VISUAL PHYSICS ONLINE
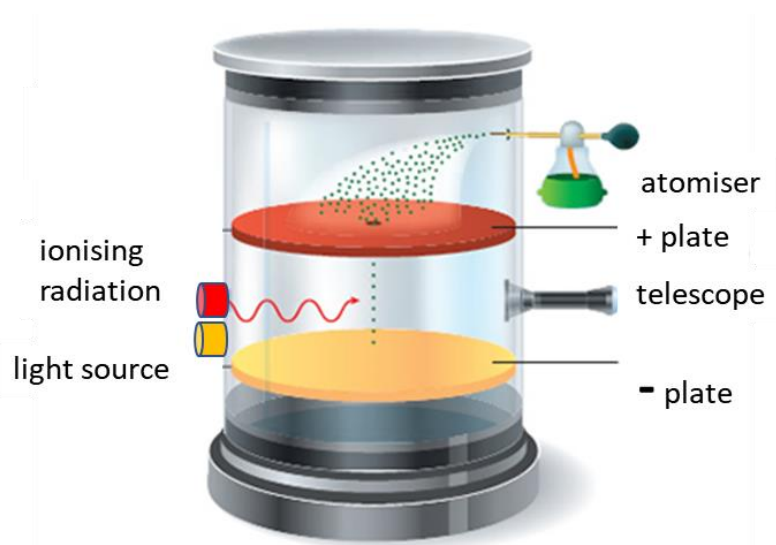
WORKSHOP

MILLIKAN'S OIL DROP EXPERIMENT #2

Modern version of Millikan's oil drop experiment

Before you start this Workshop / Experiment you should review the notes on Millikan's Oil Drop Experiment

Millikan's Oil Drop Experiment

In a more modern version of Millikan's oil drop experiment, small plastic spheres are used instead of oil drops. Their diameter is about 1 μm (1x10^{-6} m) and their mass can be accurately measured. This avoids the measurement of the oil drop's terminal velocity and the dependence on Stokes's law. The mass of the oil drop was the most inaccurate of the measurements made by Millikan.

The plastic spheres sprayed in a liquid solution from an atomiser and are easily viewed through the microscope. The plastic spheres are bombarded by alpha-particles from a radioactive source so that they can acquire a charge more effectively.

When a plastic sphere is held stationary between the plates of the capacitor, the magnitude of the charge can be expressed as

(1) $\quad q = \dfrac{m\, g\, d}{V}$

By making many measurements we can determine whether the charges determined from equation 1 are multiples of some basic charge unit.

In an actual experiment, the mass of the spheres was

$m = 5.7 \times 10^{-16} \text{ kg}$

and the spacing between the capacitor plates was

$d = 4.0 \times 10^{-3} \text{ m}$

The voltage V between the plates was adjusted and measured to keep a plastic sphere stationary in the field of view of the microscope. Table 1 shows 30 values that were recorded for V to keep the plastic spheres stationary.

Table 1: Measurements of voltage between capacitor plates to keep a sphere stationary.

Sphere	V [V]	Sphere	V [V]	Sphere	V [V]
1	-30.0	11	-126.3	21	-31.5
2	+28.8	12	-83.9	22	-66.8
3	-28.4	13	-44.6	23	41.5
4	+30.6	14	-65.5	24	-34.8
5	-136.2	15	-139.1	25	-44.3
6	-134.3	16	-64.5	26	-143.6
7	82.2	17	-28.7	27	+77.2
8	28.7	18	-30.7	28	-39.9
9	-39.9	19	26.1	29	-57.9
10	54.3	20	-140.8	30	+42.3

For each sphere calculate its charge q.

It is best to do the calculations and graphs in a spreadsheet or in Matlab.

Why are some voltage negative while others are positive?

Think of several ways to graph the results to find the elementary charge and test the hypothesis that charge is quantized.

Perform the web based simulation and obtain another 30 sets of data and repeat your analysis.

[Simulation](#)

Compare your findings to the data given in Table 1 and the data your obtained from the simulation.

SAMPLE RESULTS

The values for the charge q on the spheres can be plotted along a number line. The blue dots are the actual measurements for q. The red dots are the integer multiples values of the elementary charge e

$e = 1.602 \times 10^{-19}$ C
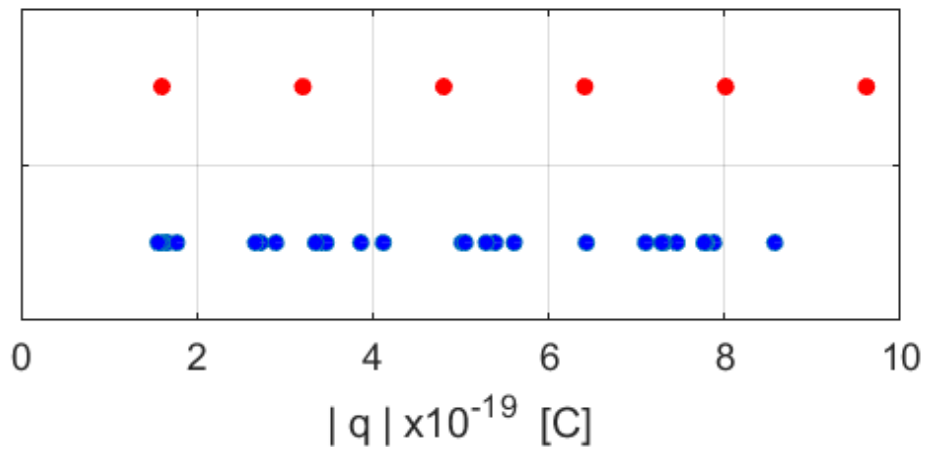
To see if charge is quantised it is better to plot q/e on a number line.
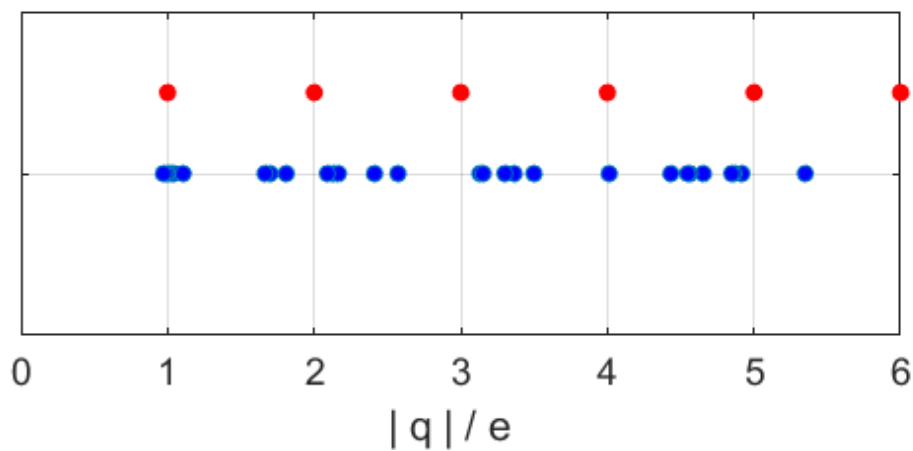
From the recorded measurements, an estimate of the elementary charge is 1.6x10^{-19} C. This value is in good agreement with the actual value of e.

From the graphs, you can conclude that the charge is quantised and that

(2) $q = N\,e$ $N = 1,\,2,\,3,\,4,5$

even though the results are not particular good. This is a very difficult experiment to perform and there is a lot of scatter in the measurements of q. You would need to take lots and lots of measurements to get stronger evidence to support equation 2.

The analysis was done using the Matlab mscript **spMillikan.m** which can be download from the directory

http://www.physics.usyd.edu.au/teach_res/mp/mscripts/

VISUAL PHYSICS ONLINE

If you have any feedback, comments, suggestions or corrections please email:

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