely hot. At night it prevents heat from escaping into space and thus keeps Earth from becoming extremely cold. Because of its atmosphere the Earth has a temperature range of 135 to -127 F (58 to -88 C), while the lack of an atmosphere allows the Moon's temperature to range from 225 to -243 F (107 to -153 C).

Another way to think of the Earth's atmosphere is as an ocean of air 1000 miles deep, and we live at the bottom of it. Further, since air is compressible, that is it has the capacity to become more dense, more solid, to have a certain amount of air be forced into a smaller space, the bottom 3 1/2 miles of Earth's atmosphere contains over half the weight of the entire 1,000 miles deep atmospheric ocean (4). Put another way, the atmosphere is heavier, more dense, at the bottom near the surface of the Earth than it is higher up. Since we live at the bottom of this ocean of air, its weight bears down on us. This weight of the air is what we call air pressure.

Figure 3. The Bottom 31/2 Miles of the Atmospheric Ocean Carries Over Half the Weight of the 1,000 Mile Deep Atmosphere (4)

(figure available in print form)

The Earth's atmosphere has five basic layers, the troposphere, stratosphere, mesosphere, thermosphere, and exosphere. It is in the troposphere, the lowest level of the atmosphere, that we live and all our weather occurs including almost all our clouds except the very highest.

Figure 4. Five Layers of the Atmosphere. (5)

(figure available in print form)

In answer to the question, "Why is our weather dependent on Earth's gravity?", it is because the Earth's gravity holds the atmosphere in place, and it is in the atmosphere that our weather occurs. Further, gravity effects the atmosphere's temperature, humidity, air pressure and wind, each of which is a major part of what we call weather. We will look at each of these elements separately later.

"Why is our weather dependent on the Sun's energy?" Because the Sun's energy heats the Earth's atmosphere and provides the power for our weather to continually change. It too effects each major weather component. Later we will see how all this is done.

Question 2. *What are the four main components of weather?* By weather we mean the atmospheric conditions of a certain place at a certain time. To describe atmospheric conditions we usually give temperature, humidity, air pressure and wind direction and speed. These are the major components of weather, and they are the elements that continually interact to give Earth constantly changing weather and sometimes fearful storms. Below we will look at each of these components separately, noting some of the interactions as we go along.

Temperature . Temperature measures the amount of heat present. The thermometer is the instrument we use to measure heat. We use both the Fahrenheit and celsius scales*. For most humans 68 to 72 F (20 to 22.2 C) is considered the optimum comfort range. As the temperature moves further away from this range, people become uncomfortable because their bodies must work harder to maintain a normal body temperature of 98.6 F (37 C). If a body is exposed to temperatures very far below or above this range, it cannot cope and dies. Of all the natural hazards, the cold of winter annually takes more lives than heat, lightning, hurricanes, tornadoes, floods or earthquakes.(6) The heat of summer takes the next largest toll. The temperature of our environment directly effects how we feel and how we function.

Looking at temperature in the broader weather picture, we see that the atmosphere's temperature is dependent on the Sun. The Sun's energy in the form of light and heat enters our atmosphere and strikes the Earth's surface. This energy heats the ground and by contact with the ground the air above it is warmed. As a layer of air is warmed, it rises, and cooler air flows in beneath it. This is a major

*F=9/5(C+32) Temperature conversion to Fahrenheit

C=5/9(F-32) Temperature conversion to Celsius cause of air movement, the difference in air temperature. If a huge mass of air warms and rises, an equally large mass of cool air must move in to take its place. This causes a lot of air movement.

Since the Sun hits the Equator most directly, the air at the Equator receives much more heat than the air at the North and South Poles. As the air around the Equator warms, it rises and cooler air from the Polar regions flows under it. The layer of warm, light air flows poleward high above the Earth. As it cools, it becomes heavier, sinks, and replaces the cool air which has moved toward the Equator.

Figure 5. One pattern of Moving Air, From the Equator Toward the Poles

(figure available in print form)

The circulating movement of warm and cool air is called“convection”, and there are other convection patterns that play an important part in our weather. Land heats faster than water during the day and cools faster at night. This sets up another moving pattern of air. There is a similar pattern with mountains and valleys. Mountains heat faster than valleys in the day, and they cool faster at night. Similarly, plowed fields which absorb more heat during the day than grassy fields cool faster at night. Thus the differences in temperature causes both global and local air movements.

Figure 6. Convection Patterns of Air Movement Between Land and Water.

(figure available in print form)

Temperature is a very important weather measurement because it influences so much of our lives including how we feel and function, how air currents move, the water distribution around the world, and what plants (food) will grow where. All weather reports give temperature readings.

Humidity. Air always contains water. water, which covers about 71% of the Earth’s surface, evaporates into the air and moves as part of the air. water can be in the air as a solid (hail or snow), a liquid (rain or clouds) or invisible vapor.

The amount of water vapor in the air is called “humidity”. When we talk about humidity, we usually mean the relative humidity which represents the amount of water vapor in the air as a percentage of what the air could hold at a particular temperature.

Warm air can hold more water than cool air. When air with a given amount of water rises it expands and cools. As it does so, its relative humidity increases because cooler air is capable of holding less water. As air drops and is warmed by the surface below, its relative humidity drops because the capacity to hold water increases as the air warms. Relative humidity is a ratio of the amount of water in the air as compared to the amount it could possibly hold at a given temperature.

Since warm air is less capable of carrying water as it rises and cools, the moisture that it carries, if it exceeds the airs saturation point,* will precipitate, or condense, out into moisture droplets to form clouds. In a similar manner a glass of cold water in warm weather will cool the air around the glass so its capacity to hold water decreases and moisture precipitates out onto the outside of the glass.

Figure 7. Table showing Relative Humidity With Regard to Temperature. (7) People are usually most comfortable in a relative humidity range of 45% to 55% at temperatures from 68 to 72 F.

(figure available in print form)

The moisture in clouds may stay in cloud form and move with the air mass of which it is part, or the water particles may grow from a cloud droplet to a raindrop or snowflake. An average raindrop contains a million times as much water as a cloud droplet.(9)

There are two basic types of clouds, cumulus clouds, clouds formed by rising air currents that look puffy and “accumulated” and stratus clouds, clouds formed by a layer of air as it is cooled below the air’s saturation point and looks sheetlike and layered. Cirrus clouds, high altitude wisps, are sometimes considered a third type.

*The saturation point is also referred to as the “dew point”. The dew point is the temperature at which a given amount of vapor in a body of air will condense or precipitate out. The dew point is influenced by temperature, amount of vapor and presents of particles on which to condense.

Figure 8. Types of Clouds

(figure available in print form)

Clouds are further classified by altitude families, high clouds (bases averages about 20,000 feet above Earth), middle clouds (bases average about 10,000 feet above Earth), and low clouds (bases go from Earth to about 6,500 feet). Cloud names are descriptive. The word “nimbus” means rain cloud and is used to describe a cloud when rain or snow may precipitate from it. Cumulonimbus are what our common rain clouds are called. “Fracto” means fragment and is used with clouds that are wind-blown and broken into pieces. “Alto” means high and usually refers to middle layer high clouds.

Clouds represent moisture in the air and are very important in the distribution of the Earth’s water. Water evaporates from the surface of large bodies of water and is carried in the form of clouds to land where it precipitates our. Farming around the world depends on this water supply. Clouds are also very important in weather predictions. Knowing what kinds of clouds there are, how fast they are traveling and in what direction are major pieces of information experts use in trying to predict weather.

Air Pressure. Air pressure refers to air weight. You can think of the atmosphere as having mountains and valleys of air, says Eric Sloane in his book *Almanac and Weather Forecaster* . (9) Naturally a mountain of dense air will weigh more than a valley, so you have more weight, higher pressure, when you have a mountain of air above you, and less weight, lower pressure, when you have a valley of air above you. A barometer, the instrument used to measure air pressure, tells you which is pressing down on you, a mountain or a valley. See Figure 9.

Looking at air pressure more specifically, at sea level, a vertical column of air one inch square and extending to the outer atmosphere weighs 14.7 pounds. One square foot of air at sea level weighs more than a ton.(10)

Relating air pressure directly to us, a person at sea level, depending on his or her size and skin surface area, has between 10 and 20 tons of atmospheric pressure exerted on him or her. The reason we survive this pressure is because we have pressure inside the body equaling the pressure outside.(11)

Another important fact about air pressure is that it decreases in weight as it rises in the atmosphere. Air that weighs 14.7 pounds at sea level would weigh only 7 1/2 pounds at 18,000 feet. This is due to the fact that air is compressible, as mentioned above.

Although air pressure is not as obvious as temperature and humidity, it is equally as important in influencing the weather and aiding in weather predictions. Low pressure areas called low pressure cells are associated with unsettled or stormy weather. High pressure areas called high pressure cells are associated with good weather. Isobars, lines of equal pressure, are drawn on many weather maps with the air pressure given in either inches or millibars at the end of each line. Weather maps usually show highs and lows because it's nice to know if a high or low is heading your way.

By knowing where the highs, lows, and lines of equal pressure are located, we can identify air masses and their fronts. Both air masses and fronts are discussed below. In the United States highs generally travel from west to east, and they alternate with lows which they generate and drive along.(12)

An air mass is a large unit of air and can cover hundreds of thousands of square miles. A body of air is considered a unit or air mass if the temperature and moisture are much the same at all points in a horizontal direction and if when it starts to move, it moves as a body.

The way masses are formed is by a body of air hovering over a particular place long enough to pick up the temperature and moisture characteristics of that location. For example, an air mass over a warm body of water takes on heat and moisture, and an air mass over a cold, dry polar region will become cold and dry. When a mass moves on, it takes the temperature and moisture characteristics of its previous location with it.

The following passage by Sloane may be helpful in understanding the significants of air masses.

Most people think that today is cooler because it is yesterday with some of its heat lost. Or they might presume that today is warmer because it is yesterday with heat added to it. Air, however, does not often stay still and just grow warmer or cooler. The air you exhale from your nostrils this second will be some five hundred miles away tomorrow; the air you inhaled was five hundred miles away from you yesterday. Weather, which is the condition of the atmosphere, is changed by new hunks of air which wander about the earth, pushed and pulled by the pressure machinery of sun heat.(13) North America's geography is such that it is regularly influenced by six sources of moving air masses, three colder ones from polar regions and three warmer ones from the tropical regions. These six masses cause North America's weather to be varied and continually changing.

Figure 9. Six Air Masses Influencing North America's Weather (14)

(figure available in print form)

Wind . Moving air is called wind. The raising of warm air and moving beneath it of cooler air, the Earth's rotation and the topography of the earth are all important influences on air movement. Sloane plainly states a somewhat complex aspect of wind in the following statement.

Moving air is called wind. Wind moves from high-pressured areas to low-pressured areas, but in a most indirect and seemingly strange manner. It first flows around the high-pressure area, all the while "leaning outward"; then it flows around the low-pressured area, all the while "leaning inward." . . . The steeper the slope of the atmospheric "hill" or atmospheric "valley," the faster does the air flow downward (the higher is the wind). In the northern hemisphere the wind goes *clockwise around the high,* then flows counterclockwise around the low.(15) *Figure 10. Winds Blowing Around High and Low Pressure Areas (15)*

(figure available in print form)

Winds are named for the direction from which they blow, not the direction in which they are heading. Hence a northeast wind is coming from the northeast. This method of naming winds is a tradition from ancient times.

Going back to our second question, “What are the four major components of weather?”, the answer is temperature, humidity, air pressure and wind. Measuring these components is one way we can become more aware of and develop greater understanding of the atmospheric conditions in which we live. Like fish moving in the conditions at the bottom of an ocean of water, we are humans living in the conditions at the bottom of an ocean of air.

Question 3. *How Are storms Created?* Storms are the most dramatic, most dangerous, and most feared of all weather phenomena. In addition to frontal storms, three other well-known types occur—thunderstorms, tornadoes, and hurricanes.(16) *Frontal Storms.* Storms are associated with low-pressure areas or cells. Because of various factors, winds blow down from high pressure areas where they have been going in a clockwise direction to low pressure areas in a counterclockwise direction. Lows usually form between two high pressure areas of different temperatures. This situation, the coming together of two high pressure air masses of different temperatures, forms what is called a boundary or front where lows develop.

When two air masses come together, various things could happen. If the masses are very much alike in temperature and moisture, the front may pass with little disturbance or notice. If two masses with different temperatures collide and nothing happens, it is called a stationary front. This is not the usual case; usually one mass pushes the other along. If the cold mass pushes the warm, we have a cold front. If the warm mass pushes the cold, we have a warm front. No matter how it goes, fronts usually bring unsettled or stormy weather caused by warm air rising rapidly, clouds forming and precipitation often falling. Fronts, low pressure areas, often bring frontal storms.

Thunderstorms.

It is estimated that at any given moment, nearly 2,000 thunderstorms are in progress over the earth’s surface. Their frequency and their potential for violence make them one of nature’s great killers and destroyers.(17)
Figure 13. Typical Thunderstorm Cumulonimbus Cloud

(figure available in print form)
How does a thunderstorm develop? The first stage of a thunderstorm develops when warm air is forced to rise rapidly. This could be from a cold front pushing under a warm mass, or by winds blowing up a mountain slope or by winds blowing into the center of a low pressure area and forcing the warm air near that center upward.

Whatever the cause, there is a strong updraft forcing warm air to rise rapidly where it is cooled by rising and expanding. The drop in temperature forces the water vapor in the air to condense out into visible droplets and clouds are formed. The updraft continues to push the clouds higher, and the cloud droplets change to liquid or frozen cloud particles. This process releases heat into the cloud which feeds the updraft and the cloud continues to build up and rise. The cloud particles continue to grow by colliding and combining with each other until rain, snow or hail is formed. Precipitation from the cloud begins when these particles become large enough to fall against the updraft.

This is the end of the first stage in the development of thunderstorm. The cloud at this point is a very tall, puffy, stormy looking cloud. It is at this point a awesome looking cumulonimbus cloud that may be several miles across its base and up to 40,000 feet or more. Such a cloud could be alone, a threatening giant in the sky, or it may form in a line with several others forming a squall line.

The next stage in the thunderstorm's development begins when precipitation starts to fall. The precipitation causes a change in the wind flow within the cloud structure. The following is a description of what happens next.

The prevailing updraft which initiated the cloud's growth is joined by a downdraft generated by precipitation. This updraft-downdraft couplet constitutes a single storm "cell." Most storms are composed of several cells that form, survive for perhaps 20 minutes, and then die. New cells may replace old ones and it's possible for some storms to last for several hours.

> On the ground directly beneath the storm system, this stage is often accompanied by strong gusts of cold wind from the downdraft, or heavy precipitation-rain or hail. Lightning always accompanies the thunderstorm. These are nature's warnings that the thunderstorm is in its most violent stage. Tornadoes may also be associated with thunderstorms.

Even so, the thunderstorm has already begun to die. The violent downdraft, having shared the circulation with the sustaining updraft, now strangles it. Precipitation weakens, and the cold downdraft ceases. The thunderstorm cell, a short-lived creature, spreads and dies.(17) While the thundercloud was developing, an unstable situation of cold air on top of warm air was created. For reason not yet clear, these huge thunderclouds develop positive charges at the top and negative charges at the bottom. The Earth, which usually has a negative charge with respect to the atmosphere, for some reason develops a positive charge beneath the thundercloud and this charge follows the storm cell like an electrical shadow which grows stronger positive as the cloud grows stronger negative.

During this time, an enormous amount of energy builds up within the cloud, and it must be released. The air, however, is a poor conductor and insulates the charges. Finally, when the energy level is great enough to overcome the resistance of the insulating air, it forces a conductive path for current to flow between the two charges. This path is made in stages and could be from cloud to cloud, cloud to ground, or ground to cloud. This conductive path is the path of lightning, and the energy released could be as much as 100 million volts. Thunder is produced by the explosive expansion of air heated by the lightning stroke.

Tornadoes. Tornadoes are the most violent of storms. The winds that spin in its funnel cloud go at speeds of up to 500 mph and sometimes more. Tornadoes have doubly destructive power, first the wind at the outer edge can hurl away almost anything in its path, and second, the air pressure within the funnel is so low that houses explode from the pressure of the air inside them. That means the *normal* pressure inside the house can cause the house to explode because the pressure in the tornadoes's center is so low that the inside house pressure explodes out. Tornadoes can travel up to 70 mph and usually last only a few minutes.

How are tornadoes formed? In the Life-Science book, *Weather* , the following account is given.

According to one theory, fast-moving cold, dry air overruns moist, tropical air-instead of wedging under, as usually happens-creating a tremendous imbalance. The warm air rushes upward, sometimes at 200 mph. Air flowing in from the sides gives the updrafts a twist. The vortex begins to spin, accompanied by rain or hail and almost continuous flashes of lightning. Tornadoes travel up to 70 mph, an often last only a few minutes. But those minutes can be catastrophic.(18) The United States has an average of 124 tornadoes a year with the great majority of them hitting the lower Mississippi Valley. Tornadoes are easily identified on radar; this has allowed us to develop an efficient system of tornado warnings and alerts.(19)

Figure 12. Tornadoes

(figure available in print form)

Figure 13. Hurricanes

(figure available in print form)

Hurricanes.

> Stated very simply, hurricanes are giant whirlwinds in which air moves in a large tightening spiral around a center of extreme low pressure, reaching maximum velocity in a circular band extending outward 20 or 30 miles from the rim of the eye. This circulation is counterclockwise in the Northern Hemisphere, and clockwise in the Southern Hemisphere. Near the eye, hurricane winds may gust to more than 200 mph, and the entire storm dominates the ocean surface and lower atmosphere over tens of thousands of square miles.
>
> The eye, like the spiral structure of the storm, is unique to hurricanes. Here, winds are light and skies are clear or partly cloudy. But this calm is deceptive, bordered as it is by hurricane-force winds and torrential rains. Many persons have been killed or injured when the calm eye lured them out of shelter, only to be caught in the hurricane winds at the far side of the eye, where the wind blows from a direction opposite to that in the leading half of the storm.(20)
>
> How is a hurricane born?

A hurricane is born in a hot moist air mass over the ocean. The cyclonic motion is often started as opposing trade winds whirl around each other. . . . The rotating low pushes air toward its center, forcing hot moist air there to lift. Lifting cause moisture to condense. Heat thrown off as the moisture condenses further warms rotating air, which becomes even lighter and rises more swiftly. As more and more moist tropical sea air sweeps in to replace the rising air, more and more condensation takes place. So air inside the storm rises faster and faster. Hurricanes are so violent because of the tremendous energy released by the continuous condensation. At first the storm is like the inside of a giant thunderstorm. Unlike a thunderstorm over land, a hurricane has an inexhaustible source of moisture. The heat given off by condensation causes the air in the hurricane to rise faster and faster. Surrounding air sweeps in rapidly until the hurricane is a giant wheel of violent winds.(20) Hurricane winds do much damage, but the greatest cause of hurricane deaths is from drowning. There are hurricanes throughout the world, but the ones that are dangerous to the U.S. eastern coast are spawned in the Atlantic Ocean where, on the average, six hurricanes a year come into being.

Question 4. *What Can We Learn From Weather Reports?* All weather reports give temperature readings such as today’s high and low, current temperature, tomorrow’s predicted temperature and current or historical statistical information such as the temperature of different cities around the country or world or possibly the lowest temperature recorded on a particular day.

All reports mention expected precipitation in the form of rain, snow or hail. Some reports may give the relative humidity, but usually they use the terms humid or dry. The possibility of a thunderstorms would make the news. Some places report the dew point and expected fog. Predicted cloud coverage is usually given so people will know how much sun they can expect.

Winds are given with their direction and speed. Officially wind speed is given in knots, but some reports give them in miles per hour.

Often the times of sunset and sunrise are given, and, where appropriate, the times of today’s and tomorrow,s tides. Phases of the moon are usually included in newspaper reports.

Cold fronts and warm fronts are reported as well as the paths they are taking or expected to take. Newspapers and television give the highs and lows.

How is all the weather information gathered? It comes from weather stations around the world, weather balloons and satellites, airplane and ship reports and radar. Basic weather information such as temperature, humidity, air pressure, and wind from different parts of the world is reported to the U.S. National Meteorological Center. All weather forecasting begins with knowing what is currently happening in different parts of the world. If from around the world one knows the different temperatures, the high and low areas, humidity, cloud development, where winds are coming from and at what speed and understands the basic global, local and seasonal weather patterns, he or she would have a good idea of what will probably happen next in a particular location. However, you can never be absolutely certain.

With the help of computers, our weather experts use all this data to make predictions. We haven't made gains in controlling weather, but we have made great gains in understanding the weather and in making weather predictions.

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D. Project Guide

Step 1. Students will divide into groups of 2 or 4 and choose of one of the given topics on which to report.

Step 2. Each student is expected to spend about two hours at the library gathering information on his or her topic.

Step 3. A one or two page written report will be due on a particular date that will be determined in class.

Step 4. A class period will be given to working in groups to share information and develop the report to give as a group to the class.

Step 5. Groups will give their reports to the class.

E. Grading Guide

Grades for thesis unit will be as follows:

40% Daily work

10% Attitude and best effort

25% Project

25% Test grade

F. Students Are Expected To Do The Following

1. Keep a daily weather log

2. In class read and share in discussion of topics

3. Do a one or two page written report

4. Give a group report to the class

5. All assignments

6. Take a final test

III. *Lesson Plans, For Four weeks.*

Day 1.	Discuss “What do we mean by weather?” Learn where students are.
	Give students a copy of the text, a weather log, and a copy of that mornings New Haven Register’s weather report.
	Explain main purpose of the unit, what is expected of them, and how they will be graded. (Parts A,D,E and F in Student Text).
	Read and discuss section B, weather Log.
	Either from reading instruments or the mornings weather report, fill out day l in the weather log.
	If any time left, discuss the day’s weather report.
Day 2.	Discuss day’s weather report and fill in day 2 in the weather log.
	Discuss projects and project topics so that students can be thinking of what they want to do.
	Begin to read and discuss Question 1:” How is Our Weather Dependent on the Earth’s Gravity and the Sun’s Energy?”
	Use ratio concept to make a completed illustration of the relative distances of the planets to the Sun. Figure 1.
Day 3.	Fill in day 3 in weather log.
	Assign worksheet #1 using data from Figures 1 & 2.
Day 4.	Fill in day 4 in weather log.
	Assign worksheet #2 using data from Figures 1 & 2.
Day 5.	Fill in day 5 in weather log.
	Complete any work left from Worksheets 1 and 2.
	Together read the rest of Question #1’s text, having students discuss it as you go along.
	Make sure everyone knows Question #1 and its answers.

Day 6. Fill in day 6 in weather log.

Each student chooses a group project topic and an individual topic as part of it. Decide due dates for rough and final drafts of the one or two page individual reports and the group presentations.

Begin Question #2:” what are the four major components of weather?” Read and discuss the section on temperature.

Give Worksheet #3 on convection, body temperature, use of the Fahrenheit and Celsius scales, Earth’s temperature range, and other things related to temperature.

Use *Winter Storms* slides and audio, if available.

Day 7. Fill in day 7 in weather log.

Read and discuss section on humidity.

Assign worksheet #4 on humidity related problems.

Day 8. Fill in day 8 in weather log.

Read and discuss section on air pressure.

Assign worksheet #5 on air pressure questions and problems.

Day 9. Fill in day 9 in weather log.

Read discuss section on winds.

Worksheet #6 on wind related questions.

Day 10. Fill in day 10 in weather log.

Begin work on the third question, “How are storms created?” by reading and discussing the sections on frontal storms and thunderstorms.

Use *When Lightening Strikes* slides and script, if available.

Have students illustrate fronts and thunderstorms.

Day 11. Fill in day 11 in weather log.

Read and discuss tornadoes and hurricanes.

Students sketch tornado and hurricane patterns.

Give students a hurricane charting exercise.

Day 12. Fill in day 12 in weather log.

Read and discuss section on the fourth question, “What can we learn from weather reports?”

Use *Weather Watchers* video if available. Pass around and discuss different kinds of weather reports.

Give students an exercise on filling in a weather map with highs, lows, temperatures of various cities, and thunderstorm predictions.

Day 13. Fill in day 13 in weather log.

Use *Global Weather* video if available.

Rough of one or two page reports due. Spend class on these. Possibly in groups, possibly sending 1 or 2 students to library.

Day 14. Fill in day 14 in weather log.

Work in groups on group presentation of topics.

Day 15. Fill in day 15 in weather log.

Begin student reports.

Day 16. Fill in day 16 in weather log.

Continue reports.

Day 17. Fill in day 17 in weather log.

Complete reports.

Turn in reports.

Day 18. Fill in day 18 in weather log.

Plan a special review.

Day 19. Fill in day 19 in weather log.

Students turn in corrected worksheets.

Day 20. Fill in day 20 in weather log.

Take test and turn in weather log.

IV. *Teacher's Footnotes, Bibliography and Materials.*

Footnotes

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2. Ibid.
3. Lehr, P.E., Burnett, R.W., Zim, H.S. *Weather* . New York: Golden Press, 1975. p35.
4 Ibid. p35
5. Ibid. p37
6. National Oceanic and Atmospheric Administration (NOAA) and the American Red Cross, *Heat Wave, A Major Killer,* Pamphlet. U.S. Dept of Commerce, 1985.
7. Lehr, P.W., Burnett, R.W., Zim, H.S. *Weather. New York;* Golden Press, 1975. p12.
8. Ibid. p22.
9. Sloan, E. *Almanac and Weather Forecaster.* New York: Hawthorn/Dutton, 1955. px-xi.
10. Thompson, P.D., O'Brien, R. and Editors of Time-Life Books. *Weather* . New York: Time-Life Books, 1968. p 13.
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12. Lehr, P.E., Burnett, R. W., Zim, H.S. *Weather.* New York: Golden Press, 1975. p 60.
13. Sloan, E. *Almanac and Weather Forecaster* . New York: Hawthorn/Dutton, 1955. p x.
14. Thompson, P.S., O'Brien, R. and Editors of Time-Life Books. *Weather.* New York: Time-Life Books, 1968. p
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17. NOAA, *Thunderstorms.* U.S. Department of Commerce, 1976. 18. Thompson, P.D., O'Brien, R. and Editors of Time-Life Books. *Weather.* New York: Time-Life Books, 1968. p 78.
19. Lehr, P.E., Burnett, R.W., Zim, H.S. Weather. New York: Golden Press, 1975. p 101.
20. NOAA, *Hurricane Information and Atlantic Tracking Chart.* U.S. Department of Commerce. 1971.
21. Illustration adapted from Eric Sloane's *Almanac and Weather forecaster, p 119.*

Bibliography

Greenwood, B” Littmann,M.,Sonntag, M. *Solar System* . A poster. Salt Lake City, Utah: Hansen Planetarium, 1982. A lot of information in a small space. Very attractive and practical for many kinds of classroom work.

Lehr, P.E., Burnett, R.W., Zim, H.S. *Weather.* New York: Golden Press 1975. Clearly written. Thorough explanation of just about all usual whether situations that most of us would care about.

National Oceanic and Atmospheric Administration (NOAA) All three are clearly written with safety information. *Heat Wave, A Major Killer* . Pamphlet. U.S. Dept. Commerce, 1985.

Thunderstorms . Pamphlet. U.S. Dept. of Commerce, 1976. *Hurricane Information and Atlantic Tracking Chart.* Pamphlet. U.S. Dept. of Commerce. 1971.

Sloan, E. *Almanac and Weather Forecaster.* New York: Hawthorn/Dutton, 1955. Very clear and informative. Absolutely charming.

Thompson, P. D., O’Brien, R. and Editors of Time-Life Books. *Weather.* New York: Time-Life Books, 1968. Very clearly discusses the most important aspects of weather.

Materials

Easy to get materials.

Student text part of unit

weather log form part of unit

Various daily and Sunday weather reports

Map of the United States

Map of the World

Thermometer

More difficult to get, not necessary, but would be nice.

Barometer	Anemometer
Hygrometer	Rain Gauge
Wind Vane	

Materials to share.

If a teacher is interested in using the worksheets and test for this unit that I use and/or in sharing material he or she uses for this topic, please contact me. I am at Hillhouse High School, 480 Sherman Parkway, New Haven, CT 06511.

Material that could be purchased.

A. From: Hansen Planetarium
Publication Division
1098 South 200 West
Salt Lake City, Utah 84101
Solar System. A poster. 1987.
$6 plus $1.50 for handling and postage.

B. From: National Audio Visual Center
8700 Edgeworth Drive
Capitol Heights, MD 20743-3701
When Lightning Strikes
67 Color Slides, silent script. 1979.
Disaster Preparedness Staff, National weather Service
Order No. A01979/WC $35 Cannot get preview.
Winter Storms
78 Color Slides, 18-minute Audio cassette, Script, 1979
Disaster Preparedness Staff, National Weather Service
Order No. 010557/WC $40 Cannot get preview.
Global Weather Experiment
Shows the effects of weather worldwide.
Won CINE Golden Eagle and Silver Hugo, Chicago Film Festival Award.
28 Minutes, Color, 1980
VHS Video No. A05473/WC
Sale $110 Rental $40 May preview.
Weather Watchers
Shows how meteorologist use technology to predict weather.
Won Gold Award, International Film and TV Festival of New York.
15 Minute, Color, 1977
VHS Video No.
Sale $95 Rental $40 May preview.

Appendix A

(figure available in print form)