Heating various liquids (Item No.: P1043800)

Curricular Relevance

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

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
- Glycerol, 250 ml 30084-25

Experiment Variations:

- with universal balance

Keywords:

Task and equipment

Information for teachers

Additional Information

The dependence of heating a liquid on its specific heat capacity should be established in this experiment.

In these experiments, the liquids' masses and their thermal input are the same. Thus, the specific heat capacities obtained are not absolute, but can be given in relation to water.

The liquids are heated with a heating coil to ensure that each experiment is conducted with the same thermal input.

If a butane burner with a constant flame were to be used, this condition 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. The density and the volume of the liquids corresponding to 100 g are given so that 100 g of each liquid can simply be measured with the graduated cylinder.
2. Glycerol should not be poured down the drain, but collected and used again in later experiments.
3. The liquids are heated with a heating current of only 6 V since slow warming provides better results. In addition, the liquid in the calorimeter should be stirred at regular intervals.
4. When reading the thermometer, the temperatures should be estimated to the nearest 0.5 °C.
5. Since glycerol is strongly hygroscopic, the water content of glycerol can be very high. The determined specific heat capacity therefore deviates from that of pure glycerol.cGl = 2.4 J/g°C = 0.57 cW
6. For this experiment we recommend the use of a balance since the specific heat capacity referred to mass. Suitable balances are on the Material page.

Supplementary problem

Warming up of liquids is described by the formula

$Q = c \times m \times \Delta\vartheta$.

The mass m and the thermal input are constant in both experiments. To obtain a comparison of the specific heat capacities, the heating period (heat input) for a specific temperature increase $\Delta\vartheta$ is required.

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Heating various liquids (Item No.: P1043800)

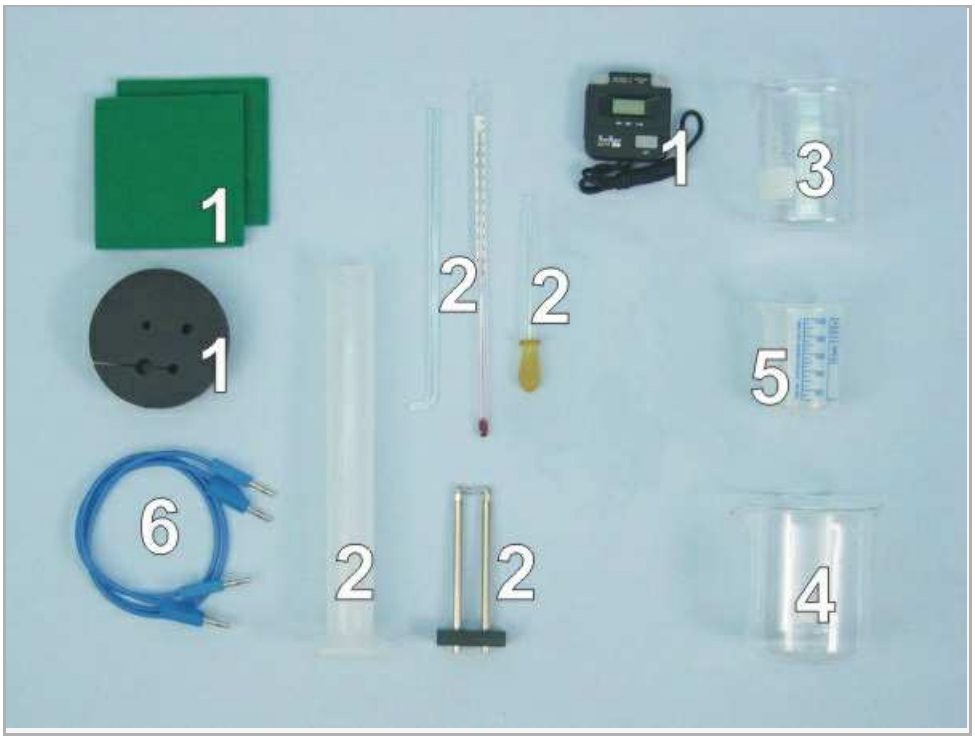
Task and equipment

Task

Are there differences when heating different liquids?

Heat 100 g each of water and glycerine with a heating coil; 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	Beaker, low form, plastic, 100 ml	36011-01	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
14	Glycerol, 250 ml	30084-25	15 ml
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

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Set-up and procedure

Set-up

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

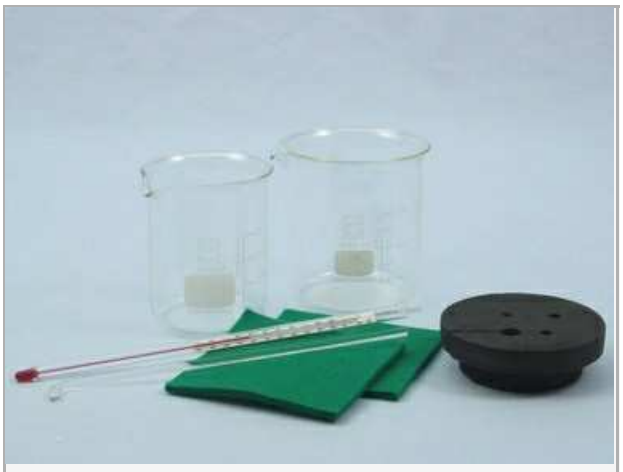


Fig. 1

Fig. 2

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

Fig. 3

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

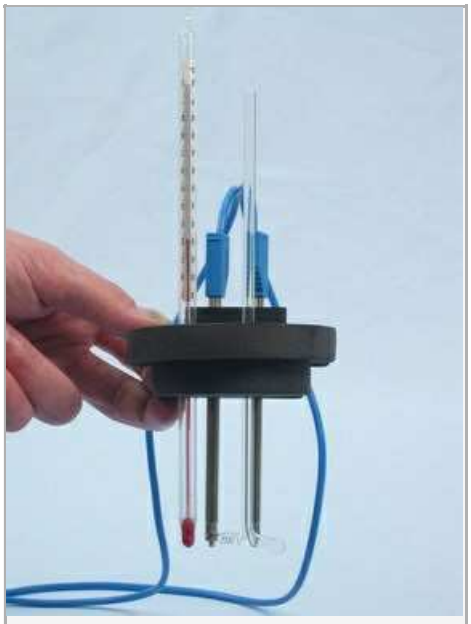


Fig. 4

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

Procedure

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

Fig. 5

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

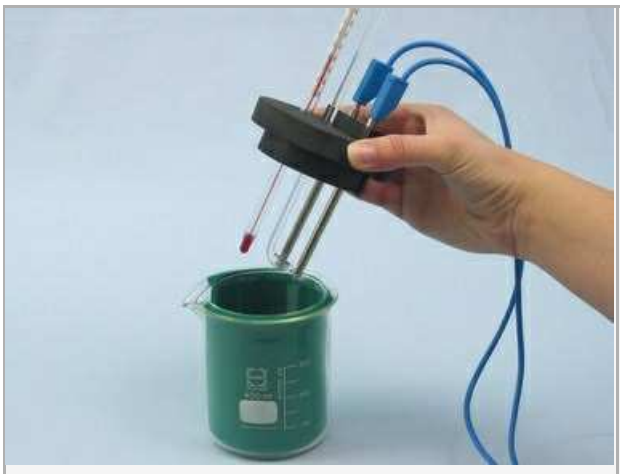


Fig. 6

Fig. 7

- Connect the heating coil to the 6 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 at the time t = 0 min.
- Turn on the power supply and start the stop watch immediately.
- Determine the water temperature after 1, 2, 3, 4 and 5 min. Stir thoroughly before reading the thermometer and record the measured values in Table 1.
- Turn off the power supply.
- Repeat the experiment with 100 g (79.4 ml) of glycerol. Rinse the calorimeter with cold water and dry it before filling.

Report: Heating various liquids

Result - Table 1

Note your measured values for the temperature of water and glycerol in the table.

	water	glycerol
t in min	ϑ in °C	ϑ in °C
0	1 ±0	1 ±0
1	1 ±0	1 ±0
2	1 ±0	1 ±0
3	1 ±0	1 ±0
4	1 ±0	1 ±0
5	1 ±0	1 ±0

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Evaluation - Question 1

Calculate the temperature increase Δϑ for both liquids (i.e., the temperature difference to the respective initial temperature) and record them in the table below.

	water	glycerol
t in min	Δϑ in °C	Δϑ in °C
0	0	0
1	1 ±0	1 ±0
2	1 ±0	1 ±0
3	1 ±0	1 ±0
4	1 ±0	1 ±0
5	1 ±0	1 ±0

Number1

Evaluation - Question 2

Compare heating time and temperature increase of the two liquids with each other. What do you notice?

.....

.....

.....

.....

Evaluation - Question 3

Compare the temperature increases after 5 minutes. What do you notice?

.....

.....

.....

.....

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Evaluation - Supplementary problem 1

Heat is added to the water by the heating coil; the greater the heating period, the greater the addition of heat.

1. Read the heating period t required for a temperature increase of 5 °C for each volume of water from the chart in Evaluation - Question 1; record the values in the table below.
2. This difference in the heating period (thermal input) is called the "specific heat capacity" of a liquid. Determine the ratio of the heating period for glycerol to that of water and record this value in the table, too. In this way you obtain a comparison of the specific heat capacity of these liquids.

	t in min	ratio
water	$\frac{1}{\pm 0}$	1.00
glycerol	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$

Evaluation - Supplementary problem 2

Which liquid has the larger specific heat capacity?

.....

.....

.....

.....

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Evaluation - Supplementary problem 3

Can you name some effects of the specific heat capacity of water in nature?

.....

.....

.....

.....

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com