Thermal conduction in liquids

P1043400

Physics > Thermodynamics > Heat transfer

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

This content can also be found online at:

http://localhost:1337/c/6425d8a4e22e3d0002013491

Teacher information

Application

Experimental setup

When water is heated at the upper layer and cooled at the lower layer, temperature stratification occurs due to differences in density. The heated water has a lower density and the cooled water a higher density; there is hardly any heat conduction.

This can be observed, for example, in the swimming pool or ocean when the top layer is heated by the sun or circulating air.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Other teacher information (1/3)

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Prior knowledge

The students should be familiar with a butane burner. In addition, they should already be aware that warmer liquids have a lower density than colder ones.

Principle

In a test tube filled with water, the upper end is heated with a burner and the lower end is cooled with ice. It can be observed that the ice at the bottom melts very slowly. Temperature stratification occurs due to differences in density. From this, the students should conclude that water is not a good conductor of heat.

Other teacher information (2/3)

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Learning objective

The students should learn that water is a poor conductor of heat. When water is heated on the surface, stratification occurs.

Tasks

Heat a test tube with water without heat flow and investigate the temperatures in the test tube.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
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Other teacher information (3/3)

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Notes on set-up and procedure

1. The test tube should be heated carefully with a low flame.
2. If you don't have ice available, poor thermal conductivity can also be shown just by measuring the temperature stratification.
3. The thermometer must be inserted very slowly so that the temperature stratification is not destroyed.

Notes

This experiment also shows that glass only has a low thermal conductivity. The experiment could not be carried out in a metal vessel.

Safety instructions

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

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

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Student information

Motivation

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Swimming pool

When swimming in the pool or sea, the top layer of water often feels warmer than deeper layers. For example, if you let your feet hang down in deeper water in the sea, the water is noticeably colder. This is especially noticeable in summer when the sun is shining.

You will learn why this is the case in this experiment.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Tasks

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Experimental setup

Is there thermal conduction in water?

Heat a test tube with water without heat flow and investigate the temperatures in the test tube.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Equipment

Position	Material	Item 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, stainless steel, l = 600 mm, d = 10 mm	02037-00	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	37715-01	1
9	Agitator rod	04404-10	1
10	Beaker, aluminum, polished	05903-00	1
11	Aluminium rod,U-shaped	05910-00	1
12	Copper rod, U-shaped	05910-01	1
13	Copper rod, U-shape,d 3mm,w.175mm	05910-03	1
14	Copper rod, U-shape,d.5mm,w.120mm	05910-04	1
15	Beaker, Borosilicate, low form, 250 ml	46054-00	1
16	Pipette with rubber bulb	64701-00	1
17	Graduated cylinder 100 ml, PP transparent	36629-01	1
18	Students thermometer,-10...+110°C, l = 180 mm	38005-02	1
19	Digital stopwatch, 24 h, 1/100 s and 1 s	24025-00	1
20	Measuring tape, l = 2 m	09936-00	1
21	Butane burner, Labogaz 206 type	32178-00	1
22	Butane cartridge C206, without valve, 190 g	47535-01	1
23	Boiling beads, 200 g	36937-20	1

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Robert-Bosch-Breite 10
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Set-up (1/3)

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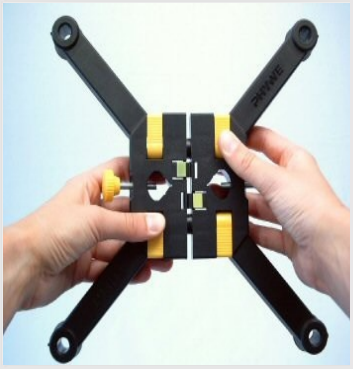
Set up the experiment according to the illustrations in order from left to right.




Set-up (2/3)

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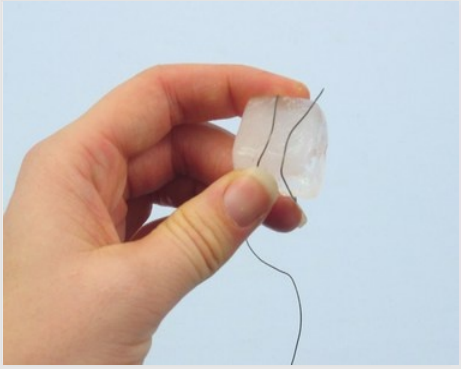
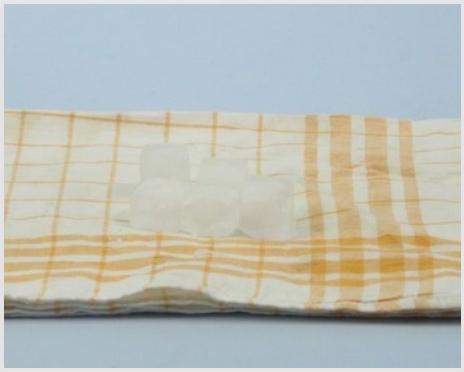
Wrap a larger piece of ice tightly with wire and place it in the test tube. The resulting wire net provides an indication of how quickly the ice melts.

Crush the remaining ice with a hammer, wrapping it in a cloth first so that no splinters jump away.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Robert-Bosch-Breite 10
37079 Göttingen

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info@phywe.de
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Set-up (3/3)

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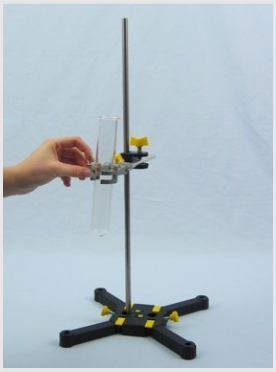
- Fill the beaker about halfway with ice. Add enough cold water to just cover the ice and stir carefully.
- Fill the test tube to about 3 cm below the rim with ice water and place it at an angle.






Procedure

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- Carefully heat the test tube in the upper part with the burner until it boils at the top.
- Observe the piece of ice and write down your observations in the report.
- Turn off the burner.
- Using the thermometer, carefully (without stirring up the water) measure the temperature in the top, middle and bottom of the test tube.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

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Report

Task 1

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What happens to the piece of ice during heating?

- The ice rises and slowly becomes smaller.
- The ice remains at the bottom of the test tube and only slowly becomes smaller.
- The ice rises and melts quickly.
- The ice remains at the bottom of the test tube and melts quickly.

Is the piece of ice still there when the water boils on top?

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Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Task 2

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Does heat flow take place in the test tube?

- ○ The warm water with the lower density is generated in the upper part and therefore sinks.
- ○ The warm water with the higher density is generated in the upper part, therefore it sinks.
- ○ The warm water with the lower density is generated in the upper part, therefore there is no cause for a flow.
- ○ The warm water with the higher density is generated in the upper part, therefore there is no cause for a flow.

Check

Task 3

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Water conducts heat well.

- ○ True
- ○ False

Check

The upper layer, warmed by sun and air in bathing establishments and waters, floats on the cold lower layers and the warm layer is not very wide.

Discuss this phenomenon together with the background.

Swimming pool

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Slide	Score / Total
Slide 16: Observations Heating ice	0/2
Slide 17: Evaluation heat flow	0/1
Slide 18: Heat conduction evaluation	0/1

Total 0 / 4

Solutions Repeat

PHYWE
Robert-Bosch-Breite 10
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