DOCUMENT RESUME

ED 178 306 SE 029 031

AUTHOR Nimmer, Donald N.; Sagness, Richard L.
TITLE How To... Activities in Meteorology.
INSTITUTION National Science Teachers Association, Washington, D.C.
PUB DATE 78
NOTE 13p.; Not available in hard copy due to copyright restrictions
AVAILABLE FROM National Science Teachers Association, 1742 Connecticut Ave., N.W., Washington, D.C. 20009 (Stock No. 471-14756; no price quoted)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Climatic Factors; *Earth Science; Laboratory Procedures; *Meteorology; *Science Course Improvement Project; *Science Education; Science Materials; *Sciences; Secondary Education
IDENTIFIERS National Science Teachers Association

ABSTRACT

This series of experiments seeks to provide laboratory exercises which demonstrate concepts in Earth Science, particularly meteorology. Materials used in the experiments are easily obtainable. Examples of experiments include: (1) making a thermometer; (2) air/space relationship; (3) weight of air; (4) barometers; (5) particulates; (6) evaporation; (7) relative humidity; (8) temperatures of different earth surfaces; (9) wind; and (10) winter activities. (RE)

HOW TO... Activities in Meteorology

National Science Teachers Association

by

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Introduction

One problem often encountered in the teaching of Earth Science is the shortage of laboratory activities that can be used to illustrate important concepts in a clear, meaningful and relevant manner. It is the intent of this pamphlet to provide such activities for Meteorology.

Activities have been gathered from many diverse sources, modified, and adapted to a consistent outline form. The materials and equipment used have intentionally been held to a minimum and are easily obtainable. The use of difficult terminology, likewise, has been held to a minimum.

Although these activities have been written for, and have for the most part been tested by, junior high school students, they are appropriate for use by older students as well.

We hope these activities will aid teachers or others who may wish to try them. Comments pursuant to the subsequent revision and improvement of this pamphlet will be appreciated by the authors.

Donald N. Nimmer
Richard L. Sagness

Making a Thermometer

Introduction

All thermometers work on the basis that things expand when warmed and contract when cooled. This activity shows several different thermometers that can easily be made with very little equipment.

Part A
Water Thermometer[1]

Materials

Flask
1-hole rubber stopper (to fit the flask)
6 inch glass tubing (to fit the stopper)
Food coloring
Water
Thermometer

Procedure

1. Fill the flask with water.
2. Add food coloring to make the water easier to see.
3. Using liquid soap or petroleum jelly as a lubricant, fit the glass tubing into the rubber stopper so it barely extends beyond the stopper bottom.
4. Put the stopper into the flask neck as shown in Figure 1.
5. Expose this homemade thermometer to different temperatures. Mark the water level for each of these temperatures and label the marks in degrees.

Questions

1. Does the water level in the glass tube change when the "thermometer" is exposed to different temperatures? Explain why.
2. Why should alcohol or mercury be used instead of water if this thermometer is to be used to measure temperatures lower than 0 degrees Celcius?

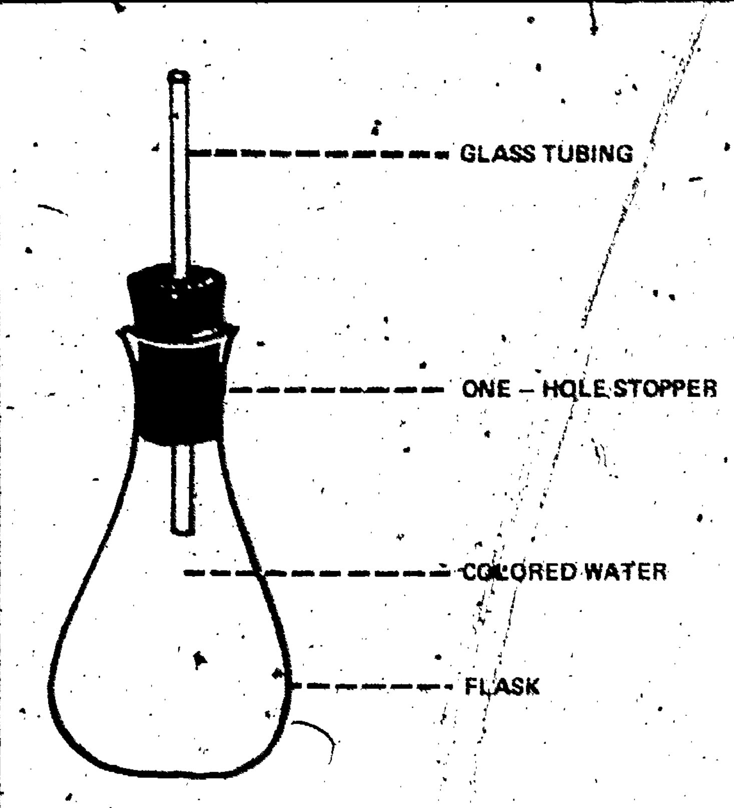

FIGURE 1: WATER THERMOMETER

Part B
Balloon Thermometer[2]

Materials
Pop Bottle (or Flask)
Balloon

Procedure
1. Stretch the mouth of the balloon over the bottle opening.
2. Set the "balloon thermometer" in a pan of hot water. Notice what happens to the balloon.
3. Set the "balloon thermometer" in a refrigerator or a pan of ice. Notice what happens to the balloon.

Questions
1. How did the balloon shape of the warm "balloon thermometer" compare to that of the cool "balloon thermometer"?
2. Explain why the balloon changed shape when the "balloon thermometer" was exposed to different temperatures.

Part C
Wire Thermometer

Materials
30 inches of fine wire
2 ring stands
1 meter stick
1 small weight
Candle

Procedure
1. Place two ring stands about 24 inches apart.
2. Attach an end of the wire to the top of each ring stand.
3. Suspend a small weight from the wire's lowest point.
4. Measure the distance from the table to the weight. Record this distance in the data section.
5. Heat the wire with a candle.
6. Measure the distance from the table to the weight. Record this distance in the data section.

Data
1. Distance from the table to the weight when the wire was at room temperature: ______
2. Distance from the table to the weight when the wire was hot: ______

Questions
1. Did the distance from the weight to the table top change as the wire temperature changed? Explain why.
2. Explain how a scale can be constructed so this "wire thermometer" can show a wide range of temperatures.

Air Occupies Space

Introduction
If we hold our hands out in front of us and bring them together quickly, it's hard to believe that air occupies space. After all, we think if air does take up space, we shouldn't be able to bring our hands together at all. This exercise shows two methods of proving that air does actually occupy space.

Part A
Beaker and Water Method[4]

Materials
Beaker (a drinking glass will do)
1 piece of note paper
Sink, bucket, or aquarium of water

Procedure
1. Crumble the piece of note paper and stuff it into the bottom one-fourth of the beaker.
2. Turn the beaker upside down and immerse it in the bucket of water.

Data
1. Make a drawing showing the positions of the following: water level in the bucket, water level in the beaker, the note paper, and the beaker.

Questions
1. Why doesn't the water fill the beaker?
2. Why does a little water enter the beaker?

3

Part B:
Air Takes Up Space[5]

Materials

Flask
2-hole stopper (to fit flask)
Funnel (to fit stopper)
Bent (45°) glass tubing (to fit stopper)
Beaker
Water

Procedure

1. Using liquid soap as a lubricant, insert the glass tubing and funnel into the stopper.
2. Insert the stopper into the flask.

The apparatus should look like Figure 2.

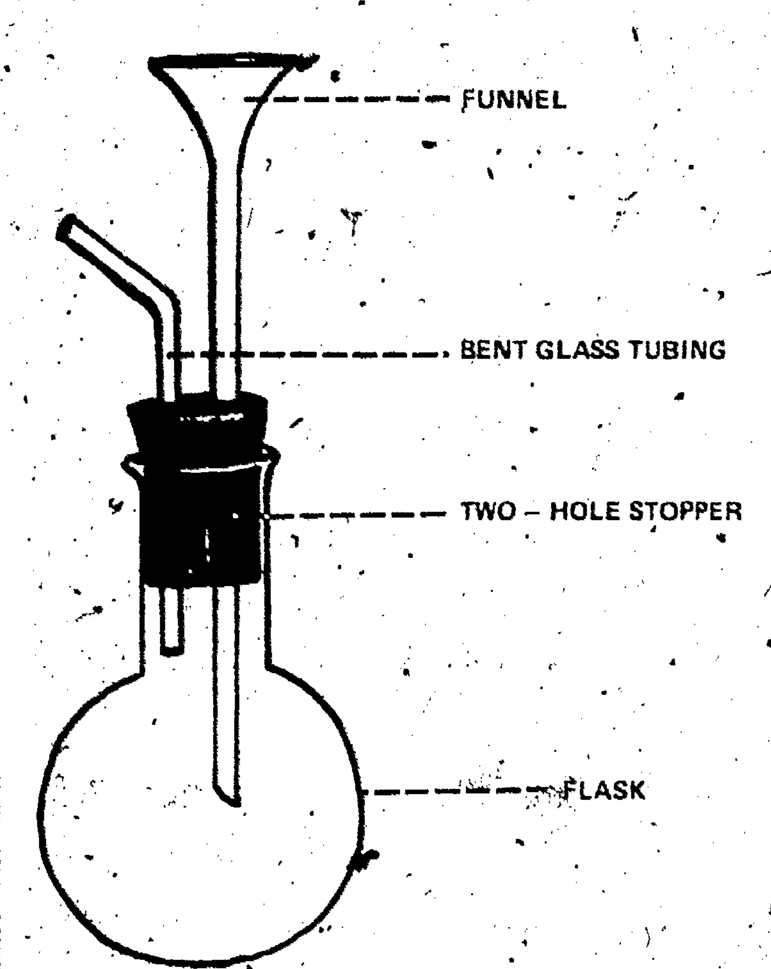

FIGURE 2: AIR OCCUPIES SPACE

3. Place a finger tightly over the opening of the glass tubing. Pour water from the beaker into the funnel.
4. Now, remove your finger from the glass tubing and pour water into the funnel.

Data and Questions

1. What happened to the water in the funnel when you had your finger over the glass tubing opening?
   Explain why.
2. What happened when you removed your finger from the glass tubing opening?
   Think carefully and explain why.

Air Has Weight

Introduction

If we place our hand in a horizontal position and lift upward, we find it very hard to believe that the air above our hand weighs anything at all. This exercise shows two simple methods of proving that air does indeed have weight.

Part A:
Basketball Method

Materials

Basketball (any inflatable ball will work)
Air pump
Balance

Procedure

1. Weigh the deflated basketball on the balance. Record its weight in the Data section.
2. Inflate the basketball using the air pump.
3. Weigh the inflated basketball on the balance. Record its weight in the Data section.
4. Find the weight of the air inside the basketball. (This may be done by subtracting the weight of the deflated basketball from the weight of the inflated basketball.)

Data

1. Weight of the deflated basketball: ______
2. Weight of the inflated basketball: ______
3. Weight of the air inside the basketball: ___

Part B
Balloon Method[6]

Materials

2 equal-sized balloons
2 equal-sized strings about 6 to 8 inches long.
Ring stand and ring
Dowel rod (about ¼" × 18")

Procedure

1. Tie a string around each end of the dowel rod.
2. Tie a balloon from each string and balance the dowel rod on the shaft just behind the ring of the ring stand. Mark the dowl's balance point with a pencil.
3. Remove one balloon, inflate it, and tie it back in place on the dowel rod.
4. Place the dowel rod back on the ring stand in its original balancing position.

Data

1. What did you observe about the balance of the dowel after one balloon was inflated? Explain why.
2. Draw a picture showing the position of the balloons, ring stand, and dowel rod after the balloon was inflated.

Barometers

Introduction

Barometers are instruments used to measure air pressure—that is, the weight of the air above us pushing downward.

Materials

Wide Mouth Bottle (A "junior" size baby food jar works well.)
Good Quality Balloon
Rubberband
Drinking Straw
Cardboard
Glue
Accurate Barometer

Procedure

1. Assemble the Bottle Barometer as shown in Figure 3.

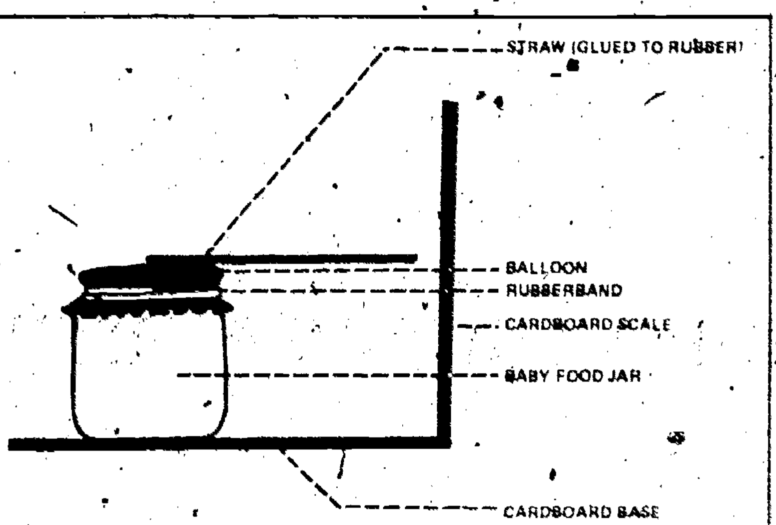

FIGURE 3 BOTTLE BAROMETER

1. The key to the construction and working of this barometer is that the balloon be of heavy strong rubber and that an air tight seal be made when it is firmly stretched over and attached to the bottle.
2. Several times each day mark the position of the drinking straw on the cardboard scale. Beside the mark, write the air pressure as determined by an accurate barometer. After about a week, you should have a large detailed set of air pressure readings.

Questions

1. Explain why the drinking straw's position changed over the week's time.
2. Why would this barometer not work if it had a hole in the balloon or if the rubberband seal wasn't air tight?

Solid Particles in the Air[8]

Introduction

Our atmosphere contains many solid particles that are very small. Although we cannot usually see these particles, they do exist. Unfortunately, when we are in areas with many of these particles, we breathe them into our bodies and our lungs become congested. Some scientists feel that the more of these solid particles our lungs contain, the more lung diseases we can incur.

Materials

Petri dishes
Colorless gelatin (Petroleum jelly will also work)
Microscope

Procedure

1. Prepare a box of colorless gelatin according to the instructions on its container. Pour a thin layer into each petri dish, and allow the gelatin to "set" in a clean, dust free place.
2. Place the petri dishes in different areas in the community—ie. outside a school, downtown, residential area, factory area, near a gravel road, etc.
3. About two or three days later, collect the petri dishes. Make sure they are properly labeled with their locations.
4. Examine the petri dishes under a microscope.

Data

Rank order the petri dishes from the one with the most solid particles to the one with the least. Draw and describe some of the particles you see in the petri dishes.

Questions

1. Which area had the most solid particles? Why do you think that is true? What do you think caused all of these particles?
2. Which locality had the fewest solid particles? Why do you think that is true?
3. Do you think the particles you viewed under the microscope are small enough to actually be breathed into our lungs?
4. In a Health or Biology book, read how our body attempts to filter out solid particles from the air we breathe. Briefly describe how this is done.
5. Also, using the information gained from a Health or Biology book, tell what effect these solid particles have on our body.

Evaporation of Water From Your Body[9]

Introduction

Water enters the atmosphere by evaporation from many earth surfaces. However, we often overlook that our bodies give off moisture—even when at rest—that will eventually add to the total amount of water in the air.

Materials

Plastic Bag
Rubberband

Procedure

1. Place your left hand in a plastic bag and put a rubber band around it at your wrist.
2. Record observations about your left and right hands for a 15 minute period on the data chart below.

Data

Minutes Passed	Left Hand Observ.	Right Hand Observ.
3 minutes		
6 minutes		
9 minutes		
12 minutes		
15 minutes		

Questions

1. Is there moisture on both hands? If one hand is dry, explain what happened to its moisture.
2. What is happening to the humidity of the air inside the plastic bag? Where is this water coming from?
3. Name other ways our body gives off moisture besides through its skin.
4. Design an experiment to show the total amount of water given off by our bodies in a 24 hour period.
5. Based upon what you saw in this activity, do you think the amount of water given off by all living things contributes much moisture to the atmosphere?

The Speed of Evaporation

Introduction

The speed with which water evaporates is affected by many factors. Three of these, surface area, wind, and heat, are investigated in this three part activity.

Part A: The Effect of Surface Area on Evaporation[10]

Materials

Two 1" × 6" pieces of filter paper or blotter
Thread
Beaker of water
Ring stand and Ring
Dowel rod (about ¼" × 18")

Procedure

1. Punch a small hole near one end of each piece of filter paper.
2. Tie a strip of filter paper to each end of the dowel rod.
3. Fold one strip four times so it is much smaller than the other.
4. Wet the filter papers in the beaker of water.
5. When the excess water falls off the filter paper, balance the dowel rod on the shaft just behind the ring of the ring stand.

Questions

1. Which strip of blotter has a larger surface area?
2. After a short time, the strips of blotter are no longer balanced. Explain why.
3. From which strip of blotter has more water evaporated? Explain why.

Part B: The Effect of Wind on Evaporation[11]

Materials

Two 1" x 6" pieces of blotter or filter paper
Thread
Beaker of Water
Ring stand and ring
Dowel rod (about ¼" x 18")

Procedure

1. Punch a small hole near one end of each piece of filter paper.
2. Tie a strip of filter paper to each end of the dowel rod.
3. Wet the filter papers in the beaker of water.
4. When the excess water falls off the filter papers, balance the dowel rod on the shaft just behind the ring of the ring stand.
5. Fan one paper strip vigorously with a a notebook (shield the other one from the draft).

Questions
1. What happened to the balance of the two strips after five minutes of fanning?
2. Which strip lost more water through evaporation?
Explain why.

Part C:
The Effect of Air Temperature on Evaporation[12]

Materials
Two 1" x 6" strips of blotter or filter paper.
Thread
Beaker of water
Ring stand and Ring
Dowel rod (about ¼" x 18")
Electric light

Procedure
1. Punch a small hole near one end of each piece of filter paper.
2. Tie a strip of filter paper to each end of the dowel rod.
3. Wet the filter papers in the beaker of water.
4. When the excess water falls off the filter papers, balance the dowel rod on the shaft just behind the ring of the ring stand.
5. Heat one of the strips with an electric light placed three inches away.

Questions
1. What happened to the balance of the two strips after five or ten minutes of exposure to the heat of the electric light?
2. Which strip lost more water through evaporation?
Explain why.

Relative Humidity

Introduction
Relative humidity is the ratio between the amount of water vapor actually in the air and the amount the air could hold at that temperature. This activity shows three different ways in which the relative humidity can be measured. Part A: Paper Hygrometer, shows a very simple instrument of limited accuracy. Part B illustrates the most accurate type of hygrometer: the Wet-bulb and Dry-bulb Thermometer. Part C shows the easiest hygrometer to read, but, again, its accuracy is somewhat limited at times.

Part A:
Paper Hygrometer

Introduction
Cobalt chloride is a substance which changes color in the presence of water. The following equation shows what happens when water is added to cobalt chloride:

Cobalt Chloride	+ Water	Hydrated Cobalt Chloride
$CoCl_2$	+ H_2O	$CoCl_2 \cdot H_2O$
(Blue)$_2$		(Pink)$_2$

If the air becomes drier, water leaves the cobalt chloride and the paper turns from pink back to blue. Therefore, the pinker the cobalt chloride gets, the more water there is in the air. The bluer it gets, the less water there is in the air.

Materials
Cobalt Chloride solution
Filter paper strip

Procedure and Questions
1. Soak a strip of filter paper in the cobalt chloride solution.
2. Let it dry completely.
Did the paper change color as it dried? From what color to what color?
3. Place a drop of water on the dry strip. What happened to the color of the paper?
4. At home, try the following:
   a. Hang the cobalt chloride strip above the sink while you are doing the supper dishes.
   b. Hang it in the bathroom while you take a shower.
   c. Explain what happens to the strip and why.

Part B:
Wet-Bulb and Dry-Bulb Thermometer

Introduction
The Wet-bulb and Dry-bulb Thermometer is the most accurate instrument to use in measuring humidity. This instrument is made of two thermometers. One thermometer has a wet cloth around its bulb. The drier the air the more water that will evaporate from the cloth and the lower the wet-bulb temperature will become. The difference in temperature between the Dry-bulb and Wet-bulb thermometers, along with the Dry-bulb temperature, is used in finding the relative humidity on a Relative Humidity Chart.

Materials
Two Thermometers
Cloth (1" x 1½" works best)
String
Water
Relative Humidity Chart

Procedure

1. Wrap a small piece of cloth once around the bulb of one thermometer and tie it in place with a string.
2. Hold both thermometers so they hang a few inches apart (about 3 to 5 inches).
3. Dip the cloth in water.
4. Fan the thermometer vigorously with a notebook for at least five minutes.
5. Record the temperatures from both thermometers in the Data section.
6. Find the difference between the two readings.
7. Use the Relative Humidity Chart to find the relative humidity.

Data
Dry-bulb temperature: ________
Wet-bulb temperature: ________
Difference: ________
Relative Humidity: ________

Relative Humidity in Per Cent[13]

Differences in degrees (F°) between wet-bulb and dry-bulb temperatures

Dry-Bulb Temperatures (Degrees Fahrenheit)	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
30	89	68	47	27	8										
32	90	69	50	31	13										
34	90	72	53	35	18	1									
36	91	73	56	39	23	6									
38	91	75	59	43	27	12									
40	92	76	61	46	31	16	2								
42	92	77	62	48	34	21	7								
44	93	78	64	51	37	24	12								
46	93	79	65	53	40	28	16	4							
48	93	80	67	54	42	31	19	8							
50	93	81	68	56	44	33	22	12	2						
52	94	81	69	58	46	36	25	15	6						
54	94	82	70	59	48	38	28	18	9						
56	94	82	71	61	50	40	31	21	12	4					
58	94	83	72	62	52	42	33	24	15	7					
60	94	84	73	63	53	44	35	27	18	10	2				
62	94	84	74	64	55	46	37	29	21	13	6				
64	95	85	75	66	56	48	39	31	23	16	9	2			
66	95	85	76	66	58	49	41	33	26	18	11	5			
68	95	85	76	67	59	51	43	35	28	21	14	8	1		
70	95	86	77	68	60	52	44	37	30	23	17	10	4		
72	95	86	78	69	61	53	46	39	32	25	19	13	7	1	
74	95	86	78	70	62	54	47	40	34	27	21	15	9	4	
76	96	87	78	70	63	55	48	42	35	29	23	17	12	6	1
78	96	87	79	71	64	57	50	43	37	31	25	19	14	9	4
80	96	87	79	72	64	57	51	44	38	32	27	21	16	11	6
82	96	87	79	72	65	58	52	46	41	34	28	23	18	13	8
84	96	88	80	73	66	59	53	47	41	35	30	25	20	15	10
86	96	88	80	75	66	60	54	48	42	37	31	26	21	17	12
88	96	88	81	74	67	61	55	49	43	38	33	28	23	18	14
90	96	88	81	74	68	61	56	50	44	39	34	29	24	20	16

Part C:

Hair Hygrometer[14]

Introduction

Of all the hygrometers, the hair hygrometer is the is the easiest to read. The percent relative humidity can easily be read directly from a numbered scale.

Materials
Two 10" pieces of hair. (Dry, non-oily, blond hair works best.)
Strong soap solution
Two straight pins
One piece of cardboard 8" x 10" to serve as a backing
One piece of tagboard 1" x 6" to serve as a pointer
Glue
Marker
Small weight (ie. paper clip)

Procedure

1. Remove any grease on the hair by washing in a strong soap solution.
   Allow the hair to dry after a through rinsing.
2. Assemble the hair hygrometer as shown in Figure 4.

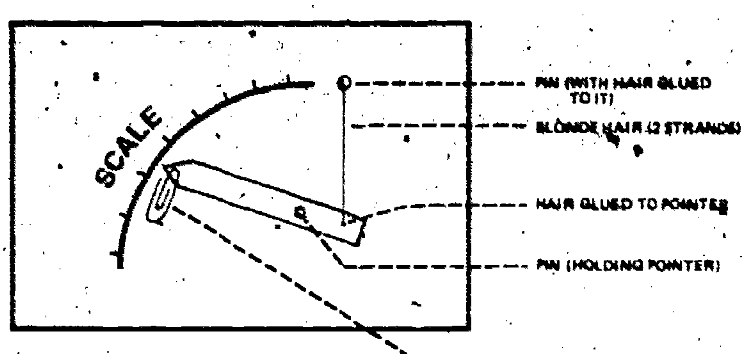

FIGURE 4: HAIR HYGROMETER

3. A relative humidity scale can be produced for this hygrometer by marking the pointer positions from time to time and labeling these marks with actual relative humidity readings taken at the same time with a wet-bulb and dry-bulb thermometer.

The Relationship Between Temperature and Humidity

Introduction

Relative Humidity is defined as the ratio between the amount of water actually in the air and the amount the air could hold at that temperature. Therefore, temperature and relative humidity must be closely related. This activity attempts to show this actual relationship in graphic terms.

Materials

A list of the hourly relative humidity and temperatures readings reported by a local weather station or newspaper.

Procedure

1. Obtain a list of times, temperatures, and relative humidities for a 24-hour period from a local weather station or newspaper.
2. Produce a graph plotting temperatures (vertical axis) with time of day (horizontal axis).
3. Produce a graph plotting relative humidity (vertical axis) with time of day (horizontal axis).

Questions

1. How does the shape of the temperature curve compare with that of the relative humidity?
2. From the graphs, it appears that as the temperature increased during the day, the humidity ________.
   Conversely, as it got cooler, the humidity ________.
3. Explain what the relationship between temperature and relative humidity really is and why the relationship found in Question 2 happened.

Finding the Dew Point[15]

Introduction

The Dew Point is the temperature to which air must be cooled before the water vapor it contains will condense. To measure the dew point we must cool the air until its water vapor condenses. This is done by filling a shiny metal can with a cold ice slush which will cool the air surrounding ~~it. The~~ temperature at which the water vapor begins to condense on the can is the Dew Point Temperature.

Materials

Thermometer
Shiny metal can
Crushed ice
Water
Tablespoon of salt

Procedure

1. Fill a small shiny tin can with a slush made of crushed ice, salt, and water.
2. Place a thermometer in contact with the outside of the can.
3. Record the temperature immediately when small droplets of water first appear on the outside of the can.

Data

Dew Point Temperature: ________________

Questions

1. If the dew point temperature is 0°C. or above, what is the condensed water vapor called?
   What is it made of?
2. If the dew point temperature is below 0°C., what is the condensed water vapor called?
   What is it made of?
3. Which kind of air will have to be cooled more to reach its dew point: Dry Air or Humid Air?
   Explain why.

Temperatures of Different Earth Surfaces

Introduction

Different types of earth surfaces absorb differing amounts of the sun's energy. The more of the sun's energy a surface absorbs, the hotter it becomes. This causes different earth surfaces to be heated to varying degrees. (This activity should be done on a calm sunny day.)

Materials

Five (5) thermometers

Procedure

1. On a sunny day, measure the temperature of the following earth surfaces: grass, bare ground, concrete, blacktop, and water (snow may be used in the winter).
   Let the thermometers sit in their positions about three or four minutes before taking their readings.
2. Record the temperatures on the data chart below.

Data

Surface	Temperature
Grass	
Bare ground	
Concrete	
Blacktop	
Water (snow)	

Questions

1. Which earth surface was the warmest? Why do you think this surface is hotter than the others?
2. Which surface was the coolest? Explain why.
3. If these different surfaces warmed up to different temperatures, how would this affect the air temperatures above them? How could you prove that?

The Heating of Land and Water[16]

Introduction

Because of differences in sunlight penetration and absorption and in the amount of energy actually required to raise their temperatures, land and water heat up and cool off at different rates.

Materials

Sunlamp (or a sunny day)
Container of Water (at least three inches deep)
Container of soil (at least three inches deep)
Two (2) thermometers

Procedure

1. Set the containers of soil and water so they receive equal amounts of energy from the closely placed sunlamp. (These may be placed in sunlight instead.) Place a thermometer at the surface of the soil and one at the water's surface. Record the temperatures of the soil and water every two minutes for sixteen minutes.
2. Turn the sunlamp off. (Or place the containers of soil and water in the shade.) Record the soil and water temperatures every two minutes for sixteen minutes.

Data

Produce a chart showing the soil and water temperatures taken at two minute intervals for sixteen minutes while exposed to sunlamp or direct sunlight and sixteen minutes in the shade.

Questions

1. How much did the soil temperature change when it was exposed to the sun's energy for sixteen minutes?
   How much did the water temperature change during the same time?
2. How much did the soil temperature change when it was in the shade for sixteen minutes?
   How much did the water temperature change at the same time?
3. Therefore, it seems that ______ heats up and cools off faster than does ______.

Soil and Water Temperature Changes Throughout the Day[17]

Introduction

In the preceeding activity it was found that soil and water heat up and cool off at different rates. The purpose of this activity is to find how water and soil change temperature throughout the day in nature; that is, comparing the temperature of a body of water with the temperature of adjacent land for a 24 hour period.

Materials

~~Two~~ (2) thermometers
Area at a Lake, River, Pond, Swamp, Creek, or Ocean
Sunny day

Procedure

1. Place a thermometer at the surface of a body of water and a thermometer at the surface of adjacent land.
2. Record the temperature of the land and water each hour throughout the 24 hour period.
3. Graph the land and water temperatures. Use a solid line to show the land temperatures and a dashed line to show the water temperatures.

Data

Produce a chart of the hourly land and water temperatures for the 24 hour period.
Produce a graph of the land and water temperatures. Time will be on the horizontal axis and temperature on the vertical axis.

Questions

1. Which held a more constant temperature throughout the day: land or water?
2. What does this tell you about the difference in the heating and cooling of each of these earth surfaces?
   Explain why:

Land and Sea Breezes

Introduction

Uneven heating of adjacent bodies of land and water causes differences in air pressure to develop. These differences in air pressure lead to the formation of land and sea breezes. This activity attempts to show how this process is started. The air movements themselves will be shown in the following way: Hydrochloric acid gives off a colorless gas; the same is true of Ammonia hydroxide. However, if the gases come in contact with each other, they form white fumes. The formation of these fumes, along with their later movement, will indicate the development of a breeze.

Materials

Five or Ten gallon aquarium
Glass top to fit the aquarium
Water
Soil or Sand
Sunlamp
Small open containers of HCl and NH_4OH (A different source of smoke could be substituted.)

Procedure

1. Set up the materials in the manner shown in Figure 5.

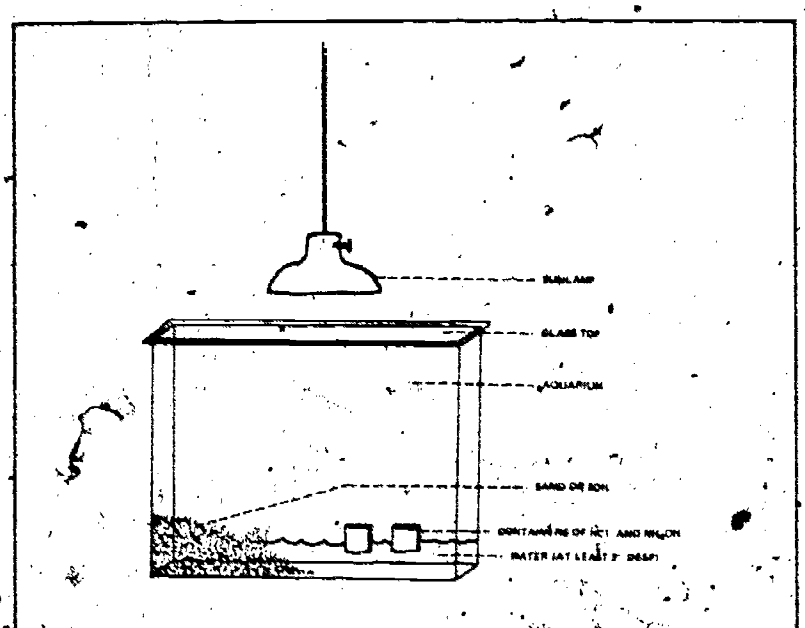

FIGURE 5. LAND AND SEA BREEZES

2. Fill one container with HCl and the other with NH_4OH.
3. Cover the tank with the glass top and turn on the sunlamp centered over the land and water.
4. Observe the circulation of smoke. (When the tank is filled with smoke, remove the glass top and allow the smoke to escape.)

Questions

1. Sketch the circulation path you observed.
2. Where might this type of breeze occur in nature?
3. Explain what causes a sea breeze.
4. Explain how a land breeze could develop.
   How could one be made in this activity using the materials already listed?
   Try it.
   What were your results?
5. What circulation pattern would develop if the land was completely surrounded by water?
   Using the materials already listed, see if you are correct.

Making a Wind Vane

Introduction

The wind direction is measured by an instrument called a wind vane. Although wind vanes come in many styles, shapes, and sizes, they all have three features in common: 1) they are always well-balanced so they may turn easily in the wind; 2) they always have one end about four or five times larger than the other; and 3) the small end always points in the direction from which the wind is coming. The most common wind vane shape is an arrow which is described below.

Materials

One wooden dowel (1" x 6")
One wooden dowel ½" x 12")
Wooden base (6" x 6" x [illegible]")
Tin or wood paneling
Glue
Drill and Bit
Bead
Saw
Nail

Procedure

1. Cut out the arrow's point and tail from the tin or wood paneling following the pattern in Figure 6a.

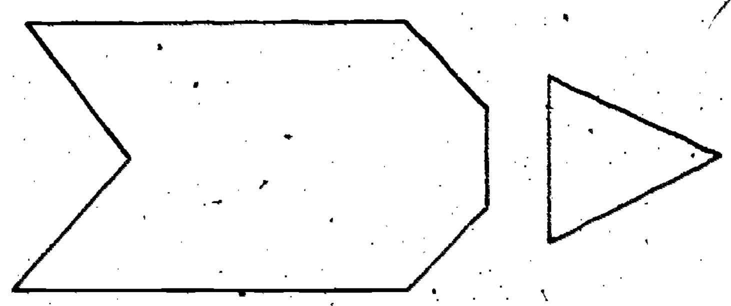

FIGURE 6a: PATTERN FOR WIND VANE POINT AND TAIL

2. Make a one-fourth inch deep saw cut at each end of the longest dowel so the arrow's point and tail may be fitted to it.
3. Glue the point and tail into place.
4. Find the center of balance for the arrow.
5. Drill a one-eighth inch hole through this balance point and assemble the rest of the wind van as shown in Figure 6b.

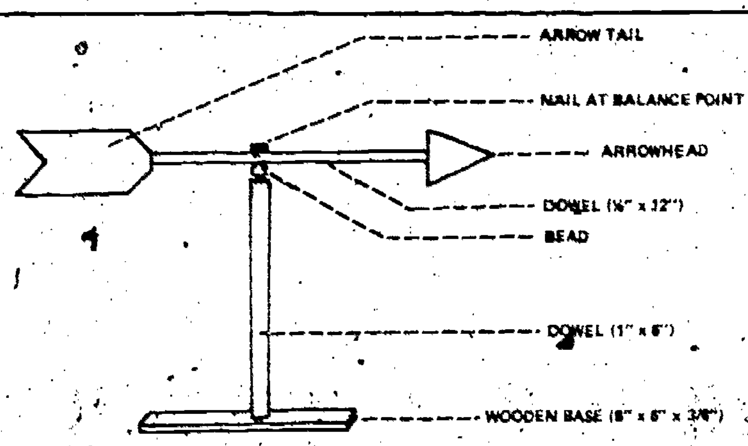

FIGURE 6b: ASSEMBLED WIND VANE

6. Lubricate the nail and bead so the arrow will turn easily.

Question

1. Thinking carefully about how a wind vane is designed, explain why the arrow head always points into the wind.

Optional Activity

Make another wind vane. This time, use your imagination to design one of a different shape. Don't forget the principles of wind vane construction mentioned in the Introduction of this activity.

Making a Raingauge

Introduction

A raingauge is used to measure the amount of moisture that falls from clouds. To accurately measure this moisture to within a hundredth's of an inch, it is necessary to use two containers of different size. This activity shows how to make a raingauge and understand how it works.

Materials

One large straight-sided can (at least six inches in diameter).
One tall, slender, straight-sided glass bottle (such as an olive bottle).
Masking tape

Procedure

1. Pour water to a depth of exactly one inch into the large can.
2. Pour the water from the can into the tall glass jar.
3. Stick a piece of masking tape vertically along the entire height of the glass jar.
4. Mark the depth of the water on the masking tape and divide the tape, below the mark, into ten (10) equal parts. Label these divisions as tenths of an inch.
5. Set the can outdoors in an open area away from trees and buildings.
6. After a rain, pour the water from the can into the jar and read the amount of rainfall to the nearest tenth or even hundredth of an inch.

Questions

1. Explain why the water became deeper than one inch when it was poured from the can into the jar.
2. Why is the water poured from the can into the jar when the amount of rainfall is being measured.
3. Explain why using the large can and the skinny jar together will give you a more accurate measurement or rainfall than using the can by itself.

Winter Activities

Introduction

One of the most interesting times of the year to study weather is during the winter. The presence of snow adds a whole new realm of subjects to investigate. (The following activities are intentionally written so they may be completed with a short exposure to cold winter temperatures.)

Part A: Snow Flakes

Materials

Cold piece (below 0°C.) of black construction paper

Handlens

Thermometer

Snowy day

Procedure

1. Collect about 15 or 20 good, clear snowflakes on the black construction paper while it is snowing.
2. Take these collected snowflakes to a sheltered area.
   CAUTION: Do Not Breathe On The Snowflakes Or Take Them To A Warm Area!!!
3. With the aid of a handlens, study and sketch two or three snowflakes.
4. Record the air temperature at the time of this activity.
5. Repeat the above procedures during several different snow storms.

Questions

1. Why do you think it was necessary to use a cold piece of black paper, not breathe on the snowflakes, and not take them to a warm area?
2. How were the snowflakes you sketched alike?
3. What relationship did you find between air temperature and snowflake appearance?

Part B: Air and Snow Temperatures

Materials

Two Thermometers

Procedure

1. Several times each day for about a week, take the snow's temperature at a depth of five (5) inches and the air's temperature five (5) inches above the snow.
2. Record these temperatures onto a data chart.

Questions

1. During the week period, what was the warmest air temperature you recorded?
   What was the coolest air temperature?
   What was the difference between the warmest and coolest air temperature?
2. What was the warmest snow temperature you recorded?
   What was the coolest snow temperature?
   What was the difference between the warmest and coolest snow temperatures?
3. Which temperature changed more during the week period: the air temperature or the snow temperature?
   Explain why:

Footnotes

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