MAKING LEMON ICE  (1 Hour)

Addresses NGSS
Level of Difficulty: 2
Grade Range: 3-5

OVERVIEW
In this activity, students will learn about thermal energy. Students will observe how energy can be conserved and transferred using ice and salt. Students will use thermometers to observe the changes in thermal energy. Students will then design their own experiment determining the proportions required to transfer enough energy to freeze and make lemon ice.

Topic: Energy

Real-World Science Topics
• Understanding that changes in temperature impact the movement of matter
• Analyzing how changes in thermal energy can be used to control environments

Objective
By the end of this lesson, students will understand that energy can be transferred from warmer to colder environments. Also, thermal energy is being measured by the change in temperature. Students will also develop skills in finding solutions to problems they may see in their world.

NGSS Three-Dimensions

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
</table>
| Planning and Carrying Out Investigations
  • Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
  • Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2) |
| PS3.B: Conservation of Energy and Energy Transfer
  • Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2),(4-PS3-4) |
| Energy and Matter
  • Energy can be transferred in various ways and between objects. (4-PS3-1),(4-PS3-2), (4-PS3-3),(4-PS3-4) |

(Source: Next Generation Science Standards)
Background Information

What is the relationship between particles and changes of state?

Everything is comprised of particles of matter. A change in the flow of thermal energy causes a change of state. As water changes state, the rate of particle movement will increase or decrease. When a solid turns to a liquid, the particles begin to move faster. When a liquid changes to a solid, the particles begin to slow down.

How does freezing point impact the flow of energy?

As a substance begins to freeze the movement of its particles slows down. (Water has a freezing point of 320 F, or 00 C). By adding a substance such as salt to ice you are lowering the freezing point of the water/salt solution. The salt mixes with the molecules of water increasing the flow of energy between the two and the ice will begin to melt. The ice will begin to melt because thermal energy is being released. We can observe this by measuring the temperature of the mixture. For example, when salt is added to an already frozen road it causes the ice to melt because the salt particles get in the way of the water molecules ability to freeze together.

How is energy transferred?

When two objects interact they transfer energy. In the Law of Conservation of Energy, we know that energy cannot be created or destroyed. Therefore, energy is either being stored as potential energy or used as kinetic energy. Thermal energy is a form of kinetic energy and transfers energy from warmer to colder matter. Thermal energy not only encompasses an increase in temperature it also encompasses decreases in temperature. Energy is absorbed by a colder object from a warmer object. The larger the variance in temperature the more quickly the energy is transferred.

Key Vocabulary

Law of Conservation of Energy – energy cannot be created or destroyed but it can be changed or transferred
Ratio – comparing two things together
Solution – when two substances are mixed together to create one substance (homogeneous mixture)
Temperature – measures the amount of heat or particle movement
Thermal Energy – is a type of heat energy when particles in matter are moving. Thermal energy is an example of kinetic energy.
MAKING LEMON ICE

Materials Needed for Activity

• Ziploc Sandwich Bags
• Ziploc Gallon Bags
• Thermometers
• Ice cubes (school cafeteria can be very helpful accessing ice)
• Ice Cream Salt (rock salt)
• Kool-Aid Lemonade or other brand
• Water Jugs
• Measuring Cups
• Stop watches or clock
• Cooler or storage containers for ice
• Popsicle Sticks
• Pencils
• Worksheet
• Extension activity - kosher/table salt or sugar cubes

Teacher Preparation

Set up for 2-3 students per group. Each group will have a bag set up. One student will gently swing the bag, another student will read the thermometer and the third student will record the data.

Mix lemonade in advance and pour about ½ to 1 cup into a sandwich zipper bag (one for each group). Be sure to close the zipper so that the bag is sealed.

Ratio of salt to ice is what causes the lemonade to freeze. Use measuring cups that allow the students to compare their ratios e.g. use 1 cup for both salt and ice or 1 cup and ½ cup measures.

Obtain ice cubes and have a cooler or other means of keeping it frozen until ready to use.

Depending on amount of materials available, you can limit the maximum quantity they can use of each substance. For example, no more than 3 cups of ice cubes or 1 cup of salt.

Depending on your lab rules, the popsicle sticks can be used to scoop out and eat their lemon ice. Have all materials ready to use.
1. **Warm-up Activity:** In their science journals students should respond to the question “How does energy affect changes in states of matter?” Have students share their thoughts and reflection.

2. The teacher will review with students when a change of state occurs energy is increasing or decreasing.
   - Teacher explains “Today, we are going to focus on one form of energy, thermal energy.”
   - Teacher should provide students with information about thermal energy. Students should understand that thermal energy is measured by average temperature and that thermometers are the tools used to measure thermal energy.
   - Provide students with thermometers and instruct them on how to read them. They should be able to see how to measure Celsius and/or Fahrenheit.
   - Discuss the freezing temperature of water both in Celsius and Fahrenheit. 320 F or 00 C.

3. Teacher will explain that today students will be observing a model and then designing their own experiment. Teacher will place ice cubes and salt in one gallon bag and only ice in another gallon bag. Teacher will place a thermometer in each bag. Do not disclose to the students the quantities used of ice or quantity/type of salt. Ask students to predict whether the temperature in each bag will increase or decrease. Teacher will ask students to read the temperature on the thermometers. After 30 seconds the teacher will record the temperature on the board, repeating again 30 second intervals for about 3 minutes. Using the temperature readings recorded; discuss with the class the accuracy of their prediction along with their reasoning.

4. “Based on my demonstration, I would like your groups to design and conduct an experiment to see who can change this bag of liquid lemonade into lemon ice in the shortest amount of time.” Describe the materials available.
   - Demonstrate to students that to do this they will be placing a small bag of lemonade in the bag of salt/ice mixture.
   - Because both bags will be sealed they won’t be able to stir the lemonade so one student in their group will gently swing the bag back and forth.

5. Pass out the worksheet. Have students read through the directions/activity and answer/clarify any questions they may have. Review the question/problem. “How will an ice/salt solution impact the transfer of energy?”
   - Explain that
     - Each member of the group will be responsible for part of the activity.
     - responsible for the bag
     - timekeeper
     - recorder
     - The thermometer should be in the ice cubes (not the lemonade)
     - Students will gently swing the bag back and forth.
     - Limitations on amounts of ice or salt to be used.

6. At the end of the lesson, discuss results as a class.
   - Which salt/ice combination created lemon ice in the shortest amount of time?
   - How did your solution of salt/ice impact the lemonade? (is it still a liquid, did it freeze, is it slushy?)
   - How did the ratio of salt to ice impact your results?
   - Did the energy transfer from the ice to the lemonade OR the lemonade to the ice? Explain your reasoning?
   - What role did energy play in your experiment?
Extension Activity

Using their data from this experiment, students could hypothesize on what would happen if they used different types of salt or used another substance, such as sugar cubes.

Sources


Websites

http://www.physics4kids.com/files/thermo_transfer.html
http://www.eia.gov/kids/
Name: __________________________________________________________________
Date: __________________________________________________________________

Lemon Ice

“How will an ice/salt solution impact the transfer of energy?”

Variable: In your group determine the proportion (ratio) of ice to salt.
How much ice will go into the bag? ____________
How much salt will go into the bag? ____________

Observation: Describe the appearance of the lemonade.

Procedure
Use the data table below to record your observations

Measure the ice into the gallon bag.
Put a thermometer in the bag and record the reading after 30 seconds. Record the temperature in the table below.
Measure and add salt into the gallon bag.
Gently shake the bag to mix the salt and ice together.
Record the temperature reading of the mixture.
Put in the bag of lemonade. Make sure that the ice/salt mixture surrounds the lemonade.
Place a thermometer in the ice. Make sure that you can see the temperature readings through the bag.
Seal the big bag of ice/salt with the lemonade.
Gently shake the bag of ice bag and forth.
Record the reading on the thermometer every 30 seconds.
Observe your lemonade at each reading until the lemonade has become a lemon ice/slush.
Data/Evidence:

<table>
<thead>
<tr>
<th>Time</th>
<th>Temperature</th>
<th>Change in temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature of salt/ice</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remove the bag of lemon ice and describe what you see.

How much did the temperature increase or decrease during your observations?

How does the change in temperature demonstrate how energy was used?