Expt. No. 01 Date

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Aim:- To determine the Surface Tension of the Given liquid.

Apparatus Used:- Stalagmometer.

A. DROP NUMBER METHOD

Theory:- When a liquid is allowed to flow through a capillary is tube, a drop formed at its lower end. It increases to a certain size and falls off. The size of the drop depends on the radius of the capillary and the surface tension in liquid. The surface tension acting along the circumference of the capillary tube supports the drop in the upward direction.

The measurement of surface tension of liquid based on the fact that the drop of the liquid at the lower end of capillary falls down when weight of drop becomes just equal to the surface tension.

1. Now the force of gravity exerted on the drop, is given by v.d.g.
where v is the volume of the drop, d its density and g its gravity. The force of gravity will pull down the drop.
2. The force tending to uphold the drop is is given by $2\pi r\gamma$

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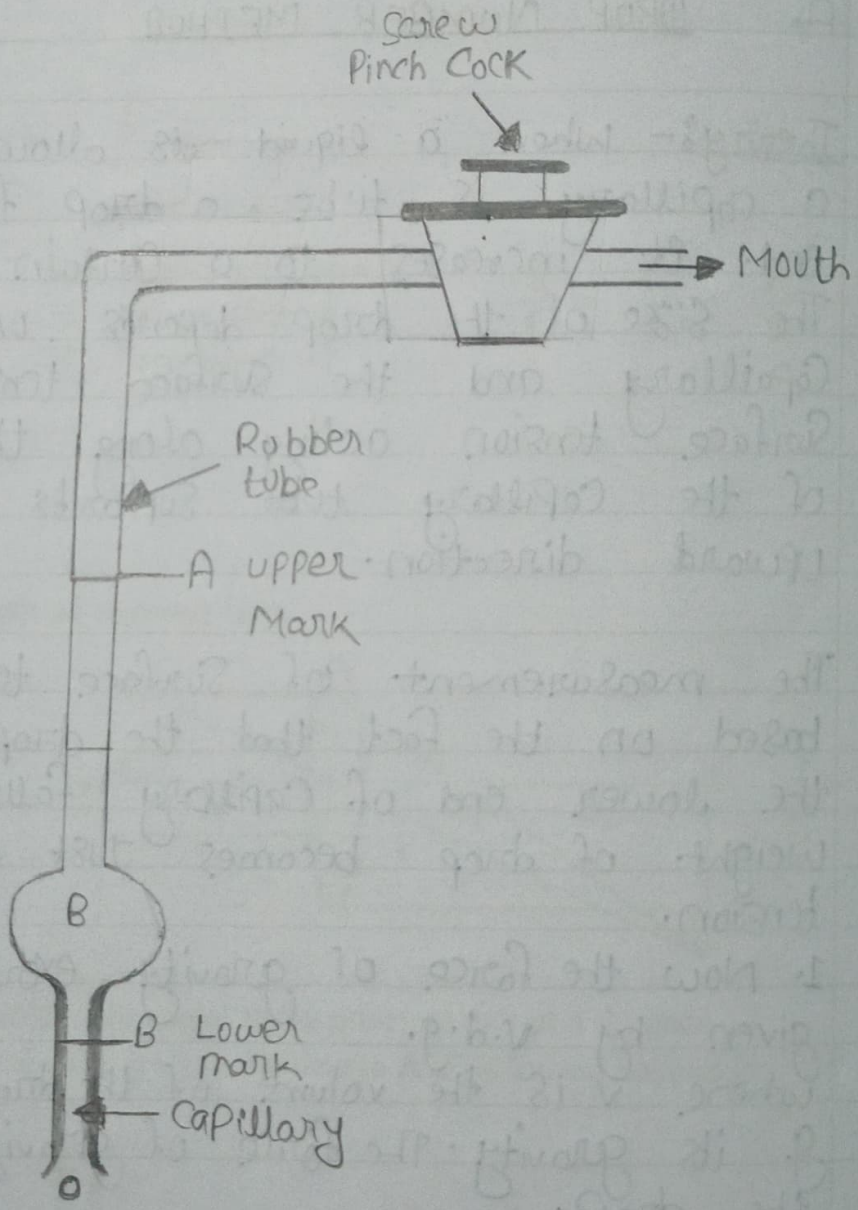
Aim:- To determine the Surface tension of the given liquid.

Apparatus used:- Stalagmometer

Diagram:-



where $2\pi r$ is circumference of the capillary of radius r.
when the two forces are balanced'

$$2\pi r\gamma = v.d.g \quad \text{——— (i)}$$

If n is the number of drops in volume v of the liquid then volume of each drop, will be from eq.(1) we have

$$v = \frac{V}{n}$$

$$2\pi r\gamma = \frac{dgV}{n}$$

Consider two liquids of densities d_1 and d_2, having the surface tension γ_1 and γ_2
Let the number of drops counted for the same volume V of the two liquids be n_1 and n_2, respectively' Then,

$$2\pi r\gamma_1 = \frac{d_1 gV}{n_1} \quad \text{for } 1^{st} \text{ liquid.} \quad \text{— (ii)}$$

PROCEDURE :-

A. Determination density of the liquid : Density of the experimental liquid is determined with the help of a specific gravity bottle in the following Step.

1. Took a specific gravity bottle wase it thoroughly with water and dried it in an oven at 120°C for ore hour. Determined the weight of empty bottle.

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Surface Tension of water at room temperature = 72 dyne/cm

$$\text{Surface Tension}(\gamma) = \frac{\rho_2 n_1}{\rho_1 n_2} \times \gamma_1$$

ρ_1 = Density of water (g/ml)
ρ_2 = Density of Liquid (g/ml)
γ_1 = Surface tension of water (dyne/cm)
γ_2 = Surface tension of liquid (dyne/cm)
n_1 = Number of Drops of water from A to B
n_2 = Number of Drops of Liquid sample from A to B

2. Filled it with distilled water and find out its weight.
3. Empty the bottle dried it in the oven at 120°C. Fill it with the experimental liquid. Find the weight of the filled bottle.
4. By putting the values in the formula we obtained the value of density of the liquid.

B. Determination of Surface tension of liquid:
1. Took a Stalagmometer rinsed it with alcohol to remove the impurites from the capillary of the Stalagmometer. washed it thoroughly. Dried it on oven at 120°C for one hours.
2. clamped it with Stand, fit a rubber tube of suitable size at the upper end of Stalagmometer. Mark two points A and B on the Stalagmometer. one above the bulb and the below the bulb.
3. Took Some water in a Small beaker. Immersed the lower end of the Stalagmometer in it and Suck waker into the Stalagmometer such that liquid level was Slightly above A.
4. Allow water to flow such that 15-20 drops fall down Per minute. Rate of flow can be adjusted with help of Pinch Cock. Count the number of the liquid flowing between Point A and B. The experiment was repeated thrice.
5. Remove Stalagmometer from the Stand. Dried it in the oven or by rinsing with alcohol. Repeat the experiment with the experimental liquid as explained above.

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Observation Table :-

(a) Determination of the surface tension

S.No	No. of drops with water	No. of drops with liquid
1.	42	96
2.	43	97
3.	42	97

Calculation :-

Density of liquid = $\frac{\text{Mass of liquid}}{\text{Mass of equal volume of water}}$

$= \frac{w_3 - w_1}{w_2 - w_1}$

$= \frac{51.06 - 23.19}{56.93 - 23.19}$

$= 0.826$ gml

6. Note down the Room temperature also.

Observation and Calculation:

(A) Density of the liquid

weight of the empty bottle = w_1 = 23.19 g
weight of bottle + water w_2 = 56.93 g
weight of liquid + bottle w_3 = 51.06 g
weight of liquid = $w_3 - w_1$ = 27.87 g
weight of water = $w_2 - w_1$ = 33.74 g
Density of liquid, $d_{liquid} = X d_{water}$. = 0.826 g/ml

Mean value of water = 42.33
Mean value of liquid = 96.66
liquid = = 21.12 dyne/cm

RESULT: The Surface tension of the given liquid by drop number method is 26.1 dyne/cm

B. DROP WEIGHT METHOD

PROCEDURE:

Determination of Surface tension:

1. Clean and dry a weighing bottle and find its weight.
2. Clean the Stalagmometer by rinsing with alcohol dried it in an oven at 120°C for 1 hours.
3. Fitted a rubber tube with a Pinch cock at the upper in a beaker. Suck it in the Stalagmometer up the mark A.

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4. Place the weighted weighing bottle under the Stalagmometer and Collect 15 drops of water into weighing bottle. Adjust the flow of water with the help of screw cock, such that one drop falls in 9 sec. took the weight of the weighing bottle and then empty it and dry it in an oven.
5. Remove water from the Stalagmometer. Dried it on oven at 120°C or by rinsing it with alochol and passing hot air with the dryer.
6. Filled the Stalagmometer with experimental liquid Placed the empty but weighted weighing bottle taking care that the drops of the liquid falls at a rate of 1 drop in 9 second. Again take 3-4 reading.

OBSERVATION AND CALCULATIONS:

weight of the empty bottle = w_1 = 23.19 g
wt of weighing bottle + 15 drops of water = w_2 _____
wt of weighing bottle + 15 drops of liquid = w_3 _____

Surface tension of the liquid = 26.12

PRECAUTIONS:

1. The rate of fall of drops of water and liquid should be same i.e drop in 9sec.
2. Stalagmometer should be held vertically.
3. Stalagmometer should be treated with alochol to clean the capillary of the Stalagmometer.

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RESULT:-

The surface tension of the given liquid at room temperature is 26.1 dyne/cm.

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Experiment: 02

Aim:- To determine the Relative viscosity of a given liquid By using ostwald viscometer.

Apparatus used:- Ostwald's viscometer, Relative Density Bottle.

Description of Apparatus:-

(i) Ostwald's Viscometer: It consist of a capilary tube connected at its upper end with a bulb A and its lower end with a u-tube provided with bulb B. Bulb is of larger Size than A. Marks X and maintain thy hydrostatic Pressure during flow of liquid. Through the capillary, the liquid flows with a measurable speed.

(ii) Relative Density Bottle:- The density of liquid is Conveniently measured by means of a relative density bottle or Specific gravity bottle. It is a round bottomed glass vessel, fitted with a glass cork Containing a fine Capilary.

Theory:- The ostwald's viscometer method is based on Poiseuille's equation. This relates the rate of flow of a liquid through a capillary tube with the Coefficient of viscosity and is expressed by the equation

$\eta =$ ——(1)

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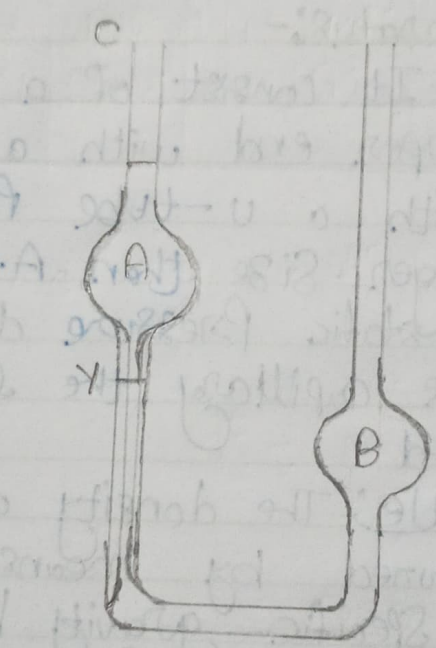
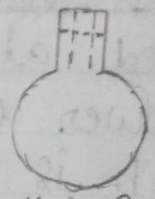
Aim :- To determine the relative viscosity of a given liquid by using ostwald viscometer.

Apparatus used :- ostwald's viscometer, Relative density bottle.

Diagram :-



Ostwald's viscometer



Relativ Density Bottle

where V = volume of the liquid of viscosity η flowing in time t, through a capillary tube of radius r and length l.
P = hydrostatic Pressure of the liquid.
Thus the determination of the absolute viscosity by means by Poiseuille's expression involves the determination of V, r, t, l and P.
The method is however tedious and laborious one. Hence, a similer method is used wherein we Compare the viscosities of the two liquids. If the Coefficient of viscosity of one liquid is known then that of the other can be Calculated.
If t_1 and t_2 are the flow times required to flow for equal volume of two liquids through the same length of a capillary tube then from equation (1) we have

$$\eta_1 = \pi P_1 r^4 t_1 / 8Vl$$
$$\eta_2 = \pi P_2 r^4 t_2 / 8Vl$$

Now $P = hdg$
where h is the height of the liquid column (it is Constant for the liquids if taken for identical Points and liquids are taken in equal volumes for a Particular set of observations)
g = acceleration due to gravity
d = density of the liquids
Since in this case for two liquids h and g are same hence, $\eta_1 = \eta_2$

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Observations:

Room temperature = 25 °C

observation Table:

Liquid Sample	Time of flow (sec)			Mean time (t) (sec)	Density (ρ) (g/ml)	viscosity (η) (centipole
	1	2	3			
Distilled water	21.34	21.37	21.43	t_1 = 21.48 sec	0.997 g/ml	0.8937 cp
Turpentine oil	26.33	25.91	25.75	t_2 = 25.99 sec	0.852 g/ml	0.9240 cp

Calculations:

Density of liquid (Turpentine oil) ρ_2 = $\frac{\text{Mass of liquid}}{\text{Mass of equal volume of water}}$

$$\rho_2 = \frac{w_3 - w_1}{w_2 - w_1}$$

$$\rho_2 = \frac{50.39 - 20.53}{55.59 - 20.53} = 0.852 \text{ g/ml}$$

Density of Turpentine oil (ρ_2) = 0.852 g/ml

Density of water at room temperature (ρ_1) = 0.997 g/ml

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Procedure:-

1. Clean the viscometer with chromic acid ($K_2Cr_2O_7$ + Conc. H_2SO_4) and then wash it several times with distilled water. It is finally washed with alchol and ether and then dried.
2. Attach a piece of clean rubber tube to the end C and clamp the viscometer vertically in air.
3. Now introduce a sufficient volume of the given liquid with the help of a pipette in bulb B so that the bend portion of the u-tube and more than half of bulb B are filled up.
4. Through the rubber tube, suck up the liquid until it rises above the mark X. Make a sure that there is no air bubble inside the liquid.
5. Now, allow the liquid to fall freely through the capillary up to the mark X. Start the stop watch and note the time t_1, for the flow of the liquid from mark X to mark Y.
6. Repeat the experiment thrice. The value should be concordant.
7. Remove the liquid and clean and dry the viscometer again
8. Repeat the experiment by taking the same volume of the distilled water and note down the time taken t_2 for flow of water from mark X to Y. Repeat thrice.
9. Weigh the relative density bottle and note down its weight.
10. Fill it with given liquid and weight it again.
11. Remove the liquid. wash it with chromic acid and then distilled water. Dry in the oven. Now fill it with the distilled water and weigh it.

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Viscosity of liquid (η_2) = $\frac{\rho_2 t_2}{\rho_1 t_1} \times \eta_1$

ρ_1 = Density of water (g/ml)
ρ_2 = Density of test sample - turpentine oil (g/ml)
η_1 = viscosity of water (cP)
η_2 = viscosity of test sample
t_1 = Mean time of flow of water
t_2 = Mean time of flow of test sample

Viscosity of water at room temperature η_1 = 0.997 cP
Density of Turpentine oil (ρ_2) = 0.852 g/ml
Density of water at room temperature (ρ_1) = 0.997 g/ml

Viscosity of Turpentine oil at room temperature is
= 0.9240 cP

weight of empty specific gravity bottle = W_1 = 20.53 g
weight of empty specific gravity bottle + given liquid (Temperature oil) = W_3 = 50.39 g
weight of empty specific gravity bottle + distilled water = W_2 = 55.59 g

Precautions:-
1. viscometer should stand vertically straight
2. four and five readings of time of flow should be recorded with water and given liquid.
3. The apparatus should be perfectly cleaned and dried.

Result:-
The viscosity of the given solution is 0.9240 cP Centipoise at 25°C °C