Millikan Help

Using the Simulator

Begin by launching an oil droplet using the New Droplet button. Unlike the original expeiment, this simulation launches only one droplet at a time. If Oil Droplet is selected, the mass of the droplet is random. If Bead is selected, the droplet has a fixed mass of 1×10^{-15} kg.

The plates are initially set at a separation distance of 2.5 cm. This spacing can be adjusted using the buttons below the lower plate. The scale (marked in 1mm gradations) can also be turned on or off as necessary

Turn the power on by clicking the On radio button. Use the coarse and fine voltage adjustments to adjust the potential so that the droplet remains morionless. The polarity switch reverses the polarity of the plates. When tuning the voltage, the Time Speed slider may be used to speed up the apparent rate of motion so that the voltage can be set more precisely.

Once the potential required to support the droplet is determined, cut the power and use the built-in stopwatch to time the rate of descent (each mark on the scale is 1mm). Since the droplets are very small, they reach terminal velocity almost instantly. Using the values for potential and terminal velocity, the charge can be determined.

Determining the charge on an electron

Given the density of the oil droplet (in this case, 900kg/cubic metre), the mass of the droplet can be found using the equation:

$$m = \frac{4}{3}\pi \cdot r^3 \rho$$

The radius, in turn, can be found if the density and viscosity of air are also known, using the equation:

$$r = \sqrt{\frac{9}{2}\frac{\eta v_0}{g(\rho - \rho_0)}}$$

Combining these two, we get the equation:

$$m = \frac{4}{3}\pi\rho\left(\sqrt{\frac{9\eta v_0}{2g(\rho - \rho_0)}}\right)$$

Inserting the density of the oil, the density of air and the viscosity of air, this equation simplifies to the following:

$$m = 3.32477 \times 10^{-9} \times v_0^{\frac{3}{2}}$$

Given the terminal velocity v_0 the mass can easily be calculated.

When the droplet is suspended motionless, the electric and gravitational forces are balanced:

$$F_e = F_g$$

$$\mathrm{E}q = mg$$

The charge on the electron can be determined using:

$$q = \frac{mg}{\mathrm{E}} \quad \text{or} \quad q = \frac{mgd}{V}$$