Determining Viscosity with a Falling Sphere

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August 29, 2026

Abstract

This report measures the viscosity of a transparent liquid from the terminal speed of a small sphere. The worked structure separates observations from interpretation and leaves clear places for repeat measurements and uncertainty budgets.

1 Objective

Estimate the dynamic viscosity η and compare it with a reference value after accounting for timing and diameter uncertainties.

2 Principle and method

At terminal speed, the viscous drag balances the effective weight. For a sphere of radius r and density ρ_s falling through a liquid of density ρ_l,

$$\eta = \frac{2r^2 g(\rho_s - \rho_l)}{9 v_t}. \tag{1}$$

Measure the sphere diameter at several orientations, release it without a push, and time its passage between two marks after the speed has stabilised. [1]

3 Apparatus and safety

- graduated cylinder, thermometer, micrometer and stopwatch;
- steel sphere, ruler and the test liquid;
- wipe spills immediately and keep the glassware away from the bench edge.

4 Observations

Table 1: Example measurements. Replace the values with the laboratory readings.

d (mm)	L (cm)	t (s)
2.04	15.0	18.42
2.01	15.0	18.63
2.03	15.0	18.51

5 Analysis

Report the mean diameter and terminal speed, then propagate the uncertainties:

$$\left(\frac{u_\eta}{\eta}\right)^2 = \left(2\frac{u_r}{r}\right)^2 + \left(\frac{u_v}{v_t}\right)^2 + \left(\frac{u_{\Delta\rho}}{\rho_s - \rho_l}\right)^2. \tag{2}$$

State whether wall effects, temperature drift or reaction-time bias dominate.

6 Conclusion

Viscosity $\eta =$ _____

Uncertainty $u_\eta =$ _____

Next check _____

References

[1] A. Researcher. *Measurement and Uncertainty in the Teaching Laboratory.* Example Academic Press, 2024.