Heat capacity of the calorimeter

P1044100

Physics	Thermodynamics	Calorimetry

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/61669491e473310003365dfd

General information

Application

Experiment setup

The heat capacity C of a body is the ratio of the heat supplied to it ΔQ and the resulting temperature increase ΔT.

With the help of this experiment, the students learn how to determine the heat capacity as an example.

For this purpose, two containers filled with water are brought to different temperatures and measured. They are then mixed in the calorimeter and the temperature is measured again.

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Other teacher information (1/3)

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Previous knowledge

The students should be familiar with a butane burner. In addition, they should know the principle of a calorimeter and be able to read the temperature on a thermometer.

Scientific principle

Equal amounts of hot and cold water are mixed together. Hot water is always poured into a calorimeter with cold water (room temperature). The measurement is repeated three times and the heat capacity of the calorimeter is calculated as the average of the three measurements.

Other teacher information (2/3)

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Learning objective

Students should learn about the quantity 'heat capacity' and understand how this value is formed.

Tasks

Mix equal amounts of hot and cold water and determine the mixing temperature each time.

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Other teacher information (3/3)

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Notes on structure and implementation

1. Already during heating the thermometer should be in the hot water. After the burner is extinguished, stir before the temperature T_2 is read off.
2. To decant the hot water, the universal clamp should be detached from the double socket and used as a handle for the Erlenmeyer flask.
3. The highest temperature that is reached after pouring in the hot water can be read off as the mixing temperature.
4. If students have thermometers with 1/10 degree graduations available, this should be used to measure the temperature of the cold water and the mixture temperature! A suitable thermometer is on the materials page. If necessary, limit the temperature of the hot water so that the mixture temperature does not exceed the measuring range of the thermometer.

Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

When heating the water, the tripod ring and the wire net become very hot! To decant the hot water, the universal clamp should be released from the double socket and used as a handle for the Erlenmeyer flask.

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Student Information

Motivation

Coffee with milk

Quantities of heat are distributed in such a way that eventually all parts in contact with each other have the same temperature.

If the heat capacities and initial temperatures are known, the final temperature can thus be predicted. Conversely, the heat capacity can be inferred from the final temperature if the initial temperatures are known.

We often encounter a mixture of liquids in everyday life: coffee and milk. To better understand the heat capacity, perform this experiment.

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Tasks

Experiment setup

How much heat does the calorimeter absorb?

Mix equal amounts of hot and cold water and determine the mixing temperature each time.

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Equipment

Position	Material	Item No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
3	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	1
4	Boss head	02043-00	2
5	Glass tube holder with tape measure clamp	05961-00	1
6	Ring with boss head, i. d. = 10 cm	37701-01	1
7	Wire gauze with ceramic, 160 x 160 mm	33287-01	1
8	Universal clamp	37715-01	1
9	Lid for student calorimeter	04404-01	1
10	Agitator rod	04404-10	1
11	Felt sheet, 100 x 100 mm	04404-20	2
12	Beaker, 100 ml, plastic (PP)	36011-01	1
13	Beaker, Borosilicate, low form, 250 ml	46054-00	1
14	Beaker, Borosilicate, low-form, 400 ml	46055-00	1
15	Erlenmeyer flask, stopper bed, 100 mlSB 29	MAU-EK17082301	1
16	Pipette with rubber bulb	64701-00	1
17	Graduated cylinder 100 ml, PP transparent	36629-01	1
18	Students thermometer,-10...+110°C, l = 180 mm	38005-02	1
19	Students thermometer, -10...+110°C, l = 230 mm	38005-10	1
20	Butane burner, Labogaz 206 type	32178-00	1
21	Butane cartridge C206, without valve, 190 g	47535-01	1

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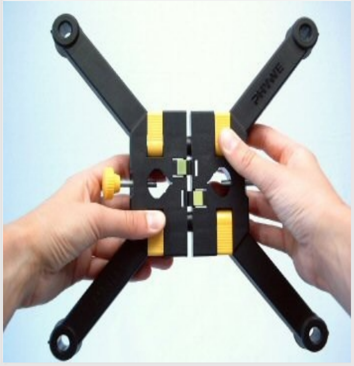
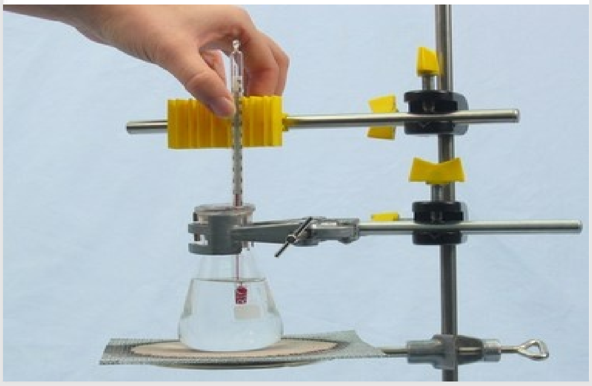
Set-up (1/3)

Set up the experiment according to the illustrations in order from left to right.



Set-up (2/3)

- Attach the thermometer with the small immersion stem above the wire mesh using the glass tube holder.



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Set-up (3/3)

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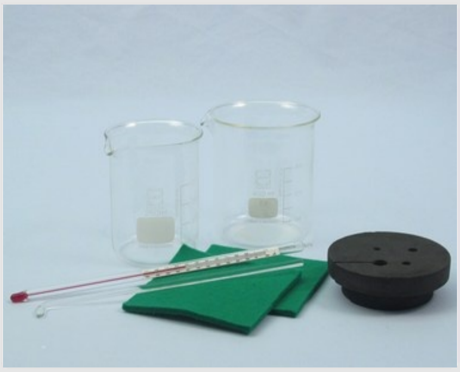
- Assemble a heat-insulating vessel (calorimeter) from two beakers (250 ml, 400 ml) and two felt plates.
- Push the long thermometer (d = 8 mm) and the stirring rod (d = 5 mm) through the holes in the lid.



Procedure (1/2)

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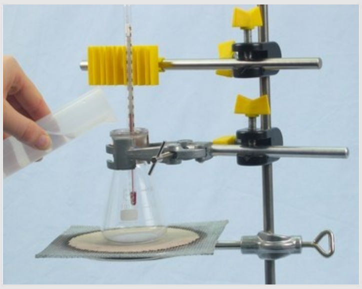

- Pour 100 ml (100 g) of water into the conical flask (measure accurately using a graduated cylinder and pipette).
- Heat the water in the Erlenmeyer flask to a value between 50 °C and 60 °C.
- Pour 100 ml (100 g) of cold water into the calorimeter (read accurately using a graduated cylinder and pipette).
- Put out the burner.
- Measure the temperature of the cold water (T_1) and of the hot water (T_2) (stir!) and enter the values in Table 1 in the protocol.
- When reading all temperatures, intermediate values of 0.5 °C must also be read.

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Procedure (2/2)

- Pour the hot water into the calorimeter.
- Stir and read off the highest temperature that occurs (mixing temperature T_m).
- Repeat the experiment twice more.

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Report

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Task 1

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Enter the measured values for the temperatures of the cold (T_1) and hot water (T_2) and the mixture (T_m) for all three tests in the table.

	Measureme	Measureme	Measureme
T_1 in °C			
T_2 in °C			
T_3 in °C			

Task 2

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1. Calculate the differences in each case $T_2 - T_m$ and $T_m - T_1$ and enter the values in the table.
2. Calculate the heat capacity C of the calorimeter using the following formula: $C = c \cdot (m_2 \cdot (T_2 - T_m)/(T_m - T_1) - m_1)$, whereby c = 4.19 J/g°C is the specific heat capacity of water, and enter the values in the table

	Measureme	Measureme	Measureme
$T_2 - T_m$ in °C			
$T_m - T_1$ in °C			
C in J/°C			

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Task 3

Calculate the heat capacity C as the average of all three measurements:

Mean value C

Solutions Repeat Export text

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