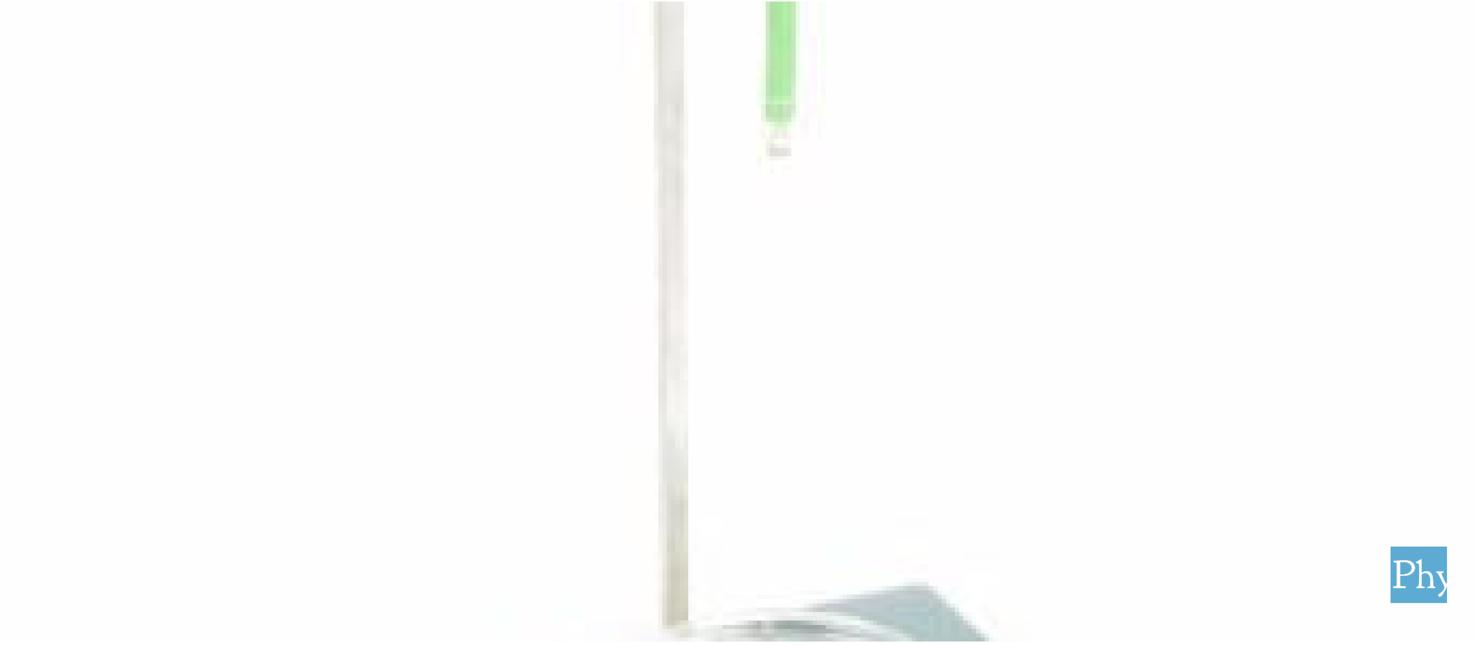
Surface tension of liquids



Physics > Mechanics > Mechanics of liquids & gases

Difficulty level	Group size	Preparation time	Execution time
medium	2	45+ minutes	45+ minutes

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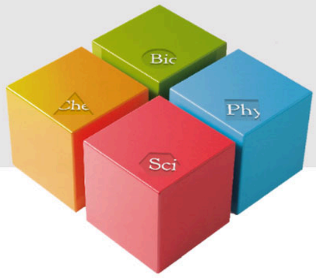

General information

Application

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Water dripping from a tap

Several effects of surface tension can be seenin our daily life, for examples:

- **Water droplets:** droplets of water tend to be pulled into a spherical shape by the cohesive forces of the surface layer.
- **Surface tension disinfectants:** Low surface tension allows them to spread out on the cell walls of bacteria and disrupt them.
- **Soaps and detergents:** Cleaning of clothes by lowering the surface tension of the water so that it more readily soaks into pores and soiled areas.

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Other information (1/2)

Prior knowledge

Cohesion is the property of like molecules sticking together, being mutually attractive. Adhesion is the tendency of dissimilar particles or surfaces to cling to one another. For example, at liquid–air interfaces, surface tension results from the greater attraction of liquid molecules to each other (due to cohesion) than to the molecules in the air (due to adhesion).

Scientific principle

The cohesive forces in a liquid generate tension on its surface, the so-called surface tension. A metal ring that is plunged into a liquid is withdrawn from the liquid. At a certain tensile force, the liquid film will be disrupted from the ring. Based on the tensile force and ring diameter, the surface tension of a liquid can be calculated.

Other information (2/2)

Learning objective

Understanding the surface tension of a liquid.

Tasks

Examine the surface tension of a liquid.

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Safety instructions

For this experiment the general instructions for safe experimentation in science lessons apply.

For H- and P-phrases please consult the safety data sheet of the respective chemical.

Theory (1/2)

A metal ring that is plunged into a liquid is withdrawn from the liquid. At a certain tensile force, the liquid film will be disrupted from the ring. Based on the tensile force and ring diameter, the surface tension of a liquid can be calculated by way of the following formula:

$$\rho = \frac{F - F_G}{2\pi d} = \text{ surface tension in N/m} \qquad (1)$$

F = indicated force in N immediately prior to the disruption

F_G = weight of the ring in N

d = diameter of the ring in m

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Theory (2/2)

Note

The surface tension is always specific to the liquid that is used. In order to demonstrate this, the experiment can be performed with several different liquids. However, liquids with a very low surface tension should not be used, since otherwise the rather simple measurement set-up would lead to excessively large measurement errors.

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Equipment

Position	Material	Item No.	Quantity
1	Tripod base PHYWE	02002-55	1
2	Right angle clamp expert	02054-00	1
3	Support rod, stainless steel, 750 mm	02033-00	1
4	Rod with hook	02051-00	1
5	Surface tension measuring ring	17547-00	1
6	Petri dish, d 150 mm, glass	64757-00	1
7	Water, distilled 5 l	31246-81	1
8	Lab jack, 200 x 200 mm	02074-01	1
9	Spring balance, transparent, 0,2N	03065-01	1

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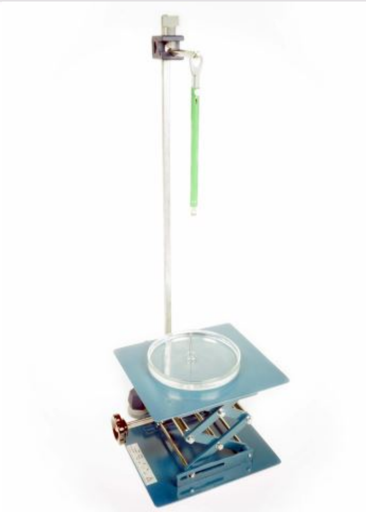
Setup and procedure

Setup (1/2)


Experimental setup

The picture shows the experiment set-up.

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Procedure

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The force gauge is suspended on a rod with a hook. By way of a right-angle clamp, the rod is fastened to a support rod that is secured in the tripod base. The force gauge is adjusted to zero. Then, the measurement ring is suspended in the eyelet of the force gauge.

The cleaned Petri dish is filled with pure water and placed on the adjustable table. The height of the table is adjusted so that the ring plunges approximately 3 mm deep into the liquid.

Then, the adjustable table is slowly lowered until the liquid film disrupts from the ring. The maximum value of the force F immediately prior to the disruption of the liquid film is read off the force sensor. Then, the weight of the ring in air is determined.

Evaluation (1/3)

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The surfaces of liquids have a certain surface tension due to the cohesive forces of the liquids. The diameter of the ring is determined and the surface tension is calculated based on equation (1). The following values represent a measurement example:

Tensile Force: F = 0080 N

Weight of the ring: F_G = 0.056 N

Diameter of the ring: d = 0.052 m

$$\rho = \frac{F - F_G}{2\pi d} = \frac{0.080 - 0.056}{2 \cdot 0.052 \cdot \pi} \, \frac{N}{m} = 0.073 \, \frac{N}{m}$$

The surface tension of water is approximately 0.073 N/m.

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Evaluation (2/3)

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Which of the following contribute to surface tension?

- only cohesive forces
- both cohesive forces and adhesive forces
- only adhesive forces

Check

Evaluation (3/3)

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Fill in the blank:

Due to ______ forces, molecules on the surface of a liquid are pulled downward to surrounding liquid molecules, while ______ forces pull them upwards due to surrounding gaseous molecules acting. This ______ force on the surface molecules is called ______.

- adhesive
- surface tension
- cohesive
- unbalanced

Check

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Slide	Score / Total
Slide 13: Contribution to surface tension	0/1
Slide 14: Surface tension forces	0/4

Total Score 0/5

Show solutions Retry

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