FROSTY FORMS

Topic
Physical change in matter

Key Question
How does the shape of ice affect how fast or slow it melts?

Focus
The students will observe ice as it melts and note the differences in melting rates of various shaped ice formations.

Guiding Documents
Project 2061 Benchmarks
- *Shapes such as circles, squares, and triangles can be used to describe many things that can be seen.*
- *Things change in some ways and stay the same in some ways.*
- *Heating and cooling cause changes in the properties of materials.*

NRC Standards
- *Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).*
- *Communicate investigations and explanations.*

*NCTM Standards 2000**
- *Recognize the attributes of length, volume, weight, area, and time*
- *Compare and order objects according to these attributes*

Math
Geometry
shape
Measurement
time
capacity

Science
Physical science
matter
physical change

Integrated Processes
Observing
Collecting and recording data
Comparing and contrasting
Communicating
Generalizing

Materials
For each group of students:
a variety of containers (see *Management 1)*
an ice cube
pie tin (see *Management 3)*
2 empty film canisters (see *Management 4*)

For the class:
access to a freezer
masking tape
salt
Which one will melt first? graph (see *Management 5*)
2 ribbon markers
graphing markers (see *Management 5*)
camera, optional

Background Information
Students will observe the physical change that takes place as ice melts into liquid water. The addition of heat causes this change to take place. Heat is added to the ice when it is taken out of the freezer and allowed to come to room temperature. When heat is taken away from the water, such as by placing it in a freezer, the water will turn to ice.

Liquid water takes on the shape of the container and can be poured. Solid water—ice—will keep its shape as long as it remains a solid. It cannot be poured.

The melting rate of ice is dependent upon its surrounding temperature and the amount of exposed surface area. Keeping all other variables the same, it can be generalized that the greater the exposed surface area, the faster the rate of melting.

This investigation develops conceptually as it progresses. *Part One* has students timing the melting rate of same size, same shape ice cubes. *Part Two* invites them to use the same volume of water in different-shaped containers to make ice. They then determine the melting rates to conclude that there are differences. *Part Three* allows students to combine different shapes (different surface areas) of ice to make ice castles and to predict the time required for them to melt.

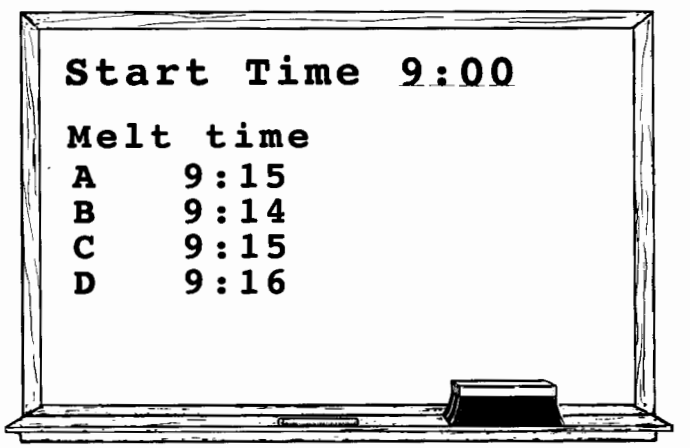
Management
1. Prior to the lesson, collect a variety of containers suitable to put in the freezer. For example, jar lids, margarine containers, paper cups, etc. Be sure to have many different sizes. When making the ice castles, each group will need at least three containers.
2. For *Part One*, bring in an ice cube for each group of four students.
3. Gather one pie tin large enough to hold the ice castle made by each group. The pie tins will be used in *Parts One* and *Three* of the investigation. To simplify the identification of the pie tins, label the bottom of each with letters of the alphabet: A, B, C, etc.

4. For *Part Two,* each group will need a different-sized container to which they will add the same amount of water (one filled film canister) that will need to be frozen. For *Part Three,* partially fill one film canister with table salt.
5. Enlarge the class prediction graph, *Which one will melt first?,* and duplicate one marker for each student. Also copy one *fastest* and one *slowest* ribbon.
6. Make arrangements to use a freezer.
7. A camera can be used to keep a record of the changes that occur to the ice castles during the melting process. The pictures can serve as a reminder to the students when they discuss the activity.

Procedure

Part One

1. Invite the students to think about ice formations they see outside. Ask them if some of the ice melts faster than others. Then ask: Do you think all these ice cubes will melt in the same amount of time?
2. Give each group of students an ice cube in a pie tin. Tell them to look at the label on the bottom of the tin so that they will know which cube belongs to their group.
3. Ask the students to describe the shape of the ice. Ask them to compare the sizes of the cubes. (They should all be approximately the same size.) Discuss how long they think it will take for their cubes to melt if left in the pie tin in the classroom.
4. Record the time on the chalkboard. Have the students place their pie tins (with cubes) on a central table in the class until they are all melted.
5. Make a chart on the chalkboard with the starting time and a list of the labels (A, B, C, etc.) for the groups. When each cube completely melts, record that time next to its label on the chalkboard.



6. Discuss how long it took these cubes to melt. Ask them why they think the ice melted.
7. Challenge students to think whether the time would be any different if the ice had been a different size or shape, or placed somewhere else (next to a heater, outside, in a refrigerator, etc.). Ask them to explain their thinking.

Part Two

1. Review with the students details of the ice cubes melting. Cover such things as: The ice cubes all took *about* the same amount of time to melt. The ice cubes were all *about* the same size and shape. The ice cubes melted—turned to liquid—because they were warmed by the room's air. The ice changed from a solid to a liquid.
2. Gather the groups together with a different container for each group. Using the same letter identification as in *Part One,* have students write the letter of their group on a piece of masking tape and attach the tape to their container. Give each group an empty film canister and tell them they will use the canister as a measuring device. Invite them to fill the canister with water and pour it into their container.
3. Tell them to compare their container of water with those of other groups. Discuss what they observe. Ask leading questions such as: Is your container full? Does the water cover the bottom of the container? How high is the water in your container? What shape is the water in the container? Is there the same amount of water in each container? How do you know? [Yes, each one has one canister of water.]
4. Discuss how some containers appear full while others appear almost empty and why this happens.
5. Ask students to predict what shape the ice will be if they freeze the water in their containers. Ask them how they can get the water to change from a liquid to a solid. [Put it in the freezer. Put it outside (if the weather is cold enough).]
6. Place containers in the freezer (or outdoors) and allow time for the water to freeze—perhaps overnight.
7. After the water has frozen, help students remove the ice from the containers and place in their pie tins. Have them place the container beside the pie tin.
8. Record the time on the chalkboard. While the ice is melting, direct the students to closely observe the ice formations. Discuss and compare the sizes and shapes of the ice from each container.
9. Have students place a marker on the enlarged class graph to show their predictions as to which formation will melt first. Discuss how they made these choices.

10. Direct each group to draw a picture of their ice formation to show the shape and thickness. Tell them to label their picture with the letter (A, B, C, etc.) that corresponds to their container and to display these pictures next to the class graph.
11. As each ice formation finishes melting, direct the students to place ribbons on the class graph to indicate actual results of the *fastest* and the *slowest* melting ice formation.
12. Again discuss why the ice melted.

Part Three

1. Inform the students that they will be making ice castles and that they need to select three different containers in which their group will freeze some water to make the ice to build the castles.
2. Have them label the containers by writing their group letter on masking tape.
3. Direct them to again use the film canister as the measuring device and to pour one full canister of water into each container. Discuss what shape and thickness the ice will be for each container.
4. Freeze the water.
5. After the water has frozen, help students remove the ice from the containers. Distribute a canister of salt to each group.
6. Demonstrate how to join ice formations by lightly sprinkling salt on one surface of the ice. As soon as some liquid appears, place another piece of ice on top. The water will begin to freeze thus joining the two pieces.
7. Once all the castles have been built, discuss the new shapes that were formed. Discuss which shapes were easier to stack.
8. Record the time. Ask the students to predict how long it will take for the ice castles to melt. Have them explain their reasoning. Ask students to indicate which part(s) of the ice castles will melt the fastest. ...the slowest. Have them explain why.
9. Direct students to draw pictures of their ice castles. (To keep a record of the melting process, you may want to take photographs of the castles at various intervals.)
10. At regular intervals, return to the ice castles to observe the changes during the melting process. Discuss the changes, emphasizing the change in the state of matter—solid to liquid.
11. When the castles have all melted, compare the students' melting time predictions with the actual results. Have the students use vocabulary such as *greater than* and *less than*.

Discussion

1. What causes water to change to ice?
2. What causes ice to change to water?
3. What is ice?
4. What shape is water? Does its shape ever change? Explain.
5. Does the same amount of water look the same in all sizes and shapes of containers? Explain.
6. When water is frozen in a container, what shape is made? Explain.
7. Did all the ice formations take the same amount of time to melt? Which ones melted fastest? ...slowest? Why do you think some melted faster or slower than others?
8. Describe your ice castle.
9. What happened when you added salt to the ice formations?
10. If you didn't want your castle to melt so fast, what could you do to make it melt slower? [Put it in the freezer. Use a container that will give "thicker" ice.]
11. Tell some things you learned about ice.

Extensions

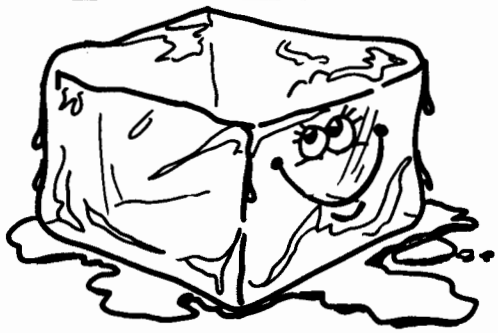
1. Have students bring containers from home that they want to use in building an ice castle. Use them to make one large castle for the entire class. To add color to the ice castles, use food coloring to tint film canisters filled with water. Demonstrate how to use a straw as a dropper by dipping one end into a canister of colored water. Once the straw is in the water, place one finger over the top of the straw. Pull the straw out of the water, hold it over the ice castle, and remove the finger from the top of the straw. This will release the water from the straw. Some of the colored water will freeze and some will simply run to the bottom of the structure.
2. Show the students pictures of icebergs. Discuss how these are very large pieces of ice found in nature. Begin a study of the Arctic regions. Study the adaptations made by humans and other animals to the severe climate conditions found there.

Home Link

Ask the students to observe the different shapes of ice formations made by nature around their homes. Do some melt faster than others? What do you notice about these shapes?

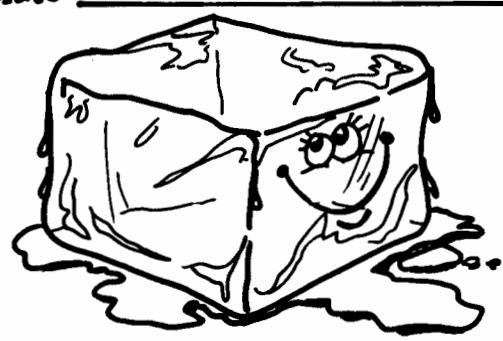
Graphing Markers

Name: _____

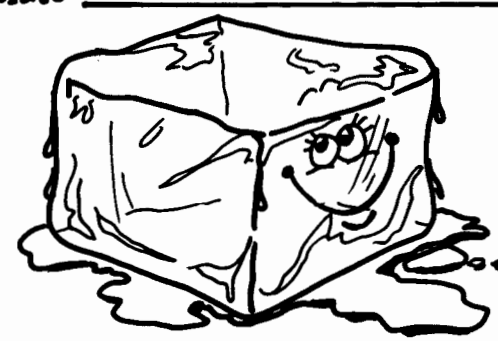


Name: _____

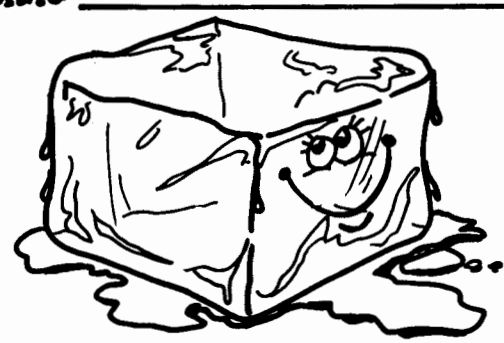
Name: _____



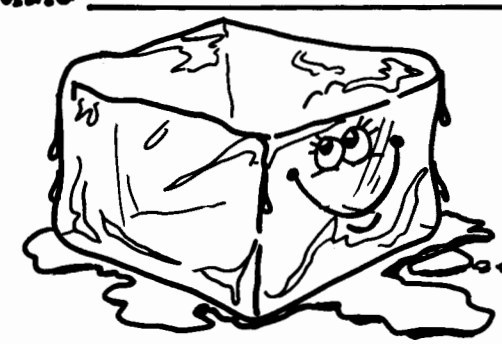
Name: _____



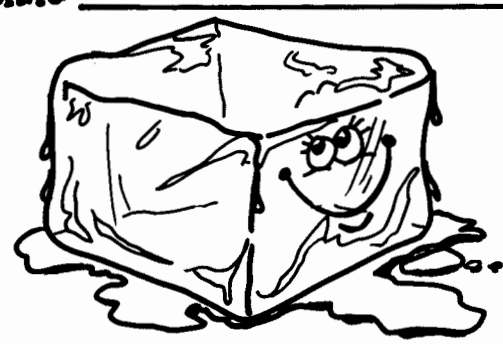
Name: _____



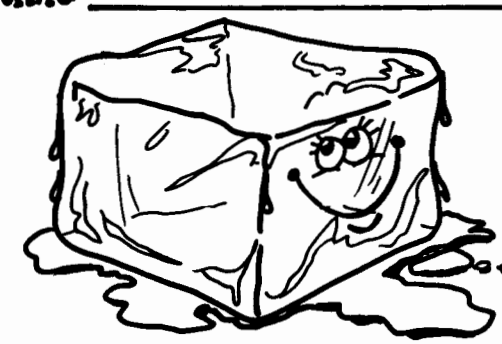
Name: _____

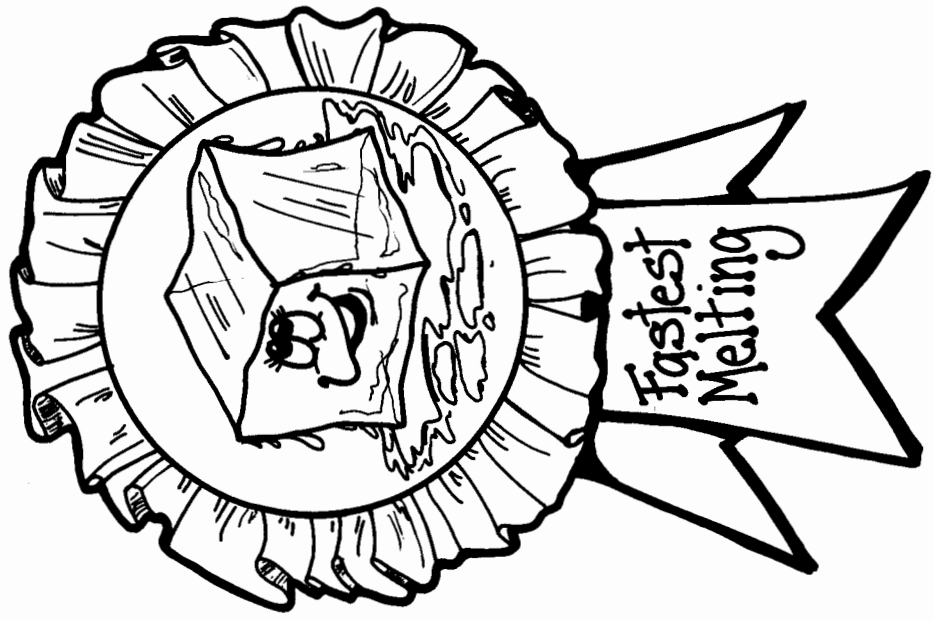


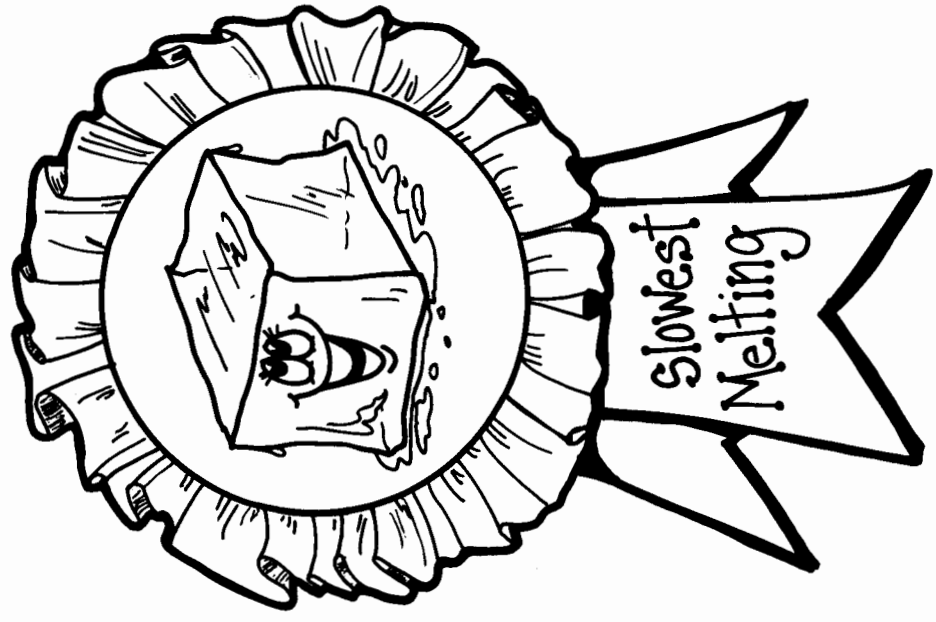
Name: _____



Name: _____







Frosty Forms

Part 1

1. Draw the shape of your ice.

2. How long do you think the ice will take to melt?

_____ minutes

3. How long did the ice take to melt?

_____ minutes

Part 2

1. Draw the shape of your ice.

2. How long do you think the ice will take to melt?

_____ minutes

3. How long did the ice take to melt?

_____ minutes

4. What shape melted fastest?
5. What shape melted slowest?

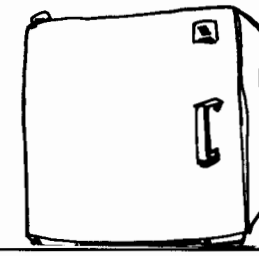
fastest | slowest

Ice Castles

1. Choose three containers.

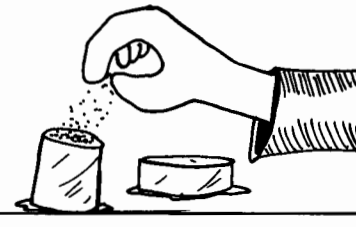
2. Pour one canister of water in each.

3. Freeze and make ice.

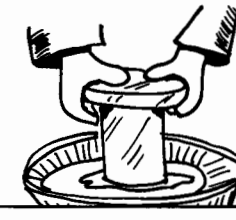


4. Take ice out of containers.

5. Sprinkle a little salt on one piece of ice.



6. When liquid shows, put another piece of ice on top.



7.

8. How long will it take for your ice castle to melt?

My prediction _____ Real Melting Time _____

FROSTY FORMS

Which one will melt first?

A	B	C	D