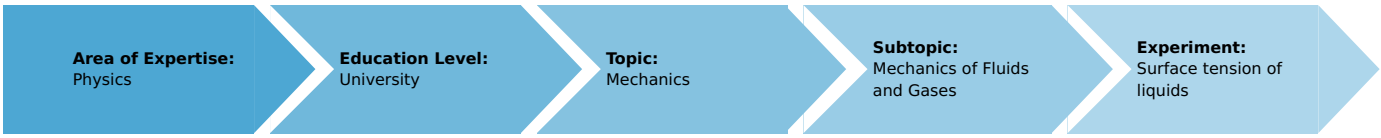
Surface tension of liquids (Item No.: P2140501)

Curricular Relevance



Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	1 Hour	1 Hour	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

wetting and non-wetting liquids, capillarity

Overview

Short description

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 A metal ring that is plunged into a liquid is withdrawn from the liquid.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.

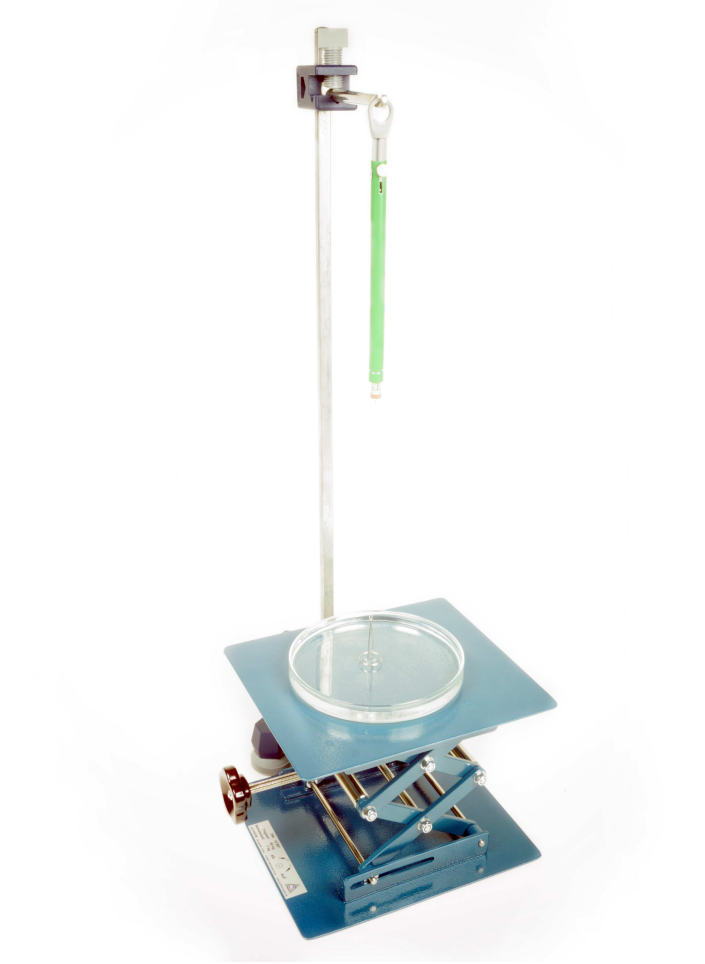


Fig. 1

Equipment

Position No.	Material	Order 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 0.1 N	03061-01	1

Tasks

Examine the surface tension of a liquid.

Set-up and procedure

The picture shows the experiment set-up. 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.

Theory and evaluation

Theory
A metal ring that is plunged into a liquid is withdrawn from the liquid.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:

$$\varrho = \frac{F - F_{\mathrm{G}}}{2\pi d} \text{ = surface tension in N/m} \quad (1)$$

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

Result

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: $F = 0.080\,\mathrm{N}$

Weight of the ring: $F_{\mathrm{G}} = 0.056\,\mathrm{N}$

Diameter of the ring: $d = 0.052\,\mathrm{m}$

$$\varrho = \frac{F - F_{\mathrm{G}}}{2 \cdot \pi \cdot d} = \frac{0.080 - 0.056}{2 \cdot 0.052 \cdot \pi}\ \frac{\mathrm{N}}{\mathrm{m}}$$

$$\varrho = 0.073\ \frac{\mathrm{N}}{\mathrm{m}}$$

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

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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