Thermal insulation with SMARTsense (Item No.: P1043669)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Thermal physics
Subtopic: Heat transfer and thermal insulation
Experiment: Thermal insulation with SMARTsense

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

Additional Requirements:

- tablet PC with measureAPP

Experiment Variations:

Keywords:

Thermal insulation, Calorimetry

Task and equipment

Information for teachers

A comparison is made between the cooling of water in a simple glass beaker and in an insulated calorimeter.

Notes on set-up and procedure

- The water is to brought to the boil in each of the two parts of the experiment so that the starting temperatures are comparable. The hot Erlenmeyer flask is to be held with the universal clamp when it is to be moved to transfer the water.
- The measurement in the glass beaker is made without the lid. With the lid, the difference between the two vessels would only be half as much, as it hinders the cooling of the hot water at the surface.

Caution!

The support ring and the wire gauze get very hot when the water is heated up! Use the universal clamp to move the Erlenmeyer flask when you are about to transfer the hot water.

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

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Task and equipment

Task

Application

A quick loss of heat is sometimes not wanted. Especially in wintertime, when we want to keep our bodyheat as long as possible. Therefore we can use downjackets.
In houses we use insulation to make heating more efficient. There is a wide field of usage for insulation.

Downjackets help us to stay warm. They insulate our bodyheat.

Task

How can water stay hot longer?

Measure the cooling of hot water in two different environments:

- In a glass beaker that is fitted out with thermal insulation in the form of felt sheets and is in a second glass beaker that has a lid, the whole of which is named the calorimeter in the following.
- In the same glass beaker but without the thermal insulation.

Equipment

Position No.	Material	Order 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, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	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	37715-00	1
9	Lid for student calorimeter	04404-01	1
10	Felt sheet, 100 x 100 mm	04404-20	2
11	Graduated cylinder 100 ml, PP transparent	36629-01	1
12	Erlenmeyer flask,wide neck,250ml	36134-00	1
13	Beaker, low, BORO 3.3, 250 ml	46054-00	1
14	Beaker, low, BORO 3.3, 400 ml	46055-00	1
15	Butane burner, Labogaz 206 type	32178-00	1
16	Butane cartridge C206, without valve, 190 g	47535-01	1
17	Boiling beads, 200 g	36937-20	1
18	Cobra SMARTsense - Temperature, - 40 ... 120 °C	12903-00	1
Additionally			
19	Tablet PC with PHYWE measureAPP		1

Android iPad

Set-up and procedure

Set-up

Fig. 1: Set-up

- Set the stand up as shown in Figure 1.
- Fill 200 ml of water into the Erlenmeyer flask.
- Prepare a thermally insulating vessel (calorimeter) from two glass beakers (250 ml and 400 ml) and two felt sheets.

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Procedure

Caution!

The support ring and the wire gauze get very hot when the water is heated up! Use the universal clamp to move the Erlenmeyer flask when you are about to transfer the hot water.

- Turn on the Cobra SMARTsense-Temperature sensor.
- Open the PHYWE measure App and select the temperature sensor.
- Bring the 200 ml of water in the Erlenmeyer flask to the boil, use some boiling chips for safety. You can alternatively take 200 ml of boiling water from a kettle.
- Pour the hot water from the Erlenmeyer flask into the calorimeter. When doing so, use the universal clamp to hold the flask.
- Put the lid on and insert the temperature sensor through one of the holes in the lid.
- The tip of the sensor should be about half way down in the water.
- Wait until the temperature that is displayed no longer increases and then start measured value recording in measureApp .
- Measure for 8 minutes and end the measurement afterwards. Therefore you can use the timerfunction of the measureApp. Finally save the measurement.
- Repeat the experiment using only the smaller beaker that was in the calorimeter – without the lid.
- Give the glass beaker a cold rinse, dry it and again fill the same amount of boiling water (200 ml) into it.
- Fix the temperature sensor so that the tip of it is again at about the middle of the water.
- Change to the measurement window and wait until the temperature no longer increases, then start a new measurement. Proceed like described above. After saving the measurement you can open them under "my measurents" for further analysis.

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Evaluation

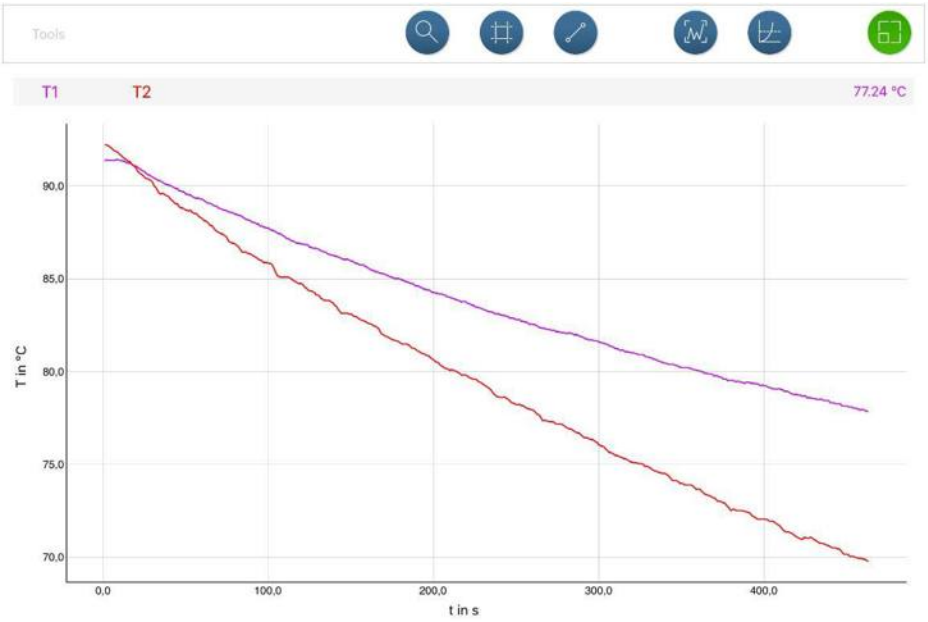

Fig. 2: Behaviour of the temperature of the water that was initially boiling against time for a beaker with thermal insulation (violet), the calorimeter, and the same beaker without thermal insulation (red)

Report: Thermal insulation with SMARTsense

Evaluation - Question 1 (1 point)

In which vessel does the temperature decrease slowest?

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Evaluation - Question 2 (1 point)

Where does the heat go when the water cools down?

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Evaluation - Question 3 (1 point)

Thermal insulation is also called heat insulation or lagging. Insulation comes from the Latin word insula (isola in Italian) for island. How do you think it came have the meaning it has for us?

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Evaluation - Question 4 (1 point)

Name examples of where thermal insulation is used.

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Evaluation - Question 5 (1 point)

Name materials that are suitable for thermal insulation.

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