To determine the relative surface tension of a given/supplied liquid at laboratory temperature using a Stalagmometer.

Requirements:

1) Stalagmometer, 2) Relative density bottle, 3) Beakers, 4) Electronic weighing balance, 5) Distilled water, 6) Supplied solutions.

Theory:

Surface tension arises from the unequal forces of attraction acting on the surface molecules, drawing them towards the bulk of the liquid and the vapour in contact with it. Since the surface is in a state of tension, an attempt to make a penetration along any line in the surface will require an application of force to hold the separate portion of the surface together. This force is called surface tension and is defined as force per unit length acting at right angles to the line along the surface of the liquid.

When a liquid is allowed to flow through a capillary tube, a drop begins to form at its lower end, and increases in size to a certain extent, and then falls off. The measurement of surface tension (γ) of a liquid relies on the principle that the drop of a liquid at the lower end of capillary falls when weight of drop becomes just equal to the surface tension. The force of gravity (weight of drop) to pull the drop downward *v.d.g* (where *v* is the volume and *d* is the density of the drop of liquid) is balanced by the force $2\pi\gamma r$ (*r* is the radius of capillary) tending to uphold the drop:

$$2\pi\gamma r = vdg$$

If *n* is the number of drops in volume of V of the liquid, then the volume of each drop, $v = \frac{V}{n}$

Measurement of relative surface tension:

If n_l and n_w are the number of drops counted in the same volume (V) of unknown liquid and water, respectively, using the same capillary, then we have

$$2\pi r\gamma_l = \frac{V}{n_l} d_l g$$

$$2\pi r\gamma_w = \frac{V}{n_w} d_w g$$

Therefore, by dividing we get

$$\frac{\gamma_l}{\gamma_w} = \frac{n_w}{n_l}\frac{d_l}{d_w}$$

So,

$$\gamma_l = \frac{n_w}{n_l}\frac{d_l}{d_w} \times \gamma_w$$

By determining n_l, n_w, d_l, d_w and putting the known value of γ_w at laboratory temperature, we can find the $\gamma_{l.}$

Measurement of relative density using Relative Density (RD) Bottle:

Mass of the empty RD bottle = m_1
Mass of RD bottle with water = m_2

So, mass of water filled in = $m_2 - m_1$

Mass of RD bottle with liquid = m_3
Therefore, mass of liquid filled in = $m_3 - m_1$

So, the relative density of the liquid

$$\frac{d_l}{d_w} = \frac{m_3 - m_1}{m_2 - m_1}$$

Procedure:

Note: The stalagmometer should be fitted vertically upright and there should not be in air bubbles in the liquid capillary

1. The stalagmometer was cleaned and filled up with distilled water up to the upper mark by sucking through a rubber tube fitted with the stalagmometer.
2. Water was then allowed to come down to the lower mark of the stalagmometer at a moderate rate such that the number of drops falling from the capillary end of the stalagmometer was made to be 15 to 20 drops per minute.
3. Total number of drops was counted and repeated for 4 times.
4. Then the stalagmometer was rinsed with provided liquid and the total number of falling drops was counted without changing the setup. The process was repeated 4 times.
5. To determine the relative density of the liquid, weight of an empty RD bottle was taken. Then weight of the RD bottle filled with distilled water and supplied liquid were taken separately.

Observations:

Laboratory temperature = ………. °C. ***{the laboratory temperature must be reported to one decimal place}***

Table 1: Counting the number of drops for distilled water

Sl. No.	Number of drops for distilled water	Average number of drops of distilled water
1 2 3 4		

Table 2: Counting the number of drops for unknown liquids

Sl. No.	Number of drops for liquid	Average number of drops of liquid
1 2 3 4		

Table 3: Wight of empty r. d. bottle, with distilled water and supplied liquid

Weight of empty RD bottle (m_1 g)	Weight of RD bottle with distilled water (m_2 g)	Weight of RD bottle with supplied liquid (m_3 g)

{the weight should be reported to three decimal places}

Calculations:

Given γ_w= 72.75 dyne/cm at 20°C ***{given as an example}***

The relative density of the liquid

$$\frac{d_l}{d_w} = \frac{m_3 - m_1}{m_2 - m_1}$$

$$\gamma_l = \frac{n_w d_l}{n_l d_w} \gamma_w$$

Result: The relative surface tension of supplied liquid at laboratory temperature …..°C was found to be …………dyne/cm.