EXPERIMENT 3

AIM: To determine the concentration of a given solution of acetic acid by measuring surface tension of the solution.

THEORY:

Surface tension is a fundamental property of liquids that arises due to cohesive forces between molecules at the liquid-air interface. In aqueous solutions, the presence of solutes such as acids or bases affects surface tension due to intermolecular interactions and ionization.

Surface tension (γ) is the force per unit length acting at the surface of a liquid, given by:

$$\gamma = \frac{F}{L}$$

where: F is the force acting at the liquid surface, L is the length over which the force acts.

The common units of surface tension is mN/m (SI unit) and dyn/cm (CGS unit)

The surface tension of a liquid can be measured using different techniques, such as the drop weight method (stalagmometer), capillary rise method, or Wilhelmy plate method. In this experiment, a **stalagmometer** is used, which is based on the principle that the number of drops falling from a capillary tube is related to the surface tension of the liquid.

The surface tension of water decreases with the addition of acetic acid due to disruption of hydrogen bonding between water molecules. By comparing the surface tension of different known concentrations of acetic acid with that of the given solution, the unknown concentration can be determined. In the drop number method, the number of drops formed by equal volumes of two liquid is counted. If n_1 and n_2 is the number of drops formed by volume 'V' of the two liquids having densities d_1 and d_2 respectively, then their surface tensions are related as

$$\frac{\gamma_1}{\gamma_2} = \left(\frac{d_1}{d_2}\right) \times \left(\frac{n_2}{n_1}\right)$$

One of the liquid is water whose surface tension and density are known. Then the surface tension of the given liquid can be calculated.

Requirements:

1)Stalagmometer   2) Small beaker

3) Pyknometer   4) A piece of rubber tube with a screw tip

5) Distilled water   6) Glacial acetic acid

Procedure:

1) The stalagmometer and the pyknometerare thoroughly cleaned.
2) A piece of clean rubber tube is attached to the tip of the stalagmometer to regulate the flow of liquid.
3) The reference liquid (distilled water) is sucked through the rubber tube in the stalagmometer and is so adjusted such that the formation of drops can be maintained.
4) The liquid is allowed to fall down from the top to the bottom of the stalagmometer arm and the no. of drops is counted.
5) The procedure is repeated with a mixture of acetic acid in different concentration and also for an unknown liquid and the respective no. of drops is counted.
6) The weight of the empty density bottle is noted down.
7) The density bottle is then filled with distilled water and its weight is noted down.
8) The density bottle is then filled with the prepared solution, and the weight is noted down.
9) The same procedure is repeated for the unknown solution.

Observation:

a) Room temperature= 25 °C

b) Surface tension of water at 25°C (γ_2)= 72 dyn/cm

c) **Determination of density**:

Weight of empty pyknometer=

Volume of liquid = 25 ml

Table 1: Determination of specific gravity

Particulars	Water	Acetic acid solution concentration				
		5 %	10 %	15 %	20 %	Unknown
Weight of pyknometer+liquid						
Weight of liquid						
Density of liquid (weight/volume)	…..(d_2)					
Specific gravity $\left(\dfrac{d_1}{d_2}\right)$						

Table 2:- Determination of no. of drops

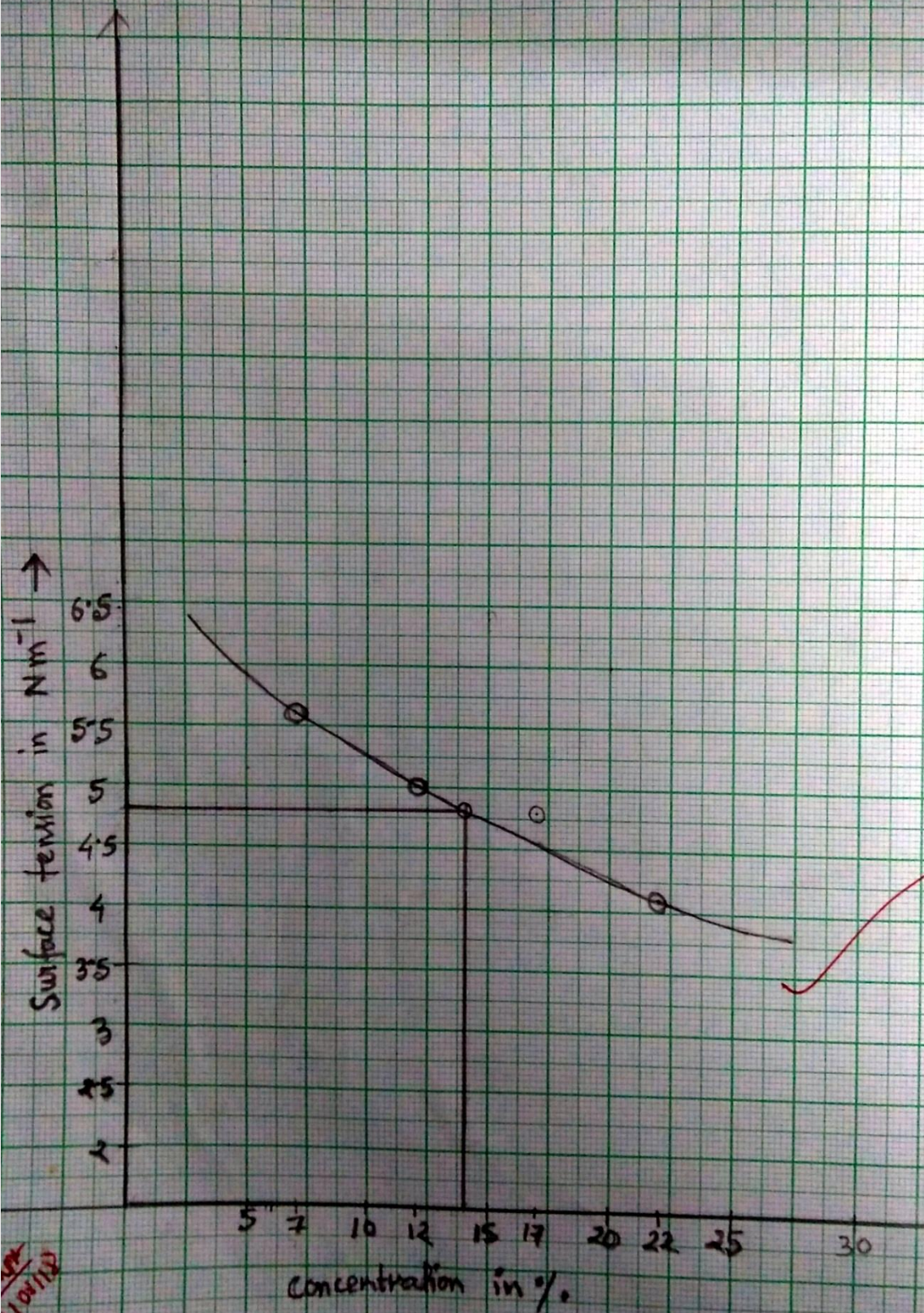| Sl. No.	Liquids	No. of Drops		Mean	$\dfrac{n_2}{n_1}$
		1st	2nd	……… (n_2)	
1	Water				
2	5% acetic acid solution				
3	10% acetic acid solution				
4	15% acetic acid solution				
5	20% acetic acid solution				
6	Unknown solution				

Table 3:- Determination of surface tension

Sl. No.	Liquids	$\dfrac{n_2}{n_1}$	Specific gravity (d_1/d_2)	Surface tension (dyn/cm) $\dfrac{\gamma_1}{\gamma_2} = \left(\dfrac{d_1}{d_2}\right) \times \left(\dfrac{n_2}{n_1}\right)$
1	Water (0% acetic acid solution)			72
2	5% acetic acid solution			
3	10% acetic acid solution			
4	15% acetic acid solution			
5	20% acetic acid solution			
6	Unknown solution			

Plotting the graph:- A graph is plotted taking concentration along X-axis and surface tension along Y-axis. From the surface tension value evaluate the corresponding conc. of unknown solution.

Result:- The concentration of the unknown solution is found to be … %

x axis = 20 small square = 5 unit
y axis = 20 small square = 1 unit

Surface tension in Nm⁻¹ →

concentration in %