Insulation Experimentation

Science Standard VI

Objective 1

Connections

Standard VI:

Students will understand properties and behavior of heat, light, and sound.

Objective 1:

Investigate the movement of heat between objects by conduction, convection, and radiation.

Intended Learning Outcomes:

1. Use science process and thinking skills
2. Manifest scientific attitudes and interests

Content Connections:

Social Studies IV-2; culture of Ancient Rome

Background Information

This lesson explores conduction, convection, and radiation in respect to insulation, the method of preventing heat from escaping a container or entering a container. An understanding of conduction, convection, and radiation are needed for optimal understanding of these concepts.

As the students will engage in a group experiment, they will need background in the scientific method. The steps in this method are ask a question; gather background research; form a hypothesis; experiment; analyze your data; draw conclusions; and record your results.

It is helpful if the students have already done several guided experiments using this method in class. If not, differentiation should be used to help those students who need more guidance, whereas more advanced students may discover on their own.

Baby food jars and several insulation materials are needed for this lesson. These include: down, gloves/mittens, cotton sock, wool sock, other types of cloth or clothing, sand, plastic foam, dirt, large piece of paper, foam packing peanuts, wood, aluminum foil, leaves, paper towels, cardboard, cotton balls, shredded paper, fiberglass insulation, etc. Collect them on your own before the experiment or have your students bring in items easily accessible from home. If using fiberglass insulation, you will need gloves so the material does not irritate the skin.

The ability to transfer heat within an object is called thermal conductivity. It varies for different materials. Gold, silver and copper have high thermal conductivity so these materials are also good conductors of electricity. Other materials, such as glass and mineral wool, have low thermal conductivity. This quality makes them good insulators. A good insula tor is a poor conductor. Less dense materials are better insulators. Thus, gases insulate better than liquids, which in turn insulate better than solids.

An interesting fact is that poor conductors of electricity are also poor heat conductors.

Research Basis

Osman, M., &: Hannafin, M.]. (1994). Effects of advance organizing, questioning and prior knowledge on science learning *journal of Educational Research, 88 (1),* 5-13.

Good questioning requires skill and planning. Learning is maximized in classes where questions are encouraged, elaboration and explanation are expected, and feedback is frequent. Effective science teachers ask many higher-lever thinking and follow-up questions throughout a lesson. Better teacher questioning practices lead to better learning by all students. The foundation to good questioning is strong content knowledge and a firm understanding of how students learn so that misunderstandings may be anticipated.

Chapman , C. &: King, R. (2005) . 11 Practical Ways to Guide Teachers Toward Differentiation. *ERIC Source* (ERIC E]752246). Retrieved December 17, 2007, from http://www .eric.ed.gov

Differentiated learning takes student differences into account. By focusing on the needs of the individual learner, students will do better in school. Eleven steps are presented to help teachers move toward a differentiated curriculum, including knowing the standards, varying instructional strategies and activities, creating a positive learning climate, providing a wide variety of materials, knowing the students, and adjusting assignments when necessary.

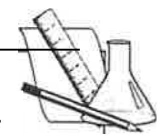
Invitation to Learn

Pass out a *Which Uses More Energy?* sheet to each student. Allow between five and ten minutes for completion and journaling.

Instructional Procedures

1. When students finish the invitation to learn, read each energy question and allow students to raise their hands to indicate their guess. Then read each correct answer and the reasoning behind it. Discuss any surprises or reactions to this information. Ask if the kids have any ideas of how we as Americans can cut back on using energy.
2. Introduce the term energy conservation (saving energy) in relationship to heat. What do we do to stay warm outside on

Materials



- O *Which Uses More Energy? half-sheet*
- O *Which Uses More Energy? answer key*
- O *Insulation Experimentation Planning Sheet*
- O Baby food jars (size 2 recommended)
- O Various insulating materials
- O Small disposable containers
- O Plastic Wrap
- O Scissors
- O Tape
- O Research materials about insulation
- O Microwave
- O Microwave-safe bowl
- O Water access
- O Thermometers
- O 50 ml measuring syringes
- O *Insulation Table*
- O *Insulation Graph*
- O Stopwatches
- O *Insulation Experimentation Sample Table & Graph*
- O *Insulation in Ancient Rome* PowerPoint
- O Science Journals

a cold day? (wear a coat) How do we save money on heating our homes in the winter? (appropriate insulation) What are some examples of insulation? (animal fur, towel, blanket, portable cooler, fiberglass, wool, foam, down, etc.)

3. Insulators are materials that help prevent any of the three types of heat transfer to keep heat in one place (either in or out). This aids in energy conservation. Homes need insulation on the roof for protection from the sun (radiation); on the floor to protect from the cold ground (conduction); and on the walls to protect from the wind (convection). A well-insulated home will not have wasted energy and will therefore not use as much heat in the winter or air conditioning in the summer.
4. Explain that the students are going to participate in an experiment that explores different types of insulation. They will select a material to insulate a jar of warm water and determine whether or not it is a good insulator. Various insulation materials are needed and should be set out prior to the lesson. Fabrics should be labeled. You will need about 40 baby food jars for this experiment. You may ask the students to bring some materials from home.
5. Students should be in groups of about four. Give each group a copy of the *Insulation Experimentation Planning Sheet* to guide preparations in their journals. Allow for differentiation when appropriate; some students may be ready to plan an experiment on their own and will not need the planning sheet. See that all students are using their journals to record each step of the scientific method.
6. Before the students begin, discuss some of the following questions: What are the variables in your project? (insulation materials) How can you make sure to only test one variable? (jars should be the same size; water should be the same amount and initial temperature in each jar; all temperature readings should be recorded at the same time) What time intervals are appropriate for temperature testing? (I would suggest 1-3 minutes between each reading. Stopwatches may be used for accuracy.) How will you record your observations? (tables, graphs, report format) Where will you keep your jars? (students may opt to take them outside if the temperature is cooler)
7. While the students are working, begin warming water in microwave. Ensure it is hot, but not hot enough to bum someone. You may also want to walk around to each group and

review how to read the thermometers. It is also helpful to pre-cut small pieces of the Glad Press'n Seal Wrap for easy assembly later.

8. After forming a hypothesis, each student in the group should surround a baby food jar or something similar with one type of material, making sure to keep a small amount of the jar available on top for sealing. Each jar should be the same size, and each material should be different. If using dirt or sand, set the baby food jar in the center of a small disposable container and surround it with the selected material.
9. When one or two jars per person are finished, use a measuring syringe to fill each jar with 100 ml of water, or enough to almost fill the jars you are using. Then place a thermometer in each. Students should immediately record the temperature. Seal with the Glad Press'n Seal Wrap while keeping the thermometer in the jar for easy readings.
10. One unsealed jar with a thermometer and no insulation should act as the control. Timed temperature readings should be recorded every few minutes. Observations should be recorded. Pass out the *Insulation Table* and *Insulation Graph* to those who need help recording their data.
11. As the students are working, monitor student progress by asking thought provoking questions that focus on student understanding. Use the *Insulation Experimentation Sample Table & Graph* as a tool to help guide your students' thinking.
12. When students are finished, they should record and analyze their data and draw conclusions to answer their question. Remind them that all parts of the scientific method need to be written up in their science journals.
13. On day two, have a class discussion about the experiment. Based on all data, which insulation was the best? Which was the worst? Did any jars remain the same temperature? Share differences in experimentation and data. At the conclusion of your discussion, instruct the students to share their conclusions in their journals, as well as write any questions they still wonder about.

Assessment Suggestions

- Hypothesize about what might happen if you tried the experiment again, this time recording the temperature for a longer amount of time (one, two, even three hours). Which materials might work better? Will there be a point when none of the jars are insulated well enough to keep the water warm? To assess a students' understanding of the scientific method and the experiment done in class, have them write up how to set up this experiment. If more time is available, try it!

- Remind the students that metals are excellent conductors of heat. Based on your experiment, did that make them good or poor insulators? Why? (Good conductors cannot be insulators because conductors remove heat, not sustain it.)
- Could you design an experiment to measure keeping things cool? Ask students to journal their ideas.

Curriculum Extensions/Adaptations/ Integration

- Invite an HVAC (heating, ventilation, and air conditioning) professional to explain how he/she knows how many radiators or ducts are needed to heat a room.
- Challenge advanced students to research how insulation techniques have changed over time, or how different societies throughout history have heated their living environment.
- Research extreme temperatures throughout the world at http://members.iinet.net.au/-jacob/worldtp.html and energy conservation techniques used in those regions.
- Visit the Utah Energy Conservation Coalition website at www. Utahenergy.org to learn about energy conservation techniques used in homes in Utah.
- Show the PowerPoint presentation entitled *Insulation in Ancient Rome*. This explores the concept of hypocausts, most likely developed by the Ancient Romans, and how they were used. You may also build a model of a hypocaust using bricks and tiles. Simple instructions can be found at www.mylearning.org/learning/investigate-archaeology/Roman%20Central%20Heating.pdf.

Family Connections

- Have students learn about the amount and type of insulation in their own homes, including techniques used by their families to stay warmer in the winter (i.e. plastic on windows, towels on floor by doors, electric blankets, etc.).

- Have students and their families design and put into place an energy conservation plan in their homes to save on energy bills.

Additional Resources

Web sites

http://www.http.mylearningt.org/learning/investigate-archaeology/Roman%20Centeral%20Heating.pdf

http://www.members.iinet.net.au/~jacob/worldtp.html

Organizations

National Insulation Association, 99 Canal Center Plaza, Suite 222, Alexandria, VA 22314, (703) 683-6422, insulation .org

Utah Energy Conservation Coalition, Inc. and Energy Rated Homes of Utah, 112 South Mountain Way Drive, Orem, UT 84058-5118, (800) 550-8322, www.utahenergy .org

Which Uses More Energy?

Energy is the *ability to do work.* Circle the option that you think uses the most energy.

1. All electric power plants or all U.S. cars?
2. Coal power plant or space shuttle?
3. 20 light bulbs or a horse?
4. The space shuttle or 50 airplanes?
5. A big ship or a big airplane?
6. An SUV or 100 horses?
7. 2,000 light bulbs or a small car?
8. On average, one American or two people from somewhere else in the world?

In your science journal, brainstorm a list of daily activities that use energy. Try to think of at least ten.

Which Uses More Energy? Answer Key

Energy is the ability to do work. Circle the option that you think uses the most energy.

1. All electric power plants or all U.S. cars? All U.S. cars (all U.S. cars = 7 times all power plants)
2. Coal power plant or space shuttle? Space shuttle (space shuttle = 14 plants)
3. 20 light bulbs or a horse? 20 light bulbs (20 light bulbs = 2 horses)
4. The space shuttle or 50 airplanes? Space shuttle (space shuttle = 56 airplanes)
5. A big ship or a big airplane? Big airplane (4 airplanes = 5 ships)
6. An SUV or 100 horses? SUV (SUV = 160 horses)
7. 2,000 light bulbs or a small car? Light bulbs (car = 1,000 light bulbs)
8. On average, one American or two people from somewhere else in the world? One American (Americans use 5 times as much power: 100 light bulbs a year compared to 20 light bulbs a year)

In your science journal, brainstorm a list of daily activities that use energy. Try to think of at least ten. These may include: television, computer, lights, music players and other electronics, stove, oven, washer/dryer, car, bath, outside doors, thermostat, fireplace, windows, appliances, such as toaster, blow dryer, can opener, etc.

Insulation Experimentation Planning Sheet

You will need:

1. Your science journal and a pencil
2. One or two baby food jars for each member of your group, plus an extra
3. One thermometer for each jar
4. One type of insulation for each jar
5. Tape, scissors, or other to secure your insulator
6. Plastic wrap
7. A stopwatch, timer, or watch with a second hand

Consider the following as you plan your experiment. Write your responses in your journal.

1. Write down the question: Which insulator will keep a jar of warm water warmest the longest?
2. What background knowledge do you have to answer this question? Think about conduction, convection, and radiation.
3. Based on your background knowledge, what is your hypothesis? You may use the classroom resources to do some research if you choose.
4. Identify the variables in your experiment.
5. Identify the controls.
6. Obtain one jar and one type of insulation for each person in your group. Will you put the insulation around the bottom of each container or just the sides?
7. Each jar should contain the same amount of water. Test the temperature immediately after adding the water to each glass. Seal quickly with plastic wrap. Leave one jar of water with no insulation as a control.
8. Record the temperature every one to three minutes. When will you stop recording the temperature?

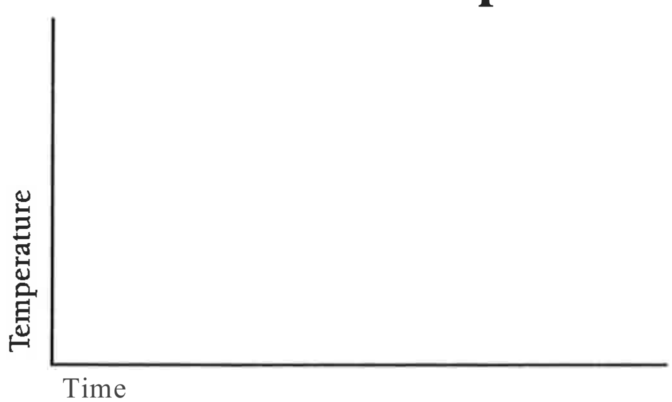
Consider the following during your experiment. Write your responses in your journal. You may want to use pictures, graphs, or tables to help.

1. How does the temperature change over time?
2. Record your data. How did you make sure all results are accurate?
3. While recording your data, begin a table and graph to show your results.
4. Write a conclusion based on your results. Which was the best insulator and which was the worst? How do you know? Don't forget to state whether or not your hypothesis was correct.

Insulation Table

Materials, Time & Degrees (F)	Control	Material 1 ________	Material 2 ________	Material 3 ________	Material 4 ________	Material 5 ________
Starting Temp						
___min						
___ min						
___min						
___ min						
___min						
___ min						
___min						
___ min						
Change in temp from start to finish						

Insulation Graph



Insulation Experimentation Sample Table

Materials, Time, & Degrees (F)	Control	52% cotton; 48% poly fabric	100% acrylic fabric	rocks	80% cotton; 20% poly fabric	black paper
Starting Temp (in °)	118	118	118	118	118	118
1 min	116	116	111	115	116	116
2 min	114	112	110	113	111	114
3 min	110	112	109	111	110	112
4 min	110	112	109	109	110	112
5 min	108	112	108	107	110	110
6 min	107	112	108	107	109	110
Change in temp from start to finish	11 degrees	6 degrees	10 degrees	11 degrees	9 degrees	8 degrees

Since the 52% cotton/48% polyester fabric only had a change of 6 degrees, it is the best insulator.

Insulation Experimentation Sample Graph