Expansion of liquids and gases

Physics > Thermodynamics > Temperature & Heat

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/5f4d83b7ce572a000382d6b1

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Teacher information

Application

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Plastic bottles in the sun

Who does not know it: crackling plastic bottle in the sun or even in the snow.

This is due to the effect of the temperature change on the water and air inside the bottle.

The basics of this principle are taught in this experiment.

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Other teacher information (1/3)

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Prior knowledge

The students should already have familiarized themselves with the functioning and use of a burner. They should also be familiar with the centigrade scale and be able to use a thermometer.

Scientific principle

Air and water are heated above a burner and the change in volume is determined by the change in level in a collecting tank.

Other teacher information (2/3)

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Learning objective

In this experiment the students learn the basics of thermal expansion of materials.

Tasks

Measurement of the different volume change when air and water are heated.

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Other teacher information (3/3)

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Additional information

In this experiment, the students are to observe qualitatively the expansion of water and air when heated.

Note

When inserting the rubber stopper into the Erlenmeyer flask filled with water, the water rises about 4 cm into the glass tube.

Make sure that there are no air bubbles underneath the plug.

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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Liquids and gases generally expand with increasing temperature.

In the case of liquids, this is used for example in a thermometer. in a thermometer is a substance that expands and then rises in a small tube. in this way temperatures can be measured easily.

Only with cold water is it different. In the range of

0...4° C the water does not expand but shrinks. This is the so-called anomaly of water.

Gases behave similarly, only the effect is much greater.

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Tasks

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Does the volume of liquids and gases change when heated?

1. heat water and observe the volume

2. heat air and observe the volume.

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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	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	Beaker, 100 ml, plastic (PP)	36011-01	1
10	Beaker, Borosilicate, low form, 250 ml	46054-00	1
11	Beaker, Borosilicate, low-form, 400 ml	46055-00	1
12	Erlenmeyer flask, stopper bed, 100 mlSB 29	MAU-EK17082301	1
13	Glass tube, straight, l=80 mm, 10/pkg.	36701-65	1
14	Glass tubes,l.250 mm, pkg.of 10	36701-68	1
15	Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
16	Rubber stopper 26/32, 2 holes 7 mm	39258-02	1
17	Silicone tubing i.d. 7mm, 1 m	39296-00	1
18	Students thermometer, -10...+110°C, l = 230 mm	38005-10	1
19	Measuring tape, l = 2 m	09936-00	1
20	Butane burner, Labogaz 206 type	32178-00	1
21	Butane cartridge C206, without valve, 190 g	47535-01	1
22	Glycerol, 250 ml	30084-25	1

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Set-up (1/5)

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Assemble the burner as shown in the following figures.

Fig. 1

Fig. 2

Set-up (2/5)

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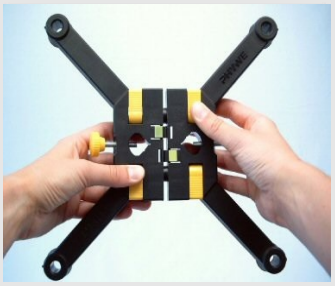
Build the tripod as in the following

pictures.



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Set-up (3/5)

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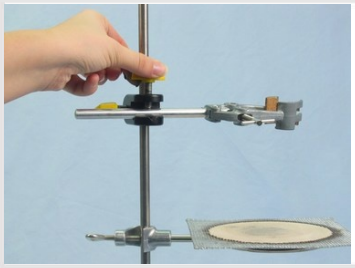
Set up the tripod as shown in the following illustrations.

Look out!

When heating the water, the tripod ring and the wire netting get very hot!

Fig. 7



Set-up (4/5)

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Fill the small and the middle beaker with 100 ml of water each, the large one with 200 ml.

Filling the beaker

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Set-up (5/5)

Place the 250 ml beaker on the wire net.

Set-up (5/5)

PHYWE

Place the 250 ml beaker on the wire net.

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Procedure (1/9)

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Careful filling of the Erlenmeyer flask

Test 1: Heating water

- Fill the Erlenmeyer flask almost to the brim with cold water.

Procedure (2/9)

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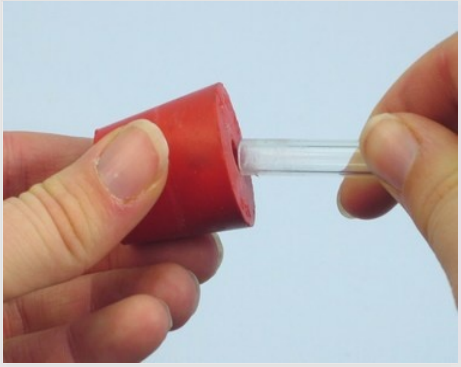
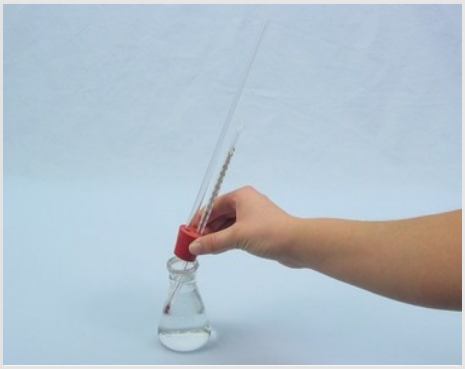
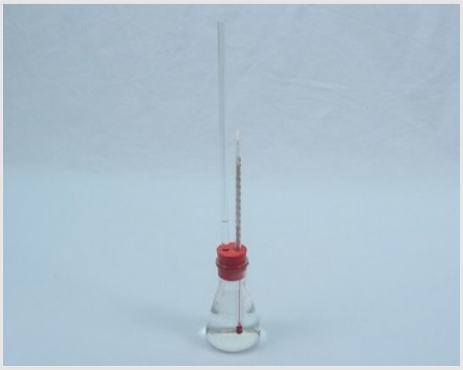
- Slide the thermometer into the rubber plug with 2 holes so that the immersion shaft protrudes almost completely.
- Push the long glass tube into the stopper so that it is flush with the bottom.
- Close the Erlenmeyer flask with the stopper. There should be no more air under the stopper!







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Procedure (3/9)

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Mark the water level in the glass tube.

Procedure (4/9)

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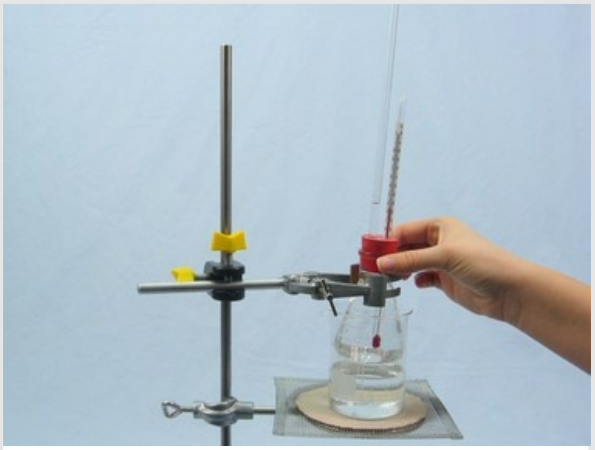

Clamping the Erlenmeyer flask

Place the Erlenmeyer flask in the 250 ml beaker and fix it with the universal clamp.

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Procedure (5/9)

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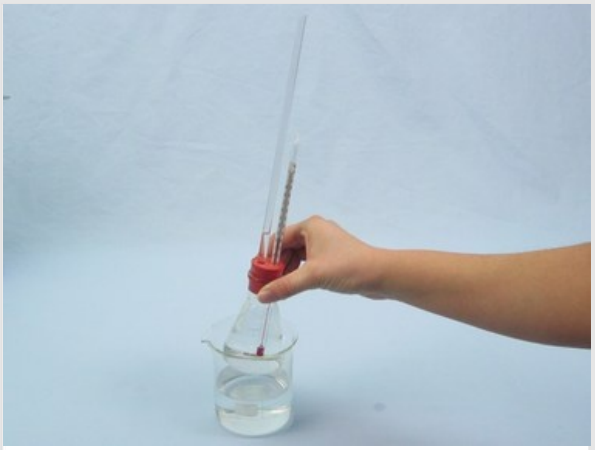
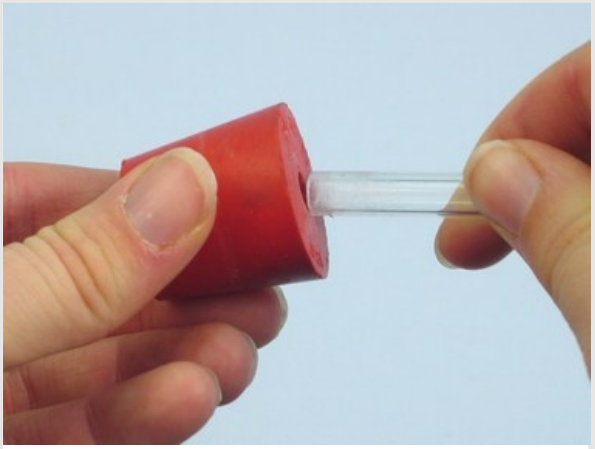


Removing the Erlenmeyer flask

- Heat the water to about 50°C and write down what you see in the log.
- Measure the change in water level.
- Immerse the warm Erlenmeyer flask in cold water (400 ml beaker) and write down your observations.

Procedure (6/9)

PHYWE



Mounting the tube

Test 2: Heating of air

- Empty the Erlenmeyer flask and dry it out.
- Push the short glass tube into the rubber stopper with 1 hole and close the Erlenmeyer flask with the stopper.

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Procedure (7/9)

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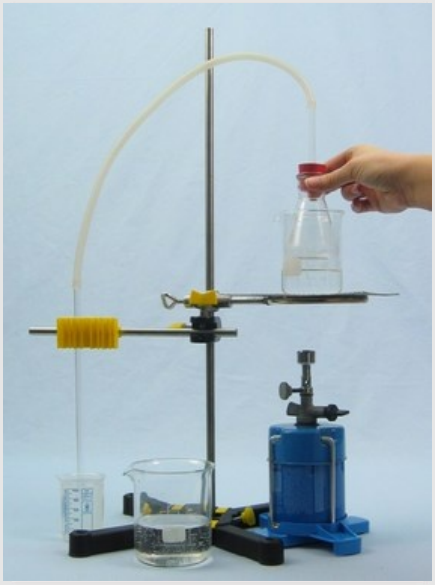
Clamp the long glass tube into the glass tube holder so that it is immersed in water (100 ml beaker).

Procedure (8/9)

PHYWE



- Connect both tubes with an approx. 50 cm long piece of hose.
- Immerse the Erlenmeyer flask in hot water (50 °C) and note your observations in the protocol.

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Procedure (9/9)

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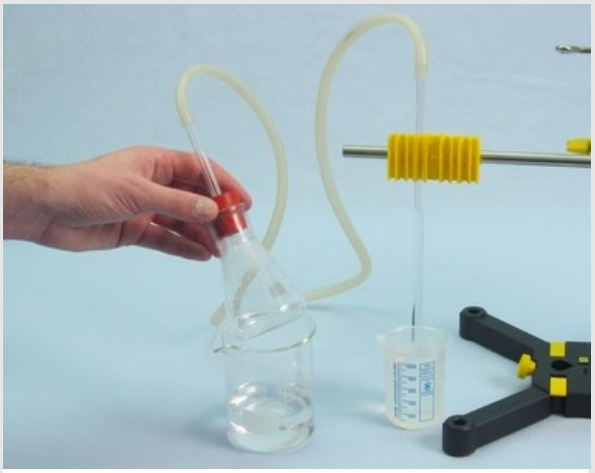

Cooling of the water

- Then dip the warm Erlenmeyer flask into cold water and write down your observations.
- Wait until the water level in the tube or hose does not change any more and read off the height.

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Report

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Task 1

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Write down your observations when heating water:

The water in the glass tube...

- ○ is rising.
- ○ does not change.
- ○ falls off evenly.

Check

Note the change in water level at 50 °C.

At 50 °C the water has risen by about _____ cm.

Check

Task 2

PHYWE

Write down your observations as the water cools.
Please drag the terms into the correct gap in the text.

The _____ in the glass tube _____ again. It _____ the original level when the water is back to its _____ temperature.

water level
initial
reaches
sinks

Check

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Task 3

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What happens in the second experimental part when the Erlenmeyer flask is immersed in hot water?

When immersed in _____,
_____ rise from the _____.

hot water | glass tube | air bubbles

Check

What happens when the warm Erlenmeyer flask is immersed in cold water?

When _____ into cold water,
_____ rises up into
_____ and into the
_____.

hose | dipping | water | the glass tube

Check

Task 4

PHYWE

Note the water level in the tube.

The water has risen approx. _____ cm when the air has reached the initial temperature again

Check

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Task 5

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How does the volume of water change with temperature?

The _____ of water _____ when _____ _____ and _____ again when _____ drops.

volume
the temperature
rises
the temperature
decreases
increases

Check

Task 6

PHYWE

How does the volume of air change with temperature?

The volume _____ increases with _____. The _____ of the water during _____ allows to estimate how large the volume increase was before

cooling
increase
of air
rising temperature

Check

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Task 7

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Compare the volume changes in water and air after heating.

The _____ of water and air at the beginning of the experiment is _____ as the volume of the _____. The volume in the hose does not have to be taken into account, as it is not heated in the _____. Therefore _____ of the air is _____, as the comparison of the measured values shows.

- Erlenmeyer flask
- much larger
- as large
- the expansion
- output volume
- water bath

Check

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