Name_____Date_____Class_____

PROJECT OVERVIEW

In Hot Water

In this chapter you will learn about temperature, thermal energy, and heat and how these concepts are related. Keep in mind what you learn because you will be using this information to design a container to slow the loss of heat from a 355-mL aluminum can of hot water.

This project has two parts. In the first part, you will design and conduct experiments to learn more about materials that can help prevent heat loss. In addition, your experiments will investigate whether certain container designs slow heat loss more than other designs.

The second part of the project involves building a container that insulates an aluminum can of hot water. Once you have built your device, you should test it with various water temperatures.

For your presentation, your teacher will fill your can with hot water of a known temperature. At the end of the class period, the temperature of the water in your can will be measured. If the difference between the starting and ending temperatures is small, your container is a good insulator!

Project Rules

- Have your teacher approve your plans before you begin your experiments.
- Your container must be something you assembled. You cannot use ready- made or manufactured devices. This excludes foam drink holders and commercial bottles or cups. In addition, you may not use electric current or heating chemicals.
- Your container should keep the water sample as hot as possible while using the thinnest amount of insulation. The insulation must be no thicker than 3 cm.
- The opening of the can must be easily reached so that hot water can be poured in. However, you may cover the opening of the can during the cooling period.
- The aluminum can may not have any other holes besides the opening in the top.
- When you design your project, keep in mind that a thermometer will be inserted through the opening in the top to measure the final temperature.

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Safety

You will be working with hot containers and water that can burn skin. Be careful, especially when moving the hot water.

Suggested Materials

In your group, you will need to test many different materials for their ability to insulate. Examples include: aluminum foil, newspaper, packing peanuts, cardboard, nylon cloth, canvas cloth, cotton balls, plastic wrap, foam board, and wood chips. You can try other materials as well.

Project Hints

- Record the data from your experiments as outlined in Project Worksheet 1.
- Share the results of your experiments with other students and rank the materials and container designs with respect to their ability to minimize heat loss (see Worksheet 1). Each person can do a different experiment and learn from each other's work.
- Use Project Worksheet 2 to help you with the design and construction of your device.
- Plan on building your insulating device several days before it is due. You will need time to test your device with different temperatures of water. Record the temperature of the water in the can every 10 minutes for 40 minutes. You can then make a graph by plotting temperature against time.

Project Timeline

Task	Due Date
1. Project Worksheet 1 completed.	Thursday, October 22nd
2. Project Worksheet 2 completed.	Friday, October 23rd
3. Insulating device constructed.	Wednesday, November 4th
4. Tests of insulating device completed.	Wednesday, November 4th
5. Device presented and tested in class.	Friday, November 6th

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PROJECT WORKSHEET 1

In Hot Water

Some of your experiments should help you to determine which types of materials make the best insulators. Make a table similar to the one below on a separate sheet of paper. Add a separate row for each material you test. Use it to record your data.

Material Tested	**Time**	**Temp. (°C)**	**Insulating Ability Rank**
	Start_____	Start_____	
	End_____ Elapsed (mins) _____	End_____ Change _____	

1. Write the name of the material to be tested in the first column.
2. Record starting and ending times of your experiment in the second column. Use these times to calculate the elapsed time in minutes. You should try to keep the elapsed time the same for all materials.
3. In column three, record the starting, ending, and change in temperature of the water in the can. The starting temperature should be the same or nearly the same for all materials tested.
4. Once you have all of your data, determine a way to rank the materials in terms of their insulating ability.

You will also need to conduct experiments to determine the best location and thickness for the insulation. Make a table similar to the one below on a separate sheet of paper. Add a separate row for each design you test. Use it to record your group's data.

Design	**Time**	**Temp. (°C)**	**Insulating Ability Rank**
	Start_____	Start_____	
	End_____ Elapsed (mins) _____	End_____ Change _____	

1. In the first column give a description of the design being tested (with or without lid, thickness of insulation, with or without bottom, and so on).
2. The elapsed time and starting temperature of the water should be the same or nearly the same for each design.
3. Once you have all of your data, determine a way to rank the designs in terms of their insulating ability.

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PROJECT WORKSHEET 2

In Hot Water

Answer the following questions to help you design your insulating device.

1. Why was it important to keep the elapsed time and the starting temperature of each of your experiments the same or nearly the same?

_____

_____

2. What method did you use to rank the materials and designs that you tested?

_____

_____

3. Which three materials that you tested were the best at insulating the hot water? Do these materials have anything in common? What are some similar materials?

_____

_____

_____

4. Which three design features that you tested were the best at insulating the hot water? Can you think of a way to include all three design features in your device?

_____

_____

_____

5. Using the results of your experiments, choose one or more materials that are good insulators and choose the design features that you want to use. Make a sketch of your plan for your container on a separate sheet of paper. Label its important features.

6. On a separate sheet of paper, make a list of the materials you will need to construct your device. Be sure to identify other materials that may be needed during construction such as tape, string, or glue.

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SCORING RUBRIC

In Hot Water

In evaluating how well you complete the Chapter Project, your teacher will judge your work in the following categories. In each, a score of 5 is the best rating.

	5	***4***	***2***	***1***	***Total***
Developing Experimental Design and Testing Materials	Experimental design clearly shows understanding of the value of keeping some variables constant. Experiments test both materials and design features.	Design shows good understanding of the value of keeping some variables constant. Experiments test both materials and design features.	Design shows partial understanding of the value of keeping some variables constant. Experiments test either materials or design features, but not both.	Design shows limited understanding of the value of keeping some variables constant. Experiments test either materials or design features, but not both.	
Designing, Building, and Testing the Insulation Device	Device adheres to project rules. Device is an excellent insulator. Complete testing of device performed on time.	Device adheres to project rules. Device is a good insulator. Testing of device performed on time.	Device adheres to project rules. Device is a poor insulator. Testing of device is incomplete.	Device clearly violates one or more project rules. Testing of device is incomplete.	
Predicting Results	Uses knowledge learned in project. Accurately predicts final temperature of several different device designs, including own.	Uses knowledge learned in project. Accurately predicts final temperature of two or more device designs, including own.	Uses knowledge learned in project. Accurately predicts final temperature of own device only.	Guesses rather than uses knowledge learned in project. Predictions of all devices, including own, are inaccurate.	
Working Cooperatively (optional)	Takes a lead in group planning. Effectively communicates container features to class.	Participates in all aspects of group planning. Communicates most container features to class.	Participates in most aspects of group planning. Communicates some container features to class.	Participates minimally in group planning. Communicates few container features to class.	
				Total	/20