Department of biology

Department of biology

((Biophysics))

Stage 1

LAB(3)

Surface Tension

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Surface Tension

The Purpose of Experiment:

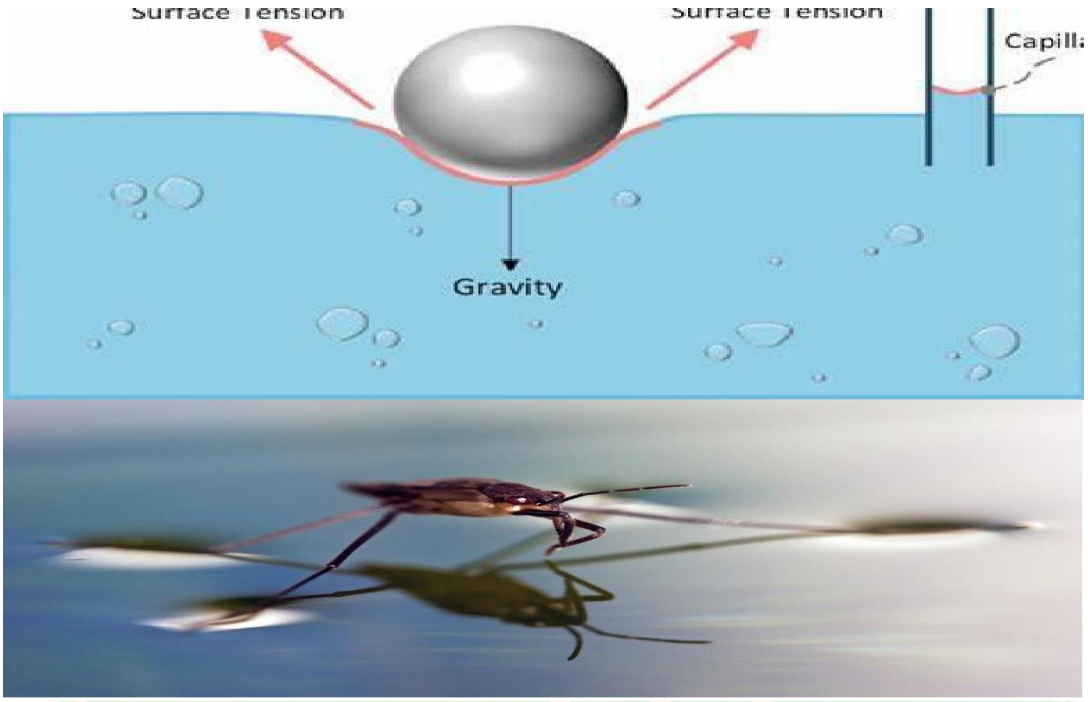
To calculate the surface tension of water by the capillary tube method.

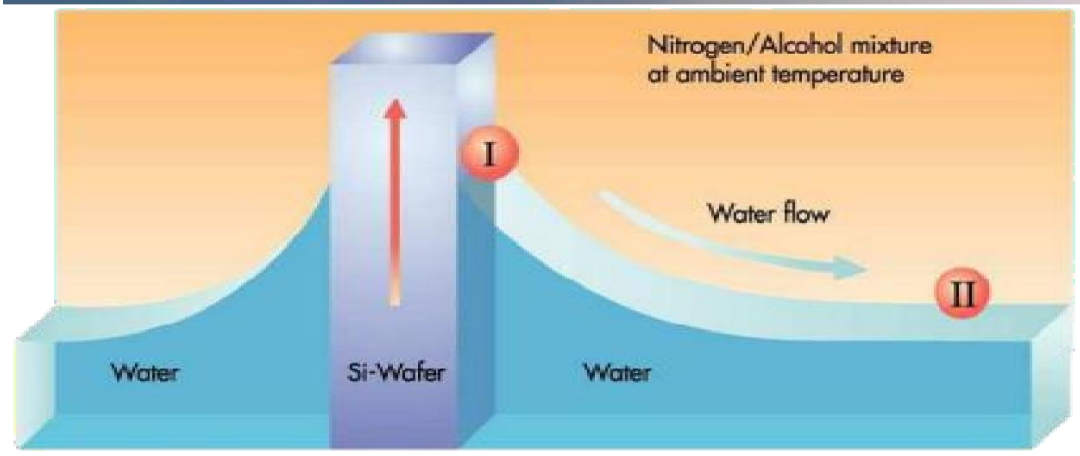
The Tools:

1. Capillary tubes.
2. Traveling microscope or glass scale.
3. Beaker.
4. Stand and clamp.
5. Thermometer.
6.

Theory of Experiment:

- Surface tension is a property of the surface of a liquid that allows it to resist an external force.
- The liquid molecules at the surface areaffected by the forces of cohesion with the liquid molecules from the lower side.and affected by the forces of adhesion with the air molecules from the upper side.
- Since the density of the liquid is greater than the density of air


Surface Tension
Surface Tension
Capill
Gravity


Nitrogen/Alcohol mixture
at ambient temperature
I
Water flow
II
Water
Si-Wafer
Water

The Steps of The Experiment:

1. Clean the capillary tube with distilled water and pull the liquid up this capillary tube

2. Immerse the lower end of the capillary tube vertically in the beaker containing the water.

3. Measure the height (h) to which the water level rises in the capillary tube above the level of the water in the beaker.

4. Measure the internal diameter of the capillary tube by using a traveling microscope.

5. Repeat all the measurements with the other capillary tubes.

6 Record the temperature of water, because the surface tension changes with a temperature change.

7- Calculate the surface tension of water using equation:

$$\gamma = \frac{1}{2} \rho g r h$$

γ : is the surface tension (N/m)

ρ: the density of water in (kg/m^3)

g: the gravitational acceleration =9.8(m/s^2)

h: height of the liquid in the capillary. (m)

r: radius of the capillary. (m)

Question:

A glass capillary tube with an inner diameter of 0.2 mm is placed vertically in a container of water at 20°C. The water rises in the tube to a height of 7.35 cm. Given that the density of water at this temperature is 998 kg/m³, the acceleration due to gravity is 9.81 m/s², calculate the surface tension of the water?

Solution:

To calculate the surface tension of water (γ), we use the following formula:

$$\gamma = \frac{1}{2} \rho g r h$$

Where:

ρ = density of water = 998 kg/m³

g = acceleration due to gravity = 9.81 m/s²

h = height of water in the tube = 7.35 cm = 0.0735 m

r = radius of the tube = (0.2 mm) / 2 = 0.0001 m

Substituting the values into the formula:

γ = (998 kg/m³ × 9.81 m/s² × 0.0735 m × 0.0001 m) / 2

γ = 0.07193 N/m

γ ≈ 72×10^{-3} N/m

Therefore, the surface tension of the water is approximately 0.072 N/m.

Question:

- **Purpose of the experiment?**
- **What are the tools of the experiment?**
- **What is the theory of the experiment?**
- **What are the steps of the experiment?**

للاطلاع فقط

The table below shows the change in density of water with temperature (at 1 atm standard pressure):

درجة الحرارة(°C)	كثافة الماء (جم/سم³)
0	0.99987
4	1.00000
10	0.99973
20	0.99823
25	0.99707
30	0.99567
40	0.99222
50	0.98803
60	0.98320
70	0.97776
80	0.97180
90	0.96535
100	0.95840

ملاحظات:

- كثافة الماء تبلغ أقصى قيمة لها عند درجة حرارة 4 درجات مئوية (1 جم/سم³).
- الكثافة تنخفض تدريجيًا مع ارتفاع درجة الحرارة أو انخفاضها عن 4 درجات مئوية.
- هذا الجدول يعبر عن الماء النقي فقط.