

# “ICE” CAPADES

## – THE POWER OF INSULATION



Missouri  
Department of  
Natural Resources

### **GRADE LEVEL:**

Upper Elementary/Middle  
School (High School with  
extensions)

### **SUBJECT AREA:**

Sciences, Mathematics

### **DURATION:**

Preparation time 30 minutes

Activity time: One 50-minute  
class session

### **SETTING:**

Classroom

### **SKILLS:**

Application, Analysis,  
Synthesis, Evaluation

### **KEY WORDS:**

Energy, Radiation, Convection,  
Conduction

### **CORRELATIONS TO**

### **SHOW-ME STANDARDS:**

Performance Standards

1.1, 1.2, 1.3, 1.10, 2.3 3.1 3.3,  
4.6

Knowledge Standards

SC-1, 5, 7, 8

M-1

### **SUMMARY**

*Students are given an ice cube to protect from the heat of a light bulb. Student groups use various insulation materials to keep the ice cube from melting. Students explore principles of thermal energy transfer and the application of insulation in minimizing energy loss.*

### **OBJECTIVES**

#### **THE STUDENTS WILL:**

- ✓ Participate in cooperative problem solving in a group setting.
- ✓ Use insulation materials to protect an ice cube from melting.
- ✓ Evaluate the effectiveness of various insulation materials.
- ✓ Discuss the application of insulation techniques in reducing energy loss from buildings.

### **MATERIALS**

- Heat source: A table lamp with a 100 Watt or higher incandescent light bulb (A heat lamp or plant grow light would be ideal).
- Various types of insulation materials.

#### Examples

News paper  
Cloth  
Foam sheeting  
Aluminum foil  
Styrofoam (cups or packing peanuts)  
Construction paper  
Wool or Fur  
Feathers  
Plastic grocery bags  
Tissue paper  
Cardboard

*Warning: Commercial fiberglass insulation is not recommended due to safety issues associated with fiberglass splinters and dust.*

- Ice cubes (1-2 per group)
- Clear tape
- Small disposable plastic cups (preferably clear, 5 to 10 ounce size)

- Large disposable plastic cup (preferably clear, 12 to 16 ounce size)
- Graduated cylinder or similar device to measure the amount of water resulting from the melting ice cubes.
- Copies of the results table (one per group)
- Copies of question sheet (one per group)

## BACKGROUND

### INTRODUCTION

What melts an ice cube? The answer is heat of course, but what is heat? What is cold?

Heat is a form of *thermal energy* and results from the motion of atoms and molecules. Warm objects have a greater amount of thermal energy than cooler objects. Cold can be described as the absence of heat (less thermal energy).

Heat will flow from areas of high thermal energy towards areas of low thermal energy. An ice cube melts as heat flows towards the ice from its surroundings. Swimming in cold water results in a similar process as your body begins to lose its heat to the cooler water. On a cold winter day one can actually

feel the thermal energy (heat) leaving the body towards the cold surrounding air.

### TRANSFER OF THERMAL ENERGY

Heat is transferred in three basic ways. The first is *radiation* and involves the transfer of heat by light energy. The heat we feel from the sun or a hot light bulb is transferred by this process.

Another way heat is transferred is by *conduction*. This occurs when two objects transfer thermal energy by physical contact. Different materials have different conduction abilities. Metals are very good conductors while wood, foam and rubber are poor conductors of thermal energy. This explains why a coin feels cool to the touch even though it may be at the same temperature as a wooden pencil.

A final way heat can be transferred is by *convection* and involves the transfer of thermal energy between two objects by flowing currents of air or water. Cold air pulled through an open window into a warm house is an example of convective processes.

### USE OF INSULATIVE MATERIALS

Insulation materials are designed to interfere with thermal energy transfer. A jacket can keep you warm in winter by minimizing the movement of cold air currents over your body surface and reducing convective heat loss. Additionally, conductive heat loss can be reduced by adding layers of materials that are poor conductors of thermal energy to your clothing such as plastic fibers (fleece) or wool. The space suits worn by astronauts also include a silver foil lining designed to reduce energy transfer by radiation.

Insulation materials are used in homes and buildings to help minimize thermal energy loss and reduce the owner's energy bills. Home insulation not only reduces the loss of heat in winter but will also help keep a home cooler in summer.

How well an insulation resists heat flow is reflected in its "R-value". The higher the R-value the greater the resistance to thermal energy transfer. Some types of building insulation work by using materials with low conduction properties such as cellulose, plastic, rubber and wool. Other insulation

materials such as styrofoam, fiberglass, blown-cellulose and mineral-rock-wool, work by reducing the flow of air and minimizing convective heat loss. Most commercial insulations also incorporate a reflective layer of metallic foil to prevent heat lost from radiation as well.

## PROCEDURE

### WARM UP



Set the stage by asking the students the following questions:

- *Why does a jacket keep you warmer in the winter?*
- *What causes ice to melt?*

Review with the class the basic concepts of thermal energy transfer such as radiation, conduction, and convection, along with the application of insulating materials. (see background section)

### CONSTRUCTION OF AN “ICE PROTECTOR”

- Break the class up into several groups.

- Either assign or allow the groups to select one or more insulating materials (depending on class size and number of insulating materials at hand)

*You can allow each group to make a choice of insulation type and compete with other groups to “protect” the ice cube. Alternatively, if a less competitive environment is more appropriate, each group can be assigned a specific insulating material and the results for each material discussed by the class.*

- Give each group a large cup and smaller cup. Instruct the class that the smaller cup will be placed within the larger cup and ice placed inside the smaller cup. The group is free to apply their insulation(s) of choice to the space between the larger cup and the smaller cup. They should allow for access to the smaller cup, so that the ice to be placed into their device. The students can use clear tape to secure the insulation material.
- When the groups are ready, the instructor should place the ice cube(s) in each group’s smaller cup.

**Note: It is important to have ice cubes of the same size.**

- Allow the students to close up their “ice protector” and place each under a mild heat source (light bulb).

**Note: It is essential that each groups “ice protector” is placed the same distance from the heat source in order to achieve accurate results.**

- The “ice protectors” are left in place for 5-20 minutes (depending on the heat source used).

**Important: All the ice cubes should not be allowed to melt fully during the heat exposure period. The instructor needs to monitor the melting and stop exposure as soon as several of the ice cubes show clear signs of partial melting.**

- Remove the “ice protectors” from the heat source and pour the resulting liquid from each design into a graduated cylinder. The

students should record the results on the table provided (see appendix).

**The group that generates the least amount of liquid is the winner!**

## ASSESSMENT

Instruct each group to discuss and answer the following questions (work sheet found in appendix).

1. What insulation material(s) worked best to minimize thermal energy transfer? Why?
2. Can you identify the role of radiation, conduction and convection in the insulation strategy used by your group?
3. What specifically is a jacket doing to keep you warmer in the winter?
4. What areas in a home could be insulated to prevent energy loss?
5. What are the advantages to insulating a home?

## EXTENSIONS

Addition of insulation to homes and buildings is an important factor in conserving energy. More than half of the energy used by a typical residential home in America is used to

generate hot water and provide heating and cooling needs.

Many homes suffer from poor weather stripping, especially around doors and windows. At these locations convective air currents pull in outside air defeating the efforts of heating or cooling systems.

Have the students construct an “convective infiltration meter” (*Draft meter...see Energy Conservation Detective activity*) by taping a piece of tissue to a pencil. With this high-tech tool the students can hunt down air leaks in the schoolroom, school building or at their homes.

The students can apply weather stripping to the air leaks they discover and help to reduce this form of convective energy loss.

## GOING FURTHER

### THE ULTIMATE “ICE PROTECTOR”



Have the class work together as a whole to build the ultimate ice cube protector. Allow the students to use multiple layers of the

various insulation materials to really shield the ice cube from thermal energy loss!

Place the classes contraption next to the heat source (light bulb) and time how long it takes to melt the ice cube.

(Note: the construction of the protector must allow you to “take a peek” at the ice cube periodically to determine if it is still intact)

You may want to also place an uninsulated ice cube next to the ultimate ice protector for comparison purposes.

## THERMODYNAMICS

A chemistry class could consider modifying the “ice protector” to create a simple “bomb-calorimeter”. The students could use this to estimate the specific heat of water.





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# **CAPADES**

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  - 2. Can you identify the role of radiation, conduction and convection in the insulation strategy used by your group?**
  - 3. What specifically is a jacket doing to keep you warmer in the winter?**
  - 4. What areas in a home could be insulated to prevent energy loss?**
  - 5. What are the advantages to insulating a home?**
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