Practical Work 2: Falling Ball Viscometer

1. Objective:

The objective of this experiment is to apply a classical method for measuring the viscosity of a liquid using a falling ball viscometer.

2. Theoretical Study

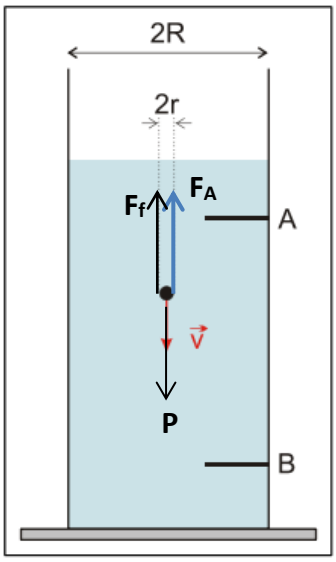
Consider a sphere of radius ***r*** falling in a viscous fluid. The sphere is subjected to its weight ***P***, the buoyant force F_a (Archimedes' force), and the frictional force $\boldsymbol{F_f}$ exerted by the fluid on the sphere.

These forces can be expressed as follows:

- Weight of the sphere: $\boldsymbol{P = m_{sphere} \times g = \rho_{sphere} \times V_{sphere} \times g}$
  m_{sphere}: mass of the sphere
  ρ_{sphere}: density of the sphere
  V_{sphere}: volume of the sphere
  g: acceleration due to gravity

- Buoyant force (Archimedes' force): $\boldsymbol{F_A = \rho_{fluid} \times V_{sphere} \times g}$
  ρ_{fluid}: density of the fluid
  V_{sphere}: volume of the sphere

- Viscous friction force: $\boldsymbol{F_f = 6\pi \times r \times \mu \times v}$
  r : *radius of the sphere*
  μ : dynamic viscosity of the fluid
  v : terminal falling velocity of the sphere the fluid



This makes it possible to establish the expression for the dynamic viscosity of the fluid:

$$\boldsymbol{\mu = \frac{2}{9}\frac{g.r^2}{v_{lim}}\left(\rho_{sphere} - \rho_{fluid}\right)} \qquad (*)$$

3. Data

Density of glycerin	Density of the sphere	Theoretical viscosity of glycerin at 20 °C
1,25	**7,8**	**1,49** *Pa.s*

4. Experimental Procedure

- ✓ A sphere is dropped into a viscous fluid (glycerin) contained in a graduated cylinder with a diameter (R) much larger than the sphere radius (R≫r).
- ✓ The sphere is released from rest (initial velocity = 0) into the glycerin in the cylindrical cylinder.
- ✓ It is assumed that between the marks A and B the sphere moves at constant velocity, so its motion is rectilinear and uniform, meaning the net external force is zero: ∑F=0.
- ✓ The terminal velocity is measured by recording the time it takes for the sphere to pass between the two marks (A and B) using a stopwatch.

Measurements:

Fill in the following table:

Measurements		Results	
Inner radius of the tube: R			
Distance between marks A and B on the tube: AB			
Radius of the sphere:	r_1		
	r_2		
	r_3		
Mass of the sphere:	m_1		
	m_2		
	m_3		
Volume V_{sphere} $(4/3*\pi * r^3)$	V_1		
	V_2		
	V_3		

- Determine the density of the sphere and of the solution
- Measure the falling time of the sphere between points A and B for three trials, and calculate the sphere's velocity

Temperature **T** =……. **°C**			
t (s)			
v (m/s) pour T =…… °C			
Temperature **T** =…….. **°C**			
t (s)			
v (m/s) pour T =…… °C			

- Calculate the viscosity μ for the three trials, then determine the average value:

Temperature **T** =……. **°C**		
μ_1	μ_2	μ_3
Temperature **T** =…….**°C**		
μ_1	μ_2	μ_3

Question : Explain why the viscosity changes between the two temperatures in the case of glycerin. What do these results indicate about the behavior of the molecules?
