Heating different quantities of water (Item No.: P1043700)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Thermal physics
Subtopic: Heat energy, thermal capacity
Experiment: Heating different quantities of water

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

- PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A 13506-93

Experiment Variations:

- with universal balance, 3000 g

Keywords:

Task and equipment

Information for teachers

Additional Information

Different quantities of water are heated with a heating coil in a calorimeter. The quantities of water were chosen to match the size of the calorimeter (100 ml, 150 ml, 200 ml) and are directly related to each other so that the following becomes obvious: the greater the quantity of water, the longer it must be heated. Or: for the same heat energy the temperature increase is inversely proportional to the quantity of water.
The water is heated with a heating coil to ensure that all three experimental runs are conducted with the same calorific input. If a butane burner with an equally large flame were to be used for each run, this requirement would generally not be fulfilled since the temperatures of – e.g. – the support ring, the wire gauze and the beaker have an influence on the measuring results.

Remarks

1. When the 12 V heating current is applied, the heating coil must be immersed in water; otherwise, it will burn out.
2. In order for the initial temperatures of the water to be nearly the same in all three experiments, a 250 ml Erlenmeyer flask (or an even larger container, if available) is used as a storage vessel for water at room temperature.
3. The water in the calorimeter must be stirred at regular intervals.
4. The thermometer reading should be estimated to the nearest 0.5 °C.

The water can also be weighed to obtain the values directly in grams. Suitable balances are on the Material page.

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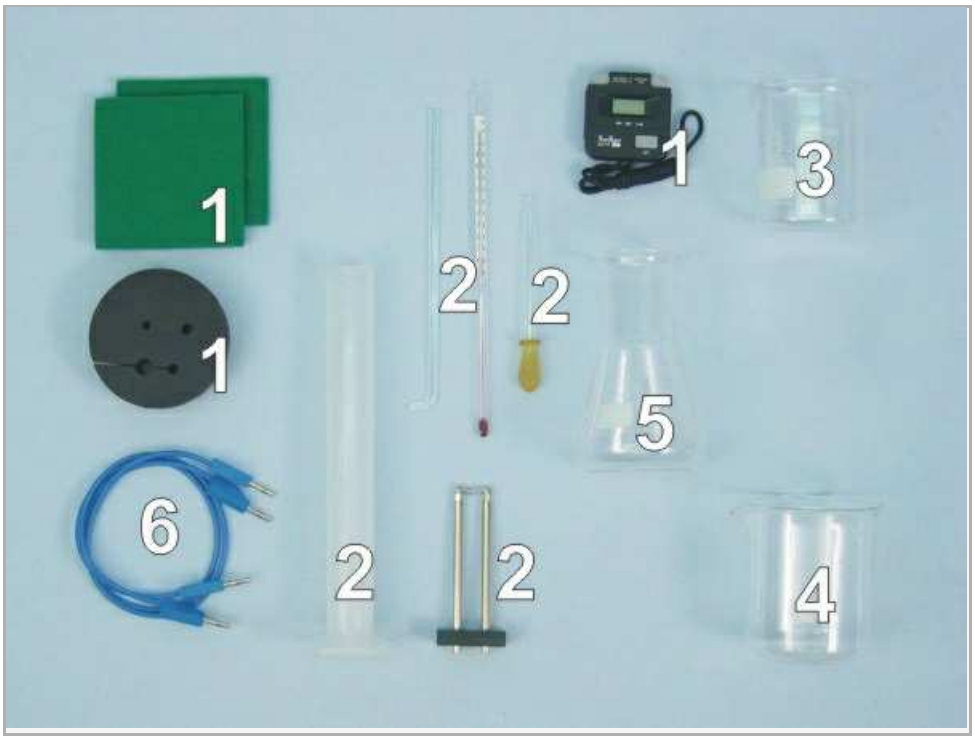
Task and equipment

Task

How fast can water be heated?

Heat various amounts of water with a heating coil and measure the temperature increase as a function of time.

Equipment



Position No.	Material	Order No.	Quantity
1	Lid for student calorimeter	04404-01	1
2	Felt sheet, 100 x 100 mm	04404-20	2
3	Stop watch 4	03078-00	1
4	Agitator rod	04404-10	1
5	Heating coil with sockets	04450-00	1
6	Pipette with rubber bulb	64701-00	1
7	Graduated cylinder 100 ml, PP transparent	36629-01	1
8	Students thermometer, -10...+110°C, l = 230 mm	38005-10	1
9	Glass beaker DURAN®, short, 250 ml	36013-00	1
10	Glass beaker DURAN®, short, 400 ml	36014-00	1
11	Erlenmeyer flask,wide neck,250ml	36134-00	1
12	Connecting cord, 32 A, 500 mm, blue	07361-04	2
Additional material:			
13	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
As an alternative	(Additional Information on the Information for teachers page)		
	Universal balance, 3000 g	46009-00	1
	Sliding weight balance, 101 g	44012-01	1

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Set-up and procedure

Set-up

Attention!

The heating coil must be immersed in water before the 12 V current is applied.

Setup

- Assemble a thermally insulated vessel (calorimeter) using two beakers (250 ml and 400 ml) and two felt sheets.

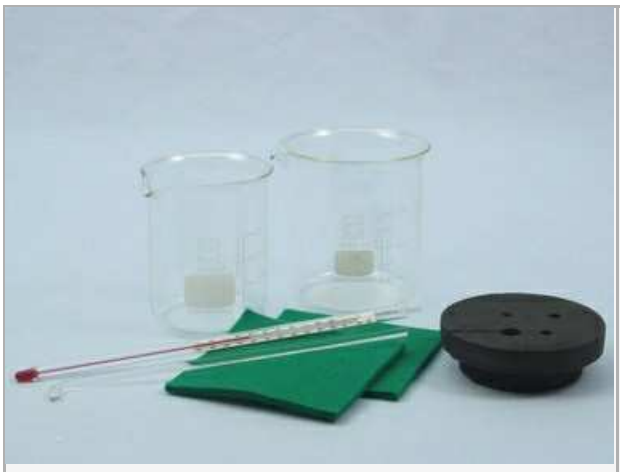


Fig. 1

Fig. 2

- Insert the heating coil carefully through the slit in the calorimeter's lid.

Fig. 3

- Insert the thermometer (d = 8 mm) and agitator rod (d = 5 mm) through the corresponding holes in the lid.

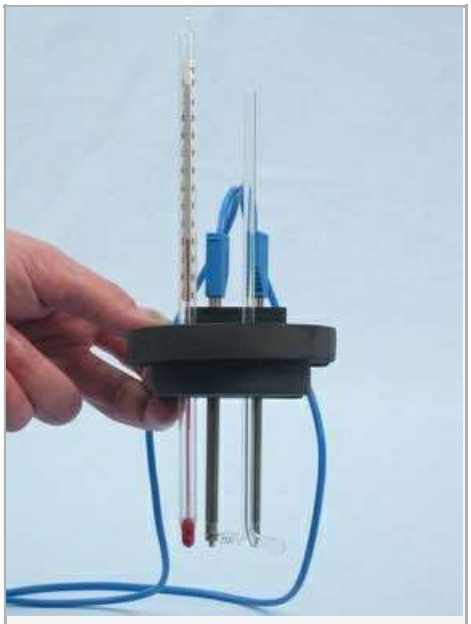


Fig. 4

- Be sure that the power supply is still turned off.

Procedure

- First, measure 100 ml of water in the graduated cylinder (exact measurement with the pipette) and then pour it into the calorimeter.

Fig. 5

- Place the lid with heating coil, thermometer and agitator rod on the calorimeter.

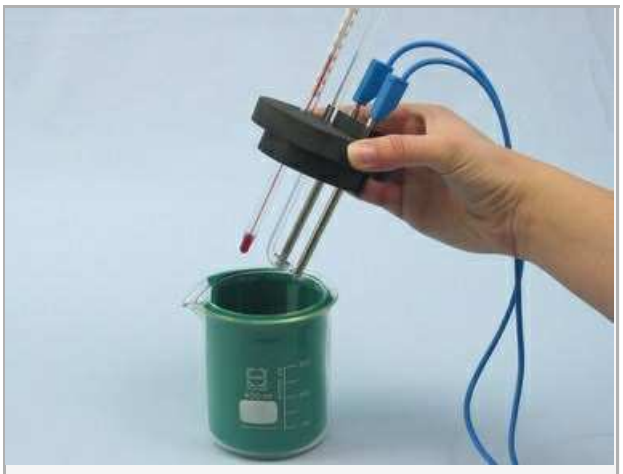


Fig. 6

Fig. 7

- Connect the heating coil to the 12 V AC outlet on the power supply (still turned off!) with the connecting cords.

Fig. 8

- Measure the initial temperature of the water and record it in Table 1 in the report under time t = 0 min.
- Turn on the power supply and start the stop watch immediately.
- Determine the water temperature after 1, 2, 3 and 4 min. Stir thoroughly before reading the thermometer and record the measured values in Table 1.
- Turn off the power supply.
- Repeat the experiment with 150 ml and with 200 ml of water. Rise the calorimeter with cold water and dry it before refilling.

Report: Heating different quantities of water

Result - Table 1

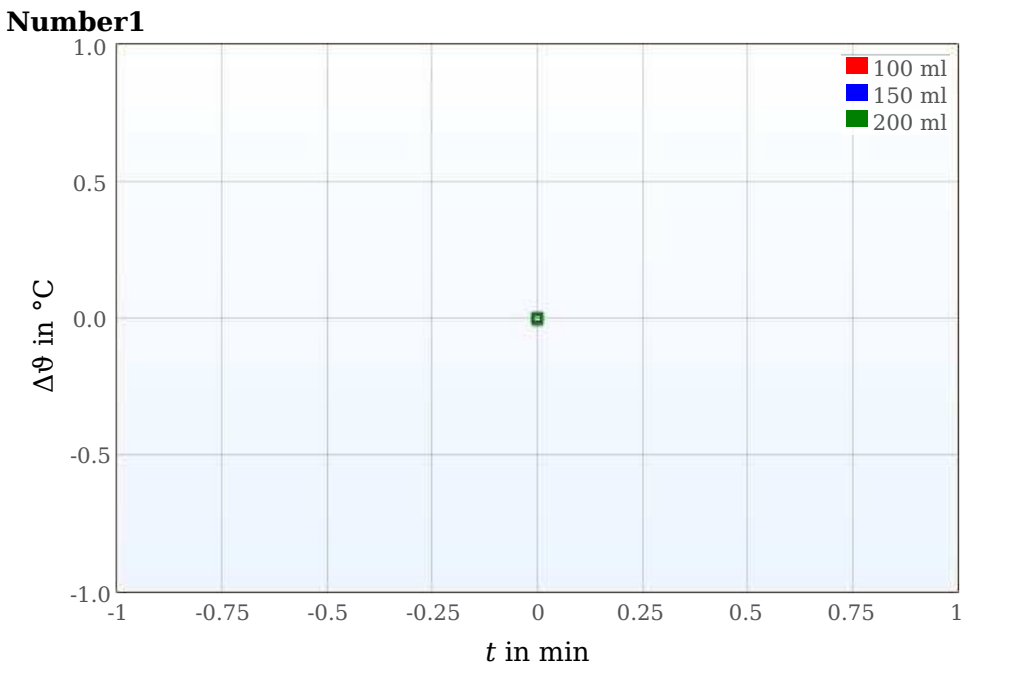
Note the measured temperatures of water in the table.

volume of water:	100 ml	150 ml	200 ml
t in min	ϑ in °C	ϑ in °C	ϑ in °C
0	1 ±0	1 ±0	1 ±0
1	1 ±0	1 ±0	1 ±0
2	1 ±0	1 ±0	1 ±0
3	1 ±0	1 ±0	1 ±0
4	1 ±0	1 ±0	1 ±0

Evaluation - Question 1

Calculate the temperature increase Δϑ for all the quantities of water (i.e., the temperature difference to the respective initial temperature) and record them in the table.

volume of water:	100 ml	150 ml	200 ml
t in min	Δϑ in °C	Δϑ in °C	Δϑ in °C
0	0	0	0
1	1 ±0	1 ±0	1 ±0
2	1 ±0	1 ±0	1 ±0
3	1 ±0	1 ±0	1 ±0
4	1 ±0	1 ±0	1 ±0



Evaluation - Question 2

Compare heating time and temperature increase for the 100 ml quantities of water (first column of the table in Question 1).

What do you notice?

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Evaluation - Question 3

Compare the volume of water and the temperature increase with each other after 4 minutes (last line of the table in Question 1).

What do you notice?

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Evaluation - Supplementary problem 1

Formulate the correlation between addition of heat and temperature increase which is shown in the chart of the table in Evaluation - Question 1.

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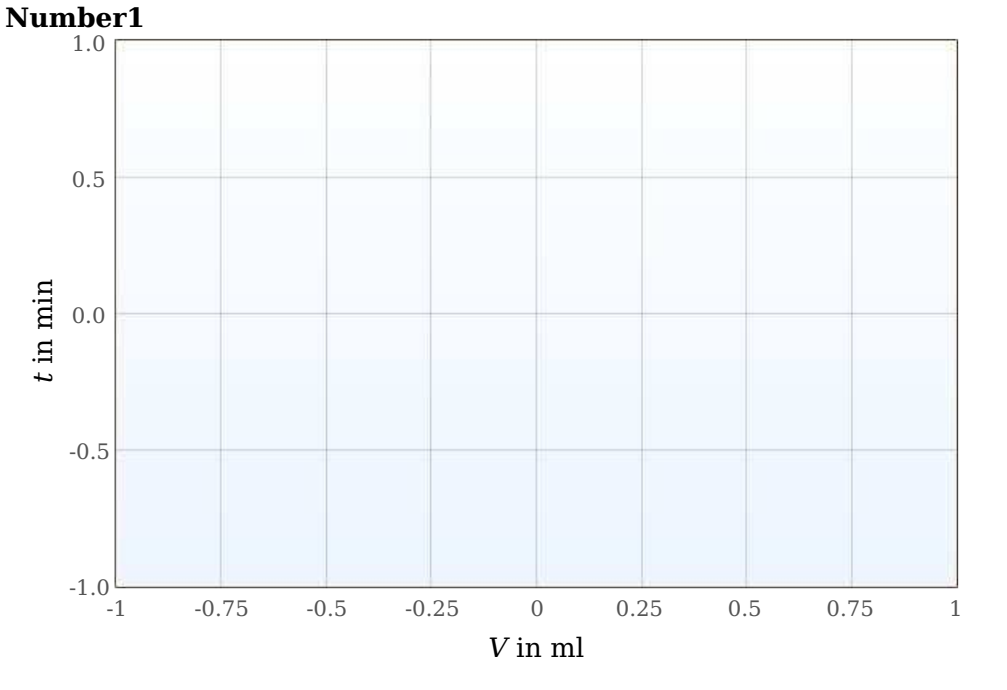
Evaluation - Supplementary problem 2

Read the heating period required for a temperature increase of 5 °C for each quantity of water from the chart in Evaluation - Question 1 and add the values to the table below.

V in ml	*t* in min
100	1 ±0
150	1 ±0
200	1 ±0



Evaluation - Supplementary problem 3

Formulate the relationship between addition of heat and volume of water for a given temperature increase Δϑ.

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