SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

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SCOPE, SEQUENCE, and COORDINATION

SS&C Research and Development Center
Gerry Wheeler, *Principal Investigator*
Erma M. Anderson, *Project Director*
Nancy Erwin, *Project Editor*
Rick McGolerick, *Project Coordinator*
Arlington, Va., 703.312.9256

Evaluation Center
Frances Lawrenz, *Center Director*
Doug Huffman, *Associate Director*
Wayne Welch, *Consultant*
University of Minnesota, 612.625.2046

Houston SS&C Materials Development and Coordination Center
Linda W. Crow, *Center Director*
Godrej H. Sethna, *School Coordinator*
University of Houston-Downtown, 713.221.8583

Houston School Sites and Lead Teachers
Jefferson Davis H.S., Lois Range
Lee H.S., Thomas Ivy
Jack Yates H.S., Diane Schranck

California Coordination Center
Tom Hinojosa, *Center Coordinator*
Santa Clara, Calif., 408.244.3080

California School Sites and Lead Teachers
Sherman Indian H.S., Mary Yarger
Sacramento H.S., Brian Jacobs

Iowa Coordination Center
Robert Yager, *Center Director*
University of Iowa, 319.335.1189

Iowa School Sites and Lead Teachers
Pleasant Valley H.S., William Roberts
North Scott H.S., Mike Brown

North Carolina Coordination Center
Charles Coble, *Center Co-Director*
Jessie Jones, *School Coordinator*
East Carolina University, 919.328.6172

North Carolina School Sites and Lead Teachers
Tarboro H.S., Ernestine Smith
Northside H.S., Glenda Burrus

Puerto Rico Coordination Center*
Manuel Gomez, *Center Co-Director*
Acenet Bernacet, *Center Co-Director*
University of Puerto Rico, 809.765.5170

Puerto Rico School Site
UPR Lab H.S.

* * * * * * * * * * * *

Pilot Sites
Site Coordinator and Lead Teacher
Fox Lane H.S., New York, Arthur Eisenkraft
Georgetown Day School, Washington, D.C., William George
Flathead H.S., Montana, Gary Freebury
Clinton H.S., New York, John Laffan*

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Student Materials

Learning Sequence Item:

939

Evidence of Heat Transformations

March 1996
Adapted by: Brett Pyle

Contents

This micro-unit was adapted by **Brett Pyle** (Grady Middle School, Houston, Tex.)

Science as Inquiry

Conduct Yourself Accordingly

What is the relationship between heat energy and conduction?

Overview:

Have you ever stirred your coffee with a metal spoon? The coffee gets cooler, but the spoon gets warmer. How does this occur? Try this experiment and then try to explain your coffee cup problem.

Procedure:

Light the candle or bunsen burner and place one finger about 6 cm to the side of the flame. Hold your finger there and note whether or not it gets hot. Bend a paper clip so that it is straight. Mark the paper clip 6 cm from one end. Hold the clip at the mark and place the other end into the flame. *Remove it and drop it if it becomes uncomfortable.* Record your observations.

Questions:

1. What did it feel like when you held your hand in the air 6 cm from the flame compared to when you held the paper clip 6 cm from the flame?

2. Describe any changes in the paper clip other than temperature changes.

3. Describe the difference between a heat conductor and a heat insulator.

4. Explain why the air and the paper clip do not conduct heat equally.

Science as Inquiry

Lord Almighty, Feel My Temperature Rising!

What are the effects of heat conduction?

Overview:

Which burner on the stove should you use—the big one or the small one? Try this experiment and see what answer you can get.

Procedure:

Fill the paper cup halfway with water. Predict what will happen when you place the cup over the flame. Hold the cup with the tongs over an open flame and observe the results. Continue to hold the cup over the flame until the water boils. Remove the cup once the water begins boiling. Put a few scraps of paper inside the metal strainer. Predict what will happen when you place the strainer over the flame. Place the strainer over the flame and hold it there for several seconds. Record your observations.

Questions:

1. Describe what happened when you placed the paper cup of water over the flame.

2. Describe what happened when you placed the strainer full of paper over the flame.

3. Explain why you got the results you did.

4. If you place a nail into a potato and place it in the oven, it will bake faster than a potato without a nail. Explain why.

5. Explain why ice will form on bridges in the winter before it will form on the roadway.

Science as Inquiry

Hot Connection

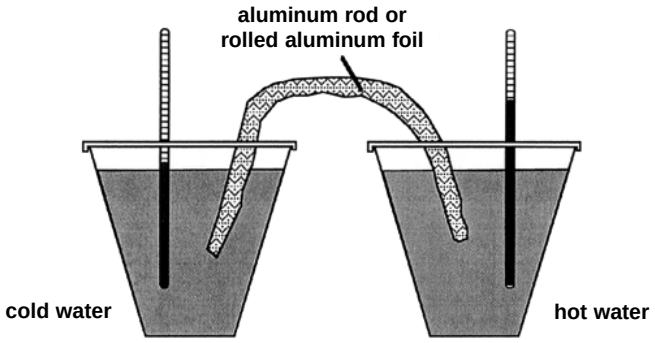
How do we measure heat?

Overview:

Can a cold liquid connected to a hot liquid by a piece of metal become warmer? This experiment examines this feat.

Procedure:

Put two holes in the top of each cup lid, one for the thermometer and one for the aluminum rod to fit through. Place boiling water in one cup and cold water in the other cup and place the thermometers in the cups. Let the cups sit until the thermometers stop moving and record the temperature in each cup. This will be used as the starting temperature for each cup. Place the aluminum rod into each cup through the holes in the lid so that each end is submerged in water. Record the temperature of the water in each cup of water every minute for 15 minutes. Construct a data table to record the temperature of the two cups of water over the 15 minute time period. Use this data to construct a line graph showing temperature changes over time for the two cups of water.



Questions:

1. Describe how the temperature of each cup of water changed over time.

2. What caused the temperature changes in each cup?

3. If you tested two or more materials to connect the cup, explain any differences you observed in the results.

Science as Inquiry

Current Events

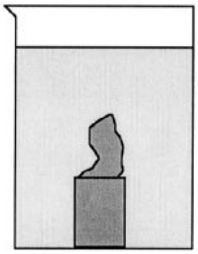
What is the relationship between heat energy and convection?

Overview:

Have you ever seen a lava lamp? This experiment may give you some insight into how the lava lamp produces that moving lava.

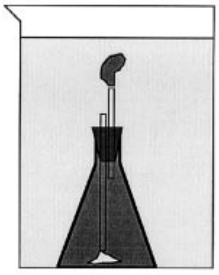
Procedure:

There are a number of variations of this experiment. They all involve setting up a convection cell in a beaker by mixing hot and cold water. Dye or food coloring is used to observe the water movement.



As the lid is removed, colored water will begin to rise.

Option a. Fill up your beaker with 700 mL of cold water. Place powdered dye or food coloring into the small vial and fill it with hot water. Place the cork on the vial and place it on the bottom of the beaker full of cold water. Slowly and carefully remove the cork and remove your hand slowly from the water, disturbing the water as little as possible. Observe the movement of the colored water over time.



Flask of hot colored water in a beaker of cold water. Note relative position of glass tubes.

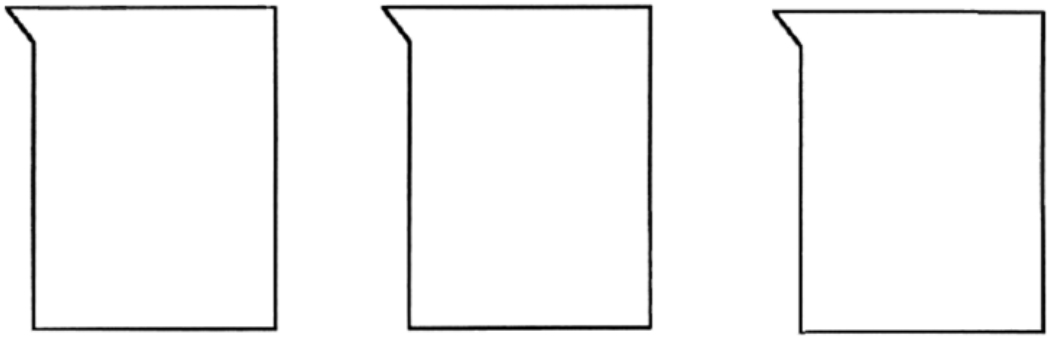
Option b. Fill the beaker with 700 mL of cold water. Place the dye in the flask and fill with hot water. Place the stopper in the flask and place the flask in the beaker. Make sure the top of both glass tubes is below the water level in the beaker. Observe the movement of the colored water in the beaker.

After you have completed either option a or option b, fill your beaker with hot water and predict what will happen if you put a colored ice cube into the water. After you have made your prediction, carry out the experiment. Draw what you see happening in the beaker over time in the two experiments on the chart provided.

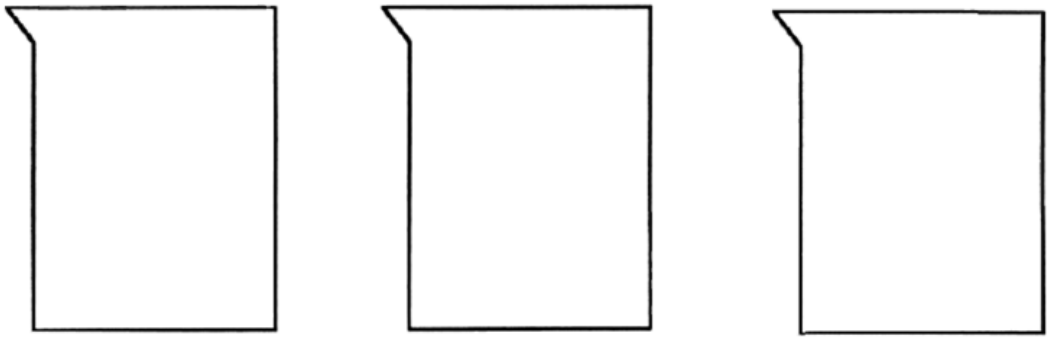
Questions:

1. What caused the movements within the water that you observed?

2. Explain why ponds take so long to freeze in the winter.



Vial or flask of hot water in a beaker of cold water



Color ice cube in a beaker of hot water.

Science as Inquiry

Thank You, Fans!

What is the relationship between convection currents and air?

Overview:

Should the air conditioning vents be close to the ceiling or close to the floor? What about the heat vents? This design problem may be easier to solve after completing this experiment.

Procedure:

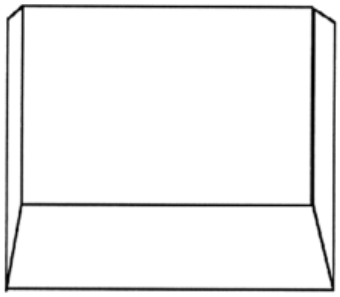
Cut the spirals out. Tape the string to the middle of the spiral and tie the other end to the paper clip. Ready the heat source (the candle, bunsen burner, or beaker of boiling water) and hold the paper spiral so that it is about 20 cm above the heat source. Record your observations and then measure the temperature of the surrounding room air. Compare it to the temperature of the air where the spiral is hanging.

Questions:

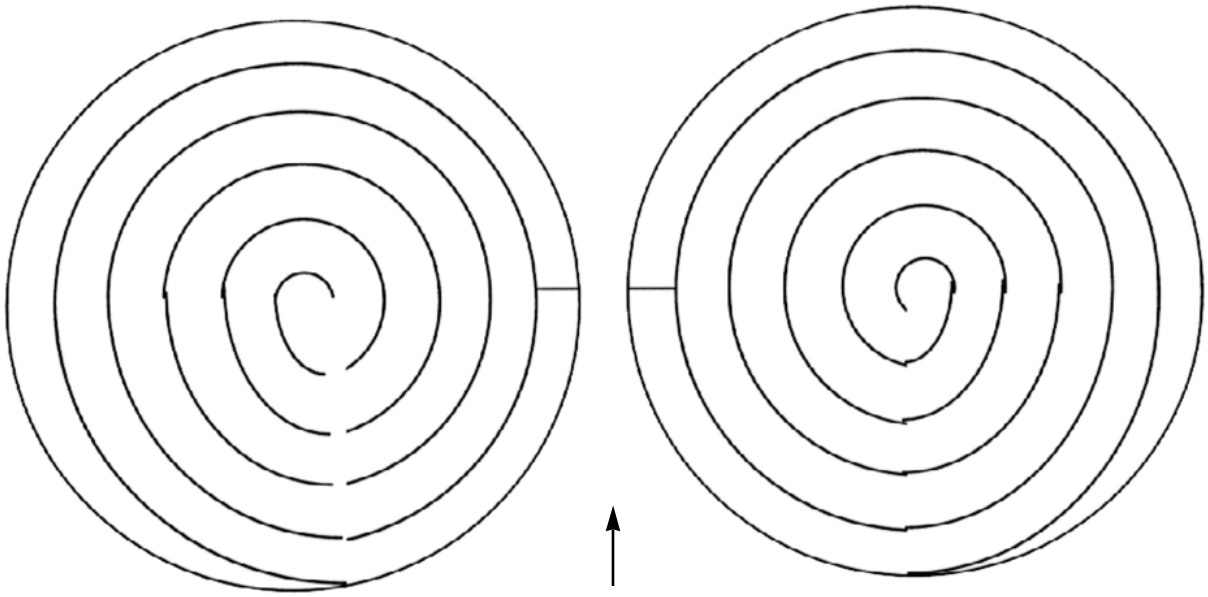
1. What caused the spiral to behave as it did?

2. Where would you expect the hottest part of a room to be? Explain why.

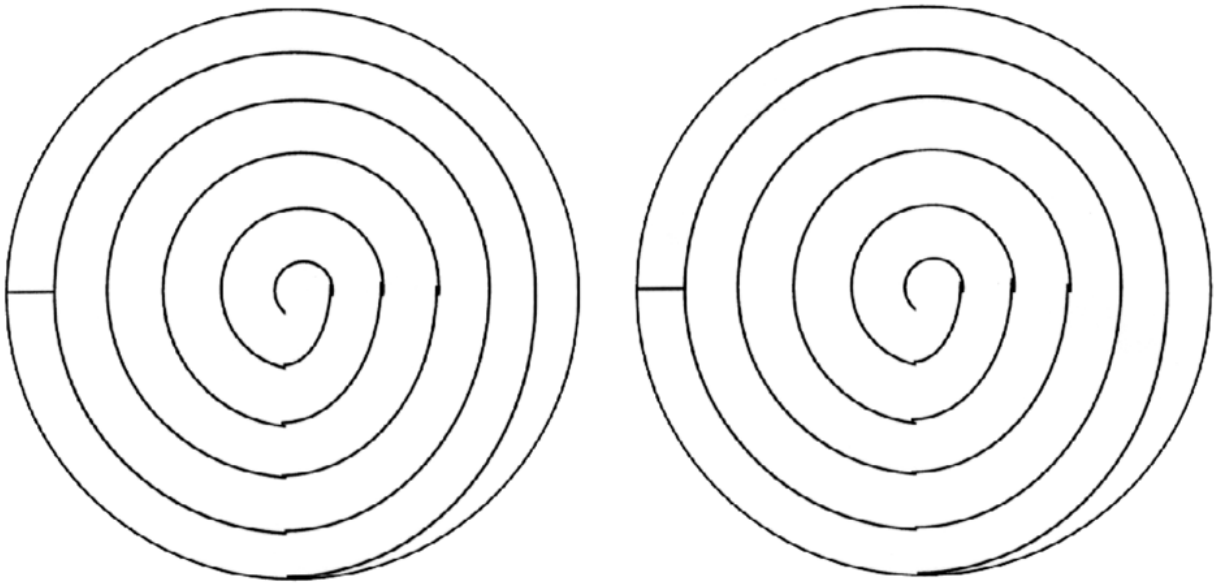
3. If you were building a house and you were installing air conditioning vents in the rooms, show on the diagram where you would place them. Explain why you placed them where you did.



4. In the summer, ceiling fans lift air up from the floor. Explain what this does for the temperature of the room and how this relates to convection.



The top two spirals are for left-handed students
(easier to cut out).



Spiral patterns for lab. Cut along all lines shown.

Science as Inquiry

Basking in the Glow

What is the relationship between heat and radiation?

Overview:

How can your hands feel the warmth of a fire without touching it? This experiment looks at this phenomena.

Procedure:

Place some wax shavings on the end of the toothpick and press them so that they form a small blob on the end. Bring the wax end of the toothpick close to the flame until the wax just begins to melt. Pull back the toothpick and let the wax solidify and repeat this process around the sides and bottom of the flame. On the diagram below, draw a line around the bottom and sides of the candle flame showing where the wax began to melt.

Questions:

1. Explain why the melting of the wax could not be caused by heat convection.

2. Explain why the melting of the wax could not be caused by heat conduction.

3. Explain how heat is transferred by radiation.

4. Explain how you know radiation can move through a vacuum.

Science as Inquiry

Don’t Just Sit There Absorbing Everything I Say: Emit a Little!

What properties affect the absorption or emission of radiation?

Overview:

Remember those hot summers and your black car? Which color of car would be best? Find out in this experiment.

Procedure:

Wrap the test tubes tightly with the given materials and tape them securely. One tube should be wrapped in black paper, one wrapped in white paper, and one wrapped in foil (shiny side out). Fill each test tube with room temperature water and place the test tube in a rack. Place the 200 watt light approximately 20 cm from the rack and point it directly at the test tubes. Record an initial temperature in each test tube and then turn on the light. Temperature readings should be taken in each test tube every minute for ten minutes. At the end of ten minutes have the students switch off the light and turn the light away from the test tubes. Now the students should record the temperature in each tube every minute for another ten minutes. When they have completed this they should construct a line graph of the data comparing temperature changes over time.

Questions:

1. When you turned off the lamp, why was it also important to turn it away from the samples?

2. Which can be absorb energy more quickly? How is this shown on the graph?

3. Which an absorb energy most slowly? How is this shown on the graph?

4. What is the relationship between how well an object absorbs energy and how well it emits energy?

5. Which can had the greatest rate of change throughout the experiment? Explain why.

6. What is the best type of clothing to wear in the winter? Explain why.