# LAB 13.2A - Millikan’s Oil Drop Simulation

[**http://www.teachscience.net/2011/02/07/millikan-oil-drop-simulation/**](http://www.teachscience.net/2011/02/07/millikan-oil-drop-simulation/)

**Aim**

To use a computer simulation of Millikan’s Oil Drop experiment to determine the charge on the electron.

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**Theory**

If the mass of the oil drop is known (the fixed value of the oil bead in the simulation is 1 x 10-15kg), then when it becomes suspended in the E-field, its weight is balanced by the electrostatic attraction,

$$qE=mg$$

As *E = V/d*, we get:

$$q=\frac{mgd}{V}$$

So far, so easy. The problem in real life is that the mass of the droplet cannot be measured – it is far too small. However, it can be determined by the Stoke’s Equation for a sphere falling through a fluid at terminal velocity, including compensating for the buoyant upthrust due to the density of the air, *ρo* :

$$r=\sqrt{\frac{9ηv\_{o}}{2g(ρ-ρ\_{o})}}$$

Assuming that that oil drop is a sphere, where:

$$m=ρV= \frac{4}{3}πr^{3}ρ$$

We get the rather cumbersome:

$$m= \frac{4}{3}πρ\left(\sqrt{\frac{9ηv\_{o}}{2g(ρ-ρ\_{o})}}\right)$$

Once the know values for the density of the oil, the density of air and the viscosity of air are factored in, this simplifies down to:

$$m=3.32477 x 10^{-9} v\_{o}^{^{3}/\_{2}}$$

**Part 1 – Using a bead of oil of a fixed mass (easier)**

Set the oil drop to “bead”. This fixes the mass of the bead to 1 x 10-15 kg. Therefore we can simply suspend the bead between the plates to determine the charge on the bead. Turn the power supply to the plates on – the voltage can be adjusted by both a coarse and a fine tune. It is help to run the time faster (use the buttons to the upper right of the screen) to determine that the bead has been completely suspended. Use the equation in the theory section above to calculate the charge on the oil drop. Repeat this at least 10 times. Either use the known value of *e* to plot a scatter graph of number of electrons v charge or an analysis of the lowest common denominator to determine a value for *e*.

**Part 2 – Using a bead of oil with an unknown mass (harder)**

Set the oil drop to “droplet”. The main difference with this approach is that you will need to measure the terminal velocity of the drop with NO ELECTRIC FIELD before then turning on the field and suspending the SAME drop. This can be tricky and takes practice – which is why Millikan et al took nearly 20 years performing the real experiment!

The analysis requires that the mass of the droplet be determined so that the charge on the droplet can be calculated. Otherwise, the analysis to calculate the charge on the electron is the same as above.