Heat Transfer Lab

Re-Energy
Learning Activity
Grade Level: 7-12

Main Objectives

Learners investigate and explain the thermal energy storage value of materials. They will evaluate the best practices in storing heat energy.

Learning Outcomes

By the end of this activity, learners will:

- Understand the science of thermal energy storage.
- Learn how to investigate and explain the thermal energy storage value of materials.
- Utilize GreenLearning's Spiral Inquiry Model to answer the question: Water is the best and easily obtainable material to transfer heat. What materials would you use to contain this heat energy for a prolonged period of time?

Curriculum Connections

Alberta

Grade 9 Science
Key concepts:

- Forms of energy, energy transformation, renewable and non-renewable energy
- Generation of electrical energy
- Electrical energy storage
- Energy transmission
- Construct, use and evaluate devices for transforming mechanical energy into electrical energy and for transforming electrical energy into mechanical energy
- Describe and discuss the societal and environmental implications of the use of electrical energy.

Grade 10 Science

- Efficient use of energy, and the environmental impact of inefficient use of energy
- Mechanical energy conversions and work
- Technological innovations of engines that led to the development of the concept of energy.

Length of Activity

2-3 hours

Materials List

Internet-enabled device
Thermal Energy Storage backgrounder
Learner handout and graph paper
Large bowl or tub
Ziplock bags
Ice
Containers of different density and materials
Water
Kettle
Thermometers
Insulating materials

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Overview

Review (10-15 minutes)

1. Read over the Heat Transferring Materials backgrounder.
2. Be sure that learners understand the concepts of heat capacity and thermal resistance.
3. In higher level courses or science this would be an optimal time to go over the measurements and mathematical calculations for both.
4. Brainstorm ways they could better insulate the materials they are testing.

Educator Lab Demonstration (20-30 minutes)

1. The educator will walk the learners through the lab using most basic materials glass, and fabric insulators.
2. The educator will also hand out lab procedures, graph paper, and the marking rubric.

Learner Lab Activity (60-75 minutes)

1. Evaluate the rubric as a class.
2. Now that the educator has demonstrated the lab activity, learners will conduct the lab experiment.

Presentation of Learner Findings

(Variable time allotment)

- Rubric evaluations dependent on grade level

Procedure

Step 1: Lay the bowl or tub on the lab bench.

Step 2: Pour your ice into the Ziplock bags and lay in the tub or bowl.

Step 3: Place thermometers on top of the ice to gain an accurate measurement of the ice.

Step 4: Place containers on top of ice sheets and fill with hot water.

Step 5: Add thermometers to the water and attach a thermometer to the outside of the container.

Step 6: Record temperature at two-minute intervals for 10 minutes in degrees Celsius.

Step 7: Repeat this process with the same containers but adding insulators on the outside of the container.

Tip: Ensure containers are at room temperature for the start of each process.

Step 8: Record temperatures at two-minute intervals for 10 minutes in degrees Celsius.

Step 9: Graph your results in either a bar graph or a line graph.

Step 10: Answer the following questions in your written lab report:

a. Which vessel has the best thermal resistance?
b. Which insulators improved thermal resistance the best inside the vessel?
c. Why do you believe they behaved that way?
d. Is there another medium that could be better at maintaining heat capacity than water? What issues might arise in commercial use of that material?
e. What changes would you make to the lab in order to have more accurate results?
f. What ways can this information be used in the future of thermal energy storage?

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Extension Activity: Heat Transferring Materials

Before you begin: This is an inquiry-based extension activity which follows GreenLearning's Spiral Inquiry Model found here: https://programs.greenlearning.ca/course/spiral-inquiry-model

The relationship between energy change and temperature change of a material is wrapped up in the concept of **heat capacity,** sometimes called specific heat. Simply put, the heat capacity expresses how much energy you need to change the temperature of a given mass. The heat capacity of a material along with its total mass and its temperature, tells us how much thermal energy is stored in a material. One way to summarize this is to say that the higher the heat capacity, the greater the thermal inertia, which means that more energy is required to change the temperature. In terms of natural materials, water has the best heat capacity at Jkg-1K-1. This means that water holds on to its temperature longer and changes slowly.

This is an important concept to understand when we are trying to transfer heat as well as store it. When we store heat, we need to evaluate a materials **thermal resistance.** Thermal resistance is a heat property and a measurement of a temperature difference by which an on object or material resists a heat flow.

Spark: We know that water is the best and easily obtainable material to transfer heat. Based on this, what materials would you use to contain this heat energy for a prolonged period of time?

Hypothesis:

- Create a list of materials that you feel would resist heat transfer. These materials must be easily obtainable and be in a vessel shape that can hold high temperature liquid.
- Create a list of materials that could be potentially manipulated to insulate the vessels. Again, for the purpose of your experiment these materials must be locally sourced.

Explore:

- Based on the information you have been given and your own understanding of thermal energy how might this information be used in energy storage?
- What kinds of modifications would you make to energy storage systems that would make them more efficient?

Analyze:

- Graph your results in either a line or bar graph. Which materials resisted heat loss best?
- Which insulators maintained heat best inside the vessel?
- What changes would you make to the lab in order to have stronger more accurate results?

Communicate: Once you have completed your analysis communicate your findings and its implications to your class. What ways can this information be used in the future of thermal energy storage?

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