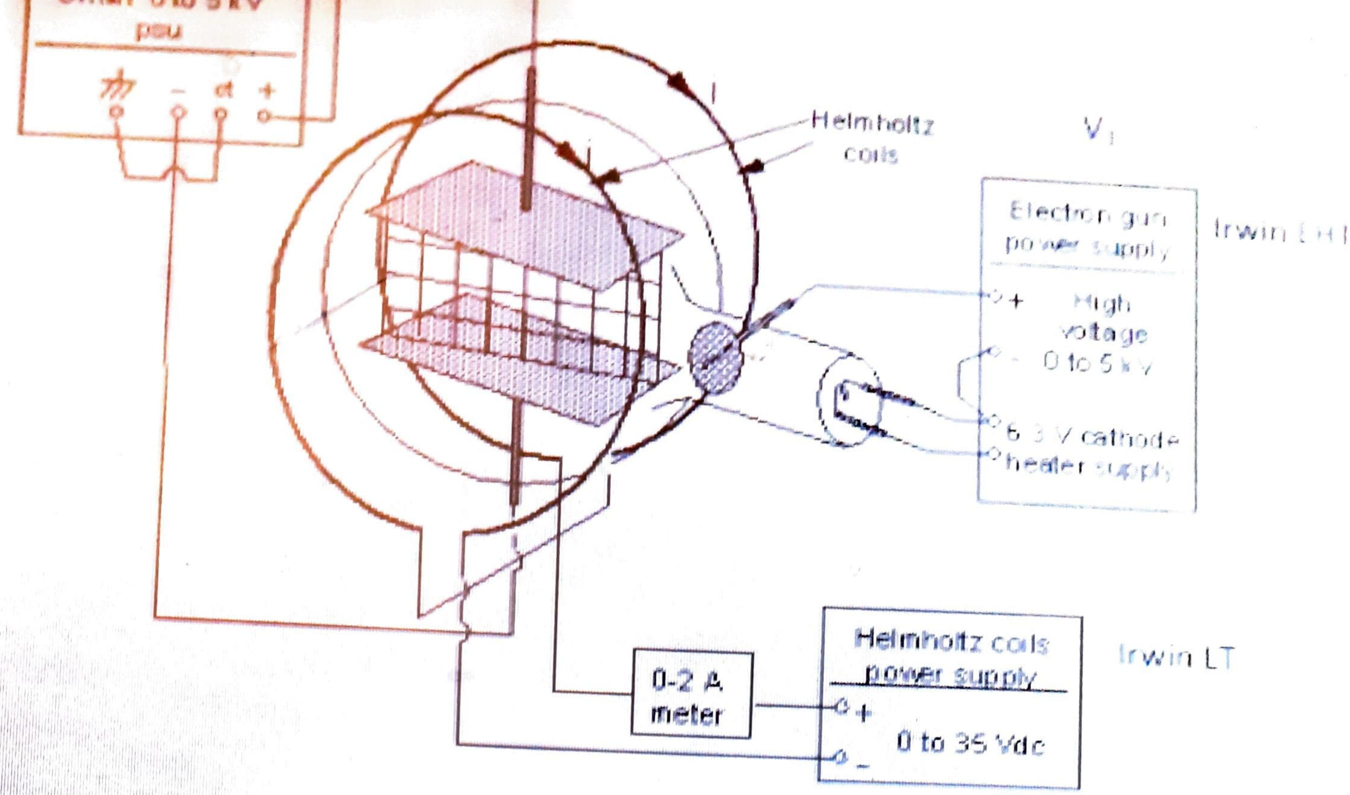

Fig 3

1 Deflection of electrons in an electrostatic field.

If you are working from home on this experiment, then you should use Video 2 (referred to at the start of the lab script) as a replacement for conducting the experiment in person.

Switch on the electron gun power supply and use an accelerating voltage of $V_1 = 3000$ V. Observe the undeflected electron beam landing on the viewing screen in a darkened lab. Apply the electric deflection voltage, V_2, initially with the positive voltage at the top connection. Do not use the magnetic field at this stage.

1. Observe and record the effect of varying the deflection voltage, using the centimetre scale on the viewing screen to transfer a sketch of what you see onto the graph paper pages of your lab book.
2. Observe and record the effect of reversing the polarity of the deflection voltage.
3. From your observations how do you know that the electron is negatively charged?

The trajectory of the electrons can be calculated from basic theory under the assumption that the deflection plates act as an *ideal parallel plate capacitor* with a uniform electric field

$$E = -V_2/d$$

...where V_2 is the deflection voltage and d is the plate separation.

The transverse force on the electrons in the beam is $-eE$. By Newton's Law this produces a transverse acceleration $a = -eE/m$. If the initial transverse velocity is zero as the beam enters the deflection region, the transverse position is given as a function of time as:

$$s = 1/2\, a\, t^2 = -eE\, t^2/2\, m \quad (1)$$

The velocity in the propagation (z) direction can be regarded as constant with a value set by the accelerating voltage V_1 as:

$$v = \sqrt{\frac{2eV_1}{m}}$$

(2)

Using $z = vt$, equations (1) and (2) can be combined to give:

$$s(z) = -\frac{Ez^2}{4V_1} = \frac{V_2 z^2}{4dV_1}$$

(3)

We approximate the deflection field E as $-V_2/d$.

1. Record the distance z along the scale at which a deflection s of 2 cm is obtained as a function of varying V_2.

2. Plot z against $V_2^{-\frac{1}{2}}$ confirm that equation (3) is true.

Does the slope of your plot agree with the expected value of $(4sdV_1)^{\frac{1}{2}}$? If not, why? (*Hint: Remember to use SI units for all values used and to put error bars on your graph*