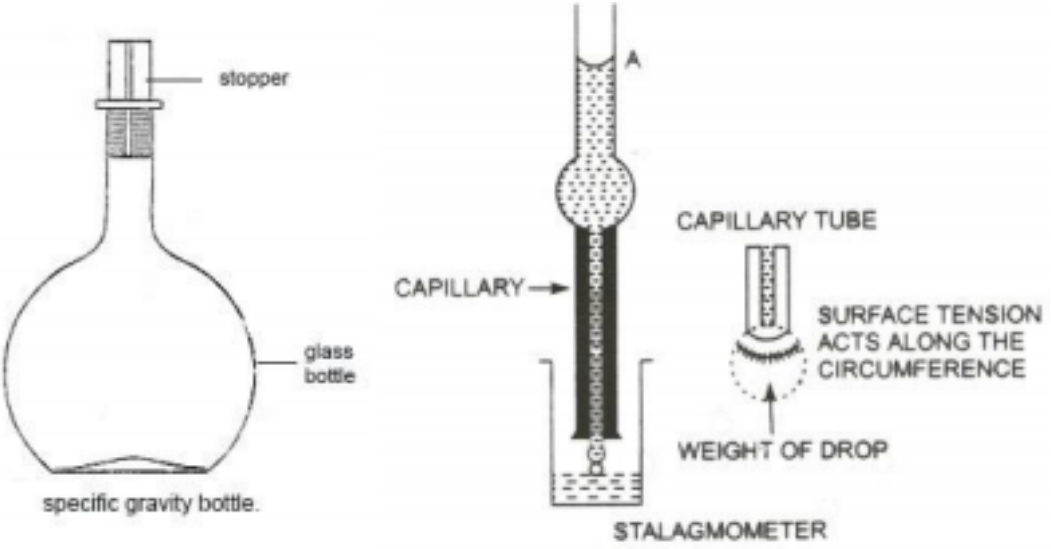
Experiment No. 4

Aim: To determine the surface tension of the given liquid by drop number method using stalagmometer.

Apparatus: Stalagmometer, beakers, pinch cock.

Chemicals: Reference liquid (H_2O), Given liquid (Ethyl alcohol)

Theory: Surface tension is the property of a liquid. The force per unit length acting at a right angle of the imaginary line drawn on the surface of the liquid. It tends in contract the surface of the liquid.
Surface tension is measured in the laboratory using stalagmometer by drop number method. The apparatus resembles a pipette with a bulb in the middle and the capillary with a flattened tip at the lower end.
Stalagmometer is a clamped vertically. There are two marks A and B above and below the bulb, liquid is sucked into the bulb above the mark A with the help of flammable rubber tube attached the mouth of the stalagmometer. Then allow the liquid to fall slowly. Count the number of drop between the two marks A and B.



When a liquid is allowed to flow through a capillary tube, a drop is formed at

the lower end. The size of the drop depends on the radius of the capillary tube and the surface tension of the liquid. The surface tension acting along the circumferences of the capillary tube support the drop in the upward direction.

When the drop is formed, two forces act on it.

1. Force of gravity – Which pulls down the drop in the downward direction is **v.d.g**

Where, v = volume of the drop, d = density of the drop, g = Acceleration due to gravity.

2. The force which holds up the drop in the upward direction is 2 ��r ��

Where, 2 πr = Circumference of the capillary of radius r (Part of stalagmometer) = Surface tension of the liquid
The two forces balance just before the drop falls,
So, 2 ��r = v.d.g

If the no. of drops in volume V of the liquid then the value of each drop, will be

v = $\frac{\text{V}}{\text{n}}$ (V = Volume of liquid, n = No. of drops of liquid)
2 ��r = $\frac{\text{V}}{\text{n}}$ x d x g

There are two liquids having two densities d_1 and d_2 and surface tension γ_1, and γ_2
so, the no. of drop counted for the same volume V of the two liquids be n_1 and n_2.
2 ��r γ_1 = $\frac{\text{V}}{n_1}$ x d_1 x g - for Ist liquid

2 ��r γ_2 = $\frac{\text{V}}{n_2}$ x d_2 x g - for IInd liquid

Hence, $\frac{\gamma_1}{\gamma_2} = \frac{n_2}{n_1} \times \frac{d_1}{d_2}$

where, γ_1 and γ_2 is surface tension of two liquids.

Observation Table:

S.No.	Water		Given Liquid (C_2H_5OH)	
	No. of Drops	Mean	No. of Drops	Mean
1.	46		69	
2.	48	47.6	70	70.3
3.	49		72	

Calculations:

Wt. of empty specific gravity bottle = w_1 g (21.60) g.

Wt. of empty specific gravity bottle with H_2O = w_2 g (45.9) g.

Wt. of empty specific gravity bottle with liquid = w_3 g (45.3) g.

Wt. of water = ($w_2 - w_1$)g (24.3)g.

Wt. of liquid = ($w_3 - w_1$)g (23.7) g.

(Relative density of the liquid = $\frac{\gamma_l}{\gamma_w} = \frac{d_l}{d_w} = \frac{n_l}{n_w} = \frac{w_3 - w_1}{w_2 - w_1}$

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

where, γ_l, d_l, n_l are the surface tension, density and no. of drops of liquids. where, γ_w, d_w, n_w are the surface tension, density and no. of drops of water.

Absolute surface tension of liquid:

$\gamma_l = \frac{47.6}{70.3} \times \frac{23.7}{24.3} \times 72$ Nm^{-1} OR dynes cm^{-1}

= 46.79 dyne/cm

Result: The surface tension of known liquid (H_2O) 72 dynes/cm
The surface tension of unknown liquid = 46.79 dynes/cm

Precautions:

1. Before use the stalagmometer should be cleaned and dry. 2. The rate of drop formation should be between 15-20 drops per minutes. 3. Stalagmometer should be vertical position throughout the counting process.