DOCUMENT RESUME

ED 480 788 SE 068 029

AUTHOR	Rushton, Erik; Ryan, Emily; Swift, Charles
TITLE	What is the Best Insulator: Air, Styrofoam, Foil, or Cotton? Grades 3-5.
INSTITUTION	Tufts Univ., Medford, MA.
PUB DATE	2001-00-00
NOTE	11p.; Produced by the Office for Technology and Industry Collaboration. For other activities in series, see SE 068 011-041.
AVAILABLE FROM	Web site: www.prek-12engineering.org/activities/ .
PUB TYPE	Guides - Classroom - Teacher (052)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	Critical Thinking; Daily Living Skills; Elementary Education; Energy; Experiential Learning; Hands on Science; *Heat; *Matter; Physics; Science Activities; Science Instruction; Science Process Skills; Scientific Concepts; Student Motivation; *Temperature; *Thermal Insulation; *Water

ABSTRACT

Contrary to what many students think, heat flows from hot to cold. Working in groups of 3-4, students investigate the properties of insulators in attempts to keep a cup of water from freezing and, once it is frozen, to keep it from melting. This activity requires a 4.5-hour time period for completion. (Author/SOE)

Activity: **What is the Best Insulator: Air, Styrofoam, Foil, or Cotton?**

GRADE LEVELS: 3-5

SUMMARY:

Heat flows from hot to cold an unfortunate truth of life, people have put a lot of effort into stopping this fact, however all have been able to do is slow the process. Working in groups of three to four, the students will investigate the properties of insulators in attempts to keep a cup of water from freezing, and once it is frozen, to keep it from melting.

LEVEL OF DIFFICULTY [1=Least Difficult: 5=Most Difficult]

4-difficult

TIME REQUIRED

20 minutes to set-up

2 ½ hours to freeze

1 ½ hours to melt

COST

$1.00 per group

STANDARDS:

1.1 Identify materials used to accomplish a design task based on a specific property (i.e., weight, strength, hardness, and flexibility).

2.1 Identify a problem that reflects the need for shelter, storage, or convenience.

WHAT WILL THE STUDENTS LEARN?

What "insulate" means and its implications in keeping things cold/warm

Basic experimental processes

How natural materials differ from human-made materials in terms of insulation

BACKGROUND INFORMATION:

VOCABULARY:

INSULATE: to prevent or slow the transfer of electricity, heat, or sound from one environment to another

CONDUCTOR: a substance or body that can allow electricity, heat, or sound to pass through it

NONCONDUCTOR: a substance that resists the flow of heat, electricity, or sound thruogh it.

HEAT: a form of energy that causes substances to rise in temperature or to go through associated changes (as melting, evaporation, or expansion)

ENERGY: the capacity for doing work, energy can be in many forms such as electrical, mechanical, chemical and solar.

CONSERVATION OF ENERGY: a principle in physics that states that energy can neither be created nor destroyed and that the total energy of a system by itself remains constant

MELT: the process of changing from a solid to a liquid state through heat gain

FREEZE: the process of changing from a liquid to a solid (as ice) by loss of heat

Insulation helps keep cold things from warming up and warm things from cooling down. Insulators do this by slowing down the loss of heat from warm things and the gaining of heat by cool things. Usually plastics and rubbers are good insulators. It is for this reason that they coat electrical wires to make them more safe to handle. Metals, on the other hand, usually make good conductors. In fact, copper is used in most electrical wires and circuit boards.

RESOURCES:

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/phase.html - phase changes and phase diagram
http://www.chem.uidaho.edu/~honors/phases.html - phase changes
http://www.nyu.edu/pages/mathmol/textbook/energy.html - Energy description

MATERIALS:

4-3 oz. plastic cups per group

4-larger clear plastic cups per group

Warm water in a pitcher

Insulating materials (3-foam cups per group, 1- 8 ½" x 11" piece of aluminum foil per group, 20 cotton balls per group)

4-Rubber bands per group

Plastic wrap

Baking Pan

Large book or magazine

PREPARATION:

Obtain the materials

To minimize the time spent on the activity in the classroom, you can prepare the insulating materials (though students CAN do this!!):

Break up the foam cup into small pieces

Tear the aluminum foil into pieces and loosely crunch the pieces up

Pull the cotton balls apart a little and flatten them so that they resemble Pancakes.

DIRECTIONS:

Discus with your students what types of devices they have seen or used to keep things both warm or cold. Talk about the materials they think these devices are made out of. Have the students examine the insulators they are going to be given and have the groups make predictions about which will work best.

1. Have the students work in groups of two or three.

2. Give each group the materials they will need.

3. Each group will have four different insulators: air, styrofoam, aluminum foil, and cotton balls. Have the students place enough of each insulating material in

each large plastic cup so that it covers the bottom of the cup. Do not put anything in one of the large cups because the air will be the insulator for that cup.

4. Place a small 3 oz. cup in the center of each large cup.

5. Have the students fill the space between the cups with the same insulating material they put on the bottom.

6. Place 3 teaspoons of warm tap water in each small cup.

7. Have each group cover all of their large cups with plastic wrap held on by a rubber band.

8. Place the cups in the freezer. Check the cups every 15 minutes to see which cup forms ice first. Keep checking until you see ice form in all four cups, and record observations on chart provided (see link).

9. Allow the cups to sit in the freezer until the ice is frozen solid in all of the cups.

10. Take the cups out of the freezer and place in a baking pan.

11. Place a book or a magazine on top of the cups to keep them from tipping or floating.

12. Pour very warm tap water into the pan.

13. Have the class check their cups every few minutes to see which one seems to be melting first, second, third, and fourth.

EXTENSION:

For students to experience first hand that foil is not a good insulator, you can follow up the activity with this suggestion:

1. Have students wrap a cup with aluminum foil and another cup with paper.

2. Pour ice water into the cups.

3. Have the students hold the cups in their hands to judge which material is the best insulator.

INVESTIGATING QUESTIONS:

What does "insulate" mean?

What materials are used for insulation?

Which insulator was best at slowing down the loss of heat from the warm water? Which was the worst?

Did the results in the second half of the activity make sense with the results from the first half?

Is Styrofoam, foil, or cotton better for insulating a cup of ice?

REFERENCES:

Kessler, James H. and Andrea Bennett. The Best of WonderScience: elementary science activities. Boston: Delmar Publishers, 1997. p 207, 210-211 ISBN: 0827380941*

*Adapted with permission from The Best of Wonderscience, Copyright 1997, American Chemical Society Published by Wadsworth Publishing, Inc.. If you enjoyed this activity check out www.chemistry.org/wondernet, Your Science Place in Cyberspace, for free elementary physical science activities.

Rubric for Performance Assessment						
Activity Title:	WHICH IS THE BEST INSULATOR?			Grade level:		
	1	2	3	4		
Criteria	Beginning	Developing	Proficient	Advanced	Weight (X	Subtotal
Experimental Process	Student did not show understanding of insulating materials.	Student is beginning to understand what insulation is.	Student showed some understanding of insulation.	Student showed high understanding of insulating materials and was able to apply it to the real world.		
TEAMWORK	Student did not work with the group in preparing or collecting data.	Student helped slightly, but did not work well with the group.	Student participated in most of the group work.	Student worked well in the group and played an active role in preparing and collecting data.		
					Total:	
Teacher Comments:						

Name _____

Date _____

WHICH IS THE BEST INSULATOR: AIR, STYROFOAM, FOIL, OR COTTON?

DATA CHART

key: N = No, ice did not form
YP = Yes, partial ice formed
YC = Yes, ice is completely formed

time (min)	Styrofoam cup	aluminum foil	cotton	air
15				
30				
45				
60				
75				
90				
105				
120				
135				
150				
165				
180				

key: M = fully melted

NM = not fully melted

time (min)	Styrofoam cup	aluminum foil	cotton	air
15				
30				
45				
60				
75				
90				
105				
120				
135				
150				
165				
180				

Name _____

Date _____

WHICH IS THE BEST INSULATOR: AIR, STYROFOAM, FOIL, OR COTTON?
RESULTS CHART

PART 1: Placing the cups into the freezer

Cup	Insulating Material	Time to Form Ice (min.)	Order Ice Formed
1	Styrofoam Cup		
2	Aluminum Foil		
3	Cotton		
4	Air		

Which material insulated the water the best? _____

Which material insulated the water the worst? _____

PART 2: Placing the cups into the warm water

Cup	Insulating Material	Time to Melt Ice (min.)	Order Ice Melted
1	Styrofoam Cup		
2	Aluminum Foil		
3	Cotton		
4	Air		

Which material insulated the ice the best? _____

Which material insulated the ice the worst? _____

PreK-12 ENGINEERING

Activity Evaluation Form

www.k12engineering.org

Activity Name: _____

Grade Level the Activity was implemented at:_____

Was this Activity effective at this grade level (if so, why, and if not, why not)?

What were the Activity's strong points?

What were its weak points?

Was the suggested Time Required sufficient (if not, which aspects of the Activity took shorter or longer than expected)?

Was the supposed Cost accurate (if not, what were some factors that contributed to either lower or higher costs)?

Do you think that the Activity sufficiently represented the listed MA Framework Standards (if not, do you have suggestions that might improve the Activity's relevance)?

Was the suggested Preparation sufficient in raising the students' initial familiarity with the Activity's topic (if not, do you have suggestions of steps that might be added here)?

If there were any attached Rubrics or Worksheets, were they effective (if not, do you have suggestions for their improvement)?

Please return to: CEEO
105 Anderson Hall
Tufts University
Medford, MA 02155

SE060029

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

Reproduction Release
(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: PreK-12 Engineering Activities

1) Touch and Discover, Grades PreK-2
http://www.prek-12engineering.org/data/d2/Touchdiscover.pdf

2) Invent a Backscratcher from Everyday Materials, Grades PreK-2
http://www.prek-12engineering.org/data/d28/Backscratcher.pdf

3) Compare Human-Made Objects with Natural Objects, Grades PreK-5
http://www.prek-12engineering.org/data/d34/HumanvsNatural.pdf

4) Do Different Colors Absorb Heat Better?, Grades PreK-2
http://www.prek-12engineering.org/data/d37/Absorbheat.pdf

5) Which Roof is Tops?, Grades PreK-2
http://www.prek-12engineering.org/data/d44/RoofTops.pdf

6) Make Your Own Recycled Paper, Grades PreK-2
http://www.prek-12engineering.org/data/d56/Recycle.pdf

7) Build an Approximate Scale Model of an Object Using LEGOs, Grades 3-5
http://www.prek-12engineering.org/data/d3/LegoScaleModel.pdf

8) Design Weather Instruments using Lego Sensors, Grades 3-5
http://www.prek-12engineering.org/data/d4/LegoWeather.pdf

9) Space Shelter, Grades 3-5
http://www.prek-12engineering.org/data/d5/SpaceShelter.pdf

10) Build a Bird House, Grades 3-5
http://www.prek-12engineering.org/data/d6/BirdHouse.pdf

11) Ball Bounce Experiment, Grades 3-5
http://www.prek-12engineering.org/data/d6/BallBounce.pdf

12) Make an Alarm!, Grades 3-5
http://www.prek-12engineering.org/data/d11/MakeAlarm.pdf

13) Design Packing to Safely Mail Raw Spaghetti, Grades 3-5
http://www.prek-12engineering.org/data/d17/MailSpaghetti.pdf

14) Disassemble a Click Pen, Grades 3-5
http://www.prek-12engineering.org/data/d33/clickPen.pdf

15) Construct And Test Roofs for Different Climates, Grades 3-5
http://www.prek-12engineering.org/data/d35/ClimateRoof.pdf

16) Compare Fabric Materials, Grades 3-5
http://www.prek-12engineering.org/data/d36/Fabric.pdf

17) A House is a House for Me, Grades 3-5
http://www.prek-12engineering.org/data/d52/House.pdf

18) Water Filtration, Grades 3-5
http://www.prek-12engineering.org/data/d53/Water Filtration.pdf

19) What is the Best Insulator: Air, Styrofoam, Foil, or Cotton?, Grades 3-5
http://www.prek-12engineering.org/data/d54/BestInsulator.pdf

20) Design a Recycling Game!, Grades 3-5
http://www.prek-12engineering.org/data/d55/Recycling.pdf

21) Tower Investigation and the Egg, Grades 6-8
http://www.prek-12engineering.org/data/d7/TowerEgg.pdf

22) Wimpy Radar Antenna!, Grades 6-8
http://www.prek-12engineering.org/data/d10/WimpyAntenna.pdf

23) Portable Sundial, Grades 6-8
http://www.prek-12engineering.org/data/d30/PortableSundial.pdf

24) An Introduction To Loads Acting on Structures, Grades 6-8
http://www.prek-12engineering.org/data/d31/IntroLoads.pdf

25) Design Your Own Rube Goldberg Machine, Grades 6-8
http://www.prek-12engineering.org/data/d32/RubeGoldberg.pdf

26) Building Tetrahedral Kites, Grades 6-8
http://www.prek-12engineering.org/data/d38/tetrakites.pdf

27) Do as the Romans: Construct an Aqueduct!, Grades 6-8
http://www.prek-12engineering.org/data/d39/Aqueduct.pdf

28) Build an Earthquake City!!, Grades 6-8
http://www.prek-12engineering.org/data/d40/EarthquakeCity.pdf

29) Design a Parachute, Grades 6-8
http://www.prek-12engineering.org/data/d41/Parachute.pdf

30) The Squeeze is On, Grades 6-8
http://www.prek-12engineering.org/data/d42/Squeeze.pdf

31) Stop The Stretching, Grades 6-8
http://www.prek-12engineering.org/data/d43/StopStretching.pdf

32) Speaker Project, Grades 9-10
http://www.prek-12engineering.org/data/d13/Speaker.pdf

Author(s): Erik Rushton, Emily Ryan, Charles Swift

Corporate Source: Tufts University

Publication Date:

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, Resources in Education (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.
If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign in the indicated space following.

☒ Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g. electronic) and paper copy.

☐ Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only.

☐ Check here for Level 2B release, permitting reproduction and dissemination in ERIC archival collection microfiche only.

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.
I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche, or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Signature: Margaret Newell

Printed Name/Position/Title: Margaret Newell, Associate Provost for Research

Organization/Address: Tufts University
136 Harrison Avenue, Suite 75K-401
Boston, MA 02111

Telephone: 617-636-6550
Fax: 617-636-2917
E-mail Address: peter.wong@tufts.edu

Date: 8/15/2003

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to:

ERIC Clearinghouse for Science, Mathematics, and Environmental Education
Acquisitions
1929 Kenny Road
Columbus, OH 43210-1080

Telephone: (614) 292-6717
Toll Free: (800) 276-0462
FAX: (614) 292-0263
e-mail: ericse@osu.edu
WWW: http://www.ericse.org

EFF-088 (Rev. 9/97)