



Developed with Laura Beres

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Time: 50+ minutes

Save the beverage!

Exploring thermal energy transfer



Standards

NGSS MS-PS3-1

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

NGSS MS-ETS1-4

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Materials list

- 10 oz. clear plastic cup for each group [KI01033(N)]
- Other cups of various sizes and materials such as paper, plastic, foam (KI01431(B) or SB51404)
- Aluminum foil (W09459)
- Plastic wrap [KI01037(I)]
- Tape
- Fabric
- Other materials to use as insulators
- Thermometer (SB19157)
- Stopwatch, timer, or clock (TB14784)
- Hot and cold beverages

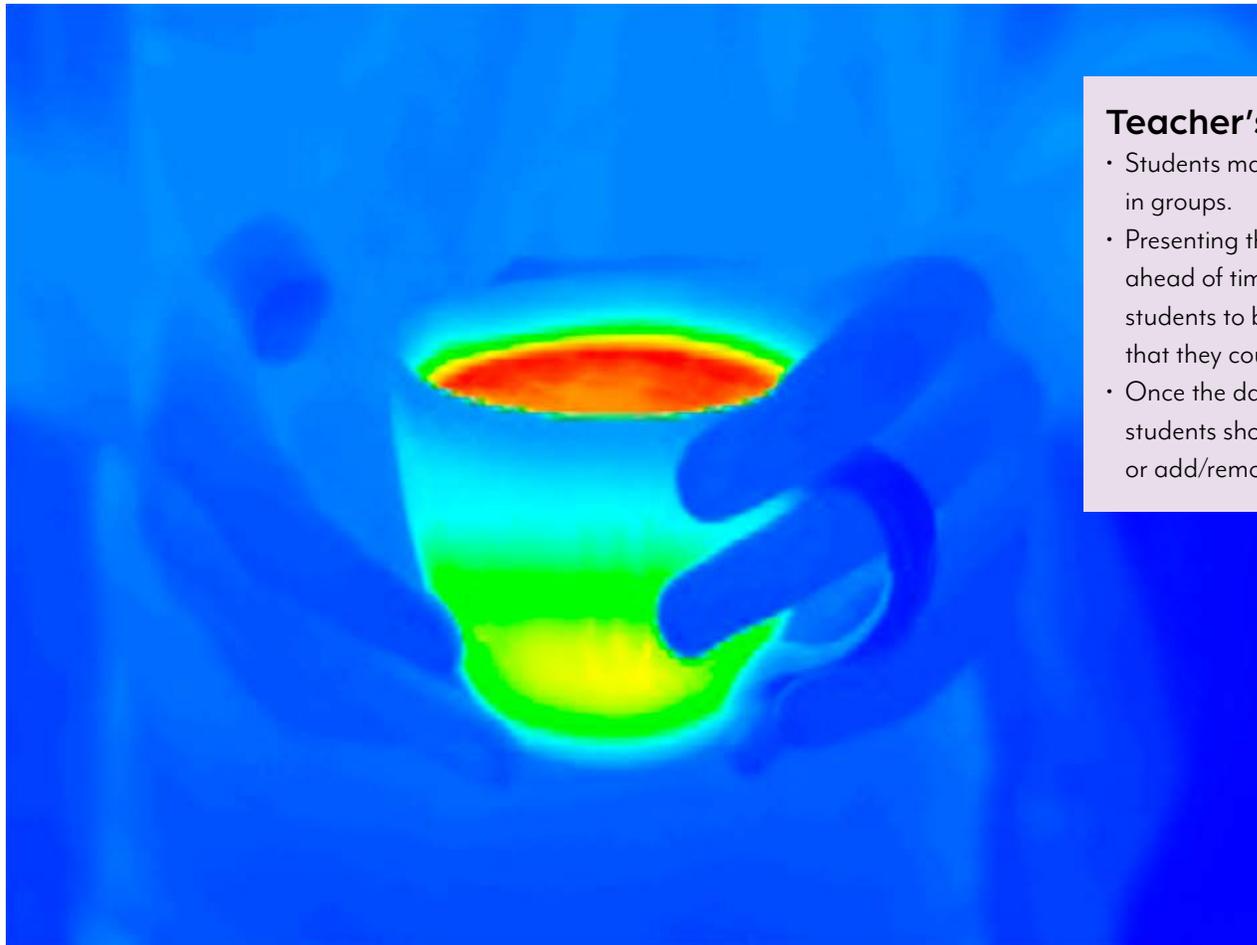
Objectives

Students will...

- Be able to apply science and engineering concepts to design, construct and test a device to maintain a beverage's temperature

Lesson content

- Thermal energy (heat energy) is the energy a substance has because of the motion of its molecules. High thermal energy means the molecules are moving quickly. This is seen in hot substances. Low thermal energy means the molecules are moving slowly. This is seen in cold substances.
- Thermal energy can be lost to the environment in the form of steam or transferred through contact.
- Thermal energy plays a role in cooking, heating and cooling processes, baking and other daily tasks.



Teacher's notes

- Students may work individually or in groups.
- Presenting the investigation ahead of time would allow for students to brainstorm materials that they could bring from home.
- Once the data collection starts, students should not touch the cup or add/remove liquid or supplies.

Extensions and content connections

- Students could build two different models, one for hot beverages and one for cold beverages, and compare efficiency of the two models and materials.
- Class data could be collected and models could be compared to evaluate effectiveness and look for modifications.
- After the initial testing, cups could be modified and retested to see if they are more or less efficient than the original design.

Misconceptions

Students might think that more layers of a material will always be the solution, but it matters more what the materials are.

Modifications

If students are learning virtually or need to maintain safety protocol, they may use materials commonly found at home. If students are in-person for school, but material sharing could be a risk, ask students to bring in common materials from home for their own experiment.

Safety information

Beverages do not need to be extremely hot or cold, but should not be room temperature. A cold beverage from the refrigerator or one with a few ice cubes added would be safest, especially for students learning from home. A hot beverage could be made by microwaving for less than one minute in a glass or ceramic mug. Use caution and hot pads to handle hot containers.

Once the model is built, add the liquid at the starting temperature. Once the liquid is in the model it should stay on a counter or table. Do not reheat or freeze/refrigerate. The initial temperature should be taken right away when the liquid is added to the model. The goal of the experiment is to see if the model will minimize transfer of thermal energy. Reheating or trying to keep the beverage colder in the fridge or freezer will compromise the data.

Save the beverage!

Name: _____ Date: _____

Mike Johnson has a big problem. He will only drink a beverage at its ideal temperature. He likes his coffee **HOT** and his water to be **COLD**! He doesn't like the cups at his office since by the time he gets to drink his beverage, it's just not right. Can you help Mike by designing and creating a cup that will keep his coffee hot and his water cold?

In this activity, you will design and create a way to keep a beverage at the ideal temperature for as long as possible.

Pre-lab thinking

1. What is thermal energy?
2. How can thermal energy be minimized?
3. Which beverage do you plan to work with (hot/cold)?

Plan your design

What materials will you use? Create a list.

Draw a diagram of your design. Add as much detail as possible to help you as you build.