Temp Probe

Mass Matters

Grades: Middle School
Time: 45 Minutes
Subject: Physical Science
Topics: Temperature, Temperature Changes

Overview

Have you ever wondered why some materials heat up faster than others? In this activity, you will investigate how different factors, such as the weight and composition of materials, affect their ability to transfer heat.

Background

When we heat a material, it absorbs energy, causing its temperature to rise. The amount of heat a material can absorb before its temperature increases depends on its heat capacity. Heat capacity is the ability of a material to store heat energy.

For example, heavier objects of the same material can transfer more heat because they store more energy. On the other hand, materials like metal and plastic have different heat capacities due to their structure. Metal heats up and cools down faster than plastic because it conducts heat better.

By comparing the way different materials and weights affect the temperature of water, you can learn more about how materials interact with heat in everyday life.

Through hands-on experiments, you'll explore the concept of heat capacity by observing temperature changes in water when heated materials are introduced. This lesson will help you develop skills in data collection, graphing, and scientific analysis while deepening your understanding of thermal properties of materials.

What You Will Need/Prep

- databot with 2 temperature sensor
- IOS/Android Smart Device
- Metal subjects of the same material but different weights
- Two small glasses
- A pot with water
- Install Vizeey™ on your Smart device.
- Scan the QR code to load the experiment.
- Test your databot™ connection.
- You will be prompted to select and connect to databot™ each time you launch an experiment.
- If there are two or more databot™'s listed, the one closest to your device will be highlighted.
- Study the background information and terms and prepare to explore!

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Learning Objectives

In this investigation you will master the following knowledge and skills:

- Learn how different materials absorb and transfer heat.
- Explore how the weight of an object influences its ability to transfer heat to another material.
- Analyze the differences in heat transfer between materials like metal and plastic.
- Understand why some materials heat up and cool down faster than others.
- Measure and record temperature changes accurately.
- Interpret data to draw conclusions about heat transfer and material properties.

Important Terms

Heat Capacity: The amount of heat energy required to raise the temperature of a material by one degree Celsius. It indicates how well a material stores heat energy.

Thermal Conductivity: The ability of a material to conduct heat. Materials with high thermal conductivity, like metals, transfer heat quickly.

Specific Heat: The amount of heat per unit mass required to raise the temperature by one degree Celsius. It is a property unique to each material.

Temperature: A measure of the average kinetic energy of particles in a material. Higher temperatures indicate faster particle motion.

Heat Transfer: The movement of heat energy from one material to another, typically from a warmer object to a cooler one.

Energy: The capacity to do work or cause physical change, often observed in this experiment as heat energy transferring between materials.

Interesting facts

This experiment models processes occurring in heating systems. Radiators, made of metal, heat up and transfer heat to the air due to the low heat capacity of metal and the high heat capacity of water.

The principle of heat capacity is widely used in construction. Materials with high heat capacity, like concrete, help retain heat in buildings during the winter and keep them cool during the summer.

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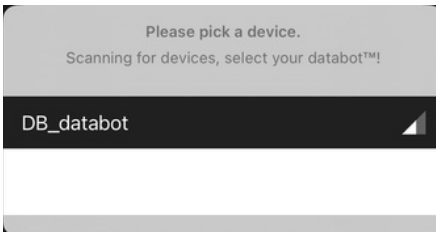
Using Vizeey

In order to work with the experiment you need to launch the Vizeey application and click on + in the upper right corner.

Then select “Add experiment from QR code” and scan the QR code prepared for this experiment. Your experiment will appear in the list.

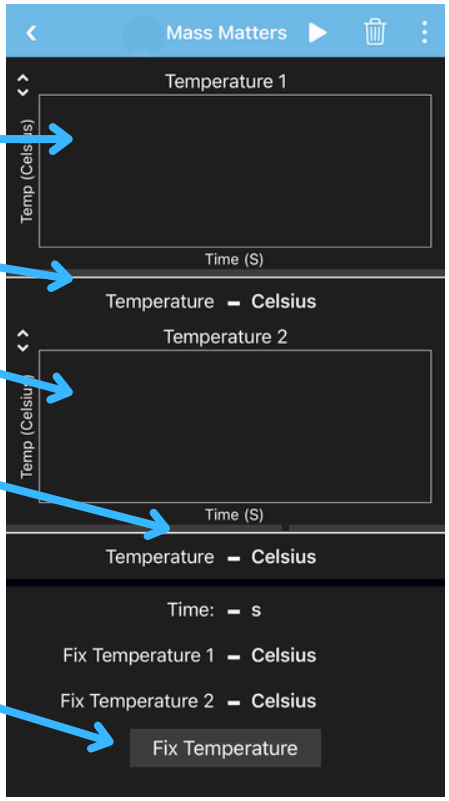
When you start the experiment you will be immediately offered to connect to your databot. Make sure that databot is enabled.



Don’t forget to check that the temperature probe 1 is connected to the Temp 1 port and temperature probe 2 is connected to the Temp 2 port.

Once in the Experiment

- Here you will see a graph of temperature 1 change over time.
- Current temperature 1
- Here you will see a graph of temperature 2 change over time.
- Current temperature 2.
- The temperature value you can fix at the current moment by pressing the button.



During the experiment, you need to record the temperature values every 30 seconds.

Press the "Fix Temperature" button every 30 seconds to capture the next values for your data table.

Once you have captured the values, write them down in the table to avoid losing any information and prepare to capture the values at the next 30 second mark. Be fast and accurate!

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Part 1: Initial Observations and Questions

How does the weight of a material affect its ability to transfer heat?

Why do different materials heat up and cool down at different rates?

How can we measure the heat transferred from an object to water?

What role does the material's structure play in its thermal properties?

Part 2: Hypothesis

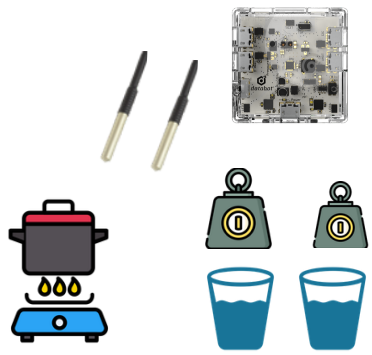
How does the weight of a metal object influence the heat transferred to water? Consider what data you might need to collect. Predict whether the heavier object will transfer more heat and why.

Part 3: Experiment Procedure

In this experiment, you will investigate how two metal subjects of the same material but with different masses transfer heat to water.

Prepare Materials:

- Two metal subjects of the same material but different weights (e.g., two weights of 20 grams and 50 grams).
- A pot with water.
- Two small glasses filled with water (we use 75 ml of water).
- databot with two temperature sensors.



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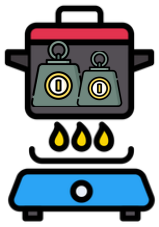
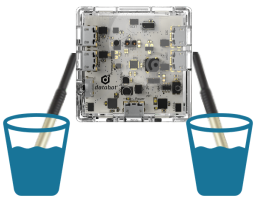


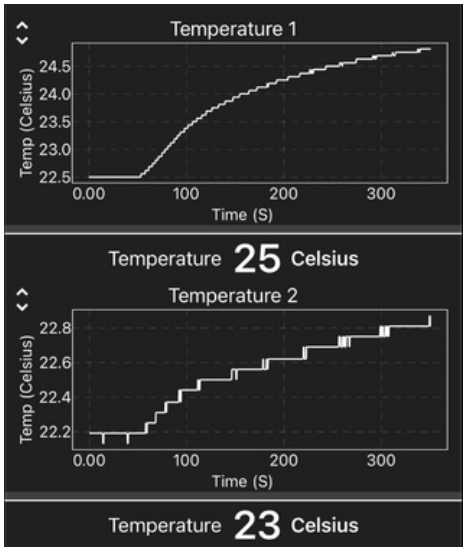
- Place the metal weights into the pot with water.
- Heat the water until it boils and allow it to boil for 2 minutes. This ensures the metal weights reach the same temperature as the boiling water (100°C).
- While the water is heating, set up two small glasses and fill them with water.

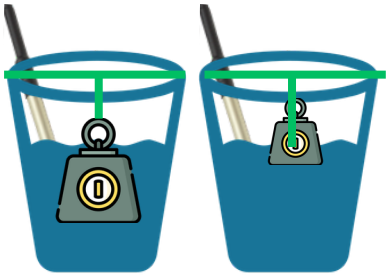


- Connect the databot's temperature sensors and put them into each glass to measure temperature of water.
- Tap on "**Mass Matters**" in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using: ▶
- Use these icons ▶ ⏸ at the top of the screen in Vizeey to start and to pause the experiment.

Note: Before starting a new experiment, cool the temperature sensor to room temperature to get more accurate results for data analysis.

- Place each weight into a separate glass of water, ensuring the weights do not touch the glass walls or the temperature sensors. (Use clips and sticks to suspend the weights if needed.)





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Part 4: Data Analysis

- Start recording temperature changes with the databot.
- Press Fix Temperature in Vizeey app. every 30 seconds and record it into the table

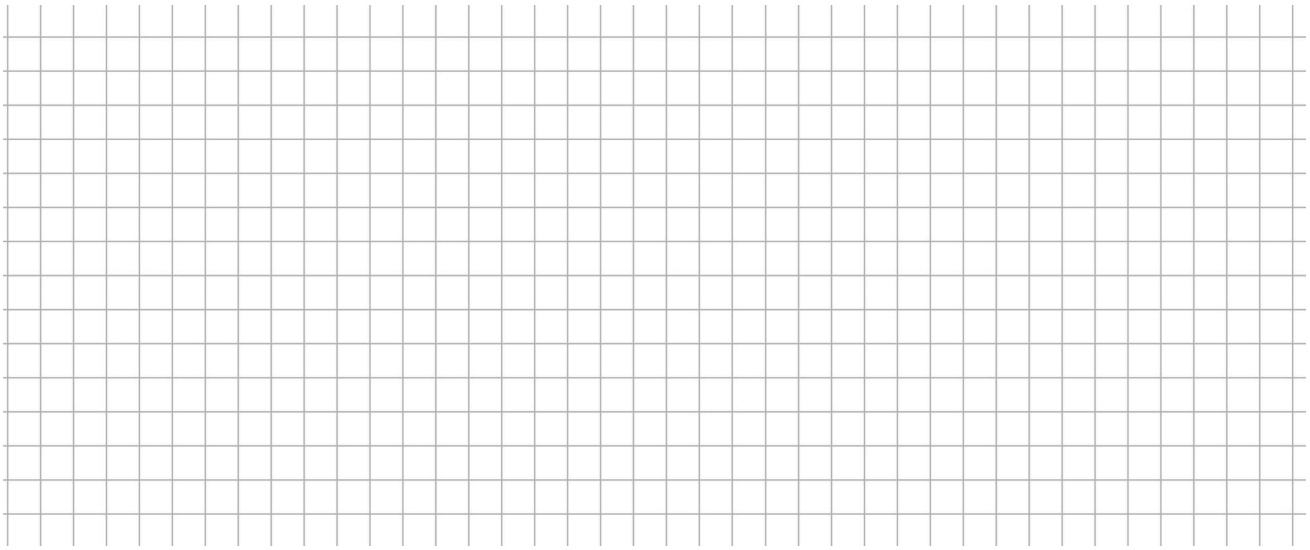
Glass 1.
Water temperature before starting the experiment _____

Time (s)	Temperature (°C)
0	
30	
60	
90	
120	
150	
180	
210	
240	
270	
300	

Glass 2.
Water temperature before starting the experiment _____

Time (s)	Temperature (°C)
0	
30	
60	
90	
120	
150	
180	
210	
240	
270	
300	

Plot a graph showing the relationship between temperature and time.



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Part 4: Data Analysis

Repeat the same experiment, but use two subjects of the same weight but different materials (for example, metal and plastic).

Before starting the new experiment, change the water to ensure it is at the same temperature.

Glass 1.

Water temperature before starting the experiment _____

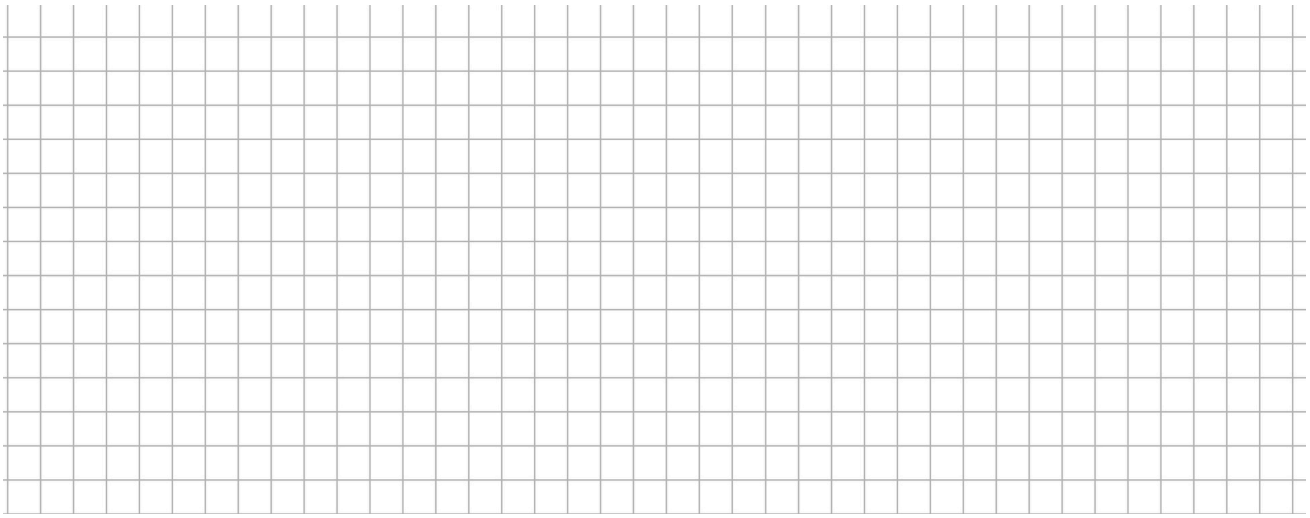
Time (s)	Temperature (°C)
0	
30	
60	
90	
120	
150	
180	
210	
240	
270	
300	

Glass 2.

Water temperature before starting the experiment _____

Time (s)	Temperature (°C)
0	
30	
60	
90	
120	
150	
180	
210	
240	
270	
300	

Plot a graph showing the relationship between temperature and time.



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Part 5: Concept Questions

Data Interpretation:

1. Why does the heavier metal weight transfer more heat to the water compared to the lighter weight?

2. How does the mass of an object influence its heat capacity?

3. If two objects have the same mass but are made of different materials, how might their heat transfer differ?

Part 6: Reflection

1. How well did the data support your initial hypothesis? Were there any unexpected results?

2. How could you modify this experiment to further explore heat transfer in different materials or under different conditions?

3. What did you learn about the concept of specific heat capacity from this experiment?