Friday March 24, 2017

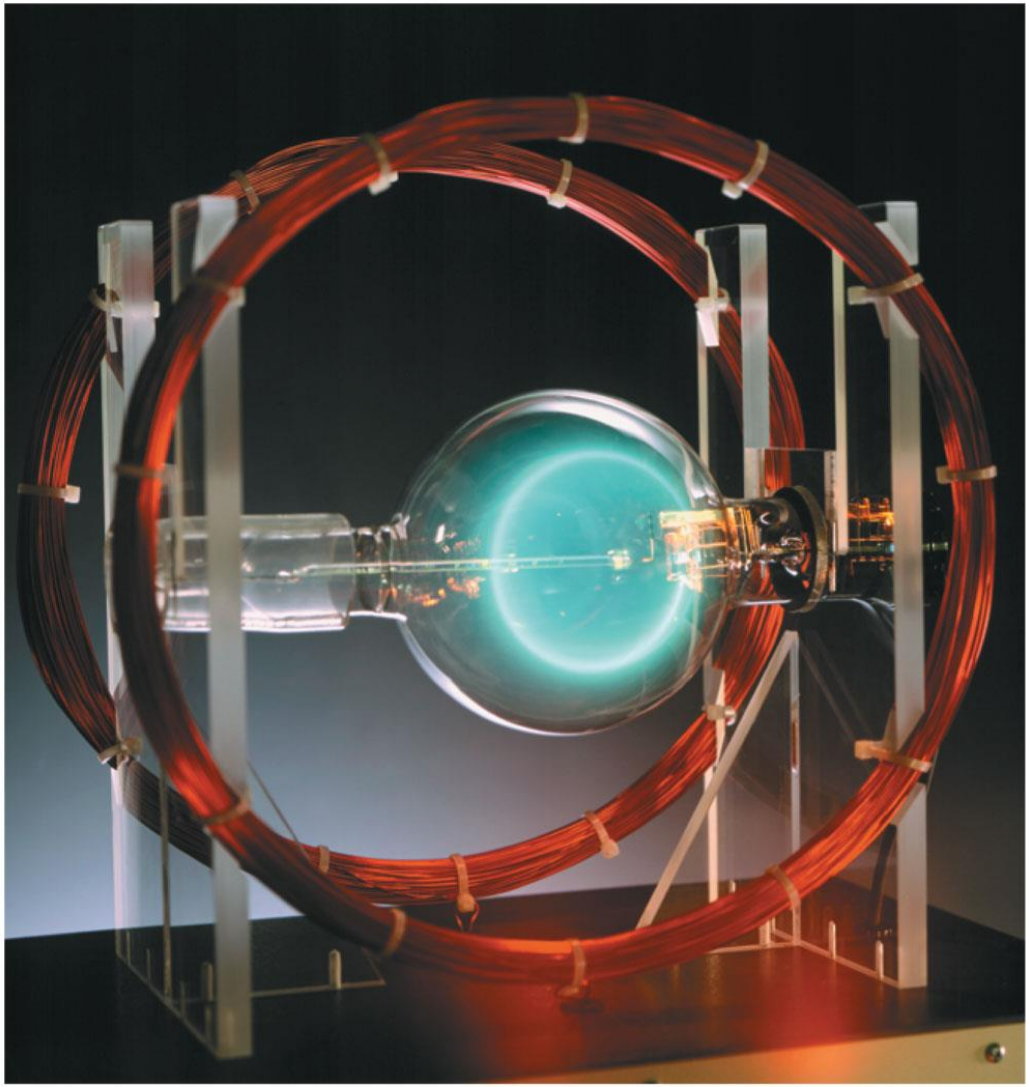
Last time:

- Charges on helical paths in B-field (aurora)
- The Hall Effect: underpinning of a B-field probe
- Velocity selector via crossed E- and B-fields
- Bainbridge Mass Spectrometer

Today:

- Charge to mass apparatus demonstration
- Group activity

Charge to mass apparatus demo



Group activity

(10 marks) Based on experimental measurements, you will find the charge to mass ratio of the electron (e/m). Figure 1 below shows a schematic representation of the experiment: the magnetic field produced by the Helmholtz coils is pointing out of the page and the electron beam follows a counter clockwise trajectory. Figure 2 is a schematic of the 'electron gun' used to accelerate the electrons in order to produce the beam. Recall $e = 1.60 \times 10^{-19}$ C.

Figure 1.

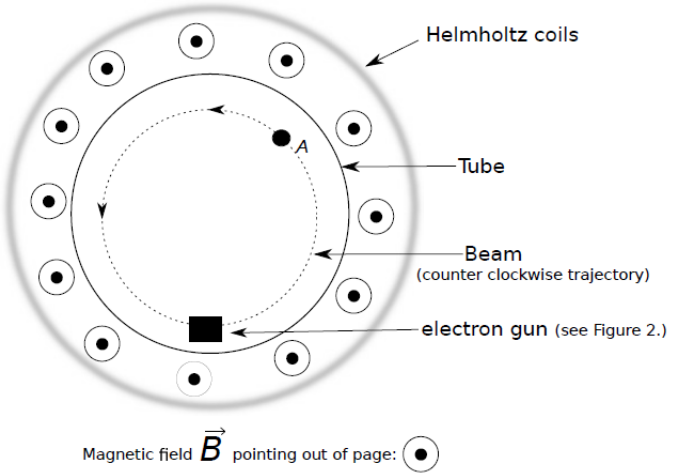
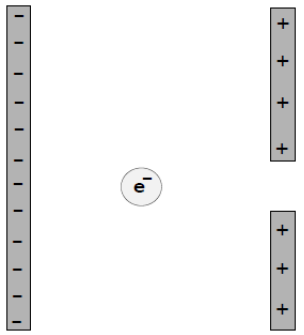


Figure 2. (electron gun)



1. **(1 mark)** For the electron beam in Figure 1 draw on the figure provided at point A; the velocity vector $\vec{v}$ and the centripetal force vector $\vec{F}$.

2. **(2 marks)** Write down the force relation acting on an electron of charge e with velocity $\vec{v}$ in a uniform magnetic field $\vec{B}$. Explain how your equation is consistent with what you sketched in question 1?
What form does the magnitude of the force equation take when $\vec{B}$ and $\vec{v}$ are perpendicular?

3. **(1 mark)** Write down an expression for the magnitude of the centripetal force of an object of mass M moving with tangential speed v along a path with radius of curvature r.

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4. **(2 mark)** Given that the electrons are being accelerated from rest by the 'electron gun' (see Figure 2) by means of a potential difference ΔV between the negative and positive plates, what is the velocity of the electron (in terms of the potential ΔV and mass m) when it exits the electron gun?

5. **(3 marks)** Find the expression for the ratio e/m in terms of the measurable quantities; magnetic field B, the potential difference ΔV and the radius of curvature r. Remember to show your work and justify your steps.