Lesson Plan

Grade/Subject
6th Grade

Is It Cold In Here?

Core Standard

6.2.4 Design an object, tool, or process that minimizes or maximizes heat energy transfer. Identify criteria and constraints, develop a prototype for iterative testing, analyze data from testing, and propose modifications for optimizing the design solution. Emphasize demonstrating how the structure of differing materials allows them to function as either conductors or insulators.

I Can Statements / Learning Objectives (In student focused language)

I can design and create a tool that will demonstrate how different materials can function as an insulator or a conductor.

Lesson Performance Expectations (description): Teacher focused language. What my students should be able to know and do after this lesson has been taught. (Identify SEP & CCC)

Materials:
2 clean, empty, 12 oz soda cans (same size), plus 2 extra cans for a control.
Thermometers-(liquid immersion)
Assortment of materials that might be used as insulators such as: pieces of foam, cotton balls, foil, bubble wrap, plastic bags, paper, drinking straws, etc.
Scissors
Tape- 1 meter in length for each group
Cold ice water

Time: 60- 90 mins
Two class periods -- Day one: Engineering their design
Day two: Analyze the data and communicate their learning.

Teacher Background or Key Content Information and Helps:
Heat is what we call the flow of thermal, kinetic energy. This idea is similar to calling a change in distance movement. One cannot change, we can only observe it. So…..

The effect of heat on water depends on whether the energy is moving into the water (endothermic) or moving out of the water (exothermic). When water molecules gain energy, the average speed of the molecules increases; this is measured as a temperature change if enough energy is gained. Conversely, when energy leaves water molecules, the average speed of the molecule decreases, and a temperature decrease may be observed.

If enough energy is absorbed, the molecules may have enough energy to overcome the forces that hold them to each other and changes phases (ex. Liquid water to steam). The inverse would be true if energy was removed; the molecules would lose enough energy that the attractive forces would be strong enough to hold the molecules together. (ex. Liquid water turns to ice a solid.)

So how does insulation work against heat transfer? Think of it as wearing a goose down jacket on a cold winter day. Even though your jacket is light as a feather, you body can stay toasty warm. That's because the feathers create millions of tiny air pockets, and air has excellent insulating value. Insulation works by slowing the transfer of heat, which can move in three ways: conduction, convection and radiation. For heat to travel from your body through your down jacket, it has to move by conduction through the tiny feather fibers that are in contact with each other. Heat transfer by convection happens through the air, and there are millions of miniscule air spaces between the fibers. Heat transfer by radiation is slow, since one fiber must radiate its heat to another.

Prior Knowledge Students Need:
Students need to know how energy and heat transfers through different materials. Some materials cause heat energy to move more slowly through them than others.

Student Performance

Phenomenon: ***Engineers encounter problems of warming and cooling liquids in many situations. Aluminum is a metal that has special qualities. It is plentiful on earth. It is inexpensive, strong, can be easily combined with other materials, and it is resistant to heat and corrosion. These qualities is why manufacturers use aluminum in soda cans. However, even over time, the soda will warm up inside a can.***

Gathering: *(Obtain Information, Ask Questions/Define Problems, Plan & Carry Out Investigations, Use Models to Gather Data and Information, Use Mathematics/Computational Thinking.)*

Your team will create a way to insulate a can of cold water that will stop heat energy from warming up the water.

Students will receive a bag of <u>useful junk</u> (items that can be used as insulators or conductors examples: foil, foam peanuts, plastic, bubble wrap, cotton balls etc.) They will need to work together in teams to stop the transfer of heat from the outside of an aluminum can to the water inside.

1. Place 2-3 students in a group. Handout the student engineering worksheet and supplies.
2. Have a class discussion on the criteria of the design.
    a. Criteria: Today you and your team will be acting as engineers to apply what you have learned about heat transfer to a design challenge: To design and build a device that will keep the liquid in an aluminum can cool as possible.
    b. Constraints: You may only use the items in the bag. You may <u>not</u> add water in the form of a solid. The original water must stay in throughout the experiment.
3. Students will need to brainstorm together ideas of how to stop heat energy from transferring to the water in the can with the materials given. Students do not need to use all the materials.
4. Give students 20 mins. To brainstorm and construct their idea. Allow students to use empty cans during the planning and construction phases, which they will need to be able to remove and replace with filled cans for the testing phase.
5. Student will draw and label a diagram describing the function of their project keeps the heat out.
6. When the projects are completed, have the students replace their empty can with a can filled with 9 oz. of cold water.
7. Students will need to measure the temperature of the water as their starting temperature. Record data on the table provided on student sheet. Students will need to take the temperature of their can every 5 mins, and record the temperature.
8. As the teacher, you will need to run a control by taking a plain can and record the temperature every 5 mins.
9. Students will record their data every 5 mins for a total of 30 mins.
10. After the first 5 mins if the students want to modify their design, let them go back to the drawing board. Give them only 5 mins to make any changes to their project. They will need to restart their data measurement again. Don't be surprised if many students do this. Engineers very rarely succeed the first time.

Reasoning: *(Evaluate Information, Analyze Data, Use Mathematics/Computational Thinking, Construct Explanations/Solve Problems, Develop Arguments from Evidence, Use Models to Predict & Develop Evidence.)*

1. Have the students take the data from the chart and create a graph of their data and the control data.
2. Students need to analyze their data, and answer the questions on the student sheet.

Communicating: *(Communicate Information, Argue from Evidence (written & oral), Use Models to Communicate).*

1. Students will discuss the things that worked and things that failed with their project. They also need to discuss other ideas that they see that they might want to include in their next design.
2. Students will then individually fill out the communication portion of their student sheet.
3. If time permits, students could create a poster, powerpoint, or present their project and what they learned.

Teacher Resources: *(Websites, videos, books etc.)*

How aluminum soda cans are made-- youtube video https://youtu.be/hUhisi2FBuw

Bozeman video on Heat Exchange (Chemistry) youtube video https://youtu.be/OBVbV5dpCCA?list=PL34TrktxxpMDPSc2g9ww10ZfyPpsqRMt8

Bozeman video on Temperature (Chemistry)-- youtube video https://youtu.be/B6hAwZH2mmA

Website explaining conduction,convection and radiation heat transfer. http://www.s-cool.co.uk/gcse/physics/energy-transfers/revise-it/how-does-heat-energy-move

Assessment of Student Learning

Short description of the evidence the teacher is willing to accept that a student is proficient with the performance expectations.
This may be a rubric, narrative, or other set of descriptors that are useful for distinguishing proficient from nonproficient performances.

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Extension:	
	Revised 10/13/16

Name _____ Team Members:_____

Is It Cold in Here?

Engineering Project

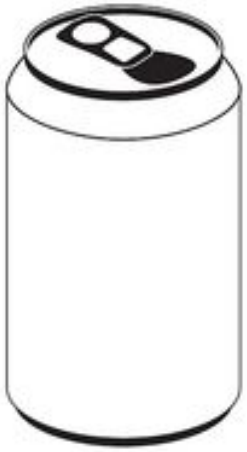
Phenomenon: Engineers encounter problems of warming and cooling liquids in many situations. Aluminum is a metal that has special qualities. It is plentiful on earth. It is inexpensive, strong, can be easily combined with other material ls, and it is resistant to heat and corrosion. These qualities are why manufacturers use aluminum in soda cans. However, even over time, the soda will warm up inside a can.

Criteria : My team create something to stop the heat energy from making the water in a soda can warmer.

Questions: Write down questions you may have.

Constraints: List your constraints.

Brainstorming: Draw a model of your design below. Make sure to label all materials.



Notes

Prediction: How long can you keep the temperature of the water at or under 40° ?

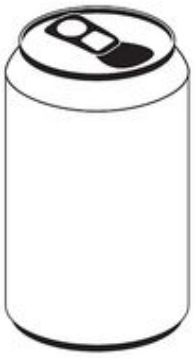
Testing: Record the temperature of the water in the chart below. Test your design for 5 minutes and record the time.

Time	Temperature
0 min	
5 min	

Redesign: Answer these questions. Does our design work? What changes could we make to it to make it better? Draw them in a model below.

Note: If the group doesn't want to make any changes, transfer the data in the chart above to the testing chart below.

The group has 5 mins to make any changes to their design. Make sure to restart your testing again.



Notes of changes made

Gathering Data: Using a stopwatch, record the temperature of the water in the can every 5 mins in the table below. The teacher will be recording the temperature of the control design.

Design	
0 mins	
5 mins	
10 mins	
15 mins	
20 mins	
25 mins	
30 mins	

Control	
0 mins	
5 mins	
10 mins	
15 mins	
20 mins	
25 mins	
30 mins	

Graphing: Using two different colors, graph the design data and the control data.

Communication : In your own words, explain what is happening with the data. How does your design effect the data shown? What didn't work?

What did you see other groups do that you would like to try to improve in your design.

Explain how the materials you used slowed the flow of heat energy into the can. Draw a model to show it. Make sure you label your model and show heat energy using arrows.