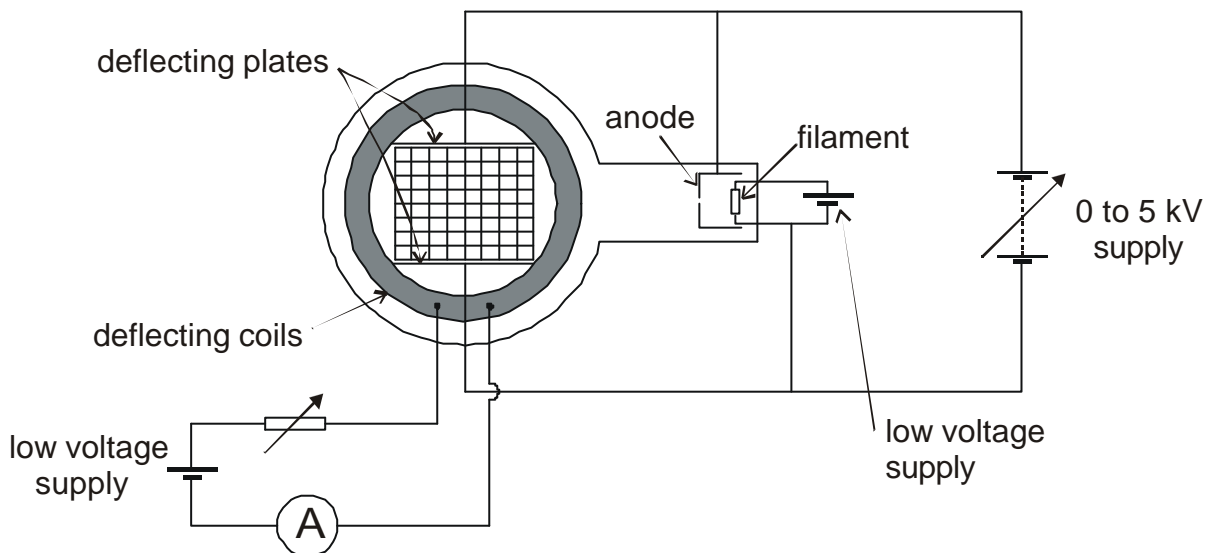


Experiment to measure the Charge to Mass Ratio of Electrons

1. **Preparation:**
 - a) Revise the motion of charged particles in electric and magnetic fields.
 - b) You must know the meaning of the term “thermionic emission”.
 - c) See part 3 below.
2. The method proposed here is similar to that used by J.J. Thomson in 1897. Electrons in an evacuated tube (a “cathode ray tube”) are sent towards a region of space where there are electric and magnetic fields at 90° to each other. If the field strengths have a **particular ratio** then charged particles can pass through them **undeflected**.



3. In the following analysis

V = voltage accelerating the electrons *and producing the electric field between the plates*

v = speed of the electrons

m = mass of one electron and e = charge on one electron

E = electric field strength ($E = V/d$ where d = distance between plates)

B = magnetic flux density

If the electrons pass undeflected (magnitude of electric force equal to magnitude of magnetic force), then it can easily be shown that

$$\mathbf{v = E/B} \qquad \text{equation 1}$$

Verify this equation for yourself.

To find the speed of the electrons, remember that during acceleration the electrons are losing electric P.E. and gaining K.E.

$$\text{E.P.E. lost} = \text{K.E. gained}$$

$$eV = \frac{1}{2}mv^2$$

therefore $\mathbf{v^2 = 2eV/m}$ equation 2

Combining equations 1 and 2 to eliminate v gives us

$$e/m = \underline{\hspace{10em}}$$

To calculate the magnitude of the flux density produced near the centre of two "Helmholtz coils"

$$B = 0.72 \mu_0 NI/r$$

where N = number of turns on *one* coil

I = current

r = radius of coils

μ_0 = permeability of a vacuum = $1.257 \times 10^{-6} \text{ Hm}^{-1}$

N, I, r, V etc can all be measured with *reasonable* precision.

What is the greatest source of error likely to be ?

It will probably be easier to answer this when you have done the **experiment**