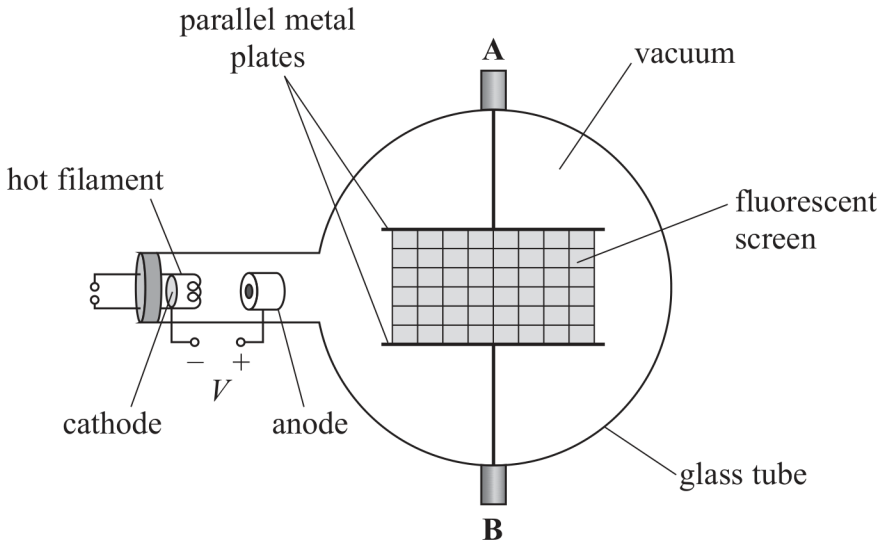
22 The electron beam tube can be used to determine the specific charge $\frac{e}{m}$ of an electron.

A potential difference V is applied between the cathode and the anode to produce a beam of electrons.



The beam is aimed at a fluorescent screen inside the tube and the path of the electrons is seen on the screen.

There are two parallel metal plates above and below the screen. A and B are connected to these plates and allow a potential difference to be applied across the plates.

(a) Explain why electrons are deflected into a parabolic path when a potential difference is applied between A and B.

(3)

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(b) A potential difference V of 850 V is applied between the cathode and the anode.

(i) Show that the maximum speed of the electrons as they emerge from the anode is about $1.7 \times 10^7 \text{ m s}^{-1}$.

(3)

(ii) The electric field strength between the parallel metal plates is $1.7 \times 10^4 \text{ V m}^{-1}$. The length of each plate is 7.5 cm. The electrons pass through the region between the parallel metal plates.

Calculate the vertical deflection of the electron beam.

You should ignore the weight of the electrons.

(5)

Vertical deflection of electron beam = ...

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(iii) The electric field between the parallel metal plates is removed. A uniform magnetic field is applied to deflect the electron beam into a circular path of radius 3.5 cm.

Assess whether this gives a value for $\frac{e}{m}$ in agreement with the standard value.

magnetic flux density = 3.0 mT

(4)

(Total for Question 22 = 15 marks)

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