AnaSonde Curriculum Guide

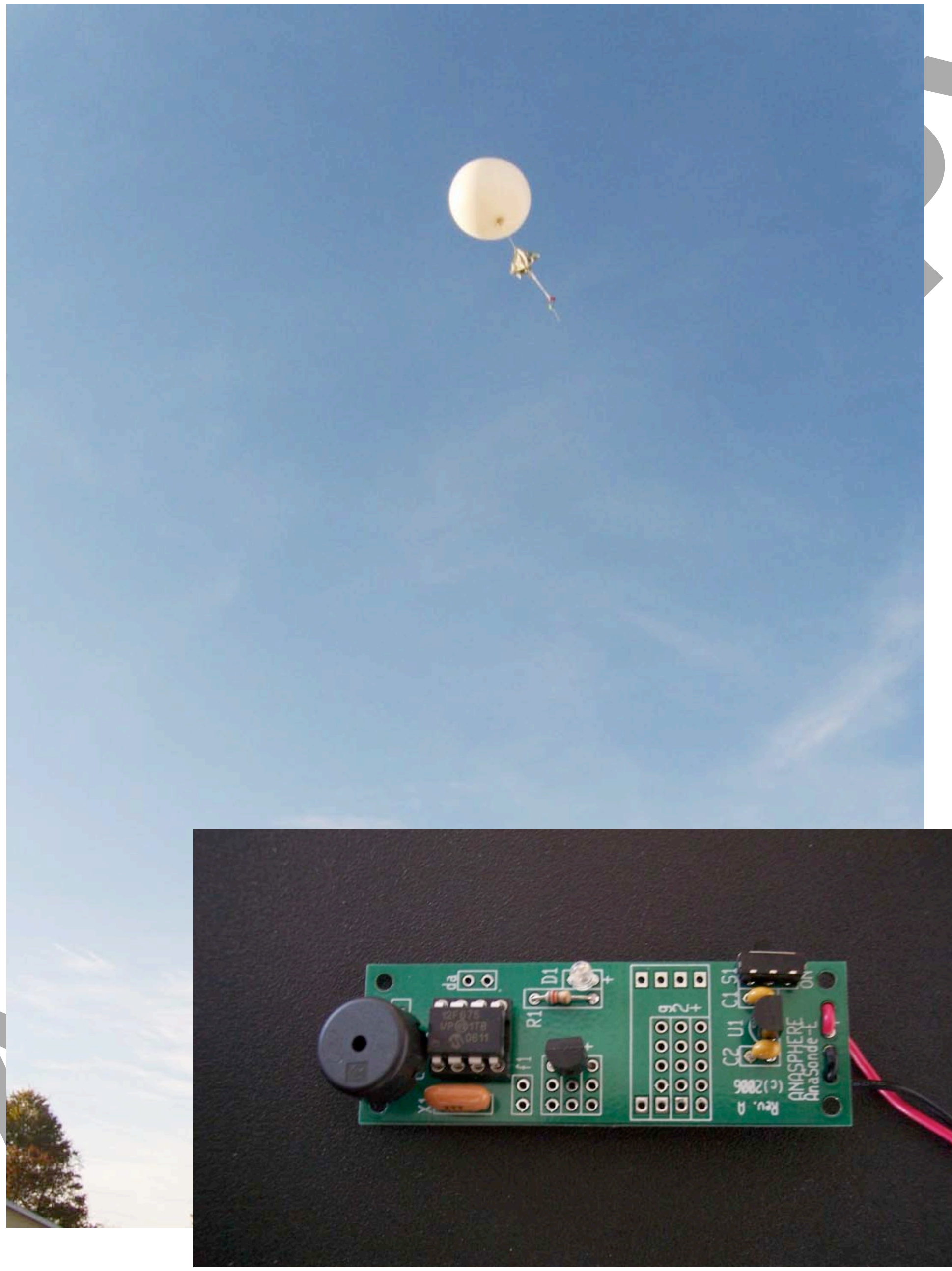


Table of Contents

Foreword

Thank you for choosing AnaSonde to aid in the education of your students! We have worked hard to make sure that the unit that follows will help your students to succeed in the scientific world and understand real world applications of the science they learn in schools. We would love to hear any comments, questions, or criticisms of the program that you have. We will do our best to continue to grow and better the program as we get feedback and ideas. We appreciate your choice in us to better your educational program!

You can send your questions/comments/ideas to:

Anasphere, Inc.
106 Pronghorn Trail
Bozeman, MT 59718

or

educate@anasphere.com

Overview

AnaSonde is an instrument developed by Dr. John Bognar, founder of Anasphere, originally as a family of digital radiosondes for research purposes. They are simple and inexpensive probes used to gather atmospheric profiles for numerous parameters such as temperature, pressure, and humidity. When flying an AnaSonde on a common 3-foot helium-filled balloon, AnaSondes are capable of gathering measurements in the lower atmosphere (troposphere) up to altitudes of approximately 35,000 feet! Since then, Anasphere has recognized the increasing potential of the AnaSonde to educate students in the areas of earth science, math, physics, atmospheric chemistry, technology, and science and technology impacts on society. This realization has resulted in the following curriculum unit. The curriculum starts out by teaching students the basic principles of weather, the greenhouse effect, the atmosphere and its layers, weather predictions, and then it moves on to go into to detail about science investigations, radio communications, and relevant, science experience. The program includes learning to use a Morse code key to determine what the data coming back from the AnaSonde is, soldering a working circuit, and studying on microclimates. It concludes with the students sending an AnaSonde into the atmosphere and receiving real time data, graphing and analyzing that data.

There are many differentiated activities to ensure student understanding and interest of the topic. Included are both a pre-assessment and a final summative assessment along with a few formative assessments along the way. The times on the lessons are an estimate; they may take you more or less time depending on how focused students are and how well they seem to understand the information. The program has been used a few times before and has been well received by many middle school students. This specific curriculum is designed for grades 9-12; however, it could easily be adapted for grades 6-8. We hope that this program successfully helps your students to meet the standards and benchmarks and improves their learning and testing. All lesson supplemental materials are included at the end of the lesson.

Please make sure all safety procedures are followed in the following lessons. Anasphere is not liable for any injury that results from performing the procedures.

Rationale

The implications of learning about weather and climate research in society are great. When society as a whole understands the concepts of weather, the atmosphere and climate change, we will have a culture that understands the consequences of many important topics such as greenhouse gases and their effects on the environments. When we are a fully educated people, we make better decisions about the laws concerning some of the topics involving thins such as global warming.

Also, technology is an integral part of our culture today. In order to become a fully productive member of the general public, one must understand what technology can do for society. With increasing technology, we can better predict the storms that cause so much damage and possibly save lives.

In science, everything is connected. Earth science, biology, chemistry, and physics are all continuous with each other and rely very much on one another. A strong foundation in earth science, physics and math is essential to continue into most other disciplines in life. When we get up in the morning we look outside to get the weather to decide what to wear for the week. Next, we use weather forecasts to determine what we will and will not be doing that week. Earth science is necessary in determining the biology and the factors affecting the biology of previous life forms. It is also an integral in determining the chemistry of the atmosphere and soils and how it depends on the earth science of minerals, layers, etc. present. With the knowledge that we can get from the atmosphere, we can predict weather, predict what will happen to the climate in years to come, determine what the climate was like centuries, even millennia ago, and determine the chemistry of the environment today and a long time ago.

The concept of weather and climate change is often misunderstood. Once students begin to understand the specifics involved in the weather they can begin to see what is happening to the earth today. This will allow for the students to become better citizens and educated voters when things come up in this field in governmental policies. This will also help students to become better at determining what weather may come that day even without a weather forecast. This will help them to develop the skills needed to make educated decisions.

AnaSonde Lesson Matrix

Synopsis	National Standards	Science Concepts
Lesson 1: What is Weather? Students learn basic concepts about weather; this includes pressure systems, clouds, humidity, greenhouse gases, and much more.	**Content Standard A** (Science as Inquiry) **Content Standard B** (Physical Science) **Content Standard E** (Science and Technology)	• Weather is caused by many factors contributing to the state of the atmosphere. • Clouds form as a result of a condensation nuclei and atmosphere changes. • Greenhouse gases can cause long term changes in weather (the climate) that can be bad but also are important to sustaining life.
Lesson 2: Forecasting the Weather Students learn the methods behind forecasting weather, past and present, and learn to use both to predict the weather outside.	**Content Standard E** (Science and Technology) **Content Standard G** (History and Nature of Science)	• The study of weather patterns is important to many everyday activities. • Weather can be predicted fairly accurate because of the advanced technologies today.
Lesson 3: Radio Waves and the Electromagnetic Spectrum Students learn about the electromagnetic spectrum and how the different wavelengths of the spectrum can be used in the real world (including applications such as the AnaSonde).	**Content Standard A** (Science as Inquiry) **Content Standard B** (Physical Science)	• The electromagnetic spectrum contains elements that are useful, harmful, both or none to us. • Each area of the spectrum has its own use in the world, particularly radio waves and their use with the AnaSonde.
Lesson 4: Building and Learning to Use the AnaSonde Students learn about circuits and the basics of electrical parts by building an AnaSonde (by soldering it).	**Content Standard A** (Science as Inquiry) **Content Standard E** (Science and Technology)	• A circuit is a closed "loop" in which electrical charges can flow continuously. • Soldering is the process of making an electrical connection. • Several different components make a circuit.
Lesson 5: The Scientific Method, Graphing, and Data Analysis Students learn the scientific method, how to graph scientific data and how to use the data and graphs to come to conclusions.	**Content Standard A** (Science as Inquiry)	• Scientific research is performed in a certain way to ensure that research is as accurate as possible. • Backing up conclusions with data and graphs is important for making the case for the conclusions.
Lesson 6: Microclimates Students learn the difference between climate and microclimate. They use the AnaSonde in different microclimates and predict why each one might be useful.	**Content Standard A** (Science as Inquiry) **Content Standard D** (Earth and Space Science) **Content Standard F** (Science in Personal and Social Perspectives)	• Climate is the average weather conditions of an area over a period of time. • Microclimate is an area that differs from the surrounding climate. • Microclimates can be used to our advantage for many things.
Lesson 7: Flight and Flight Discussion Students fly a real weather balloon and collect data in real time to learn how scientists predict the weather.	**Content Standard A** (Science as Inquiry) **Content Standard D** (Earth and Space Science)	• The technology of predicting weather has become a very advanced science. • Characteristics of the atmosphere (temperature, humidity, pressure) cause weather.

Pretest Procedures

Pre-assessment
Students will take the Pretest for the unit to assess the level of proficiency that the students are at before the unit. The learning targets in the unit are what are being assessed. This will allow the teacher to better assess what student learning has occurred throughout the unit.

(Time: 25 minutes)

Sharing of Pre-unit Knowledge
Students will be given a piece of poster board. They will be told to use this “graffiti wall” throughout the unit to ask and answer any questions that they have about weather, climate or anything other subjects included in the unit. Students will be given the instructions and some markers as well. The students will read the directions aloud and then begin working on the graffiti wall. It is very important for the students to write on the back what their questions are on the back. Once the students are done with their “walls” they will present them to the class and there will be a brief discussion of the poster boards.

(Time: 25 minutes)

Lesson # 1 What is Weather?

Grade Level: 9-12th Grade

Duration: 160 minutes

Learning Objectives:

Concepts: Students will understand the basic ingredients of weather. They will understand temperature, pressure, and humidity and the importance of each to weather. Students will be able to differentiate the levels of the atmosphere and know the conditions of each layer.

Skills: Students will be able to build a model cloud and a model of lightening.

Affect: Students will appreciate the need to know what the weather is and that predicting weather is a complicated process. Students will appreciate the need for greenhouse gases in the atmosphere but will also appreciate that too much of the greenhouse gases can cause problems for the earth.

Materials:
Matches, Glass Cracker jar, Party balloons, Rubber Bands, Plastic Combs, Wool, Plastic silverware, Pepper, Crispy rice cereal, Re-sealable zipper baggies (2 per group of 3)
Alka-Seltzer (1 tablet per group of 3), Water, Thermometers (1 per group of 3), Heat Lamp (students rotate when one group done) or very warm sunlight

Content Background:

Weather. According to Webster's Dictionary, ***weather*** is "the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness". Weather is an important factor in everything that we do. It can decide what you are going to do that day (if it is raining out it may cancel that trip to the beach) or what you are going to wear that day (do you need that winter coat?). Because of the necessity of knowing the weather to make plans, it is increasingly important to know more about the weather, this thing of which we have no control.

Pressure Systems. One of the factors in predicting weather is high and low pressure systems appearing in the region. A region where the air is sinking is called a ***high pressure*** region. In a high pressure region (anticyclone) there is clear skies and fair weather. This is because the sinking cold air warms as it does so and becomes stable. In general, they cover a greater area and last longer than a low pressure system. A ***low pressure*** region (depression or cyclone) is caused by rising air and often occurs in conjunction with clouds, rain and very strong winds. As the air rises, clouds form and air instability produces vertical development of clouds such as cumulonimbus clouds. In the Northern hemisphere, air sinking spirals in a clockwise direction and rising air in a counterclockwise direction.

Clouds. Clouds are another way that we can tell what the weather will be like. They are created when the water in the air is saturated and there are ***condensation nuclei*** present in the air for the water to collect on (such as smoke, pollution, or dust). Cirrus clouds are high altitude wispy clouds composed mostly of ice. They are usually white and predict fair weather. Watching how these clouds are moving can predict which direction weather is approaching from. Usually they mean a change in weather within the next 24 hours. Cirrostratus clouds usually cover the sky in thin sheets meaning that the sun or moon can shine through. These clouds usually mean that there will be a rain or snow storm. Cirrocumulus clouds appear to be in rows of cotton. They can vary from white to gray. In winter they predict cold but fair weather. In the tropical regions, however, they predict that a hurricane may be on its way.

Alto clouds are mid-level clouds that predict changes in the next 6-12 hours. ***Altostratus*** clouds cover the sky and are a grayish color. It usually makes the surrounding area appear hazy and is foreboding of rain or snow. ***Altocumulus*** are a lighter gray and look like cotton balls strewn across the sky. If they are seen in the morning they indicate afternoon thunderstorms.

Stratus clouds are the lowest in the sky. They are uniformly gray and cover the entire sky. When this cloud gets close enough to the ground it is just called fog. These usually indicate a drizzle throughout the day. ***Stratocumulus*** clouds are puffy gray clouds that form with the blue sky still visible. These rarely mean rain unless they become nimbostratus. ***Nimbostratus*** clouds are dark gray and usually mean rain or snow.

Cumulus clouds are puffy clouds that develop vertically. These usually indicate fair weather unless they become very tall. In this case, they have become ***cumulonimbus*** clouds and are indicative of thunderstorms. They also can predict hail, tornadoes and snow. When they are shaped like an anvil, it points in the direction that the storm is headed.

Increasingly lower altitude of the cloud formations usually means that a storm is approaching. Cumulus clouds developing upward indicate stormy weather as well. In general, weather changes come from the west or southwest. If winds change or temperature and/or pressure drop suddenly, a storm should be watched for as well.

All of the main things involved in weather are involved in the creation of clouds (temperature, pressure, and humidity). Water condensation above the earth's surface on little particles creates clouds. This is generally because the air is ***saturated*** with moisture. Saturation occurs when the temperature cools an air mass to its ***dew point*** or air is forced to rise.

Air can be forced to rise in several different ways. One way is when it meets elevated land forcing the air upward (***orographic uplift***). Another way is associated with the surface hearting the air. When enough heating has occurred, the air mass becomes hotter and lighter and it begins to rise, expand, and cool. Once it has cooled enough the air becomes saturated with moisture because of the air's decreased capacity to hold water when cooled. ***Convergence*** occurs when two air masses come together. The warm, moist air mass gets lifted over the cold, dry one. The warm one is cooled as it is lifted over the cold and this once again results in saturation of the air.

Finally, there is ***radiative cooling***. This occurs when the sun is not heating the air and ground (this occurs at night). The earth begins to lose the heat and this causes the ground and air above it to cool saturating the lower and producing a fog.

Temperature, pressure and humidity all work as a team to produce weather. Temperature describes how warm the air is. Pressure describes how much air is in the area. Humidity describes how much water is in the air.

Temperature. When looking at temperature, it is obvious how it works when looking at the air. When they are place closely to each other, the air masses exchange heat until the cool object has warmed and the higher temperature object has cooled enough that they are at roughly the same temperature. This is called thermal equilibrium. Air higher in pressure is usually cooler air and air lower in pressure is usually warmer air. When the two meet, the air becomes uniformly dispersed and the cooler air warms and the warmer air cools.

Humidity. Humidity that we talk about most of the time when we talk about weather is ***relative humidity***. Many people have misconceptions about what relative humidity is. It is not how much water the air can hold it is how much water is in the air over how much water could fit in the air before maximum capacity is reached (right before the water begins to condense out of the air). The temperature at which the moisture saturates the air is the dew point. If the air were to drop in temperature further, the moisture would begin to condense out of the air.

Wind. Wind is caused by the earth's surface being heated unevenly by the sun because of the tilt in the earth's axis. Also, the different things that make up the earth's surface hold heat differently. Warm air is less massive than cool air and as it rises, the cool air moves in and replaces the warm air. This movement makes the wind blow.

Thunderstorms. Thunderstorms are a type of storm produced by cumulonimbus cloud. They usually consist of gusty winds, heavy rain and hail. The basic things that create a thunderstorm are moisture, unstable air and lift. The moisture is needed to form rain and clouds. Unstable air that is relatively warm can rise rapidly causing lift. They can occur at any point in time but are most likely to happen in the spring and summer months later on in the day.

Lightning. Lightning is the partner of thunder and an electric current. Lightning is the bright flash of light before the sound of that flash (thunder). Therefore, lightning must be present for the storm to be a thunderstorm. Just because thunderstorms are small does not mean that they are not dangerous. It is estimated that more people are killed each year due to lightning than tornadoes.

For lightning to occur there must be a build-up of electric charge in the cloud caused by the water particle bumping into each other. The charges in the cloud separate with the positively charged protons at the top and the negatively charged electrons at the bottom. With charges, opposites attract, this means that since the bottom of the cloud is negatively charged, the ground get all of the positive charges moving toward the surface and collects wherever there is something that is higher in elevation than the ground, such as a tree. When the charge from the tree meets the charge coming down from the cloud it causes a giant spark (lightning). This is the same as when you drag your feet across the floor and then turn on the light switch. The switch can shock someone even before they touch it because of the attraction between the charges when close to the other. The little zap that can be heard when this occurs is comparative to the thunder only not as loud because the shock is not as big. The zap or the boom is caused by a hole in the air that opens when the electricity travels through the air. When the lightning bolt is gone, the air collapses back into the hole

Greenhouse Gases and Climate. ***Greenhouse gases*** include several gases such as carbon dioxide, methane, water vapor, nitrous oxide, and fluorocarbons. These gases are naturally part of the atmosphere. They are what keeps the Earth at a temperature that we can live in. If it were not for them, the Earth would be about 33 degrees Celsius cooler. These gases help to retain the heat through a process called the Greenhouse effect. This process begins when the Sun's short wave rays enter the Earth and the Greenhouse gases allow them to pass through the atmosphere to get in. Once they get to the ground, they are either absorbed or reradiated back to the atmosphere. When they bounce off the Earth, the waves changed into long wave infrared radiation and the gases do not allow the rays to leave. This keeps the Earth warm.

In the last century, however, the Earth's temperature has increased by about 0.5 degrees Celsius. Scientists believe that this increase in temperature is caused by the increase in greenhouse gases caused by humans. This is being called climate change. (***Climate*** is the weather of a place over a long period of time.) It is theorized that such an event will cause catastrophic events for nature such as rising sea levels and melting polar ice caps. This will also cause economic damage. Other scientists say that this is just the natural cycle of the Earth.

Atmosphere. The atmosphere consists of several different layers. The gases in the atmosphere and the conditions of it change from the ground up. The five distinct layers are classified by using temperature, chemical composition, air density, and movement. The boundaries of the layers are where the maximum variances in the above characteristics occur.

The layers, in order from the ground up are described below. The ***troposphere*** begins at the surface of the earth and extends up to about 10 miles in height varying around the equator and the poles. This is where we live and where most of the weather occurs. The temperature decreases with height in this layer. It is often windy in this layer (there is much movement). The boundary between the next layer and the troposphere is called the ***tropopause***.

The ***stratosphere*** comes next. This layer goes from the tropopause up to around 30 miles above the surface. This is where 19% of the atmosphere's gases reside, however, there is very little water vapor here. This is also where we would find the ozone layer, the layer that protects us from the sun's harmful rays. The temperature increases in height in this layer because the gases in this layer absorb the radiation from the sun. This is what causes the formation of ozone. The layer that separates this from the next is the ***stratopause***.

Next, we have the layer called the ***mesosphere***. This layer extends up to around 53 miles above the earth. The density of the gases in this layer is low. Because of this, there is less radiation from the sun absorbed in this layer making the temperature decrease with height once again. This is where most meteorites burn up. The ***mesopause*** separates this from the next layer.

The ***thermosphere*** is the next layer. In this layer, the gases of the thermosphere are increasingly thinner than the previous layers. This is where all of the high energy rays from the sun are absorbed and therefore this is where the temperatures in the atmosphere are the hottest.

Finally, the exosphere is the outermost layer of the atmosphere. The barrier between this and the thermosphere is called the ***thermopause***. This is the layer where molecules from our atmosphere begin to escape into space. This is also where our satellites orbit the earth.

Instructional Procedures:

Focusing Event:
An AnaSonde that the teacher built before hand will be sent up in the air after being tethered to the ground with a kite string. The teacher should have the balloon filled and everything setup so that the balloon can be launched as soon as the configuration sequence is picked up from the AnaSonde. The flight will be much like the final flight of the unit except that it is tethered and will not go as high. The setup will involve filling a balloon with enough helium to lift a 90 gram weight. The radio receiver will need to be hooked up to the computer to obtain the data. Students will be asked about the data that they are seeing coming down from the balloon.

What are the patterns in temperature as the AnaSonde goes up? Patterns in pressure?
Why does each of these occur?
What do you think these conditions have to do with the weather?

Students will use the data collected and their previous knowledge of weather to create a conceptual model of the weather. This will be done in the form of a concept map.

(Time: 25 minutes)

Teaching Methods and Student Activities:
Days1-2:
Students will be involved in an interactive lecture. This PowerPoint presentation is provided by Anasphere as well. They students will be told to ask any questions that they have at any point during the lecture. During the lecture, there will be several demonstrations to keep the students involved in the lecture. The first one will start with the cloud demonstration. The demonstration on how to create a cloud is included below. Next, when the appropriate time comes, students will be broken into groups and given the materials necessary to perform the different lightning demonstrations.

(Time: 75 minutes)

Day3:
Students will be given a brief introduction to greenhouse gases from the PowerPoint. Then they will discover what the greenhouse effect is through a lab. Students should write their data from the lab on a class table on the board. The teacher should lead the discussion about the data.

(Time: 40 minutes)
Closure:

The teacher will lead a discussion of pros and cons of the greenhouse effect. Students will be asked what they think how global warming and weather might be affected by this.

(Time: 10 minutes)

Evaluation Procedures:

Students will write a short discussion of the lab. See Appendix A for requirements.

Suggested Supplements Lesson #1

Cloud Demonstration

Materials needed:
Cracker or cookie jar with wide mouth lid, Water, Match, Rubber glove or strong balloon, and Rubber bands

To begin, the teacher will fill the jar with ~1 inch of water and then seal it by stretch the rubber glove/balloon (cut balloon in half to get a single layer piece to put over the top). The teacher will then place rubber bands around the mouth of the jar, over the top of the rubber glove/balloon seal. This should be done the day before so that the jar can sit to build up some water vapor. The following day (with most of the lights dimmed), with students gathered around the jar, the teacher will ask for a volunteer to strike a match, blow it out and drop the match into the jar. The jar will need to be resealed immediately, making sure the seal is not too tight. When it is secured, the teacher will push their fist into the rubber seal, then release. While the teacher does this, a second student volunteer should have a laser pointer or a flashlight shining on the jar. Students should then see a cloud form; the jar will get foggy and hard to see through. Students will then be asked the following set of questions:

What did you observe?

From observing, what do you think the main ingredients needed to make a cloud are?

What does each component in the demonstration represent in the real life model of creating a cloud?

Why is it important to know how clouds form? What can we learn from clouds?

Lightning Demonstrations

These demonstrations were found and adapted from the Discovery Education Website. The teacher should make a copy of these and then cut them into sections for each demonstration. Then, the students should be broken into 4 groups and then each group will get one of the demonstrations to perform. The students should get a few minutes to get it ready and then all of them will perform it in front of the class.

Lightning Demonstration #1

Procedure:

1) Distribute ground pepper on table.
2) Rub a plastic utensil with wool.
3) Hold the plastic utensil just above the pepper.
4) Discuss what occurs.

Lightning Demonstration #2

Procedure:

1) Turn off at least part of the lights.
2) Rub a plastic comb with wool.
3) Hold the comb near a metal surface.
4) Discuss what occurs.

Lightning Demonstration #3

Procedure:

1) Rub two inflated balloons on your sleeve.
2) Turn off the lights.
3) Rub the balloons together.
4) Discuss what occurs.

Lightning Demonstration #4

Procedure:

1) Pile some puffed rice cereal onto a table.
2) Comb your hair (do not share combs!).
3) Place the comb in the pile of dry puffed rice, pick up.
4) Discuss what occurs.

Students should be asked the following questions when all of them are done:

What is the unifying concept in all of the demonstrations?

Why does lightning occur?

Why does thunder occur? How can you tell?

Greenhouse Gas Lab

In this lab, students will create a model of the atmosphere and the greenhouse effect. Divide the students into groups of 2 or 3. Each group will receive two half-gallon re-sealable bags, an Alka-Seltzer tablet and a thermometer (in the AnaSonde Activity Book there is a lab that does the same thing using an AnaSonde). The students should label one bag "control" and the other bag "test".

Students will put 250 mL of water in each bag along with the thermometer, making sure that it is kept out of the water and in the top of the bag, with the water in the bottom. The first bag tested should be the control. This bag will have just water in the bottom, the thermometer will be placed in the bag and the bag will be sealed. It is very important that the students hold onto the thermometer in the bag and do not let it touch the water. This is because the students are measuring air temperature, not water temperature. ***Remember:*** The greenhouse gases affect the "atmosphere" in the bag faster because water has a higher specific heat. Once the bag is sealed, students should place the bag under a heat lamp or direct and very warm sunlight and begin taking measurements as directed by the Greenhouse Effect Lab Worksheet. The students will need to listen and watch carefully for the measurements to come to them via LED or buzzer.

Once the group has finished with their "control" atmosphere, they should begin the test on the "test" atmosphere. To do this one, drop an Alka-Seltzer tablet into the second bag that contains 250 mL water; seal immediately (for best results, it is recommended that the thermometer and the Alka-Seltzer Tablet both be held out of the water while sealing the bag, once the bag is closed, the students should keep hold of the thermometer but drop the tablet into the water). Students should then put the bag under a heat lamp or direct (very warm) sunlight. The test experiment should be placed in the exact same place and conditions as the control experiment to be able to compare results. Students should be reminded once again to NOT let the thermometer touch the water.

Greenhouse Effect Lab

Name ___________________

Procedures: Assign a recorder, a reader, and a timer within each group. The recorder will record the data, the reader will read the temperatures and the timer will tell the reader when to read.

1) Read the procedure and hypothesize what you think will happen and why.
Should say something about how the alka setlzer tablet will add carbon dioxide to the bag's__ atmosphere and will increase the temperatures inside the bag. ___________________________

2) Obtain the following materials for your group: 1 Thermometer, 1 Alka-Seltzer tablet, 2 half-gallon Ziploc bags, a 250 mL beaker, tape, stop watch and a permanent marker.

3) Fill both bags with 250 mL of water. Place the thermometer in one of the bags containing water and close it (this is your control). **Important:** *Make sure to hold the thermometer up out of the water while sealing the bag and during the entire experiment. The temperature that we want to know is of the atmosphere and not of the water.*

4) Place the thermometer (and the bag) under a heat lamp, or under direct and VERY warm sunlight. Record the measurements from the thermometer at time 0 and then every 30 seconds after that for the next 2 minutes in the following data table using a stop watch to ensure equal time intervals. Record the temperature readings to the nearest half degree.

5) In the other bag of water, place the thermometer, once again keeping it out of the water AT ALL TIMES. Put the Alka-Seltzer tablet into the bag, but do not drop it into the water yet. Once the bag is sealed, place it under the same heat source in the same spot that was used for the control. Drop the Alka-Seltzer tablet into the water and begin taking measurements. Repeat the same methods for the experimental group that was used in the control.

Greenhouse Gas Data

Time (s)	Temperature of Control (F)	Temperature of Experimental (F)
0		
30		
60		
90		
120		
Total Change in Temperature		

Discussion: Write a short paragraph discussing the following things. What do you notice about the data? What do you think this means? What are possible sources of error? How is the study relevant (what are the practical applications)? If you did a follow up study, what would you do?

Answers will vary fo rthis worksheet. Make sure that whatever the students says in the discussion is supported by facts.

Lesson # 2 Forecasting the Weather

Grade Level: 9-12th Grade

Duration: 50 minutes

Learning Objectives:

Concepts: Students will be able to understand the past predictors of weather and how valuable this field of study has always been.

Skills: Students will be able to apply an analysis of existing weather and conditions in the area to predicting the following day's conditions.

Affect: Students will appreciate the role that weather plays in our everyday lives and how they can use this information to help them get through their lives.

Content Background:

Weather prediction has become highly evolved in the last half a century. However, people have been doing it for ages. Some of these methods still work great. The Native Americans used things such as flight patterns of birds, thickness of the skin of an onion, etc. Settlers used many things such as pine cones, wool, and sea weed.

Starting with pine cones, when the cone is open the weather will be dry. They retain their original shape when the weather begins to become wet. This is one of the most reliable indicators. Next, wool is used as a humidity indicator as well. When the weather is dry, it shrinks and curls up; when it is wet, it swells and straightens out. Another humidity indicator is sea weed. When rain threatens, it swells and feels damp.

In order to keep things straight, many sayings were invented to represent how people used to predict the weather. A few are listed below:

If the crows fly low, the wind's going to blow. If crows fly high, the wind's going to die.
A sunshiny shower won't last half an hour.
Clear moon, frost soon.
When sea birds fly to land, there truly is a storm at hand.
Onion skin is very thin, mild winter coming in. Onion skin is thick and tough, winter will be cold and rough.
Rainbow in the east, sailors at peace. Rainbow in the west, sailors distress.
Red at morning, sailors take warning. Red at night, sailors delight.

These next few predictors have the logic behind the reasoning written below it:

If a muskrat builds his house toward the edge of the lake it means we will have a mild winter. If a muskrat builds his house toward the middle of the lake, we will have a long winter.

Logic: A muskrat needs open water to get out of his house. So if he builds near the edge of the lake, it means he knows that there won't be a long hard freeze. If there was, he could not get out of his house.

If snakes stay around in late fall, we will have a long fall.
Logic: Snakes hibernate in the winter, so this can be used as an indicator of the length of the fall.

If rabbits keep their gray colors unusually long, we will have a long fall. If rabbits turn white early, we will have an early winter.
Logic: Since they turn white in winter, we can use them as an indicator of when winter is coming.

If crows are seen in February there will be an early spring.
Logic: Birds migrate instinctively at various times of the year.

When leaves on the ash trees turn upward it will rain.
Logic: Moisture in the air affects the position of some types of leaves.

A chattering squirrel is a call for rain.
Logic: This is more of a sign that it will rain than a call for rain. Squirrels will chatter while gathering or eating food. They eat and store food before a rainstorm.

If the quarter moon starts to tip downward it will rain. If the quarter moon tips upward we will have dry weather.
Logic: The moon affects the weather of the earth. When it is tipped down this signifies the dumping of rain.

Even though the technology we use today is great, we still use the old standby sayings as well to ensure the most accurate forecast possible. The instruments used today consist of several things that have been around for decades. These examples include (but are not limited to) thermometers, barometers, and sling psychrometers. ***Thermometers*** are used to measure the air temperature. A thermometer works using a liquid center in a glass tube. Once the liquid in the tube is filled up, the temperature is determined. A ***barometer*** measures the pressure in the air. If the pressure is rising, the weather is going to sunny and dry. If it is falling it will be stormy and wet. A sling ***psychrometer*** measures the relative humidity through evaporation. Two thermometers are used to make this psychrometer. A regular one and one with a wet "sock" on. It is swung around in the air a few times and the water evaporates causing the temperature on the one with the "sock" to drop.

Newer technologies that we use in predicting weather are things such as maps, satellites, and balloons. Weather maps are used to put all of the conditions of a particular region together and watch the movement of the conditions to determine when and if that weather will hit the location being watched. Weather balloons are used to measure the weather conditions higher in the atmosphere to determine what the conditions could be like if changes occurred in the atmosphere. These balloons usually go only as high as the top of the troposphere because that is where most of the weather occurs. Finally, weather satelllites are used to photograph and track larger scale air mass movements. These are compiled onto the weather maps and then with the help of computers the data is analyzed.

Instructional Procedures:

Focusing Event:
Students will view storyboards and have to relate the predictors and logic that Native Americans had to the boards. The teacher will emphasize that there is a distinct difference between Traditional Native American science and Contemporary Western Science. The distinction between the two is that the Native Americans were more concerned with observing what was occurring and relating it to other occurrences around them. Contemporary Western science is not as concerned with observing what occurs, but how and why it occurs. Data is recorded and analyzed to explain something. Traditional Western science was similar to Traditional Native American science in that it was mostly based on observations of what was occurring as well.

(Time: 5 minutes)

Teaching Methods and Student Activities:
Students will be given a cloud finder worksheet (found at http://teacher.scholastic.com/lessonrepro/reproducibles/profbooks/cloudkey.pdf). They will assemble the cloud finder. This is a handy tool built on contemporary science that is readily accessible to help students predict the weather. Next, they will use the cloud finder and existing conditions to predict the weather later on that evening. The students will be informed that for a week they will be tracking their predictions with what the weather is at night.

(Time: 10 minutes)

Students will then be introduced to the newer ways of predicting weather (satellites, weather balloons, etc.) in a short lecture. Students will use this information to discuss which method (the old or new) predicts the near future weather best and whether they are both worth using.

(Time: 20 minutes)

Closure:

Students will discuss how they see the weather being predicted on the news and then use the same principles in forecasting on the weather on a map they are given in their weather prediction worksheets. These are the same worksheets that are referred to in the evaluation procedures below.

(Time: 15 minutes)
Evaluation Procedures:

Students will do the weather predictions worksheet to demonstrate their abilities to use critical thinking to predict the weather in a specific area like meteorologists do. This worksheet is planned as homework. Students will also keep a running table of the data that they collect with the cloud finder. They will need to record their prediction, what the actual weather was like that afternoon, and what other conditions may have existed that may have contributed to their predictions being wrong or right.

Suggested Supplements Lesson #2:

Native American Models Demonstration

There is a PowerPoint presentation with story boards on the website. Help students to come up with the following weather predictors (through questions) from looking at the story boards in the following order.

When the cup tips down, the rain will pour. When the cup tips up, it will pour no more.

What do you notice about the quarter moon in each picture?
What do you notice about the vegetation in each picture? What would make the vegetation like this?
Can you come up with a saying for this observation?

If crows are seen in February there will be an early spring.

What do you notice about the weather during the month?
What animals are present?
What does the season look like?
Can you come up with a saying for this observation?

If rabbits keep their gray colors unusually long, we will have a long fall. If rabbits turn white early, we will have an early winter.

What do you notice about the rabbits?
What do you notice about the seasons (the snow came earlier and the rabbit was already white)?
Can you come up with a saying for this observation?

Forecasting Weather

Name___________________

Not only do meteorologists predict weather using clouds, they can collect data about the earth's weather using things such as weather balloons (like we will use) and then use that data to construct maps of the conditions of an area. These maps can be used to predict what the weather will be like over the next couple of days. In this activity, you will use the given information to create a weather map of an area and then forecast the weather for the next couple of days.

Fill in the blanks to help give you a guide for weather conditions.

Things to know:

A cold front is a mass of cold air that moves in and replaces warm air. Warmer air is __less____ dense than cool air so it ___rises___. Since the warm air can hold _more__ water, when the air cools, it condenses and forms a big column of clouds. This type of front also causes _colder___ temperatures.

A warm front is a mass of warm air that moves in and replaces _cold__ air. This type of front causes _warmer__ temperatures. Since more surface area of the two masses touch in this situation, it causes more water to condense and form _clouds_. These conditions last longer.

Use the following information and the key for weather maps to draw in the conditions listed below on the map of the United States.

Information Received from Weather Satellite:

****Remember***: *In general, the wind blows weather across the United States in a south eastern direction. Warm fronts tend to move north east, however*.

-- A warm front stretches from Indiana to Ohio.
-- There is precipitation along the warm front.
-- A low pressure system is over Texas and Maine.
-- A cold front stretches from the top left corner to the bottom right corner of Montana.
-- A high pressure system is over Nebraska and Georgia.
-- There is a hurricane off the coast of Louisiana.
-- There are some severe thunderstorms with high winds in Kansas that look like they may turn into tornadoes.

Key for Weather Maps:

Weather	**Symbol**	**Associated Weather**
Precipitation		Rain, snow, fog, etc.
Cold Front		Cooler temperatures with a chance of precipitation
Warm Front precipitation		Warmer temperatures with a chance of
Low Pressure		Cloudy skies with a chance of precipitation
High Pressure		Clear skies
Hurricane		Damaging winds and rain with flooding
Tornado Watch		Area where with a good chance of a tornado or severe thunderstorms
Tropical Storm		Heavy rain with strong winds

<u>Use the above map as today's weather. Predict (and justify) tomorrow's weather for Kansas below:</u>

<u>Students should appropriately label the correct areas above. They should predict that the weather in Kansas will be clear skies and justify it by saying that the high pressure system over Nebraska will likely shift over Kansas and in a high pressure system, the weather is fair.</u>

Predicting Weather

Fill in the table every morning this week. Make sure to compare your predictions to the actual weather in the afternoon.

Date/Time	Cloud Type	Weather at Class Time	Predicted Weather Later	Weather/Time

Student answers will vary, just make sure that the descriptions of weather and predictions make sense and were well thought out.

Lesson # 3 Radio Waves and the Electromagnetic Spectrum

Grade Level: 9-12th Grade

Duration: 50 minutes

Learning Objectives:

Concepts: Students will be able to understand the electromagnetic spectrum particularly radio waves.

Skills: Students will be able to resolve whether a section of the spectrum is harmful, useful, both, or none to us.

Affect: Students will be able to relate the value of each area of the spectrum and will understand the implications of each area's characteristics. Students will also be able to understand the value of radio wave technology being used to transmit the data from the AnaSonde.

Materials:
Slinky

Content Background:

Wavelength, frequency and energy are the first very important things to know to understand the electromagnetic spectrum. ***Wavelength*** is the distance from crest to crest or trough to trough. Wavelength is measured in meters. ***Frequency*** is how many crests or troughs (whichever you pick) goes by every given unit of time (cycles/second or Hertz). Energy is measured in electron volts.

The ***electromagnetic spectrum*** is the full spectrum of radiation. This includes visible light, radio waves, microwaves, infrared and ultraviolet light, x-rays, and gamma rays. The highest energy forms of radiation (x-rays and gamma rays) are caused by extremely hot bodied objects. These forms of radiation have the shortest wavelengths and also the highest frequency. Starting with the lowest energy and working the way up to the highest in order, the following is the electromagnetic spectrum.

Radio waves are emitted by many other things besides the radio. These things include stars and gases in space. These waves can be studied by scientists to learn what the stars are made of or what the gases are. When we talk about the radio waves as we know them we see that the lowest energy/ lowest frequency magnitudes are reserved for aircraft and ship radio contacts. Next, come the AM, then shortwave radio, and finally the waves that produce the picture on your TV and FM radio. Radio waves have a very long wavelength and a low frequency. These waves are the ones used by the AnaSonde to transmit the data from the atmosphere to the ground. If it were not for these waves, we could only get data from the AnaSonde up to the point that we could not hear it anymore.

Microwaves are just as they sound, the waves the can make your food very quickly. Not only this, but microwaves can be used by astronomers to learn about the structure of nearby galaxies.

Infrared waves are often confused as heat. These are the rays that night vision goggles use to allow to us see at night. When we can see this heat, we can find warm bodies like animals or humans. These also help to map the dust between stars.

Visible waves of light are next. This is the part of the electromagnetic spectrum that we can see. This includes "ROY G BIV".

Ultraviolet light is the light that comes from the sun (UV radiation). Because of the hot body that it comes from, it is high energy radiation. This radiation can cause damage to our skin (sun burns and skin cancer).

X-rays are increasingly more dangerous than UV radiation, but are also very useful in looking at bones and teeth. These are very high energy waves and can cause mutations if a person is exposed to them too much. Hot gases in space also emit X-rays, so even if we did not get X-rayed by doctors, we would still receive some of this radiation.

Gamma rays are the most high energy form of radiation and thus the most dangerous. Radioactive materials emit gamma rays. These rays have been known to cause cancer and mutations because of the genetic mutations that they can cause. Their high frequency/high energy allows them to penetrate us deeper and can cause damage to more than the skin.

All of the above are forms of ***electromagnetic radiation***. This means that they are a stream of photons traveling in a wave-like motion at the speed of light. The difference in the above forms is how much energy is found in the photon. Radio wave photons have low energies where as gamma-rays have the highest energies.

In order to keep the numbers understandable, scientist use additional names on the units to keep track of how big or small the numbers really are. If the wavelength were 4000 meters it would be easier to say 4 kilometers. Scientists could also use scientific notation to do the same thing. Rather than saying the wavelength is 0.000000001 m it could be called 1 nanometer or 10-9 m.

<u>Instructional Procedures:</u>

Focusing Event:
The teacher will ask the students; "If you microwave your food, will you get cancer from the food?" The students will then discuss the topic as a group. If needed, the teacher can facilitate more discussion by asking, "Is microwaving your food bad for you in other ways?" or "What do you know about the science behind waves and how a microwave works?" Then the teacher will have student volunteers show the wave demonstration and ask students to explain the wave, where energy comes into play over this, and what the force behind the wave is.

(Time: 10 minutes)

Teaching Methods and Student Activities:
Students will complete the electromagnetic spectrum worksheet with the help of the teacher. (See Suggested Supplements at the end of the lesson.)

(Time: 15minutes)

The teacher will ask the students:

How do you think this applies to the AnaSonde knowing what you know about it? What kind of wave is used to transmit the AnaSonde data?
Why is this technology important to have?
Could we receive data from 30,000 ft without these waves?
What other kinds of things could be done with wave technology?

(Time: 10 minutes)

<u>Closure:</u>

Students will then help lead a discussion about the different characteristics and specifications of each different part of the spectrum. Students will take the last 5 minutes of class to fill in their cloud finder data sheet for the day.

(Time: 15 minutes)

<u>Evaluation Procedures:</u>

Students will discuss how dangerous they think microwaves are relative to the other waves in the spectrum. This should take place during the closure discussion. They will also discuss which part of the spectrum seems to be the most dangerous and why. To facilitate the discussion, the teacher should ask the following questions:

Which part of the spectrum has the highest frequency and thus the highest penetration power?
Which type of wave has the lowest frequency?
Which parts of the spectrum are we exposed to the most?
Which part of the spectrum is the most likely to give us cancer with how much a normal person is exposed to each section in their lifetime? Why?

Wave Demonstration:

In this demonstration, the teacher will pick a few students to hold the ends of a slinky. A student on one end of the slinky will hold it still and the other student will move their end up then down once. The other students should observe and discuss what happens next.

Where did the energy for the wave come from?

Can waves occur by themselves?

The teacher will then draw a picture of the wave on the board an label the frequency, wavelength, and amplitude. Students will be asked:

If there is a greater force behind the wave will have a higher frequency, a bigger wavelength?

Then they will be asked to come up with a way that they could test what they have come up with for the answer to the question. Students will then actually perform this test and discuss the results that come from the test.

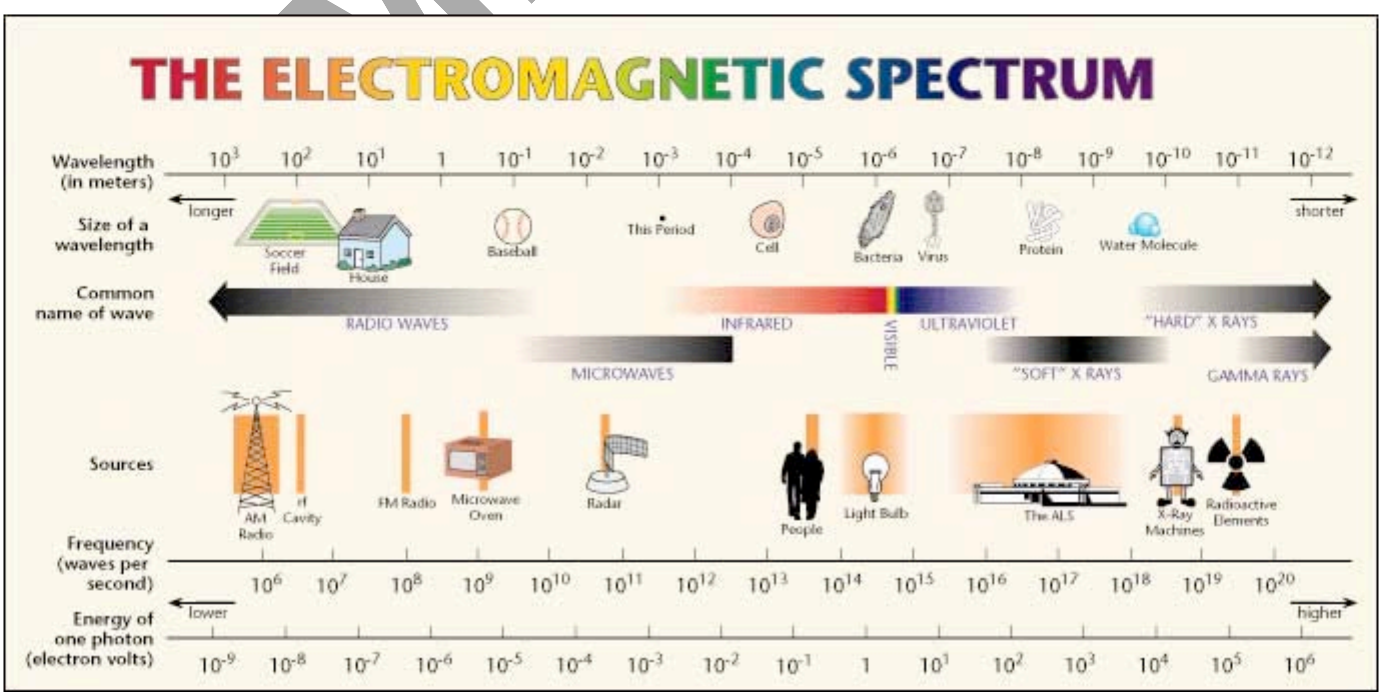
Electromagnetic Spectrum

Name ____________________

Match each kind of wave with one item from column one and one item from column two.

COLUMN 1		WAVE		COLUMN 2
A. used in remote controls for TVs and VCRs	__F___	RADIO	__M___	**H.** used to find a broken bone
B. goes through most matter except bone & lead	__E___	MICROWAVE	__L___	**I.** used to kill bacteria on food
C. highest frequency and energy	__A___	INFRARED	__N___	**J.** ROY G. BV
D. can cause skin cancer promote vitamin D production	__G___	VISIBLE	__J___	**K.** shortest wavelength
E. longest wavelength	__D___	ULTRAVIOLET	__I___	**L.** thought to alter food properties & make unhealthy
F. used to transmit cellular phone calls	__B___	X-RAY	__H___	**M.** TV signals from stations, used in car alarms
G. wavelengths and frequencies that can be seen by the human eye	__C___	GAMMA	__K___	**N.** radiant heat rays

15. As you go from left to right across the electromagnetic spectrum what happens to the frequency and energy of the waves? ________The frequency increases and the waves become more energetic. This gives these waves a higher penetration power and they become increasingly dangerous to us.____



Lesson # 4 Building and Learning to Use the AnaSonde

Grade Level: 9-12th Grade

Duration: 100 minutes

Learning Objectives:

Concepts: Students will understand Morse Code.

Skills: Students will be able to solder a simple circuit. Students will also be able to use Morse Code to translate data.

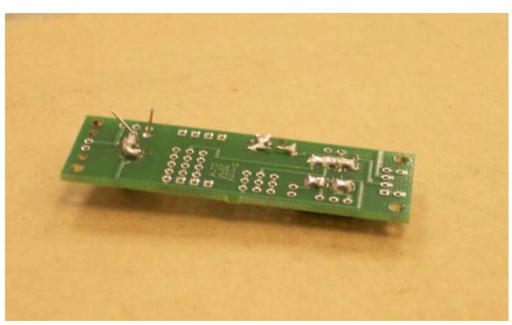
Affect: Students will get the real life experience of building and using scientific instruments that real scientists use. Students will also value the use of technology to further our scientific knowledge.

Materials:
Soldering iron and stand (1 per group of 2), Solder, Safety Goggles (1 per student), Wet sponge (1 per soldering iron), Copper Braid (for desoldering if any accidental soldering occurs), Wire Cutters (1 per group of 4), 9V Battery (1 for each AnaSonde Kit), AnaSonde E or M (1 for flying), AnaSonde Buzz-E kit (1 per student group of 2), AnaSonde Instructions PowerPoint (download off www.anasphere.com)

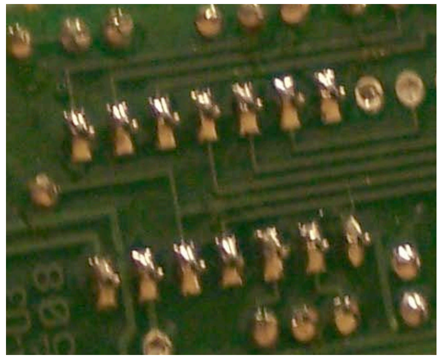
Content Background:

Circuit Board. Circuit boards are made with an insulator (usually fiberglass). The board contains "threads" that run across it that are the wires of the board. These threads allow for an electrical circuit to be built without a mess of wires. In a ***circuit***, charges can flow continuously throughout a closed loop of electrical parts and wires.

Solder. Soldering is a process of making an electrical connection. The ***solder*** is an alloy of metals with a low melting point. A soldering iron is used to heat the solder and make the connection between the part and the board. In order to make the best possible connection, the soldering iron tip must contact both the board and the component to make sure they are the same temperature. To ensure that no ***solder bridges*** (two joints are connected by solder, see below) are made, the solder should be applied in the smallest amount possible. Several solder bridges are pictured below.



However, if there is not enough solder to make the connection all the way around the part, the circuit will not work either. Therefore, it is important to pay attention to how much solder is applied to each joint. Below is the picture of multiple perfect solder joints.



There are a few key terms to know when learning about soldering; the first of which is tinning. ***Tinning*** is the process of coating the soldering iron tip with solder. This allows the solder to melt and stick to the joint better. The ***solder joint*** is where (in this case) the part is soldered to the board. A short occurs when there is an unwanted electrical connection between the positive and negative source. This connection can cause damage to the other parts on the board or the battery. Solder bridges cause shorts and are usually caused by putting too much solder on the joint. This can short the circuit and the AnaSonde will not work. ***Desoldering*** is a process in which solder is removed from the joint so that the part can either be removed or moved to a different space on the board.

Ground. The ***ground*** is a body, such as the earth, that acts as the reference point in the electrical circuit from which all voltages are measured. Ground has a voltage of zero and can be the common return for an electrical circuit. Connections to ground limit the build-up of static electricity which can cause harm to the circuit and to the handler.

Circuit Board Components. A circuit board has several components that are soldered to it to allow it to perform its function.

A ***resistor*** is a component that restricts the electrical current flow through the circuit, in other words, it causes resistance. This is done in order to drop the voltage of current that is flowing through the circuit to a level that is safe for the parts in the circuit. Resistance is measured in ohms.

Capacitors are called capacitors due to their capacity to store an electric charge. They can be used to store both digital and analog data. They can also be used with telecommunications equipment to adjust frequency and tuning.

A ***voltage regulator*** does just what the name implies, regulates the voltage output. The voltage that enters the regulator varies and the voltage regulator is able to take the varied input and turn it into a constant regulated output.

As an integrated chip, a ***microcontroller*** contains most of the same basic parts as a computer. It is essentially a very small computer meant to control a simple system and perform one specific task.

Transmitters, with the help of an antenna, send out signals that allow for telecommunications.

A ***resonator*** naturally oscillates at some frequencies (resonance frequencies). Resonators are used to either generate waves of specific frequencies or to select specific frequencies from a signal.

Morse Code. The ***telegraph*** was invented by a man named Samuel Morse in 1836. Before this invention, Samuel Morse communicated with his deaf wife by tapping his fingers into her hand in a special pattern. This system of dots and dashes is known as Morse Code. He demonstrated the ability of a telegraph system to transmit this dot and dash information over wires using electrical signals. The short signals became referred to as dits and look like dots when on paper; the long signals are called dahs and represented by dashes on paper. This system became very widely used and the most known use for it is dit dit dit//dah dah dah//dit dit dit, or SOS (save our souls). The dits are only one unit in time, the dahs are 3 units in time, the pause between letters are 3 units in time and the pause between words are 7 units in time.

<u>Instructional Procedures:</u>

The first day (around 50 minutes) should be spent teaching the students about the different parts of the AnaSonde. Ask the students if they know what the different parts do before going into an explanation. The students may be able to guess what the parts do. Use this time to correct any misconceptions the students might have about electricity, circuits, etc.

Before getting started on assembling the AnaSondes (days 2 and 3 or the last 100 minutes), place the students into groups of two or three. Give the students a lesson on how to solder, making sure to first have the students gather around to observe the soldering process. While instructing the students on how to solder, be sure to emphasize how important it is to pay attention to the soldering iron at all times. The iron is hot and could burn them or anything it comes into contact with if not used correctly. Be sure to also stress the importance of wearing safety goggles. Bits of wire are cut off and could injure an eye; the iron could burn an eye, etc. The students in the group should alternate soldering the parts. Before beginning, stress how VERY important it is that the instructions be followed EXACTLY. If the parts are oriented incorrectly, the AnaSonde will not work!

Students should assemble the AnaSonde according to the AnaSonde Assembly Instructions and the AnaSonde Assembly PowerPoint (provide for free online at www.anasonde.com). Wander the room at this point to try to ensure students place the parts in the correct locations. Ask questions relevant to what the students are doing at that point (i.e. if they are soldering the resistor on, the teacher should ask “what will that part do?”) to generate understanding of each part. Once finished, students should check for solder bridges and joints that do not have enough solder and fix them. They should also recheck the placement and orientation of each part.

Closure:

Give the students a battery only after they have thoroughly checked their AnaSonde to ensure that the parts are placed correctly. Students should then put the battery on the battery snap. If the LED lights up, the AnaSonde is working! If not, the students will need to go back over the board and make sure that they put everything in the right spot, in the right direction, check for solder bridges, and check for joints with not enough solder. Any problems should be fixed, and the AnaSonde tried again until it works.

Evaluation Procedures:

Students will apply their knowledge of Morse Code to decoding the temperature measurements they take in the room. Students will have a discussion about how technology and science are complimentary and why it is a necessity for us to use the technology we have in science.

Learning Morse Worksheet

Background Information

Morse code is one of the earliest forms of communication. It uses combinations of dots and dashes (short and long pulses, respectively) of light and/or sound to symbolize the alphabet, numbers, and symbols. Telegraphs were the first instruments to use this system. The telegraph sent electrical signals through metal wires. This was important because at that point in time, there was no other way for immediate long distance communication.

Morse Code Key

Letters		***Numbers***	
A	· -	**1**	· - - - -
B	- · · ·	**2**	· · - - -
C	- · - ·	**3**	· · · - -
D	- · ·	**4**	· · · · -
E	·	**5**	· · · · ·
F	· · - ·	**6**	- · · · ·
G	- - ·	**7**	- - · · ·
H	· · · ·	**8**	- - - · ·
I	· ·	**9**	- - - - ·
J	· - - -	**0**	- - - - -
K	- · -	**+**	· - · - ·
L	- · ·	**-**	- · · · · -
M	- -		
N	- ·		
O	- - -		
P	· - - ·		
Q	- - · -		
R	· - ·		
S	· · ·		
T	-		
U	· · -		
V	· · · -		
W	· - -		
X	- · · -		
Y	- · - -		
Z	- - · ·		

Procedure

1. Use the Morse Code Key to decipher these messages:

Hotter air always holds _m__ _o___ __r__ _e___ water vapor than cold air.

- - - - - . . - .

Weather occurs in the atmosphere _l___ _a___ _y___ __e__ __r__ called the troposphere.

- . . . - - . - - . - . .

Lightning strikes because of __s__ _t__ __a__ __t__ __i__ __c__ electricity due to friction from dust, ice, and water droplets

. . . - . - - . . - . - .

Circuits that are not __c_ __o_ _m_ _p__ _l__ _e__ _t__ _e__ will not work.

- . - . - - - - - . - - . . - . . . - .

2. Write a secret message in the Morse Code.

   Answers will vary.

3. Exchange papers with someone. Use the Morse Code Key to translate the secret message.

   Answers will vary.

List the measurements that you found in the classroom and where you took them. What areas of the classroom were coldest? Warmest? Was there any variation in the temperature around the classroom? How might this tool be useful in the real world?

Answers will vary.

Lesson # 5 The Scientific Method, Graphing and Data Analysis

Grade Level: 9-12th Grade

Duration: 50 minutes

Learning Objectives:

Concepts: Students will know the scientific method.

Skills: Students will be able to set up a graph and use data that they collect to create a graph.

Affect: Students will also be able to communicate the results from their data collection and analysis to their peers and give constructive criticism.

Content Background:

The scientific method is important in determining what the aim of the study is and what is expected to be learned from performing the study. There is always a question that needs to be answered at the start of a study. The scientist then collects background information so that they can intelligently guess (hypothesize) what is expected to happen and why. Then, a research project must be designed to figure out if the hypothesis holds true or not. The design will have procedures that should be followed and documented carefully every step of the way. Finally, the data will be collected and analyzed into results. The analysis will lead to a discussion/conclusion of the results. This would involve things such as:

What are the possible errors in the experiment?
Can the hypotheses be accepted or rejected?
What is a real world application of this study?

The analysis of data is of great importance in determining what can be concluded from the study. Once it is determined what the data means it should be easy to figure out how it applies real life. Data analysis can be done in a few different ways. The first way is using statistics. There are several different equations that can be used to determine if there is a statistically significant difference in the control group versus the variable group. The next way is graphing. By graphing the data, trends become more obvious and multiple trials can be compared side by side.

Graphing procedures are very important in ensuring that scientific data is presented in a way that makes it easily read and analyzed. Graphs must have the five following features to give all the information necessary for reading them: 1) a title 2) labels for the axes 3) units 4) a scale 5) a key explaining the data. In order to label the axes, the independent and dependent variable must be found. The independent variable is a constant, it is consist throughout the experiment. This variable is on the x-axis. The dependent variable "depends" on the independent variable

and is thus recorded on the y-axis. This means that the independent variable causes change in the dependent variable, but it is not possible for the opposite to occur.
Trends in graphs are very important to analyze the data in science. First, a line of best fit should be found. Students in the lesson will do this simply by approximating what the line most looks like. There are three types of trends. Linear graphs, are just as they sound, in the form of a line. With a positive linear relationship, both will increase. With a negative linear relationship, one will increase as the other decreases. Asymptotic graphs can have positive and negative relationships as well. A positive one will also increase as the other variable increases, but in the beginning it will do so more slowly than at the end, creating a curved line. With a negative asymptotic graph, one variable decreases as the other increases, but does so less at the beginning, also creating a curve. Finally, there can be no relationship at all. This is when the line of best fit is just straight across the graph.

Instructional Procedures:

Focusing Event:
Students will use data they collected during the greenhouse lab to graph on the board. This will be done as a group. The teacher will explain the graphing requirements as they go and several student volunteers will come to the front of the class and help the teacher graph the data on the board. There should be a title, labels on the axes, units on the axes, a numerical scale on each axis, and a key (the students should note that unless there are two things on the same graph, the key is not as important-the teacher can ensure that they know this by putting another person's car values over the years in the table and pointing out that they should be coded for on the graph so that they do not get mixed up). The teacher should draw examples of linear (both positive and negative), asymptotic (both positive and negative), and a graph with no pattern on the board. The students should use these to describe the trends in the data. The teacher will then lead a discussion about what can be learned from the graphs by asking the following questions:

What was the hypothesis of the experiment?
What background information was used to determine the hypothesis?
Which variable is independent (independent of the other)?
Which variable is dependent (this depends on what the independent is)?
What trends do you see in the data?
Can you draw a better conclusion from the graph than you could from just the data alone? Is graphing (and mathematics) important in reporting scientific data?
What conclusions can you draw from this graph?

(Time: 15 minutes)

Teaching Methods and Students Activities:
The teacher will begin explaining the scientific method and what the necessary questions to answer in the discussion and conclusion are. This will be taught through a short lecture. The students will have a discussion on why the conclusion and discussion are very important to write in great detail about. The students should also understand that the study should have practical applications (relevance) to the real world that they should write about.

(Time: 10 minutes)

Students will receive the graphing worksheet. This data comes from an example of AnaSonde flight data. They will use this data to create a proper graph.

(Time: 10 minutes)

Closure:

Students will practice data analysis from the worksheet graph on their own. As a class, students will analyze the data and answer the important discussion questions listed below. The evaluation procedures should also be performed here.

What conclusions can you make from this graph?

What is a real world application of this study?

(Time: 10 minutes)

Evaluation Procedures:

Students will discuss the importance of having graphs and equations in science. Students will have recorded all of the data from the cloud finder worksheet now. Students will analyze what they recorded from the clouds and determine whether or not the clouds are a good predictor of the afternoon weather. They will discuss their results with the class. They should then determine what types of errors may have caused the class to come up with different results.

Graphing Practice Worksheet

Name _________________

Directions: Read the following material, examine and line graph the data, then answer the questions that follow. We sent up an AnaSonde, and this is the data that we got back. We know that the average pressure at ground level for this area is 850 and 4600 ft is ground level. We have already converted it from the Morse code numbers using software, but we need to graph it now so we can see the profile of the atmosphere as the balloon flies through it.

Height in atmosphere (m)	Pressure (mb)	Temperature (C)	Humidity
4600	800	14	49%
6000	772	12	52%
7500	750	9	63%
9200	698	7	74%
10700	658	7	75%
12000	617	6	80%

Students should follow graphing procedures when creating the graph. It should have a title, labels, and a key. The height should be on the x axis and everything else on y. During the discussion of data student should be able to use the information to determine that the pressure was low that day and the weather conditions that would ensue. They should also be able to determine the trends in the atmosphere.

Graph Title: ____

Lesson # 6 Microclimates

Grade Level: 9-12th Grade

Duration: 50 minutes

Learning Objectives:

Concepts: Students will know the difference between weather and climate. Students will understand the concept of a microclimate and why this important.

Skills: Students will collect and analyze real data. Students will hypothesize how microclimates vary in a small area and be able to predict what the differences between two microclimates will be.

Affect: Students will appreciate why most animals will hang out in the shade on a very sunny day. Students will also value the importance of using microclimates to their advantage (such as planting a tree within close proximity to a house to shade the windows in the summer).

Materials:
Assembled AnaSondes, different microclimates around the school

Content Background:

A ***microclimate*** is region where the climate varies from the surrounding climate. The term can refer to anything from a small shaded area under a tree to a large valley. They are very important for many different things such as an area that will support some plant where that plant can normally not grow. A microclimate under a tree can also help block the sun from getting into a house or provide a cooler environment for an animal on a sunny day.

Instructional Procedures:

Focusing Event:
The teacher will tell the students what a microclimate is and will facilitate a discussion of why microclimates are important to us using the following set of questions:

What are some examples of microclimates at your home?
What kinds of things these microclimates do? (Do they help support plant life?)
What would our world be like if we did not have them?

(Time: 10 minutes)

Teaching Methods and Student Activities:
The students will use their AnaSondes to collect data from several different microclimates around the school. They should do this using the Microclimates worksheet. They will then

convert the Morse Code into numbers and graph it. The students will use their data to create a graph on the board. They all should overlay their graphs on the same grid so they can compare their results.

(Time: 30 minutes)

<u>Closure:</u>

The teacher will lead a discussion on the results. The following are sample questions of what could be asked:

Why was the temperature under the tree cooler than out in the direct sun?
Why is the microclimate in the building different than outside?
Why is it important that each of these microclimates is different?
Why are these microclimates relevant to real life?

(Time: 10 minutes)

<u>Evaluation Procedures:</u>

Students will use real scientific data that they collected to create a graph, interpret the data and then analyze it. The students will then compare their results with the rest of the class and discuss the different trends they see in the different microclimates. This is done in the teaching methods section of this lesson.

Microclimate Worksheet

Name ___________________

Directions: Read the following material, examine the data and create a line graph with the data, then answer the questions that follow.

Hypothesis: _____Answers will vary.____

____

Using your Buzz –E AnaSonde, take your temperature sensor to a microclimate and write the name of that microclimate on the data chart. Make sure to label your graph!!! Record your temperature in that area once every minute for ten minutes. Get another group's results from a different microclimate and then graph them both. Compare your data to theirs, what was different in their microclimate? Why is this important to know? Write your responses to this on the back of this page.

Answers will vary, students should know to back up their answers with whatever details they can provide.

Time (s)	Group 1 Temperature (C) ____________________		Group 2 Temperature (C) ________________________	
	Morse Code	Decoded	Morse Code	Decoded

Graph Title: ____

Lesson # 7 Flight and Flight Discussion

Grade Level: 9-12th Grade

Duration: 100 minutes

Learning Objectives:

Concepts: Students will collect real time data and record it as the data is received.

Skills: Students will model the weather based on the data that they have collected along with the information that they have learned throughout the curriculum.

Affect: Students will value the relationship between atmospheric conditions and the weather. Students will be able to think critically about which of the atmosphere's layers is most important and give examples why they feel that way.

Materials:
Laptop Computer (1), Yagi Antenna (1), Radio (1), Helium, 90 gram weight (can be homemade), AnaSonde Software (free), Flight AnaSonde

Instructional Procedures:

Focusing Event:
Students will ready for the flight right away. They will fill the balloon with helium to the point where it has 90 grams of lift. They will also attach the parachute to the balloon and to the AnaSonde with the parachute being between the balloon and AnaSonde. (Refer to Appendix B for help.) Finally, the computer must be attached to the walkie-talkie receiver.

(Time: 10 minutes)

Teaching Methods and Student Activities:
Day 1: First of all, the AnaSonde will be turned on to start collecting sample data on the ground. This is to ensure that everything is working properly before it is sent into the air. Once the AnaSonde is on, the CW get program should be turned on. Next, the software should be opened up and the correct configurations should be put it. The necessary information should mostly be on the AnaSonde kit, but the teacher will need to find out the ground level (in feet) of where they are at. Finally, before proceeding to the next step, the software must be receiving clean lines of data from the AnaSonde. Once it is launched you cannot turn the AnaSonde on or adjust other parts of it.

Next, the balloon will be launched. Three students will be needed for this part, one to hold the balloon, one to hold the parachute, and one to hold the AnaSonde. The students will let go of the balloon in a way such that the balloon goes up first and it pulls the rest of it out of the other two student's hands. This should be done gently to ensure nothing gets broken.

Students will write down the data points every 1 to 2 minutes. Once the AnaSonde reaches a height in which the temperature goes below zero, the students will take the set up back inside and clean up for the day. Students will be asked to discuss what they see occurring as the AnaSonde goes up into the atmosphere.

Why does the temperature drop?
Why does the pressure go down?
What is the significance of the data that is coming back to the computer?
What do you think would happen if we could get data from the balloon as it went through the stratosphere? The mesosphere?

The last five minutes or so should be spent putting away the computer, receiver, etc.

(Time: 40 minutes)

Day 2: Students will take the data that they have received and graph it. From the graph, the students should be able to pick out trends in what happened as it went up into the atmosphere. They should be able to relate the data that they received to the weather. They should discuss why this type of data is relevant in the real world and understand how the weather could be predicted with the data obtained and a few observations.

(Time: 20 minutes)

<u>Closure:</u>

Students will be asked:

What happens to the pressure as the AnaSonde gets higher into the air? Why?
What sort of relationship does each of temperature and pressure have with the height? (i.e. linear (positive or negative), no real pattern, asymptotic (positive or negative))
What does that mean?
What happens to the temperature as the AnaSonde ascends?
Do you think the AnaSonde went through any clouds? Why do you think that?
What does this tell us about the current weather conditions?
Do you think we could use this information to predict the weather? How?
What would you predict using this information and what you know about the weather?
What future studies do you think that you could do with the AnaSonde? What would you be trying to find in these studies?

(Time: 10 minutes)

<u>Evaluation Procedures</u>:

Students will create a conceptual model of the weather in the form of a concept map. They should do their best to include what was just discussed about the AnaSonde data. Students will also describe which layer they think is most important and why and relate it to what happens in that layer.

(Time: 20 minutes)

Annotated Bibliography

"Activity: Cloud Key." www.scholastic.com. Scholastic. 4 June 2008. <http://teacher.scholastic.com/lessonrepro/reproducibles/profbooks/cloudkey.pdf>: This pdf file is the cloud key for the cloud finder activity. Students will need to cut out the two circles and then the two cut outs in the top circle and finally attach the two in the center in with a brass fastener to make the cloud key.

"Climate Change – The Greenhouse Effect." 16 Feb 2008. Science 10. 12 Aug 2008. <http://wblrd.sk.ca/~sci10_dev/2_weather/cc_grnhouse_ef_demo.html>: The greenhouse lab idea was taken from this website and adapted to fit in this curriculum. They just were comparing having a bag over the thermometer. This curriculum adds the Alka Seltzer tablet to produce gas to fill the bag to compound the effect and make it more obvious that we are talking about greenhouse gases.

"Electromagnetic Spectrum." 23 July 2008. NASA. 23 July 2008. <http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html>: This was a resource in creating the lesson on the electromagnetic spectrum.

"Electromagnetic Spectrum." PULSE. 23 July 2008. <http://pulse.pharmacy.arizona.edu/12th_grade/shifting_balance/physics/electromagnetic_spectrum.html>. This was a resource in creating the lesson on the electromagnetic spectrum.

"Fundamentals of Physical Geography 2nd Edition." 16 April 2008. University of British Columbia Okanagan. 12 June 2008. <http://www.physicalgeography.net/fundamentals/contents.html.>: This link provided a lot of information on everything in general. It is a great eBook to use as a resource in the classroom as well.

"Greenhouse Effect" Encyclopaedia Britannica. Volume 5. 1988, p. 470: This is where some of the information on the greenhouse effect came from.

Henriques, Laura. "Children's misconceptions about weather: A review of literature." 9 Sept 2008. California State University, Long Beach. 29 Apr 2000. <http://www.csulb.edu/~lhenriqu/NARST2000.htm>.: This link provided some of the misconceptions that were used to help create the assessment.

"Layers of the Atmosphere." 28 Aug 2007. National Weather Service. 5 June 2008. <http://www.srh.noaa.gov/jetstream/atmos/layers.htm.>: This link provided some of the information on the atmosphere.

"National Science Education Standards." www.nap.edu. National Committee on Science Education Standards and Assessment. 1996.National Research Council. 2 June 2008. <http://www.nap.edu/html/nses/overview.html>: This website allows you to either buy the book with the National Science Standards in it, or you can read them for free online.

“Soldering and Troubleshooting Tips.” www.bae.ncsu.edu. North Carolina State University. 24 July 2008. <http://www.bae.ncsu.edu/programs/extension/4-h/solderingandtroubleshooting_tips.pdf>: This website contains some tips for soldering and tips for troubleshooting if the AnaSonde does not work right away.

Stiggins, Richard J., Judith A. Arter., and Jan Chappuis. Classroom Assessment for Student Learning: Doing it Right – Using it Well. Princeton, NJ. Educational Testing Service. 2006.: This book provided helpful information for building a sound assessment of the unit.

“Stormy Weather.” 5 June 2008. Discovery Education. 5 June 2008. <http://school.discoveryeducation.com/lessonplans/programs/lightning/>: This is where the lightning demonstrations were adapted from.

Wiggins, Grant and Jay McTighe. Understanding by Design 1st Edition. Lebanon, Indiana. Prentice Hall. 2000: This book was used as a reference for the layout of the design of the unit.

Appendix A: Educational Resources

http://www.mediacollege.com/misc/solder/: If the teacher or students need more help on learning how to solder, this website contains great tips on how to solder.

http://www.andythelwell.com/blobz/: This website is great for learning the basics of electronics. It is something that might not interest high school level students much, but for middle school this would be a great way to get the students accustomed to circuit basics.

sh013.k12.sd.us/mdu/NATIVE%20AMERICAN%20WEATHER%20SIGNS%20AND%20THEIR%20MEANING.doc: This link can be copied to the web address box to open a word document. It is where the information on the Native American contributions to weather prediction came from.

Appendix B: AnaSonde-E Parts List and Assembly Instructions

Parts list:

In the foil bag:

- q Circuit board
- q U1: 78L05 voltage regulator
- q U2: PIC12F675 microcontroller
- q U3: 433.92 MHz transmitter (direction sensitive)
- q X1: 4 MHz resonator (3-pin brown device, not direction sensitive)
- q D1: light emitting diode (LED)
- q R1: 620 ohm resistor
- q C1, C2: 0.1 mF capacitor
- q S1: switch
- q 9-volt battery snap
- q 8-pin socket for U2
- q antenna wire, approximately 6.5 inches long

Additional sensors (only checked items are included)

- q LM19 temperature sensor
- q ASDX015A24R pressure sensor (this is loose inside the box)
- q HIH-4000 humidity sensor
- q Other:____

In the box:

- q 3 x 5 index card to create a sun shield for the sonde
- q balloon
- q cable tie for sealing the balloon and attaching the payload to the balloon
- q parachute
- q 18 feet of Dacron line for parachute lines, to attach the sonde to the parachute, and to attach the parachute to the balloon – cut it into six pieces of 3 feet each
- q 4 clear round stickers to attach the parachute lines to the parachute

Assembly Instructions

Circuit board assembly:
Note: all components are installed on the component side of the board, which is the side with the white labels. All soldering is done on the solder side (without the labels). You may need to temporarily hold parts in place by gently bending pins or using a small piece of tape prior to soldering them.

1. Install the socket for U2. Orientation is indicated on the socket (notch) and on the board (notch on white outline).

2. Install R1 and D1. D1 is direction sensitive – the longer leg should go to the side marked + on the circuit board.

3. Install U1. This is direction sensitive – be certain the flat side of the case matches with the flat side of the outline on the circuit board. Be certain this is a 78L05, and not the temperature sensor which comes in a case that looks the same.

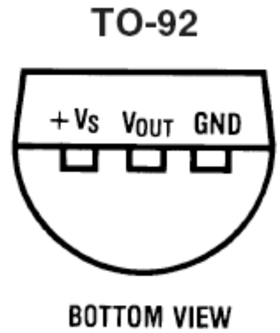
4. Install C1 and C2. These are not direction sensitive.

5. Install S1. Be sure to move it to the off position at this time.

6. Install X1.

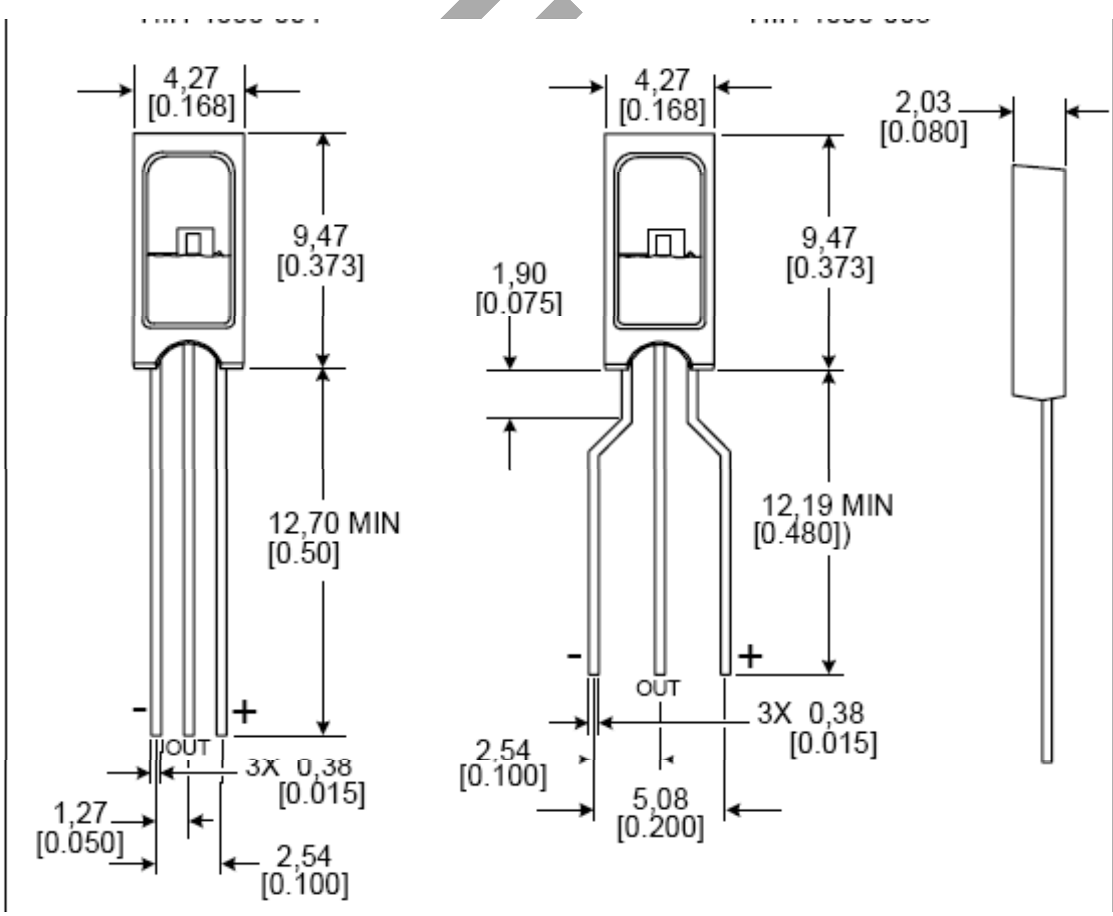
7. Install the sensors – refer as needed to steps 7A through 7D. Only follow those steps for which you have parts. Sensors are installed into the blocks on the board labeled as g1+ and g2+. This notation refers to the connections which are made to the sensors: the “g” section is ground (zero volts), the “1” or “2” refers to where the signal from a device goes, as well as which channel number it will appear under in the telemetry, and the “+” refers to the positive 5-volt power supply. Thus, each sensor section supplies ground, 5 volts, and a signal line for a sensor.

> 7A. Install the pressure sensor. This sensor is in a large 8-pin package, and will only fit the channel 2 position on the AnaSonde-E. Pin 1 has a little notch cut out of it, and this pin goes into the oval pad (in the + row) within the channel 2 block outline. Be certain this is installed correctly – reverse installation will cause immediate destruction of the sensor.
>
> 7B. Install the temperature sensor. This sensor can go into either channel 1 or 2. This sensor has 3 leads, which correspond to +5 volts (pin 1), signal out (pin 2), and ground (pin 3). The following figure illustrates the pinout as viewed from the bottom of the device:

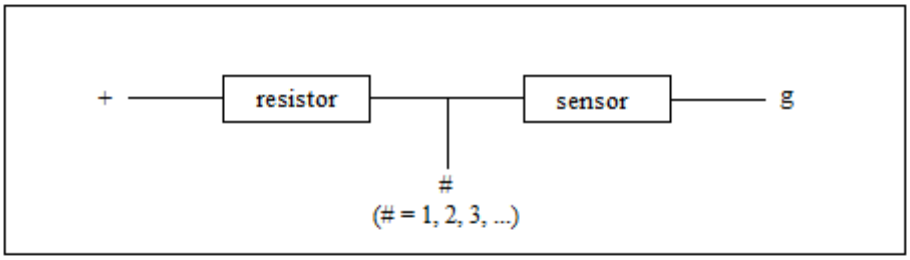


Install the sensor so that pin 1 goes to 5 volts (+), pin 2 to the input (labeled with a channel number), and pin 3 to ground (g). On the AnaSonde-E, this means that the flat side of the case will face the inside of the board if it is board-mounted. However, for fastest response (and best performance on flights), the temperature sensor should be mounted away from the board using either 3 fine wires (two inches of 28 gauge solid wire works well) or a flat ribbon cable.

7C. Install the relative humidity sensor, which can go into either channel 1 or 2. On this sensor, pin 1 is ground, pin 2 is the signal, and pin 3 is +5 volts. This is backwards from the temperature sensor. This figure illustrates the pinout of the device as viewed from the front (when you can see the tiny sensor chip):

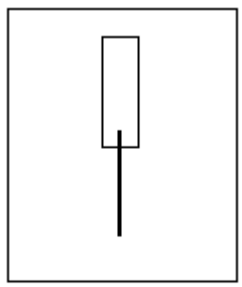


7D. Install any other sensors. A typical connection will use a resistive sensor coupled with a fixed resistor as a voltage divider:



8. Install U3, the transmitter. The transmitter has its pin 4 labeled “ant”, which should go next to the hole labeled “ant” on the circuit board. The circular can on the transmitter will face the inside of the board.

9. Install the antenna wire in the hole labeled “ant”. Bend this antenna so that it points straight out from the board (and be sure to straighten it before launch!).



10. Install the 9-volt battery snap. Bring the wires from under the board, through the large holes adjacent to the + and – markings at the bottom of the board, and then solder the wires into the smaller holes adjacent to the + and – markings. The black lead goes to -, the red lead goes to +.

11. Install U2 in the socket. Be sure the little indented dot on the top of U2 (which marks pin 1) is placed closest to the notch in the socket.

This concludes the circuit board assembly. You may now connect a 9-volt battery and test the AnaSonde.

Flight Preparation:

12. Assemble the parachute. There are dots on four corners of the parachute indicating where the shroud lines should be attached. Each shroud line should be 3 feet long (cut from the long piece of Dacron line supplied with the kit), and be attached to the parachute with one of the very sticky clear round stickers. It helps to wrap the end of the line around the sticker once before attaching it to the parachute (so that there are two parts of the line under the sticker). Tie the four lines together at the bottom.

13. Cut another 3 ft long piece of Dacron and tie a small, about 1/2-inch loop in one end of it (this will go to the cable tie that seals the balloon in step 17). Tie the other end of this line to the top center of the parachute by pinching part of the parachute together to provide something for the line to grab onto. Be sure this knot tightly holds the parachute.

14. Use the remaining Dacron line (about 3 feet) to attach the AnaSonde to the knot where the parachute lines come together. When attaching to the AnaSonde, it is best to tie a loop around the 9-volt battery snap such that the loop around the snap passes between the battery terminals. That way, when the battery is snapped on, the loop can't come off.

15. Make a sun shield for the AnaSonde by folding the 3 x 5 index card into a tube and taping it. The purpose for the shield is to protect the sensors which are sensitive to sunlight, either due to heating by the sun (in the case of the temperature sensor) or whose circuitry is exposed and would be disrupted by exposure to sunlight (in the case of the humidity sensor). Slip the tube around the AnaSonde and tape it to the battery wires to hold it in place. It may help to cut a small slit at one end of the tube into which the wires go, so that the wires can be inserted into the slot and then taped in place there.

16. Fill the balloon with helium. You will want the balloon to lift about half again as much mass as the mass of the AnaSonde plus its battery. Typically, the AnaSonde plus an alkaline 9-volt battery will have a mass of about 60 grams – so, you would w ant a total lift of about 90 grams.

An easy way to do this is to make up a dummy mass using small blocks of wood with holes drilled in them, and then securing the appropriate mass of blocks to a small binder clip with a loop of wire (see adjacent photo). When you are ready to check the balloon lift, twist the neck closed and use the binder clip to hold it closed and to hold the weights on the balloon. If the balloon can just lift the dummy mass, you're ready to go.

17. Take the end of the line that goes to the parachute (this is the end with the small loop in it you tied in step 13) and put it around the cable tie. Then, with the balloon neck twisted closed, put the cable tie around the neck and tighten it to hold the balloon closed and to attach the payload to the balloon.

Appendix C: Assessment Materials

<u>Pre-assessment</u>

Directions:
Get into small groups (2-4 students per group). Each group will receive a large piece of poster paper and all of the group members should write their names on the bottom right hand corner of the poster. Several different colored markers will be given to each group so that the group can creatively design a "graffiti wall" on what they know about meteorology, climate change, and weather. The ideas can be depicted in several ways such as with words, phrases, or pictures. The back of the poster board should be divided in half; the group should write what they want to know about in this unit on one side. Throughout the unit, the group should add what is being learned to the poster in markers colored differently than those used during the pre-assessment activity to the other half of the back side of the poster board. The groups will share their "graffiti wall" and their questions with the class when they are finished. Any misconceptions that the groups have will be addressed during this time as well. These posters will be displayed in the hallway when the students are finished with them. An example of this poster is below.

Examples of things to put on the "graffiti wall" (in case the group is having trouble getting started) include but should not be limited to:

What are examples of cloud types? What kinds of weather does each one predict?
What is global warming? Why should we care?
What are the main factors affecting the weather? What instruments can be used to read each factor?

AnaSonde Curriculum Test

Name ____________________

Class period ______________

Multiple Choice Directions: Choose the letter that best answers each question and circle it. Each of the following multiple choice questions is worth 1 point. Section totals 15 points.

1. What happens to temperature as you get higher in altitude?

   a. Increases as you move through the layers

   b. Varies depending on the atmospheric layer

   c. Decreases as you move through the layers

   d. Remains the same regardless of the atmospheric layer

2. Which type of pressure system is likely to cause clear skies and fair weather?

   a. Low　　　c. High

   b. Medium　　　d. Pressure systems do not affect the weather

3. Adrian was describing the importance of the *ozone layer* to his brother Marcus. He told Marcus the ozone layer is found in the stratosphere. He also told him the ozone layer was bad for life on earth. Is Adrian correct about the ozone layer? Why or why not?

   a. Correct; it absorbs sun's radiation, increasing temperatures on earth

   b. Correct; it is smog created by air pollution

   c. Incorrect; it shields us from the sun's damaging radiation

   d. Incorrect; it is found in the troposphere

4. Most of the weather in our atmosphere takes place in the:

   a. Tropopause　　　c. Ozone Layer

   b. Troposphere　　　d. Stratosphere

5. As you go up through the atmosphere, pressure decreases. This is because ______________________________________.

   a. the clouds are only present in the bottom layer

   b. the air is less dense as you go up through the atmosphere

   c. the varying amounts of radiation from the sun absorbed

   d. the air is more dense as you go up through the atmosphere

6. Samuel Morse changed the way we communicate. This allowed for advances in many other areas. Why is this discovery important to science?

   a. The function of Morse code in science is solely to transmit data from the AnaSonde.

   b. It allowed scientists from all over the globe to communicate their data with each other better.

   c. Morse code allowed scientists to design experiments about precipitation.

   d. Morse code was not a significant discovery for science; it just helped people to keep in touch.

7. Every morning during her week-long camping trip, Sondra looks at the clouds and checks her cloud finder to predict the day's weather. This morning she sees cumulonimbus clouds. What weather should she expect today? (1 pt)

   a. Thunderstorms
   b. Clear and sunny
   c. Light rain
   d. Cloudy but dry

8. There have been many advances in technology to help us to determine the weather. What type of device would you use if you wanted to determine what type of pressure system existed outside? (1 pt)

   a. Hair hygrometer
   b. Sling psychrometer
   c. Barometer
   d. Thermometer

9. Which of the following statements is NOT a factor in cloud formation?

   a. Low pressure system pushes air upward

   b. Water condenses on particles in the air

   c. A body of air cools as it sinks

   d. Cold air holds less water vapor

10. The most dangerous part of the electromagnetic spectrum to us is ______________.

   a. UV radiation
   b. Gamma Radiation
   c. Microwaves
   d. X-rays

11. Lightning is caused by _________________ .

    a. Two clouds colliding at high speeds

    b. Electrical charge building up in a cloud

    c. High pressure system hitting a low pressure system

    d. Thunder producing friction in the air

12. If there are a few *cirrus* clouds in the sky, what kind of weather can you predict?

    a. Cloudy
    b. Windy
    c. Fair
    d. Humid

13. Wind is caused by

    a. Moon's gravitational pull on the earth's surface

    b. Uneven heating of the earth's surface by the sun

    c. Static charge build up on the earth's surface

    d. Static charge build up on the clouds' surface

14. The part of the electromagnetic spectrum that the AnaSonde uses to transmit data is _________________. These are also used for TVs.

    a. Microwaves
    b. X-rays
    c. Radio waves
    d. UV waves

15. The temperature at which moisture saturates the air is called _____________________.

    a. Dew point
    b. Boiling point
    c. Humidity
    d. Precipitation

Short Answer Directions: Answer the following questions to the best of your ability making sure to answer in enough detail to be worth full credit.

A science class in Billings, MT launched their Anasonde (weather instrument) a couple weeks ago and recorded the following data as it rose through the atmosphere. The ground pressure is usually 630 mb. The altitude at ground level is 5000 ft. Use these data to answer questions 19-22.

Data Taken from an AnaSonde Flight

Altitude	Temperature	Pressure	Humidity
5000ft	20 C	600mb	30%
12000ft	18 C	500mb	46%
19000ft	13 C	400mb	80%
26000ft	5 C	300 mb	98%
33000 ft	0 C	200 mb	56%

16. In what layer of the atmosphere were the data collected? (1 pt)

    a. mesophere　　　c. troposphere

    b. exosphere　　　d. stratosphere

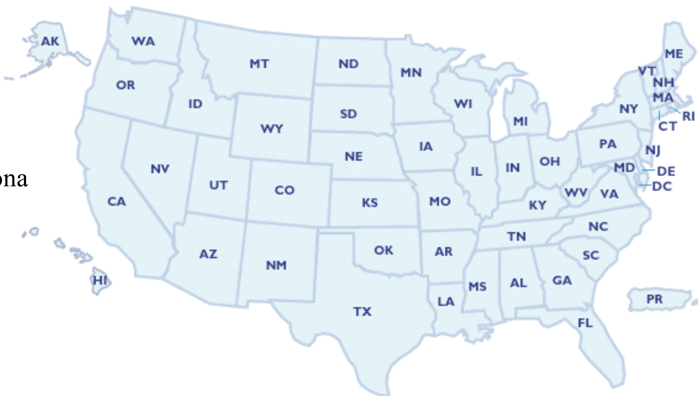
17. Create a graph of the data (fulfilling all five requirements of graphing). (5 pts.)

18. What trends do you see in the graph? Describe fully. (3 pts)

19. What were the weather conditions in Billings when the students launched the Anasonde? Justify your answer using the data. (3 pts)

20. Use the following information to predict the weather and draw a weather map. Remember, weather tends to move in a southeast direction accept for warm fronts which tend to move northeast. (3pts)

- A cold front stretches from south central Oregon to the southwestern corner of Montana.
- There is precipitation along the cold front.
- A low pressure system is over Texas.
- A warm front stretches from the center of Arizona to the center of Colorado.
- A high pressure system is over Nebraska and Maryland.
- There is a hurricane off the coast of Florida.
- There are some severe thunderstorms with high winds in Oklahoma and Tennessee.



Key for Weather Maps:

Weather	**Symbol**
Precipitation	
Cold Front	
Warm Front	
Low Pressure	
High Pressure	
Hurricane	
Tornado Watch/Severe Thunderstorms	
Tropical Storm	

Using the map you created as today's weather, predict tomorrow's for Utah below (5 pts):

____

____

____

____

21. What is the role of technology in science? Use the AnaSonde as an example in your explanation. (2 pts)

22. What does graphing contribute to scientific studies? Be specific. (5 pts)

23. Explain what a greenhouse gas is in great detail. How do greenhouse gases affect the weather and climate on earth (both pros and cons)? (5 pts)

24. What do you think is the most important layer of the atmosphere? Why? (2 pts)

AnaSonde Curriculum Test

Name **KEY**

Class period ________________

Multiple Choice Directions: Choose the letter that best answers each question and circle it. Each of the following multiple choice questions is worth 1 point. Section totals 15 points. *Marks the correct answer.

1. What happens to temperature as you get higher in altitude?
   a. Increases as you move through the layers
   b. Varies depending on the atmospheric layer*
   c. Decreases as you move through the layers
   d. Remains the same regardless of the atmospheric layer

2. Which type of pressure system is likely to cause clear skies and fair weather?
   a. Low
   b. Medium
   c. High*
   d. Pressure systems do not affect the weather

3. Adrian was describing the importance of the *ozone layer* to his brother Marcus. He told Marcus the ozone layer is found in the stratosphere. He also told him the ozone layer was bad for life on earth. Is Adrian correct about the ozone layer? Why or why not?
   a. Correct; it absorbs sun's radiation, increasing temperatures on earth
   b. Correct; it is smog created by air pollution
   c. Incorrect; it shields us from the sun's damaging radiation*
   d. Incorrect; it is found in the troposphere

4. Most of the weather in our atmosphere takes place in the:
   a. Tropopause
   b. Troposphere*
   c. Ozone Layer
   d. Stratosphere

5. As you go up through the atmosphere, pressure decreases. This is because __________.
   a. the clouds are only present in the bottom layer
   b. the air is less dense as you go up through the atmosphere*
   c. the varying amounts of radiation from the sun absorbed
   d. the air is more dense as you go up through the atmosphere

6. Samuel Morse changed the way we communicate. This allowed for advances in many other areas. Why is this discovery important to science?

    a. The function of Morse code in science is solely to transmit data from the AnaSonde.

    b. It allowed scientists from all over the globe to communicate their data with each other better. *

    c. Morse code allowed scientists to design experiments about precipitation.

    d. Morse code was not a significant discovery for science; it just helped people to keep in touch.

7. Every morning during her week-long camping trip, Sondra looks at the clouds and checks her cloud finder to predict the day's weather. This morning she sees cumulonimbus clouds. What weather should she expect today? (1 pt)

    a. Thunderstorms* c. Light rain

    b. Clear and sunny d. Cloudy but dry

8. There have been many advances in technology to help us to determine the weather. What type of device would you use if you wanted to determine what type of pressure system existed outside? (1 pt)

    a. Hair hygrometer c. Barometer*

    b. Sling psychrometer d. Thermometer

9. Which of the following statements is NOT a factor in cloud formation?

    a. Low pressure system pushes air upward

    b. Water condenses on particles in the air

    c. A body of air cools as it sinks*

    d. Cold air holds less water vapor

10. The most dangerous part of the electromagnetic spectrum to us is ______________.

    a. UV radiation c. Microwaves

    b. Gamma Radiation* d. X-rays

11. Lightning is caused by _________________.

    a. Two clouds colliding at high speeds
    b. Electrical charge building up in a cloud*
    c. High pressure system hitting a low pressure system
    d. Thunder producing friction in the air

12. If there are a few *cirrus* clouds in the sky, what kind of weather can you predict?

    a. Cloudy
    b. Windy
    c. Fair*
    d. Humid

13. Wind is caused by

    a. Moon's gravitational pull on the earth's surface
    b. Uneven heating of the earth's surface by the sun*
    c. Static charge build up on the earth's surface
    d. Static charge build up on the clouds' surface

14. The part of the electromagnetic spectrum that the AnaSonde uses to transmit data is _________________. These are also used for TVs.

    a. Microwaves
    b. X-rays
    c. Radio waves*
    d. UV waves

15. The temperature at which moisture saturates the air is called _____________________.

    a. Dew point*
    b. Boiling point
    c. Humidity
    d. Precipitation

Short Answer Directions: Answer the following questions to the best of your ability making sure to answer in enough detail to be worth full credit.

A science class in Billings, MT launched their Anasonde (weather instrument) a couple weeks ago and recorded the following data as it rose through the atmosphere. The ground pressure is usually 630 mb. The altitude at ground level is 5000 ft. Use these data to answer questions 19-22.

Data Taken from an AnaSonde Flight

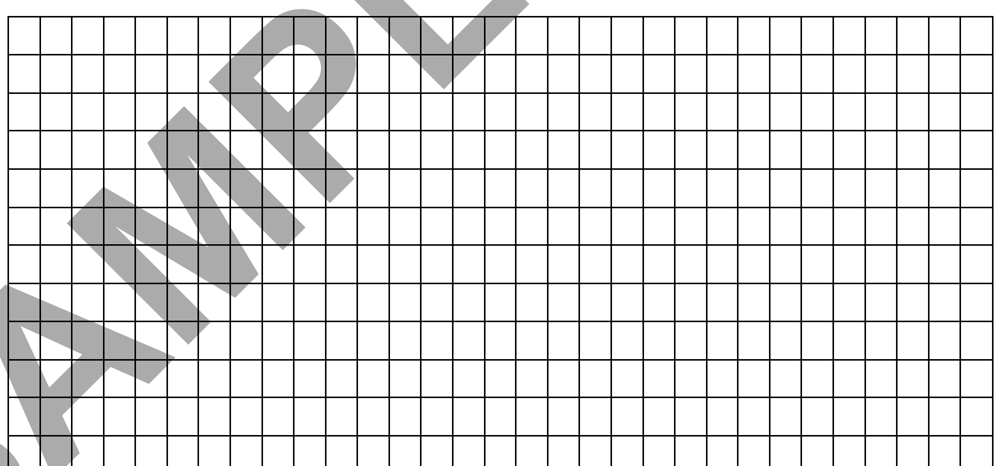
Altitude	Temperature	Pressure	Humidity
5000ft	20 C	600mb	30%
12000ft	18 C	500mb	46%
19000ft	13 C	400mb	80%
26000ft	5 C	300 mb	98%
33000 ft	0 C	200 mb	56%

16. In what layer of the atmosphere were the data collected? (1 pt)

    a. mesophere   c. troposphere*

    b. exosphere   d. stratosphere

17. Create a graph of the data (fulfilling all five requirements of graphing). (5 pts.)



Altitude should be on the x-axis, temperature, pressure, and humidity should be on the sides. All graph requirements (title, labels and key) should be met.

18. What trends do you see in the graph? Describe fully. (3 pts)

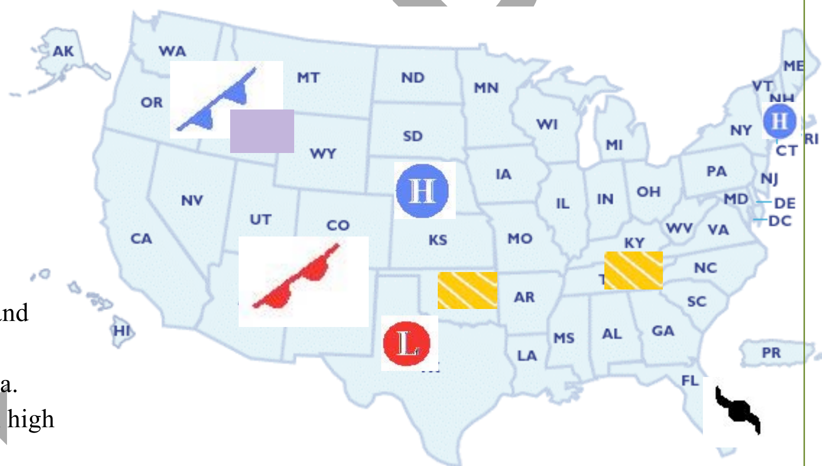
Altitude and Pressure should be negative linear, Temperature and Altitude should be a negative asymptotic, and finally Altitude and Humidity will appear to have no relationship.

19. What were the weather conditions in Billings when the students launched the Anasonde? Justify your answer using the data. (3 pts)

The students should be able to say that it will probably be cloudy and there will probably be rain on a day like this and justify why (low pressure, high humidity in the air).

20. Use the following information to predict the weather and draw a weather map. Remember, weather tends to move in a southeast direction accept for warm fronts which tend to move northeast. (3pts)

- A cold front stretches from south central Oregon to the southwestern corner of Montana.
- There is precipitation along the cold front.
- A low pressure system is over Texas.
- A warm front stretches from the center of Arizona to the center of Colorado.
- A high pressure system is over Nebraska and Maryland.
- There is a hurricane off the coast of Florida.
- There are some severe thunderstorms with high winds in Oklahoma and Tennessee.



Key for Weather Maps:

<u>**Weather**</u>	<u>**Symbol**</u>
Precipitation	
Cold Front	
Warm Front	
Low Pressure	
High Pressure	
Hurricane	
Tornado Watch/Severe Thunderstorms	
Tropical Storm	

Using the map you created as today's weather, predict tomorrow's for Utah below (5 pts):

Utah should have some precipitation coming through as a result of the cold front that is directly north west of Utah. The cold front will mean chilly weather as well.

21. What is the role of technology in science? Use the AnaSonde as an example in your explanation. (2 pts)

The AnaSonde is has a tiny computer chip on it that runs the circuit board. This technology goes where we cannot regularly send people to collect data. It is also less expensive to use the AnaSonde to collect the data than it would be to send up a human. Finally, it can collect more accurate results by eliminating human error in the experiments.

22. What does graphing contribute to scientific studies? Be specific. (5 pts)

Graphing allows for scientists to see trends and relationships in the data. By seeing these trends, scientists can determine whether to reject or accept their hypothesis. They also may be able to extrapolate and come up with more hypotheses to test. Finally, once scientists know what they are dealing with, they can come up with practical applications for the study and determine what sources of error could be.

23. Explain what a greenhouse gas is in great detail. How do greenhouse gases affect the weather and climate on earth (both pros and cons)? (5 pts)

Greenhouse gases are gases that trap the heat from the sun in the atmosphere. These are such things as water vapor, methane, and carbon dioxide. If it were not for these gases, our earth would be so cold, it would not be habitable. However, with an increase in these gases, the earth may get so warm that all of the ice caps will melt and we will lose some of our great species of animals.

24. What do you think is the most important layer of the atmosphere? Why? (2 pts)

Answers will vary, students should support whatever they claim is the best answer with real facts and details.

AnaSonde Artwork

Students will create some form of artwork that demonstrates: 1) their knowledge of the history of weather prediction, 2) their understanding of atmosphere and what happens in each layer, 3) the value that weather has in our everyday lives, 4) the value of the electromagnetic spectrum to our everyday lives, 5) the ability to apply data analysis to data they have collected and 6) to relate that analysis to the real world and make it relevant in their lives. This could be in the form of a poem, collage, scrapbook, song, drawing, etc. There should be some visual and written aspect to each work of art. Students should perform a self evaluation before turning the scrapbook into the teacher. Students will be assessed with the following rubric.

Points	4	3	2	1	Earned assessment	
	Masterful	**Proficient**	**Basic**	**Minimal**	**Self**	**Teacher**
Content	Information is complete and is enhanced by accurate and appropriate details. Each of the numerated topics (Main points) above is covered.	Main points are covered but lack some detail.	Some main points and details are missing.	Main points are not complete and are greatly lacking in detail.		
	Pictures, drawings, diagrams, graphs, or other similar devices add to the overall effectiveness of the artwork; captions are relevant and explanatory.	Number and types of visuals are adequate as are captions.	More and better visuals could be used; captions only identify and label rather than explain.	Very little pictorial representation is present; captions are incomplete.		
	The design of the work of art adds to the overall effectiveness of the scrapbook.	Design elements and principles used are adequate.	Shows evidence of use of some design elements and principles.	There is no consideration of design elements and principles.		
Theme	There is wholeness about the artwork; the theme is consistent throughout.	Most of the information relates to the theme.	Only a portion of the information relates to the theme.	Confusing and/or inconsistent information.		
Language & Conventions	Conventions of spelling, punctuation, and grammar are used with a high degree of accuracy.	Most conventions of spelling, punctuation, and grammar are used accurately.	Common conventions of language are used with some accuracy but there are some mistakes.	A significant number of errors are made in spelling, punctuation, and grammar.		
Overall Effectiveness	The requirements of the assignment have been exceeded. The art is very creative and interesting.	All the requirements of the assignment have been fulfilled. The art is neat and presentable.	Only some of the assignment requirements are fulfilled. Some areas lack neatness.	Few of the assignment requirements have been met. The presentation as a whole lacks neatness.		
				Total Points		