

Insulation

Student Objectives

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, plus a few extras for “mishaps”)
- 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 to impede 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 vacuum flask or

Thermos[®] bottle, 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 a 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 two 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 100 mL of frozen water inside their insulating device. Material that covers the top of the insulation device should be removable or flapped, so that the frozen cup can be inserted and the amount of water (melted ice) can be poured out periodically to be measured. The cup also needs to be able to stand upright in the device during testing, so the water does not leak out.
 - 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** – a material or substance that is used to stop heat, electricity or sound from going into or out of another material or substance
- **radiant energy** – energy that is transmitted in the form of electromagnetic radiation (i.e. solar), energy that exists in the absence of matter and 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.energyhog.org/childrens.htm>

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

<https://www.youtube.com/watch?v=WMZDYDvNqEM>

PBS SciGirls video, *Insulation Station*, the girls are tasked with making an ice shanty on a frozen lake in Minnesota warmer on the inside. The girls visit the University of Minnesota’s Solar Decathlon house and learn about insulation and the engineering process. They use this information to create and conduct their insulation experiments.

Insulation

Florida NGSS Standards & Related Subject Common Core

			.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								
Language Arts Standards	Sixth Grade: LAFS.6.SL.1.1 Seventh Grade: LAFS.7.SL.1.1 Eighth Grade: LAFS.8.SL.1.1													

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.

Language Arts–Standards for Speaking & Listening

- LAFS.6.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 6 topics, texts, and issues, building on others’ ideas and expressing their own clearly.

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.

Language Arts–Standards for Speaking & Listening

- LAFS.7.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.

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.

Language Arts–Standards for Speaking & Listening

- LAFS.8.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 8 topics, texts, and issues, building on others; ideas and expressing their own clearly.

National Next Generation Science Standards - Sixth to Eighth Grade Standards

Science–Energy

- MS-PS3-3 - Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- MS-PS3-4 - Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

Science–Engineering Design

- MS-ETS1-2 - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3 - Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

