Thermal convection in liquids and gases

P1043300

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/62e8153199933e00032706c9

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Teacher information

Application

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Experimental setup

Heating liquids or gases causes a flow, because the heated medium has a lower density than the cold one. Therefore, it rises upwards. In closed rooms, this can cause circulation.

This principle is used for heating, for example. Heaters are usually installed on the cold outer walls. Here, the warm heating air rises and the room becomes evenly warm through circulation.

The students learn about these heat flows with the help of this experiment.

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Other teacher information (1/3)

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Prior knowledge

Students should be familiar with a butane burner.

Principle

First, water coloured with food colouring is heated to observe heat flow in water. Then, with the help of a burner and a spiral, rising air flow is demonstrated.

Other teacher information (2/3)

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Learning objective

The students should realise that heating liquids or gases causes a flow because the heated medium has a lower density than the cold one and therefore rises upwards. In closed systems, this leads to circulation. Thermal energy is transported by the flow.

Tasks

1. Observe the behaviour of water when it is heated.
2. Observe the behaviour of air when it is heated.

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Other teacher information (3/3)

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Notes

1. Only a few grains of food colouring should be used to colour the water. The grains dissolve gradually and create a fine colour structure. If too much food colouring is used, the water will be uniformly coloured too quickly and the flow can no longer be observed.
2. There is a copy template for the paper spiral.
3. The paper spiral should hang at least 15 cm above the burner.
4. Protect the experimental set-up from draughts.

The first part of the test can also be carried out with the help of a circulation pipe (order no. 04510-01).

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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Radiator

Heaters are usually placed on outside walls. If you switch them on, the whole room gets warm after a while. The reason for this is heat flow in the air.

This phenomenon can also be observed with candles if you look at the air directly above the flame.

You can learn more about heat flow in liquids and gases in this experiment.

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Tasks

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Test part 2

1. Observe the behaviour of water when it is heated.
2. Observe the behaviour of air when it is heated.

Test part 1

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Equipment

Position	Material	Item 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	37715-01	1
5	Beaker, Borosilicate, low form, 250 ml	46054-00	1
6	Spoon, with spatula end, 180 mm, plastic	38833-00	1
7	Fishing line, l. 20m	02089-00	1
8	Butane burner, Labogaz 206 type	32178-00	1
9	Butane cartridge C206, without valve, 190 g	47535-01	1
10	Potassium permanganate, chem. pur., 250 g	30108-25	1

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Set-up (1/2)

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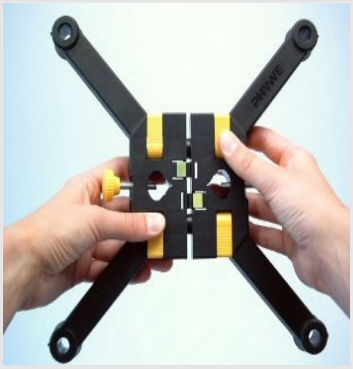
Set up the experiment according to the illustrations in order from left to right.




Set-up (2/2)

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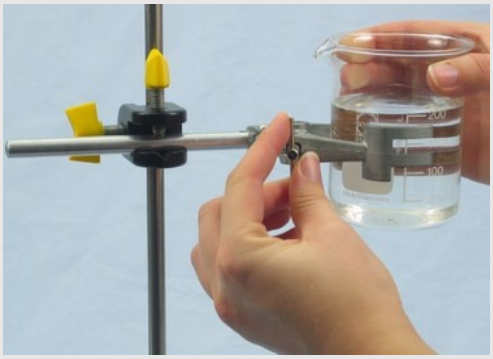
- Fill the beaker with about 200 ml of water.
- Carefully clamp it into the universal clamp.

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Procedure (1/3)

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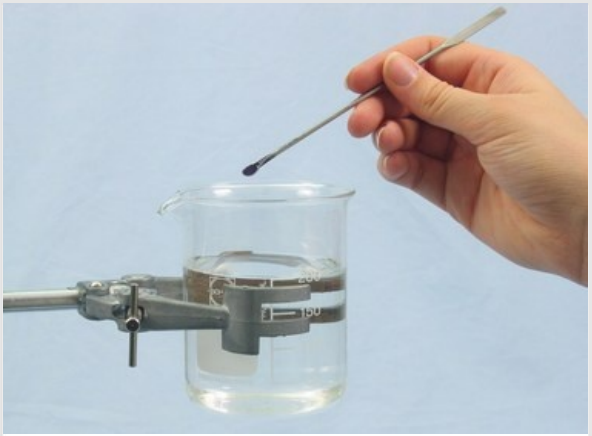


- Drop a few grains of food colouring into the water at the edge of the beaker.

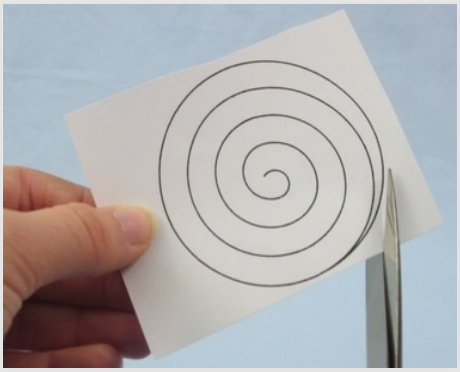
- Place the burner with a small flame at this point slightly to the side under the beaker (cf. fig. right).

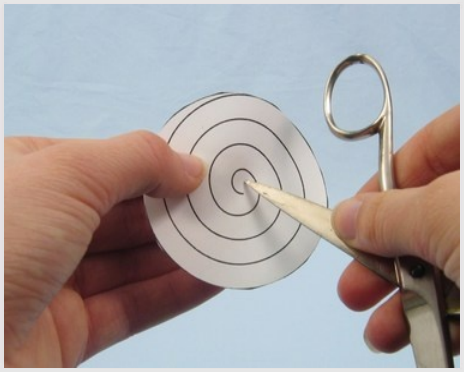
- Observe the coloured water as it heats up and write down your observations in the report.

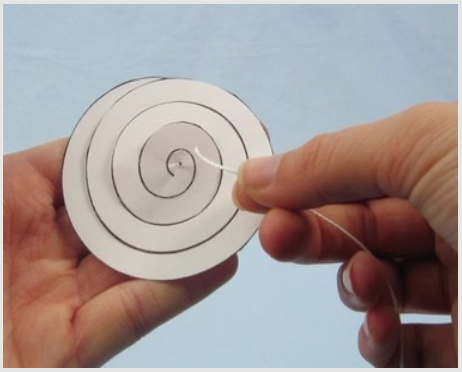
Procedure (2/3)

If you click here, you can download the copy template "Spiral".

Print out the "Spiral" template. Cut out the spiral, tie a piece of string (approx. 20-30 cm) with a knot at one end and pull this string through the hole in the spiral.







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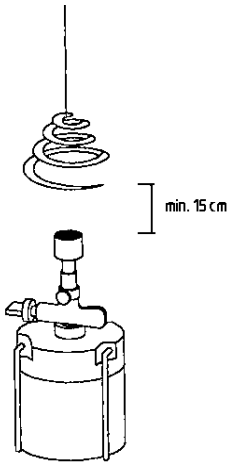
Procedure (3/3)



- Hang the spiral about 15 to 20 cm above the burner.
- Light a small flame.
- Write down your observations.

Report

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Task 1

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What can be observed when heating water?

- The water sinks on the side where the burner is. It rises again on the opposite side.
- There is nothing to observe.
- The water rises and evaporates directly.
- The water rises on the side where the burner is. It sinks down again on the opposite side.

Task 2

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Sketch the beaker and the flame. Draw in the picture where the water rises and sinks when it is heated by the flame.

Drag the words into the correct boxes!

[ ] water has a lower density than [ ] water (cf. experiment "Thermal expansion of water"), so it rises to the top. Since the closed system of the beaker is clear, you can also see that there is [ ] because [ ] water is flowing in at the bottom. Warm air has a lower density than cold air, so it rises and sets the paper spiral in motion.

Warm
cold
circulation
cold

Check

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Task 3

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Additional task

Drag the words into the correct boxes!

In the case of hot water heating without a pump (gravity heating), the system must be built in such a way that all radiators are reached by _____ or horizontal flow of the _____ water. Such a heater is usually located on the outside wall of rooms. On the outside wall, a room is _____ than inside. The _____ air is heated, the room is evenly warmed by _____. Otherwise, the inside wall and ceiling would be _____, but the outside wall and floor would be _____.

- cold
- hot
- colder
- cold
- warm
- rising
- circulation

Check

Slide	Score / Total
Slide 17: Water heating	0/2
Slide 18: Thermal expansion	0/4
Slide 19: Hot water heating	0/7

Total 0 / 13

Solutions Repeat

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