

Lesson 5: The Value of R-Value

Adopted/Revised From

NEED, Xcel Energy

Grade Level

6-12

Objectives

- Discuss and describe the importance of insulation for home energy efficiency
- Measure the cost savings over a specific amount of time with the addition of insulation
- Estimate the “payback period” for adding insulation

Overview

Students compare the properties, R-values, costs, and potential energy and cost savings associated with insulation.

Materials (per group)

- One ice tray
- Three thermometers
- Three sections of insulation
- Six rubber bands (optional)

Estimated Cost of Materials

\$15 per group

Computer Required?

No

Duration

1-2 class periods

Primer References

2.2 Insulation and Heat Transfer

Engagement

1. What does it mean to be energy efficient?
2. Why is it important?
3. What would it be like to live in a house with no insulation?
4. What are the benefits of insulating a building?

Investigation

Now we’re going to explore if using above average levels of insulation really makes a difference in the comfort, energy costs, and carbon emissions of a home or building:

1. Fill one ice tray per group with water so that the water is frozen in time for the activity.
2. Familiarize yourself with relevant background information in the teacher primer, ask students the inquiry questions, and tease out the answers to those questions.
3. Divide the students into small groups (no more than 5 recommended) and have one student per group retrieve the group's ice tray.
4. As the student is retrieving the ice tray, supply the groups with the other listed materials.
5. Once all group members have all materials, students place or rubber band one section of insulation randomly atop one third of the ice tray – this represents the average amount of insulation in a home.
6. Students should then layer two sections of insulation over another third of the ice tray in the same fashion representing an *above*-average amount of insulation in a home.
7. Students should then place (or rubber band) one thermometer directly atop the ice (the “control” representing no insulation) and each of the two sections of insulation.
8. Students should record relevant data on the activity sheets.

Class Review

1. Ask the groups to share the results of their experiments by reviewing each of the questions on the activity sheets as a class.
2. Which level of insulation would you purchase for your home? Why?

Elaboration

Now we have to figure out what makes a material a good insulator:

1. Have students read the Primer References.
2. What is R-value?
3. Do different materials have different R-values?
4. What is it about the foil insulation that makes it a good insulator? (air pockets)

Instructor Notes

- The thermometer placed directly atop the ice tray is the control and represents a home with no insulation. The thermometer placed atop one layer of insulation represents the average home. Two layers of insulation represent a building with an above-average level of insulation.

Extensions and Variations

- Use various types of insulation and/or insulating materials.
- Have each group arrange the control, one layer, and two layer setup in different orders on their ice trays and report differences in findings.

References/For More Information

U.S. Department of Energy:

www.newton.dep.anl.gov

www.ornl.gov

www1.eere.energy.gov

The Value of R-Value

Tray	Temperature						Delta T
	0 min.	2 min.	4 min.	6 min.	8 min.	10 min.	
Control (no insulation)							
Average (one layer)							
Above average (two layers)							

Questions

1. Graph the temperature change for all three levels of insulation.

2. Use the following equation to calculate a "payback period" for adding insulation to the attic of a home:

$$\text{Years to Payback} = (C(i) \times R(1) \times R(2) \times E) \div (C(e) \times [R(2) - R(1)] \times HDD \times 24)$$

Description of Variable	Figure to be Used
C(i) = Cost of insulation	\$0.50 per square foot
C(e) = Cost of energy	\$0.000008 per Btu
E = Efficiency of the heating system	80% efficient
R(1) = Initial R-value of attic	R-30
R(2) = Desired R-value of attic	R-49
HDD = Heating degree days/year	Find the "Seasonal Norm" for the town closest to you at: http://www.coloradoenergy.org/procorner/weather/hddz.htm or similar website

From: U.S. Department of Energy - www.energysavers.gov

3. Calculate the number of inches of insulation needed to add R-19 based on the following table:

What you see:		What it probably is	Depth (inches)	Total R-value
Loose fibers	light-weight yellow, pink, or white	fiberglass	_____	=2.5×depth
	dense gray or near-white, may have black specks	rock wool	_____	=2.8×depth
	small gray flat pieces or fibers (from newsprint)	cellulose	_____	=3.7×depth
Granules	light-weight	vermiculite or perlite	_____	=2.7×depth
Batts	light-weight yellow, pink, or white	fiberglass	_____	=3.2×depth

From: Oak Ridge National Laboratories - www.ornl.gov

Fiberglass (loose) _____

Rock Wool _____

Cellulose _____

Vermiculite _____

Fiberglass (batt) _____