heat conduction in solids

P1043100

Physics > Thermodynamics > Heat transfer

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/6166c0f8e473310003365f18

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Teacher information

Application

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Test setup

Energy can be transferred by heat flow, heat radiation or heat conduction.

The greater the thermal conductivity of a material, the better this material can conduct heat. When a material with high thermal conductivity is heated, it heats up faster than a material with lower thermal conductivity.

In this experiment, the students learn this by means of 3 different materials through heat paper and their own feeling.

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Other teacher information (1/3)

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Previous

Students should be familiar with a butane torch. In addition, they should understand how the heat paper behaves when in contact with heat.

Principle

Three rods made of different materials are placed in the same warm water bath with heat paper on the end. After a few minutes, have the students determine the different heat spread in the materials by using the heat paper and touching the ends of the rods.

The copper rod with the greatest thermal conductivity will be warmest with red colored heat paper. The glass rod, on the other hand, will show an unchanged heat paper and will not feel warm.

Other teacher information (2/3)

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Learning

Students should learn that different materials have different thermal conductivity.

Tasks

Investigate heat conduction in metals and in glass.

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Other teacher information (3/3)

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Notes on structure and implementation

1. The stand rod is insulated with hose.
2. Make sure that the two rods project as far as possible equally above the beaker and that the heat paper, which is in the middle of one rod, is approx. 2 cm away from the beaker. Otherwise, heat radiation from the hot beaker and water vapor can discolor the heat paper and thus lead to falsification of the observation.
3. The glass rod is at an angle and, due to its arrangement and length, is somewhat favoured over the metal rods in terms of heat input. Nevertheless, its end remains much colder than that of the metal rods, so that the comparison of thermal conductivities is clear. The heat paper on the glass rod must be pushed all the way up so that the hot steam does not discolor it.
4. Record when the red colouring of the heat paper on the bars begins and what final state it assumes after 3 minutes.

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

Motivation

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Cooking pot with hard plastic handles

If we touch a pane of glass in summer after the sun has shone on it, it is warm, but by no means hot. It is different with a metal plate or a copper pipe (e.g. a rain gutter). If we touch these after a day of sunlight, we can get a burn in the worst case.

I'm sure you've had a pot on the stove that got hot on the handles while another had cold handles.

These differences are due to the different thermal conductivity of the substances, which will be observed in more detail in the following experiment.

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Tasks

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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	1
5	Ring with boss head, i. d. = 10 cm	37701-01	1
6	Wire gauze with ceramic, 160 x 160 mm	33287-01	1
7	Agitator rod	04404-10	1
8	Aluminium rod,U-shaped	05910-00	1
9	Copper rod, U-shaped	05910-01	1
10	Beaker, Borosilicate, low form, 250 ml	46054-00	1
11	Butane burner, Labogaz 206 type	32178-00	1
12	Butane cartridge C206, without valve, 190 g	47535-01	1
13	Silicone tubing i.d. 7mm, 1 m	39296-00	1
14	Heat sensitive paper	04260-00	1
15	Boiling beads, 200 g	36937-20	1

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Set-up (1/3)

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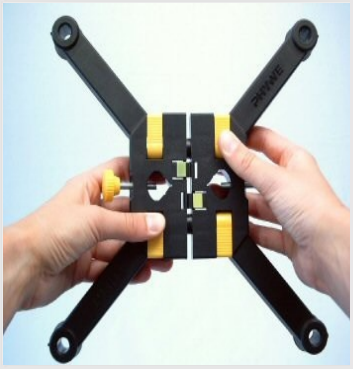
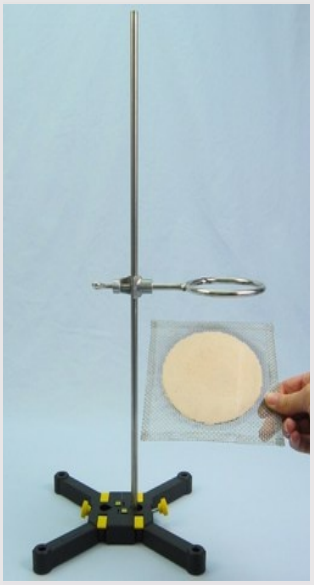
Set up the experiment according to the illustrations in order from left to right.

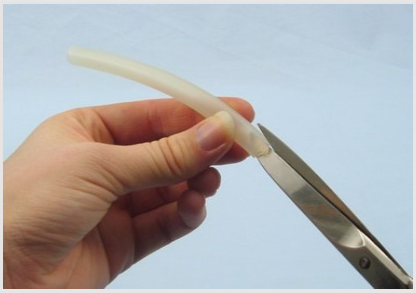
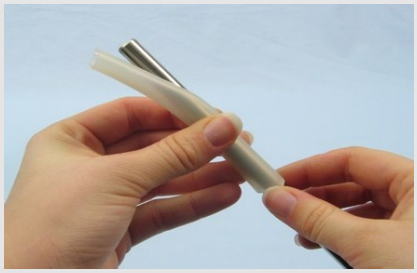



Set-up (2/3)

PHYWE

- Cut an approx. 10 cm long piece of tubing at the side (cf. fig. top right).
- Slide it over the small tripod rod (see figure below right).

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Set-up (3/3)

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- Arrange the tripod ring and the small tripod rod so that you can place the U-shaped rods over the rod and beaker.
- Fill about 200 ml of water into the beaker and add some boiling stones.

Procedure (1/3)

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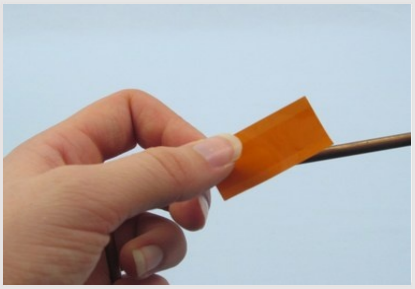
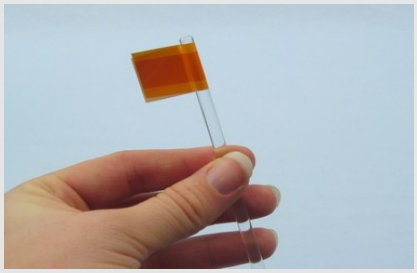
- The rods are not initially between the beaker and the rod.
- Heat the water in the beaker until boiling.
- Attach a piece of heat paper in the middle of each U-shaped rod, with the yellow side facing outwards (see illustration above). The paper should fit the rod as tightly as possible and all the way around.
- A heat paper is also attached to the glass rod, but at the very end (see figure below).





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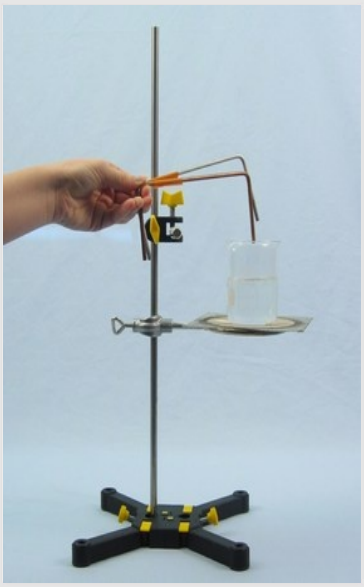
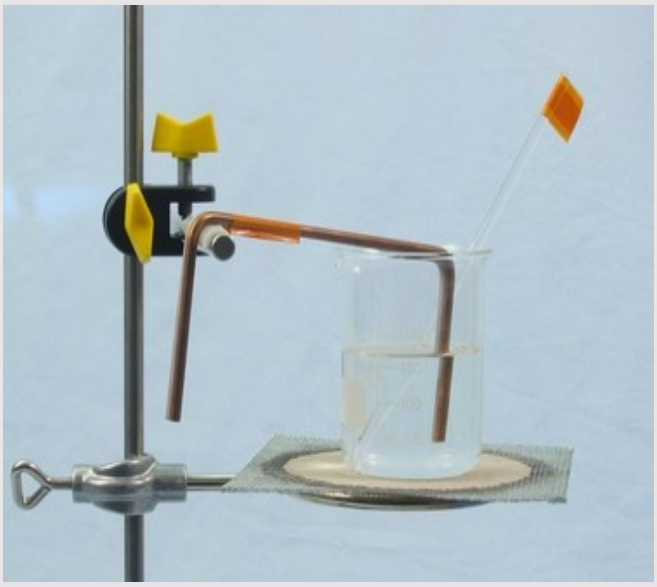
Procedure (2/3)



- Hang both metal rods simultaneously with one leg in the hot water and the other over the bar.
- Make sure that the heat paper is the same distance (approx. 2cm) from the beaker on both rods!



Procedure (3/3)

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- Place the stirring rod as diagonally as possible in the beaker so that the heat paper does not come into contact with the hot steam.
- Observe the heat papers on the rods and note in the protocol the beginning of the red coloration and the state after about 3 minutes.
- After a few minutes, touch the end of the rods hanging over the bar and note your observations.
- Touch the end of the glass rod and note your observations.

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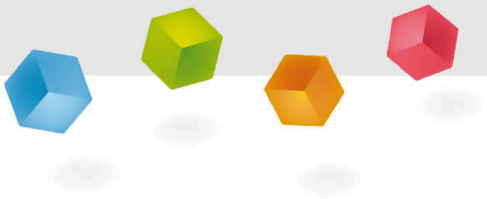

Report

Task 1

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Note the length of time it takes for the heat paper to start turning red.

	t in s
for aluminium:	
for copper:	
for glass:	

Note the colour of the heat paper after 3 min.

Aluminium

Copper

Glass

How warm is the rod at the end?

Aluminium

Copper

Glass

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Task 2

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Drag the words into the correct boxes!

The heat paper changes colour at approx. 45°C. At low temperature it is yellow, at higher temperature red. Arrange the bars in order from good to bad heat conduction.

copper

glass

aluminium

, , .

Check

Task 3

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Does a rod have the same temperature along its entire length?

- No. There is a temperature gradient along the length of the rod.
- Yes. Once the rod is heated to a certain temperature at one end, the entire length of the rod is set to that temperature.
- No. The rod is warmer at the ends than in the middle.
- No. On one side the temperature is approx. 100 °C, on the other between 20 °C and 60 °C, depending on the rod. In the case of the aluminium rod, the temperature gradient can also be seen in the colouring of the heat paper.
- Yes. The temperature is the same along the entire length of the rod.

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Slide	Score / Total
Slide 19: Order thermal conductivity	0/3
Slide 20: Heat distribution	0/1

Total 0 / 4

Solutions Repeat Export text

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