Insulation

Student Objective
The student:
- knows practical applications for insulation
- given a list of insulation materials will be able to tell their relative insulation properties.

Key Words:
conduction
convection
heat transfer
insulation
radiant energy
thermal

Materials
- small paper cups with 100ml water, frozen (two per group)
- small paper cups, empty (two per group)
- scissors
- tape
- various materials including cotton, shredded paper, aluminum foil, bubble wrap, styrofoam, commercial insulation materials, etc.
- graduated cylinders (enough for one for every two or three groups)

Time:
1 hour

Background Information

Insulation means providing a barrier for the flow of energy, in this case heat. Insulation is used, for example, on stoves and ovens, refrigerators, freezers, water heaters, water pipes and other appliances or industrial applications where it is important to reduce heat and energy losses or to prevent heating nearby objects.

Thermal insulation is the practice of surrounding a building or other object, with a material that conducts heat poorly. There is no perfect insulator, but a thin layer of air resists the flow of heat about 15,000 times better than a good metallic conductor of the same thickness. Many good insulators are made of nonmetallic materials filled with tiny air spaces. These air pockets must be small; otherwise movement of the air by convection currents may transport heat across the space. This tends to occur when an air layer becomes thicker than about 1/4 inch (0.6 centimeter).

Heat transfer can also occur through radiation in the absence of intervening conducting materials. For example, the sun's energy is transmitted by radiation through the vacuum of outer space. To reduce heating effects from radiation, reflective paints or metallic coatings are used. Thin aluminum foil in building walls can serve as a radiation barrier. In a thermos bottle or a

Dewar flask, heat losses are reduced by evacuating, or removing, most of the air from the space between a double-walled enclosure covered with a polished coat of aluminum or silver.

Procedure

1. Place the bin of various insulating materials at the front of the class.
2. Explain to the class that they will be trying to create the most efficient insulating device.
3. Divide the class into groups of 2 students per group.
4. Explain the lab procedure
    - students may use any combination of materials that they wish
    - they will then place a cup with 5 oz of frozen water inside their insulating device (Note: Material that covers the top of the insulation device should be removable or flapped, so that the frozen cup can be inserted. Cup also needs to be able to stand upright during testing.)
    - the insulation devices are then placed in the sun and the students complete the table in their Science Journal pages, draining and measuring the melted ice at the designated intervals
    - students will then construct a second device using the knowledge that they gained from the first trial.
5. Help students as needed during the construction process.
6. After the second trial, have the students share their results with the rest of the class, and lead a discussion on which materials and techniques worked best.
7. Students should complete the conclusion section of their Science Journals.

Key Words & Definitions

- **conduction** - the transmission of heat across matter
- **convection** - heat transfer in a gas or liquid by the circulation of currents from one region to another
- **heat transfer** - the process whereby heat moves from one body or substance to another by radiation, conduction, convection, or a combination of these methods
- **insulation** - the process of keeping heat or cold in one place and preventing it from escaping with little or no air movement
- **radiant energy** - energy that is transmitted in the form of electromagnetic radiation (i.e. solar); energy that exists in the absence of matter; energy that can travel through space
- **thermal** - relating to heat and cold

Related Research

1. Research how animals insulate themselves against the extremes of climate.
2. Design an experiment to compare the insulating properties of several ice chests.
3. Is the same type of insulation used for houses when the objective is to keep the heat out (Florida) as when you wish to keep the cold out? Investigate the building practices in northern and southern climates. How are they similar? How are they different?
4. Divide the class into two groups. One lives in Alaska and one live in the New Mexico

desert. Have them brainstorm and sketch a comfortable dwelling that is energy efficient, an outfit suitable to wear when walking to school, and a picnic basket that would keep a meal fresh even after two hours outside.

5. Research what materials are currently being used in clothing to insulate against the cold.

Internet Sites

http://www.fsec.ucf.edu/en/education/k-12/curricula/bpm/lessons/lesson03/index.htm

Florida Solar Energy Center's Building Performance Matters activities on conduction, convection and radiation

http://www.ornl.gov/roofs+walls/insulation/

Insulation fact sheet contains information on different types of insulation as well as an R-value calculator.

http://www.energyhog.org/

Alliance to Save Energy. Interactive site includes games that students use to find the 'Energy Hog' and learn to save energy

http://www.naima.org/insulation-knowledge-base/general-overview-of-insulation.html

North American Insulation Manufacturers Association website with general information about building insulation

http://www.miamisci.org/af/sln/mummy/pyramid/index.html

Miami Science Museum. How many layers of insulation is needed on the Mummy's Tomb to keep it cool.

Insulation

			.1	.2	.3	.4	.5	.6	.7	.8	.9	.10	.11	.12
Grade 6														
Practice of Science	# 1	SC.6.N.1	X			X								
Grade 7														
Practice of Science	# 1	SC.7.N.1	X											
Energy Transfer & Transformations	# 11	SC.7.P.11	X											
Grade 8														
Practice of Science	# 1	SC.8.N.1	X											
Properties of Matter	# 8	SC.8.P.8				X								

Sixth Grade Benchmarks
Science–Big Idea 1: The Practice of Science
- SC.6.N.1.1 - Define a problem from the sixth grade curriculum, using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
- SC.6.N.1.4 - Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.

Seventh Grade Benchmarks
Science–Big Idea 1: The Practice of Science
- SC.7.N.1.1 - Define a problem from the seventh grade curriculum, using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

Science–Big Idea 11: Energy Transfer and Transformations
- SC.7.P.11.1 - Recognize that adding heat to or removing heat from a system may result in a temperature change and possibly a change of state.

Eighth Grade Benchmarks
Science–Big Idea 1: The Practice of Science
- SC.8.N.1.1 - Define a problem from the eighth grade curriculum, using appropriate

reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

Science–Big Idea 8: Properties of Matter

- SC.8.P.8.4 - Classify and compare substances on the basis of characteristic physical properties that can be demonstrated or measured; for example thermal conductivity, and how that this property is independent of the amount of the sample.

Insulation

1. Describe your insulation device for trial one and the materials that you used.

2. Complete the table below

Total time	**Trial 1 Amount of water**		**Trial 2 Amount of water**	
	Current amount	**Cumulative total**	**Current amount**	**Cumulative total**
5 minutes				
10 minutes				
15 minutes				
20 minutes				

3. Describe your insulation device for trial two and the materials that you used.

4. Was your insulation device for trial two more effective at keeping the water frozen than your trial one device?

5. Why do you think this was so?

Conclusion

6. In your class, which material(s) and construction techniques worked the best in keeping the ice?

7. Which material(s) and construction techniques were the worst in keeping the ice cube?