Heating different quantities of water

P1043700

Physics > Thermodynamics > Heat energy, thermal capacity

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

This content can also be found online at:

http://localhost:1337/c/62e8156399933e00032706d1

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Teacher information

Application

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Experimental setup

Different quantities of water are heated with a heating coil in a calorimeter. The selected water quantities are matched to the size of the calorimeter (100 ml, 150 ml, 200 ml) and are in simple ratios to each other so that it becomes obvious:

The more water, the longer heating is required, or, for the same heating energy, the temperature increase is inversely proportional to the amount of water.

It is used, for example, when choosing the amount of water for cooking.

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Other teacher information (1/3)

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Prior knowledge

No previous experience is necessary.

Principle

Different amounts of water are heated with the help of a heating coil. The increase in temperature is measured as a function of time. By adding heat, the "internal energy Q" of the water is increased. The correlation applies: $Q = c \cdot m \cdot \Delta T$. Thereby c the specific heat capacity.

Other teacher information (2/3)

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Learning objective

The students should learn the relationship between heat input, water quantity and temperature increase.

Tasks

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

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Other teacher information (3/3)

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Notes

When the heating voltage of 12 V is switched on, the heating coil must be immersed in water because otherwise it will glow through. To ensure that the initial temperatures are approximately the same for all three experiments, a 250 ml Erlenmeyer flask (or an even larger vessel, if available) is used as a storage vessel for water at room temperature. The water in the calorimeter must also be stirred regularly. In addition, when reading the thermometer, intermediate values of 0.5 °C should also be estimated. The water can also be measured to have the information in grams directly. Suitable scales are on the materials page.

The water is heated with a heating coil to ensure that all three test series are carried out with the same heating power. If a butane burner with a constant flame is used as a heater, this condition is only insufficiently fulfilled because the temperatures of e.g. the stand ring, wire net base and beaker also have an influence on the measurement result.

Safety instructions

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

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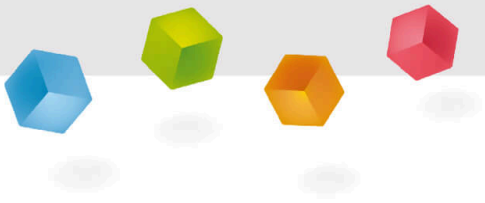

Student information

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Motivation

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Boiling water for tea

When boiling water in a kettle, for example, the boiling time depends on various factors.

With the help of this experiment, you should be able to decide whether it is worth the time to pre-boil water for the next tea or to only put the exact amount of water for one tea into the kettle.

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Equipment

Position	Material	Item No.	Quantity
1	Lid for student calorimeter	04404-01	1
2	Agitator rod	04404-10	1
3	Heating coil with sockets	04450-00	1
4	Felt sheet, 100 x 100 mm	04404-20	2
5	Beaker, Borosilicate, low form, 250 ml	46054-00	1
6	Beaker, Borosilicate, low-form, 400 ml	46055-00	1
7	Erlenmeyer flask, borosilicate, wide neck, 250 ml	46152-00	1
8	Pipette with rubber bulb	64701-00	1
9	Graduated cylinder 100 ml, PP transparent	36629-01	1
10	Students thermometer, -10...+110°C, l = 230 mm	38005-10	1
11	Digital stopwatch, 24 h, 1/100 s and 1 s	24025-00	1
12	Connecting cord, 32 A, 500 mm, blue	07361-04	2
13	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

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11	Digital stopwatch, 24 h, 1/100 s and 1 s	24025-00	1
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Set-up (1/2)

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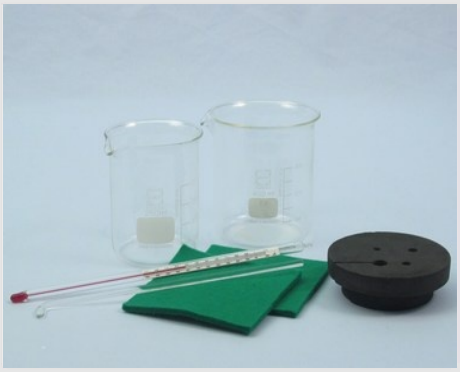
- Assemble a heat-insulating vessel (calorimeter) from two beakers (250 ml and 400 ml) and two felt plates.
- Carefully push the heating coil into the slot in the calorimeter lid (fig. right).



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Set-up (2/2)

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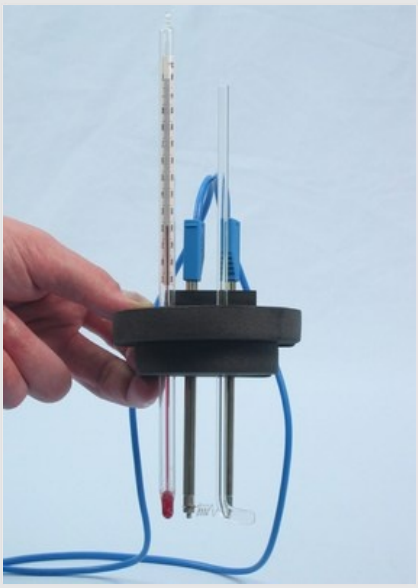

- Push the thermometer (d = 8 mm) and stirring rod (d = 5 mm) through the corresponding holes in the lid.
- Make sure that the power supply unit is still switched off.

Procedure (1/2)

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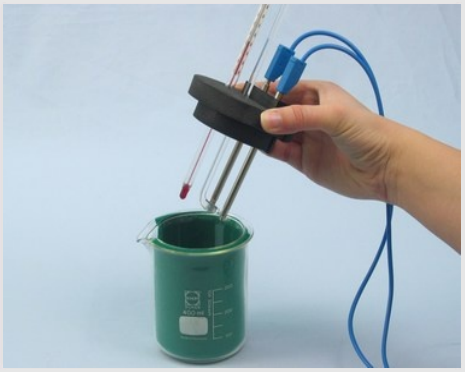
- First measure 100 ml of water in the measuring cylinder (exact measurement with the help of the pipette) and then fill the water into the calorimeter.
- Place the lid with heating coil, thermometer and stirring rod on the calorimeter.



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Procedure (2/2)

Power supply unit with heating coil

- Connect the heating coil with the connecting leads to the 12 V AC output (**Power supply unit off!**).
- Measure the initial temperature of the water and enter it in Table 1 in the report at time t = 0 min on.
- Switch on the mains unit and the stopwatch at the same time.
- Measure the water temperature after 1, 2, 3 and 4 minutes. Stir carefully before reading and record the readings in Table 1 in the report.
- Switch the power supply unit off again.
- Repeat the experiment with 150 ml and 200 ml of water. Rinse the calorimeter in cold water and dry it out.

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Report

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Task 1

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Enter the measured water temperatures in the table.

Water quantity	100ml	150ml	200ml		100ml	150ml	200ml
t in min	T in °C	T in °C	T in °C	t in min	T in °C	T in °C	T in °C
0				3			
1				4			
2							

Task 2

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Calculate the temperature increase for all water quantities ΔT (i.e. the temperature difference to the respective initial temperature) and enter it in the table.

Water quantity	100ml	150ml	200ml		100ml	150ml	200ml
t in min	T in °C	T in °C	T in °C	t in min	T in °C	T in °C	T in °C
0				3			
1				4			
2							

Enter the values in a t-ΔT-diagram.

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Task 3

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Compare heating time and temperature increase for the water quantity 100 ml. What do you find?

- ☐ Heating time and temperature increase are antiproportional to each other.
- ☐ Double the heating time brings double the temperature increase.
- ☐ Double the heating time brings half the temperature increase.
- ☐ Heating time and temperature increase are proportional to each other.

Check

Task 4

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Compare the amount of water and the temperature increase after 4 minutes. What do you find?

- ☐ With twice the amount of water, the temperature increase is the same.
- ☐ Water quantity and temperature are inversely proportional to each other for the same heating time.
- ☐ With twice the amount of water, the temperature increase is twice as great.
- ☐ Water quantity and temperature are proportional to each other for the same heating time.
- ☐ With twice the amount of water, the temperature increase is only half as great.

Check

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