Unit 5: Insulation

PEAK Lab: Insulation – Keeping Heat In and Keeping Heat Out

Lesson Description: Students build model "hot water heaters" and examine the role insulation plays in blocking the flow of heat energy.

Student Learning Objectives: Students use the scientific method to compare different materials and to examine their insulating properties.

Standards Supported

<table>
<thead>
<tr>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>Grade 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Comprehension: 2.0, 2.7</td>
<td>Reading Comprehension: 2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investigation and Experimentation: 5c, 5d, 5e</td>
<td>Investigation and Experimentation: 6c, 6d, 6e, 6f</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investigation and Experimentation: 2.0</td>
<td>Investigation and Experimentation: 2.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PEAK Student Energy Action Activity: Insulation Audit

Lesson Description: Students participate in a classroom discussion about insulation and its effects on a building’s temperature, energy efficiency, and energy costs. Students also conduct a Classroom Insulation Audit. At home, students perform an Insulation Audit and present their findings to an adult, discussing how proper insulation saves money on energy bills.

Student Learning Objectives: Students know that proper insulation increases energy efficiency and understand the link between energy conservation, saving money and reducing greenhouse gas emissions.

Standards Supported

<table>
<thead>
<tr>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>Grade 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigation and Experimentation: 5e</td>
<td>Investigation and Experimentation: 6c, 6f</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listening and Speaking: 1.0, 1.1, 1.2, 1.3, 1.5 - 1.8</td>
<td>Listening and Speaking: 1.0, 1.5 - 1.9, 2.0, 2.2a, 2.2b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investigation and Experimentation: 6h</td>
<td>Investigation and Experimentation: 6b, 6c, 6e - h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listening and Speaking: 1.0, 1.4, 1.5, 1.6, 2.0, 2.2a, 2.2b, 2.2c</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade 6</th>
<th>Grade 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Science: 3a, 3c</td>
<td></td>
</tr>
<tr>
<td>Reading Comprehension: 2.0</td>
<td></td>
</tr>
<tr>
<td>Investigation and Experimentation: 7a, 7b, 7c, 7e</td>
<td></td>
</tr>
<tr>
<td>Listening and Speaking: 1.4 - 1.6, 2.0</td>
<td></td>
</tr>
<tr>
<td>Speaking Applications: 2.4a, 2.4b</td>
<td></td>
</tr>
</tbody>
</table>
Unit 5 Lab: Insulation
Keeping Heat In and Keeping Heat Out
Classroom Time: 2 hours

Lesson Description: Students build model “hot water heaters” and examine the role insulation plays in blocking the flow of heat energy.

Student Learning Objective: Students use the scientific method to compare different materials and to examine their insulating properties.

Where does this activity fit into your classroom?
The activities in this lesson support the following California academic content standards:

Grade 3: Reading Comprehension: 2.0, 2.7
Investigation and Experimentation: 5c, 5d, 5e

Grade 4: Reading Comprehension: 2.0
Investigation and Experimentation: 6c, 6d, 6e, 6f

Grade 5: Reading Comprehension: 2.0
Investigation and Experimentation: 6b, 6c, 6e - h

Materials/Resources:
Student Background (Page 97); Lab Instructions (Pages 98-100); Insulation Lab Worksheet (Pages 101-102); Analyze and Assess Questions (Page 103)
2 pieces of graph paper

Per Student Group (4-6 students)

Provided by Teacher
- 3 identical soda cans
- A clock, watch or timer
- Ruler
- Safety glasses
- Disposable gloves
- 750 ml of hot water (50° C/122° F)
- One or more of the following suggested insulating materials: fiberglass, wool, styrofoam, newspaper, aluminum foil, jeans.
- 3 Post-its
- A 100-Watt incandescent lamp (Optional: Groups can conduct experiment outside in sunny weather.)

Provided in PEAK Tool Kit
- Felt and foam
- 3 thermometers
- Rubber bands
Lesson Background

How Does Heat Energy Move?
Heat energy tends to move from hotter areas toward cooler areas. For example, on a cold day the warmth inside a home can escape through a crack under a window or through thin walls to the outdoors. On a hot day, the heat outside can enter an air-conditioned home through the same crack. This means that some of the energy used to heat or cool the home is being wasted! This energy waste can be stopped by installing proper insulation. (In this lab, we focus on insulation for temperature control. Unit 6 explores how insulators inhibit the movement of electricity.)

What is Insulation?
Insulation is any material that blocks or reduces the flow of heat energy. Some materials are more effective insulators than others. The best insulating material for a home or building keeps the most heat in during cold weather and the most heat out during hot weather. To conserve energy and to control temperature, insulation is used in attics, exterior walls, basements, and crawl spaces. Insulation is also wrapped around hot water heaters and pipes to prevent heat from escaping and to reduce the amount of energy required to heat the water.

Common Types of Building Insulation
- Fiberglass insulation is made of tiny fibers of glass and can be very dangerous to handle.
- Cellulose insulation is made primarily out of recycled newspaper.
- Rock wool insulation is made from rocks and minerals that have been heated and processed into a mass of tiny fibers.
- Foam insulation is made of a special kind of plastic.

Are All Types of Insulation the Same?
Insulation is rated by how well it resists heat flow. Materials with a higher R-value, or resistance value, have better insulating power. Windows, window shades, and curtains have low R-values (around 1 to 3.) The insulation used in walls has an R-value of approximately 21.

(NOTE: In this lab, students will not determine the R-value of the insulation materials they test. Students will decide which materials appear to be the most effective insulators.)
Why is Insulation Important for Energy Efficiency?

Because many homes use natural gas to run heating systems, many households can shrink waste and conserve natural gas by installing proper insulation. Remember, when you use less natural gas, you save money on your utility bill, conserve a limited natural resource, and help reduce greenhouse gas emissions!

In this lab, students will build mini “water heaters” and test different materials to determine which provides the best insulation.

Pre-Activity Discussion

1. Begin by asking students what they do to stay warm when they are outside on a cold day. (Wear jackets, hats, gloves, etc.) Let students know that these items of clothing help trap body heat to keep us warm. Tell students that houses, pipes, and water heaters use insulation, which serves the same purpose as a jacket or layers of clothes. Explain that insulation is made of materials that stop the flow of heat. Insulation in a home can keep a home warm or keep a home cool depending on the time of year.

2. Ask students which kind of jacket they would prefer on a cold day: a jacket with a satin lining or a puffy down jacket. Request that students explain their answers. (A puffy jacket is better for cold days because down provides better insulation than satin.)

3. Ask students to name materials that they think would make good insulators. Tell students that they are going to be making mini “water heaters” that they will wrap with insulation. Show students the materials you have gathered for use in the lab and ask students to predict which materials would best keep heat in or keep heat out. Record student responses.

4. Discuss the different ways we use insulation. (We use insulation in walls, ceilings, and attics to keep warm air from escaping or from coming into our homes. We wrap insulation around water heaters to keep heat from escaping and to reduce the amount of energy we need to keep water hot. We wear clothes and use blankets to keep warm.)

5. Ask students if they can guess why insulation in the home is important. (In California, most home heating systems rely on natural gas or electricity. During winter, a well-insulated home keeps heat inside the house and we do not need to turn up the thermostat to stay warm. During summer, a well-insulated home keeps cool air inside, prevents warm outside air from entering the home, and reduces our need to turn up the air conditioning to stay cool. Insulation helps us use less energy to heat and to cool our homes. Insulating water heaters reduces heat loss and saves natural gas. When we save energy at home, we reduce our impact on the environment and save money on our energy bills.)

6. Explain that in this lab students will build mini “water heaters” and test different materials to find out which material is the most effective insulator.
Lab Preparation, Trouble-Shooting Tips and Safety Measures

Safety Measures:

- If you choose to use fiberglass as an insulator, ensure that students wear safety glasses and thick disposable gloves when handling the fiberglass.
- Hot water is used in Part 1 of the lab. Please use caution when filling the cans.
- The light fixture used in Part 2 of the lab may become dangerously hot. Remind students not to touch the light fixture. Also, make sure that students do not look directly at the lamp. Thermometer readings should take place from behind the lamp.

Lab Preparation:

- Provide cans with the tabs still attached.
- Prepare thermometers by trimming the sides of the thermometers so they easily fit into the opening of the soda can. Depending on your math goals, trim away either the Fahrenheit or the Celsius side of the thermometer.
- Insulating materials listed under the Materials/Resources section are suggestions of common household/classroom items that can be used in this experiment. The PEAK Tool Kit does not contain these items. You may also ask students to bring various insulating materials to class.
- Students will need 2 sheets of graph paper to chart the information from their data tables.

Trouble-Shooting Tips:

- Results of the experiment will be more accurate if students do not spill any water on the insulation when wrapping the cans.
- Students will track the temperature change for their 3 cans every 15 minutes. Setting a timer will help students know when to take the next set of measurements.
- There are two data tables. Data Table #1 will be used for Part 1 of the lab. Students will use this data table to record how quickly water in the cans drops in temperature or how well the insulating material keeps the heat in. Data Table #2 will be used for Part 2 of the lab. Students will use this data table to record how quickly the air in the can increases in temperature or how well the insulating material keeps heat out.
Teacher Answer Key
Unit 5: Insulation

Analyze and Assess

1. Of the materials you tested, which insulator was the best at keeping heat in? How did you know that this material was the best insulator? Compare your results with those obtained by the rest of the class.

   *Answers will vary. The material that is the best insulator will keep the water in the can the warmest for the longest amount of time. The water in the best-insulated can will have the highest water temperature at the end of the hour.*

2. Which material was the best at keeping heat out? How did you know that this material was the best insulator?

   *Answers will vary. The material that is the best insulator will keep the air in the can the coolest for the longest amount of time. The air in the best-insulated can will have the coolest temperature at the end of the hour.*

3. Was the same material the best insulator in both cases?

   *Answers will vary, but it is highly likely that the material that keeps heat in the best will also keep heat out the best.*

4. Why did you use the third can in this activity?

   *The third can was used as a control to test the effect of insulation.*

5. Which material is the best insulator overall? Why?

   *Answers will vary. The material that is the best insulator overall will slow the movement of heat energy.*

6. Why should a house be insulated?

   *Insulation helps keep the temperature outside from affecting the temperature inside. During the winter, insulation helps keep warm air from the heater inside the house. During the summer, insulation helps keep cool air from the air conditioner inside and prevents warm air from outside from entering the house. When a house’s temperature is regulated using insulation, we use less energy, save money and conserve natural resources!*