Life of a Can

The Never-Ending Story

Classroom Activity

Novelis

Cool Computers

Overview

In this activity, students will design, build, and test their own aluminum heat-sinks. They will observe how aluminum's lightweight, malleable, and conductive properties make it an ideal material for use in our technological devices.

Activity Duration: 3 class sessions (45 minutes each)
Grade Level: Grades 3–5

Background Information

Computer designers and engineers use aluminum to build laptops, tablets, and smartphones. They use aluminum because it has the following properties:

- Aluminum is lightweight
- Aluminum is very malleable, which means it can be bent into lots of shapes and still remain strong
- Aluminum is a great conductor—it transmits heat and electricity very well.[1]

Technological devices include circuits and processors—parts that generate lots of heat and electricity. If the computer doesn't have a way to get rid of this heat, it might fry up the data we store or the graphics card we use to play our games! Computers, smartphones, and tablets include a part called a heat sink. The heat-sink is made of a thermal conductor, like aluminum. The conductive metal attracts heat away from other parts of the device and spreads it out across a larger surface area, allowing it to dissipate faster.[2]

Key Vocabulary

Heat-sink: a device that absorbs excessive heat
Circuit: a pathway that begins and ends at the same place
Conductor: a material that helps electricity and heat to travel through
Insulator: a material that absorbs heat and electricity, preventing them from moving through
Surface area: a measurement of the area of the surface of an object

Materials

Each student will need the following materials:

Thermal Paste

- 5ml (~1tsp.) petroleum jelly
- 20ml (~4 tsp.) mint toothpaste
- Toothpicks for stirring
- Popsicle stick
- Syringe without a needle
- 2 small cups
- Ziploc bag

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Circuit
- Small lightbulb
- Two D batteries
- Two pieces of aluminum foil cut to 6" long and 3" wide
- Electrical tape
- Two paper clips

Heat Sink
- Aluminum foil
- Thermal paste (made in previous lesson)
- Circuit (made in previous lesson)

Thermometer
Scale
Cool Computers Capture Sheet

Procedure

Lesson 1: Background, Circuit Construction, and Thermal Paste

Background[3] (10 minutes)

1. Draw a T-chart with the word "Conductor" on one side and the word "Insulator" on the other.
2. Explain to students that a conductor is a material that helps electricity to flow and an insulator is something that blocks and absorbs electricity.
3. Ask students to call out a variety of different materials that they think are conductors (examples include water, aluminum, copper and the human body). Then, ask students to call out a variety of materials that they think are insulators (examples include plastic, rubber, Styrofoam, and wood).
4. When you have a good representation of conductors and insulators listed, write the word "Electronics" and ask students to call out materials that they see in their gaming devices, computers and smart-phones (examples include aluminum, plastic, glass, and rubber).
5. Ask students why they think these materials are used to make these electronics. What is plastic used to make (keyboard, casings)? What is aluminum used to make (frame, internal components)? What is glass used to make (screens)? What is rubber used to make (protective coatings)? Note to students that some of these materials are conductors while others are insulators. Ask students why they think computers and technological devices might need conductors (transmit electricity) and insulators (protect from damage).

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6. Ask students if they have ever noticed their computer or smartphone becoming hot to the touch. Ask them why they think that might happen. Explain that computers have many different mechanical pieces inside that generate lots of heat. Ask students what they think happens when the computer cannot release some of that heat (the computer can overheat, damaging the components inside).
7. Explain that computers have parts called heat-sinks that attract the heat away from temperature-sensitive parts of the computer and spread it out over a wide area so that it can dissipate quickly.
8. Tell students that over the next three lessons, they are going to build their own heat-sink. To do this, they will need three components: a circuit, thermal paste, and the heat-sink itself. In this lesson, students will build the circuit and mix the thermal paste.

Circuit Construction[3] (20 minutes)

1. Explain to students that they are going to begin by building a circuit. This circuit is going to transmit electricity from D batteries to a lightbulb through foil "wires."
2. Have students begin by folding the two pieces of aluminum lengthwise into long, thin strips.
3. Ask students to place one of the D batteries with the "+" side up and the other with the "-" side up. Instruct students to tape the two batteries together in the middle.
4. Using the electrical tape, have students tape a paper clip over the top of the batteries such that it connects the "+" end of one battery to the "-" end of the other.
5. Ask students to tape their aluminum foil "wires" to the paper clips.
6. As students are forming and taping their wires, unscrew the screws on each student's light bulb slightly so that a piece of aluminum foil can fit underneath.
7. Have students connect the free ends of their wires to the light bulb, sliding the foil underneath the screws. The light bulb should light up. Once the students have tested their circuit and are sure it functions, they can disconnect and pack up their circuits. Be sure to have students label their circuits with their names.
8. Troubleshoot with students as necessary. While troubleshooting, ask students to begin measuring out the ingredients for their thermal paste into the small cups.

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Thermal Paste (15 minutes)

1. Have students measure out the following ingredients into the two cups: 5ml (~1tsp.) of petroleum jelly and 20ml (~4 tsp.) of toothpaste into the other.
2. Using the popsicle stick, have students slowly mix the petroleum jelly into the toothpaste and stir until it is well combined (8-10 minutes).
3. Once the paste is mixed, have students put the mixture in the syringe using the popsicle stick.
4. Have students place the syringe in the plastic bag, seal the bag, and write their name on it.

Lesson 2: Circuit Test and Heat-Sink Construction

Circuit Test (5 minutes)

1. Have students assemble their circuits but not connect the light bulb.
2. Using their thermometer, have students take the temperature of the battery and report it on their Cool Computing capture sheet.
3. Have students connect their circuits to their light bulbs. The light bulb will remain on for the rest of the lesson, with the goal of generating heat in the battery.

Heat-Sink Construction (30 minutes)

1. Once their light bulbs are on, students will begin construction on their heat-sinks. Begin by showing students the provided examples of heat-sinks. As you show each different example, ask students why they think that heat-sink is effective at removing heat. Ask students to identify the materials used in each heat-sink.
   a. ***Passive heat-sink***
   b. ***Passive aluminum fin heat-sink***
   c. ***Active cooling aluminum heat-sink***
2. Ask students to record the similarities and differences between the heat-sinks on their Cool Computers capture sheet. Note to students that each heat-sink is made of aluminum. Ask them why they think that is. Explain that aluminum is a strong and lightweight conductor that allows heat and electricity to flow through. Ask students why the second heat-sink has many fins. Explain that the heat-sink has fins because it creates more surface area. The more surface area an object has, the quicker it can dissipate heat. Ask students to think about an ice cube and a thin sheet of ice are next to one another. Both pieces of ice weigh the same, but the thin sheet will melt faster. That's because it has more surface area.

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3. Instruct students to use aluminum foil to build a heat-sink. The heat-sink must have a base and must have fins. They can use the thermal paste to glues the pieces of the heat-sink together where necessary.
4. At the end of the lesson, have students record the temperature of the battery on their Cool Computers capture sheet.
5. Ask students to disconnect their circuits and pack them away. Make sure each student has labeled his or her heat-sink.

Lesson 3: Heat-Sink Test

1. Using thermal paste, have students affix their heat-sink to the battery.
2. Have students connect their wires to the light bulb so that it turns on. Students will leave their circuits running for 30 minutes. At the end of the lesson, they will record the temperature of their battery in order to observe that the heat-sink helped to dissipate heat from the battery, making the temperature of the battery lower than it was without the heat-sink.
3. Ask students to share the results of their heat-sink. What could they do to make their devices more efficient? Ask students why they think aluminum is an ideal material to use in building our technological devices.

Cool Computers Capture Sheet

Name_____

Aluminum is a lightweight, conductive metal that is used in many technological devices. Because these devices generate lots of heat, computer engineers integrate heat-sinks into our laptops, smartphones, and tablets. The heat-sink is usually located near the device's processor, which is like its engine. In this experiment, you will learn how the properties of aluminum and the physics of surface area work to reduce the heat created by computing.

In the table below, list some materials that are conductors and some that are insulators.

Conductor	Insulator

In the table below, list some similarities and some differences between the heat-sink examples.

Similarities	Differences

Use the table below to record the temperatures of your circuit.

Resting temperature (control)	
Active temperature	
Active temperature with heat-sink	

How did the heat-sink affect the temperature of the battery? Why do you think that is?

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Standards

Next Generation Science Standards
4-PS3-2 Energy
Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Works Cited

[1] AluminumDesign.Net. *Properties of Aluminum*. 2017.
http://www.aluminiumdesign.net/why-aluminium/properties-of-aluminium/

[2] Das, Shuvojit. *Heat Sink – Basics*. CircuitsTune. 2017.
http://www.circuitstune.com/2012/11/heat-sink_20.html

[3] Science Buddies Staff. *Which Materials are the Best Conductors? Science Buddies*. Science Buddies, 24 Feb. 2017. Web. 7 June 2017
http://www.sciencebuddies.org/science-fair-projects/project_ideas/Elec_p018/electricity-electronics/conductors-insulators-basic-circuit.shtml