Build a Cooler

Science Experiment

Key Concepts: Physics, Heat, Temperature, Insulation

Introduction: How does a cooler keep things cold? Which material makes the best insulation? Try this project to find out how long you can keep an ice cube from melting once it's out of the freezer!

Background:

Have you used an insulated lunch box or bag to pack lunch for school or a cooler to pack food for a picnic? Why not just throw the food in a paper bag or plain box? What exactly does the cooler do that's so special? You'll find out in this project—but first let's learn a little bit about heat transfer.

Heat naturally flows from hot to cold. You can observe this by watching (and feeling) a hot drink. A cup of hot chocolate will eventually cool down and reach room temperature. In this case heat flows from the hot drink to the cooler environment. A cup of cold water will also eventually reach room temperature. In this case heat flows from the warmer environment to the cooler cup.

Heat is the vibrations and collisions between the molecules in a substance. There are three different ways heat can move between objects: conduction, convection and radiation. Conduction occurs when objects are in direct contact with one another. You feel conduction when you touch, for example, an ice cube or a hot mug. Convection occurs when a fluid (such as air or water) flows over an object. Convection can be natural (for instance, a hot object, such as a pan on the stove, will warm the air around it, causing this warmer air to rise) or forced (such as by a fan in an air conditioner). You feel convection when you stand outside in a chilly winter wind and feel cold. Finally, heat can be transferred by electromagnetic radiation. Most notably, you can feel this when you stand outside in the sun. You can feel the warmth of the sun on your skin—even though the sun is millions of miles away with the vacuum of space between you and it (so there is no matter that allows for conduction or convection)!

That's a lot of different ways for heat to flow from one place to another. That makes keeping food cold (or hot) a challenge. How do you *stop* heat transfer if it's happening naturally all the time? Or how can you at least slow it down so your food doesn't spoil? The key is insulation! Thermal insulators are materials that help reduce the rate of heat transfer. Some materials are poor conductors of heat so they make good insulators to slow down heat conduction. Other materials can block radiation in visible or infrared light. In this project you will build your own cooler and explore how insulation can help keep an ice cube from melting (for a while, at least).[1]

[1] "Build a Cooler - Scientific American." 27 Feb. 2020, https://www.scientificamerican.com/article/build-a-cooler/. Accessed 27 May. 2020.

<u>Challenge:</u> How long can you keep an ice cube from melting?

<u>Directions:</u>

- Design and create a device that will keep an ice cube from melting.
- Run three trials that time how long it takes for your ice cube to melt.
- Any material is allowed (provided it is safe, check with your parents!) in your design.
- Your design CANNOT use an existing device that is already used for insulating *(Ex:. Yeti/Hydroflask/Stainless steel tumbler or water bottle, cooler, etc…).* <u>All designs must be original.</u>
- Use your scientific method skills and include the following:
    - Diagram showing the design for your device.
    - Materials List
    - A picture of your completed device (upload with documents)
    - Procedure steps
    - Data Table for three trials
    - Graph showing the results of three trials
    - Conclusive statements - what worked? What would you change?

Design:

Materials:

- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________

Safety Precautions to Include:

1.____

2.____

3.____

Procedure:

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____
7. ____
8. ____
9. ____
10. ____
11. ____
12. ____
13. ____
14. ____
15. ____
16. ____

17. ____
18. ____
19. ____
20. ____

Data Table

	Trial #1	Trial #2	Trial #3	Trial #4 (optional)	Trial #5 (optional)
Time (sec)					

Graph:

Conclusive Statements:

1. What worked well in your experiment?
2. Were there any errors in your experiment?
3. Which trial was the best and why?
4. What changes would you make to your device if you were to do this again?