Heat Transfer: Why Do Metals Feel Cold?

How efficiently can heat transfer from one container to another? Not all materials conduct thermal energy equally. This ability is an intrinsic property of a material. Materials that do this well are known as conductors. Insulators are materials that do not conduct thermal energy efficiently. In this lab, you will investigate which materials make good conductors and which make good insulators.

Watch Video 1

Data Table —Aluminum and Copper				
Strip type	**Aluminum Strip**		**Copper Strip**	
Calorimeter	**Calorimeter 1**	**Calorimeter 2**	**Calorimeter 1**	**Calorimeter 2**
Cold/Hot Cup	**Cold**	**Hot**	**Cold**	**Hot**
Time (minutes)	**Temperature (°C)**	**Temperature (°C)**	**Temperature (°C)**	**Temperature (°C)**
0 (initial temp)	6.4	96.0	4.0	93.2
1	7.4	84.4	4.1	79.6
2	7.8	81.1	4.6	75.9
3	8.5	77.8	5.3	72.9
4	9.2	75.3	6.1	70.2
5	10.0	72.4	7.3	67.6

Data Table — Iron and Zinc				
Strip type	**Iron Strip**		**Zinc Strip**	
Calorimeter	**Calorimeter 1**	**Calorimeter 2**	**Calorimeter 1**	**Calorimeter 2**
Cold/Hot Cup	**Cold**	**Hot**	**Cold**	**Hot**
Time (minutes)	**Temperature (°C)**	**Temperature (°C)**	**Temperature (°C)**	**Temperature (°C)**
0 (initial temp)	6.6	93.6	5.0	99.4
1	7.0	81.0	6.0	87.2
2	7.1	78.4	6.2	84.1
3	7.5	76.0	6.6	81.5
4	7.9	73.7	7.0	79.0
5	8.3	71.5	7.3	76.5

Observe

Examine the data tables. For which metal does the temperature of the hot water drop fastest? Which metal is the most efficient conductor of heat?

The temperature of the hot water drops the fastest when copper is used to connect the hot water to the cold water. This indicates that copper is the most efficient conductor of heat because less heat is lost to the surroundings if it is moving faster between two objects.

Identify an Experimental Design Flaw

Remember that the piece of metal in the experiment connects the hot water to the cold water and that over time the hot water gets colder and the cold water gets hotter because heat flows from hot objects to cold objects. Why, in the experiment shown in **Video 1**, does all of the heat lost by the hot water not transfer to the cold water? Where does it go?

Some of the heat is lost to the surroundings. In other words, it is transferred to the foam calorimeter and also to the air outside the calorimeter.

Refine/Expand the Experiment

Describe an experiment you could conduct to investigate the relationship between the size of the metal piece and how fast heat is conducted by it. Identify the variable you would have to change, the variable you would have to measure, and the things you would have to keep the same.

I could change the size of the piece of metal (e.g., decreasing the width) and measure the rate of heat exchange over time versus the initial width. In this kind of experiment, the independent variable would be the size of the metal strip, the dependent variable would be the rate of heat exchange or how fast the temperature of the hot water drops, and the control variables (the things that must stay constant) would be the amount of water in the calorimeters and the initial temperatures of the water.

Watch Video 2

Practice Scientific Reasoning

Why do you think a copper pan feels cold to the touch?

I think a copper pan feels cold to the touch because it is able to conduct heat away from my finger quickly, and my finger feels cold as a result.

Connect to Your World

Imagine you work for a company that manufactures cookware, such as pots and pans. Which of the metals tested in this experiment would you use to make a line of pots and pans? Explain and indicate what factors you would consider in addition to heat transfer.

I would consider how efficiently the metal transfer heat, how durable it is, and how much it costs. Considering these factors, I would choose copper because it is relatively inexpensive, and it would conduct heat well from my stove to the food in the pan.

Learn More by Exploring These Links

Use this link to further explore how and why heat is exchanged between objects: https://phet.colorado.edu/en/simulation/legacy/energy-forms-and-changes.

At-Home Extension

Explore the thermal conductivities of different materials in your home, following the methods demonstrated in **Video 3**.

In School

If you would like your students to conduct an experiment like this one, and collect data first hand, try this kit: https://www.flinnsci.com/360-science-thermal-energy-and-heat-transfer/.