
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 through 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

www.prek-12engineering.org

Copyright © 2001

All Rights Reserved

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? _____

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