

Capillary action



Physics

Mechanics

Mechanics of liquids & gases



Difficulty level

easy



Group size

2



Preparation time

10 minutes



Execution time

10 minutes

This content can also be found online at:



<http://localhost:1337/c/5fb1550e3222c2000318beff>

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Teacher information

Application

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Test setup for determining the capillarity of water

Capillary action, or capillarity, is the behaviour of liquids which they exhibit on contact with so-called capillaries. Capillaries are generally narrow tubes or gaps and cavities in solids.

Capillarity occurs due to the surface tension of liquids and the interfacial tension between liquid and solid surface.

A classic example of capillarity is the glass tube immersed in water, in which the water rises a certain height against the force of gravity.

Other teacher information (1/2)

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Prior



The students should already have basic knowledge of buoyancy and swimming as well as hydrostatic pressure. In addition, it would be an advantage if the students already have knowledge about the density of materials and fluids.

Scientific



The principle behind capillary action is based on the surface tension of the liquid itself (cohesion) and the interfacial tension between the liquid and the wetted surface (adhesion).

Other teacher information (2/2)

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Learning



The students should learn that the tension between fluid and solid can cause the fluid to move upwards against gravity in narrow tubes.

Tasks



In this experiment, the students are to immerse four glass tubes with different inner diameters in water and observe whether and how high the water finally rises.

Note: The readability of the ascent height can be significantly improved by adding a few drops of food colouring to the water.

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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High trees in the forest

In the human body, blood is pumped through the body by the heart muscle. Trees, on the other hand, have no such organ. To ensure that the leaves can still be supplied with water and nutrients even at a height of 100 metres, trees make use of so-called capillarity.

Capillarity is an extremely interesting physical effect that occurs in narrow tubes or gaps in solids and causes a fluid to rise against gravity. Surely you have already observed the capillary effect when you dip a piece of paper in water or at a candle when the melted wax rises in the wick.

In this experiment, you examine the capillarity with the help of narrow glass tubes immersed in water.

Tasks

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In this experiment, you will investigate the capillary effect using water in thin glass tubes.

For this purpose, you will immerse four glass tubes with different inner diameters in water and observe if and how high the water rises.

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 with hole, stainless steel, 10 cm	02036-01	1
4	Boss head	02043-00	1
5	Capillary tube, 4, 0.5 to 1.2mm	40581-00	1
6	Glass tube holder with tape measure clamp	05961-00	1
7	Beaker, Borosilicate, low form, 600 ml	46056-00	1
8	Measuring tape, l = 2 m	09936-00	1

Additional equipment

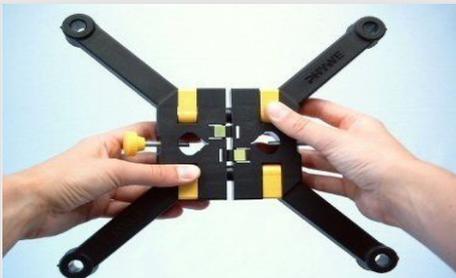
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Position	Equipment	Quantity
1	Scissors	1
2	Coloured chalk	1

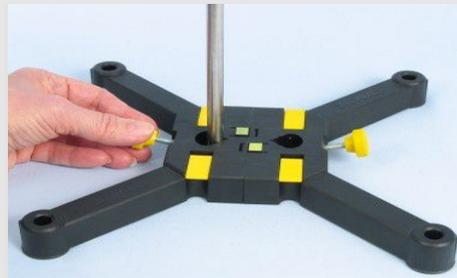
Set-up (1/2)

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Build a tripod with the tripod base and the 250mm long tripod rod. Clamp the double socket to the end of the 250 mm long rod and then clamp the 100 mm long rod into the double socket.



Assembling the tripod base



Mounting the support rod



Clamping the stand rod

Set-up (2/2)

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Attach glass tube holder to the stand rod

Attach the glass tube holder to the 100 mm stand rod.

Fix the capillary tubes in the glass tube holder, arranging them according to the size of the inner diameter.

Fill the beaker with about 500 ml of water.



Beaker with water and immersed capillaries

Procedure (1/2)

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Immersion of the glass tubes and measurement of the risen height

- Wet the four tubes completely by dipping them as deeply as possible into the water and then pull them out again until only the tips are immersed.
- Measure the rising heights, i.e. the heights of the water columns within the four tubes, with the measuring tape. If necessary, hold a piece of paper behind the tubes if you can hardly see the water level.
- Note the measured values of the four heights in Table 1 in the protocol.
- After the measurement, dry the capillary tubes well and blow the remaining water out of the tubes to prevent the formation of residues.

Procedure (2/2)

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Disassembling the tripod base

- To disassemble the tripod base, press the buttons in the middle and pull both halves apart.

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Report

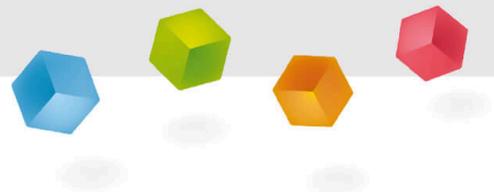


Table 1

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Immersion of the glass tubes and measurement of the risen height

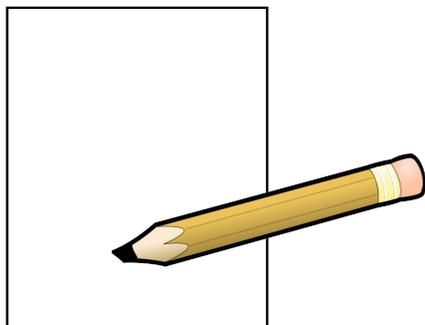
Note your measured values in the table. Note the inner diameters of the tubes d_i and the corresponding climbing heights h . Then calculate the reciprocal value of the inside diameters.

d_i [mm] h [cm] $1/d_i$ [1/mm]

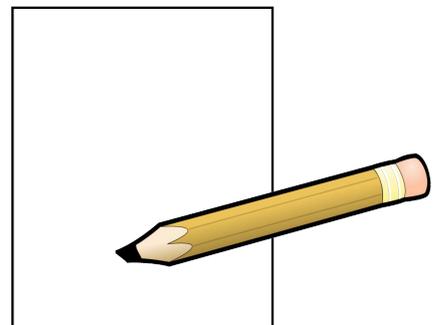
Task 1

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Now take a piece of paper and create a diagram on it. On this diagram you set the climb height h (y -axis) depending on the inner diameter d_i (x -axis).



Create another diagram, in which you set the climb height h (y -axis) as a function of the reciprocal value of the inner diameter $1/d_i$ (x -axis).



Task 2

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What kind of function results for the graph $h(d_i)$?

- A hyperbola function: With increasing inner diameter the risen height decreases more than linearly.
- A linear function: With increasing inner diameter the risen height increases linearly.
- A constant function. With increasing inner diameter, the risen height remains constant.
- A parabolic function. As the inner diameter increases, the risen height increases more than linearly.

✓ Check

Task 3

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Immersion of the glass tubes and measurement of the risen height

Which statement can you make about the results?

- The larger the diameter d_i , the higher the value for the climbing height h .
- There is no such thing as an everlasting relationship.
- The smaller the diameter d_i , the higher the value for the climbing height h .

✓ Check

Task 4

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Immersion of the glass tubes and measurement of the risen height

What kind of function do you get for the graph $h(1/d_i)$?

- A parabolic function.
- A constant function.
- A linear function.
- An exponential function.

✓ Check

Task 5

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Pour a drop of water on the table and hold a piece of chalk inside. What are you watching?

- The chalk absorbs the water because the chalk is porous and the water rises in the fine channels as in narrow capillary tubes.
- The water wets the outside of the chalk. Otherwise nothing happens.
- The water retreats because the chalk is hydrophobic, similar to the lotus effect.

✓ Check

Slide	Score / Total
Slide 18: Type of function 1	0/1
Slide 19: The... the... relationship	0/1
Slide 20: Type of function 2	0/1
Slide 21: Chalk in water	0/1

Total amount  0/4

 Solutions

 Repeat

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