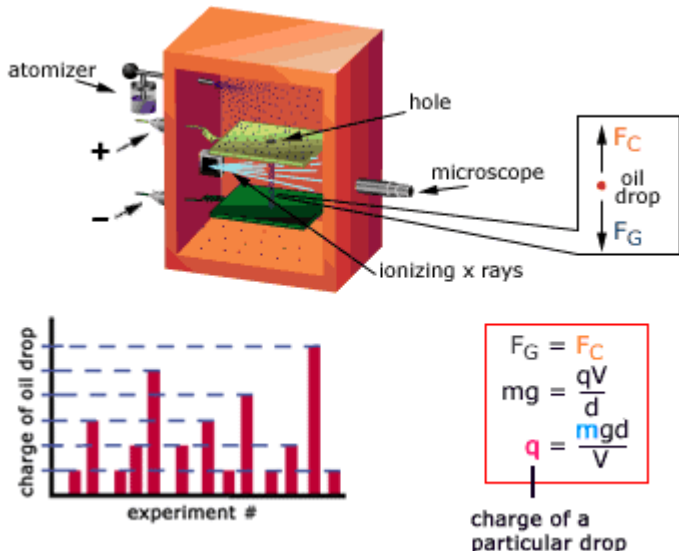


## Understanding Electrons

### key concepts:

- Robert Millikan determined the **charge** of an **electron** by observing oil droplets in an electric field.
- Today, the charge of an electron is accepted as  $1.60 \times 10^{-19}$  C, and the **mass** of an electron is accepted as  $9.11 \times 10^{-31}$  kg.

 <p>charge of oil drop</p> <p>experiment #</p> $F_G = F_C$ $mg = \frac{qV}{d}$ $q = \frac{mgd}{V}$ <p>charge of a particular drop</p>	<p>Robert Millikan determined the charge of an electron by observing oil droplets in an electric field.</p> <p>In the Millikan oil drop experiment, oil is atomized into small droplets, and then allowed to fall through a hole into the chamber. Droplets fall because of <b>gravity</b>. An <b>x-ray</b> beam knocks electrons off of air <b>molecules</b>, and some of those electrons become attached to the oil droplets. The negatively charged oil droplets feel an upward <b>force</b> from the <b>electrical potential</b>.</p> <p>With the proper choice of an electric field, <math>F_C</math> (the <b>Coulomb force</b>) will exactly balance <math>F_G</math> (the <b>gravitational force</b>), and the droplets will become motionless. This means that <math>q = mgd/V</math>, where <math>q</math> is the charge of a particular droplet, <math>m</math> is the mass of that droplet, <math>g</math> is the <b>acceleration</b> due to gravity, <math>d</math> is the distance between the plate and the droplet, and <math>V</math> is the electrical potential. Since the mass of the droplet can be determined by measuring the <b>terminal velocity</b> when the electric field is turned off, the only unknown is <math>q</math>.</p> <p>Through repeated measurements, Millikan found that the charge of each droplet was an integer multiple of <math>1.59 \times 10^{-19}</math> C. This was the charge of an individual electron.</p>
<p><b>modern values:</b></p> $q = 1.60217733 \times 10^{-19} \text{ C}$ $\approx 1.60 \times 10^{-19} \text{ C}$ $m = 9.1093897 \times 10^{-31} \text{ kg}$ $\approx 9.11 \times 10^{-31} \text{ kg}$	<p>J. J. Thomson had previously shown that the charge-to-mass ratio of an electron was <math>1.76 \times 10^{11}</math> C/kg. Using this ratio and the experimentally determined charge, the mass could also be calculated.</p> <p>Today, the charge of an electron is accepted as <math>1.60 \times 10^{-19}</math> C, and the mass of an electron is accepted as <math>9.11 \times 10^{-31}</math> kg.</p>