Calorimetric temperature measurement (Item No.: P1044300)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 16-19
Topic: Thermodynamics
Subtopic: Calorimetry
Experiment: Calorimetric temperature measurement

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

Additional Requirements:

- Butane burner, Labogaz 206 type 32178-00
- Butane cartridge C206, without valve 47535-00
- Matches

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional Information

The temperature of a hot metal body is determined in a mixing experiment.

Remarks

1. Due to high temperatures, wire must be used for the support loop instead of fish line. The wire should be at least 40 cm long.
2. On immersion of the hot body in the cold water, there is a hissing noise because the body's temperature is greater than 100 °C.
3. The aluminium body may not be used in this experiment since its melting point is less than 1000 °C.
4. When reading the thermometer the temperature should be estimated to the nearest 0.5 °C.

The temperatures of both bodies should be about the same if they have both hung in the flame for the same period of time and in the same position.
The flame's temperature is about 1000 °C. The bodies' temperature depend on their height above the flame and how long they hang there. For example, if a body hangs immediately above the flame for 5 minutes, a temperature of about 700 °C can be achieved.
Since this is an experiment for students and the principle of temperature measurement should be demonstrated, it is sufficient to heat a body for about 1 minute above the flame.

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

Calorimetric temperature measurement (Item No.: P1044300)

Task and equipment

Task

How can the temperature of a hot body be determined?

Heat a metal body above a flame, then place it in a calorimeter filled with cold water and determine the mix temperature.

Equipment

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	1
3	Boss head	02043-00	1
4	Universal clamp	37715-00	1
5	Lid for student calorimeter	04404-01	1
6	Felt sheet, 100 x 100 mm	04404-20	2
7	Iron wire, d = 0.5 mm, l = 50 m	06105-00	1
8	Students thermometer, -10...+110°C, l = 230 mm	38005-10	1
9	Graduated cylinder 100 ml, PP transparent	36629-01	1
10	Pipette with rubber bulb	64701-00	1
11	Agitator rod	04404-10	1
12	Beaker, low form, plastic, 100 ml	36011-01	1
13	Glass beaker DURAN®, short, 400 ml	36014-00	1
14	Glass beaker DURAN®, short, 250 ml	36013-00	1
15	Metal bodies, set of 3	04406-00	1
Additional material			
16	Butane burner, Labogaz 206 type	32178-00	1
17	Butane cartridge C206, without valve	47535-01	1
18	Matches		

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

Attention!

1. The support wire should be 40 cm long so that its upper end does not get too hot.
2. The metal body gets very hot! Be sure that it cannot fall when it is moved with the universal clamp.
3. When reading the thermometer, the temperature should be estimated to the nearest 0.5 °C.

Setup

- Set up the support stand according to the following pictures.

Fig. 1

Fig. 2

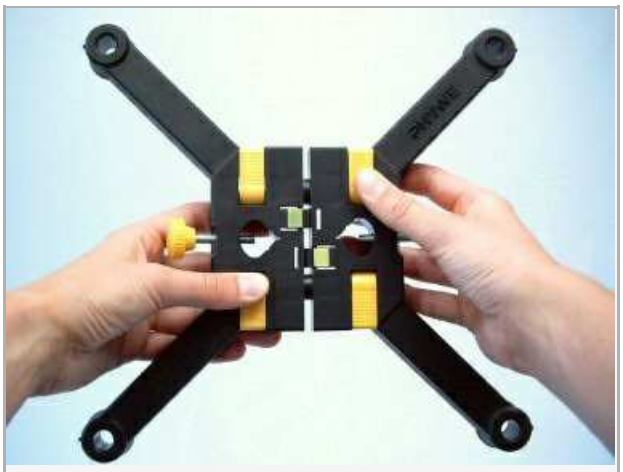

Fig. 3


Fig. 4a


Fig. 4b


Fig. 5


Fig. 6

- Make a loop out of a 40 cm long piece of wire and hang the brass body on the universal clamp with it.

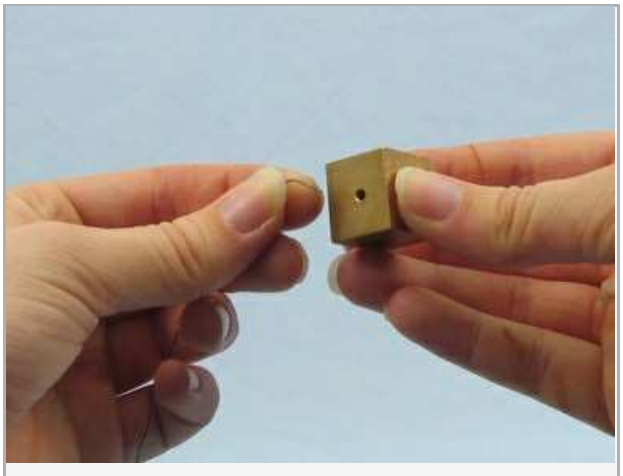
Fig. 7

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

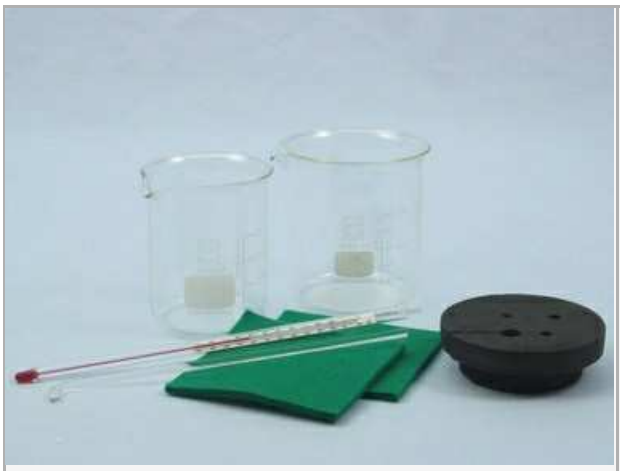

Fig. 8

Fig. 9

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

Fig. 10

Fig. 11

- Pour 150 ml of water into the calorimeter (exact measurement with graduated cylinder and pipette).

Fig. 12

Procedure

- Measure the temperature of the cold water ϑ_1 and record the values in the report.
- Hang the brass body about 5 cm above the burner's flame and heat it for one minute.
- Transfer the brass body to the cold water.
- Place the lid on the calorimeter, stir well and measure the mix temperature ϑ_m.
- Repeat the experiment with the iron body.

Report: Calorimetric temperature measurement

Result – Table 1

Note down the temperature of the cold water ϑ_1 and the mix temperature ϑ_m with metal body inside of the calorimeter in the table below.

	ϑ_1 in °C	ϑ_m in °C
Brass	1 ±0	1 ±0
Iron	1 ±0	1 ±0

Evaluation – Question 1

1. Calculate the heat Q absorbed by the cold water and by the calorimeter and record the value in Table 2 below.
   $Q = (c_W \text{ x } m_1 + C\ ) (\vartheta_m - \vartheta_1)$
   where
   c_W = 4,19 J/g°C, specific heat capacity of water,
   C = 80 J/g°C, heat capacity of the calorimeter,
   m_1 = 150 g, the mass of the water in the calorimeter.
2. This heat was released by the metal body. Calculate its temperature ϑ_0 for each case using this information:
   $\vartheta_0 = Q / (c \text{ x } m_0) + \vartheta_m$
   where
   c = 0,385 J/g°C, specific heat capacity of brass, and
   c = 0,450 J/g°C, specific heat capacity of iron,
   m_0 = 60 g, mass of each metal body.

	Q in J	ϑ_0 in °C
Brass	1 ±0	1 ±0
Iron	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

Robert-Bosch-Breite 10
D - 37079 Göttingen

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

info@phywe.de
www.phywe.com