

Objectives:

- 1) Derive an equation for q , the charge on the oil drop, in terms of constants (η , π , g and coefficients), given variables (d and ρ) and measured variables (V , v_{up} , v_{down}).
- 2) Use the java applet to find the experimental value of the fundamental charge.

In Millikan's oil drop experiment a charged drop of oil is inserted between parallel plates. First the terminal velocity with no voltage applied is measured. Stokes' Law can then be used to calculate a radius for the drop. Then a voltage is applied to the parallel plates and the terminal velocity in an upward direction is measured. The radius, terminal velocities and applied voltage can be used in to find the charge on the drop. This charge must be an integer multiple of the fundamental charge so if enough trials are conducted it is possible to identify the fundamental charge.

Stokes' Law: $F_D = 6\pi\eta vr$

where F_D is the drag force, η is the viscosity of air, v is the terminal velocity, and r is the radius of a spherical object.

Values for the experimental data

Distance between the plates: 1.35 mm

Viscosity of air: $1.2 \times 10^{-5} \text{ m}^2/\text{s}$

Density of water drop: 1000 kg/m^3

Show your derivation of the equation for q below. After your derivation, show how the fundamental charge was determined from the experimental data.