5 Fig. 5.1 shows the horizontal path of an electron travelling in a vacuum.

The electron leaves the electron gun with a constant speed v. The electron of mass m and charge e then enters a region of uniform magnetic field of flux density B.

The electron follows a circular path of radius r within the magnetic field.

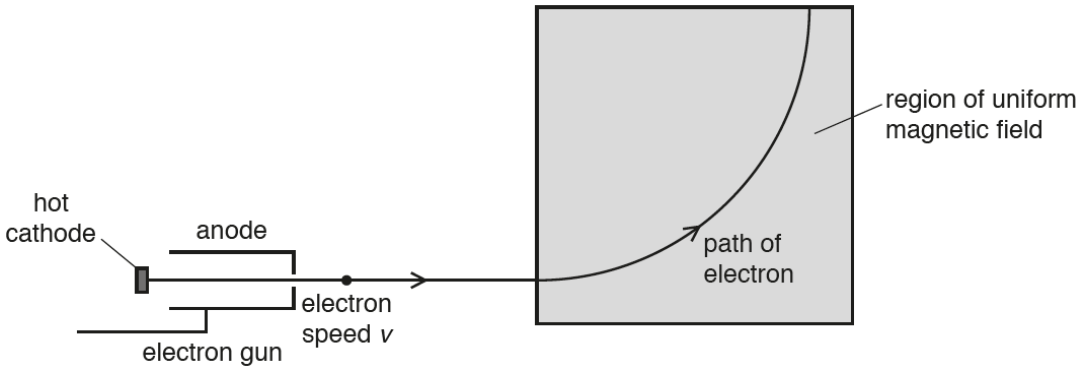

Fig. 5.1 (not to scale)

(a) (i) State the direction of the magnetic field.

.....
.... [1]

(ii) Derive an expression for the speed of the electron in terms of B, e, r and m.

[2]

(b) The electron gun produces the electron by emission from the hot cathode. The electron is then accelerated from rest to speed v by the electric field between the anode and the cathode, where there is a potential difference of V.

(i) State the equation relating the gain in kinetic energy of the electron and the work done on it by the electric field.

[1]

(ii) The charge per unit mass of an electron e/m is called its specific charge. Its numerical value is 1.76×10^{11} C kg^{-1}.

Determine the radius of the circular path of an electron in Fig. 5.1 when the magnetic field has flux density 5.00 mT and the magnitude of the potential difference between the anode and the cathode is 576 V.

radius = ... m [3]

(c) Explain why the speed of the electron remains constant as it moves within the magnetic field.

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[2]

[Total: 9]