9 **(a)** State what is meant by a *field of force*.

.....

.....[1]

(b) Two parallel metal plates are separated by a distance of 6.0 cm in a vacuum, as shown in Fig. 9.1. The plates have length 16 cm and potential difference of 2400 V.

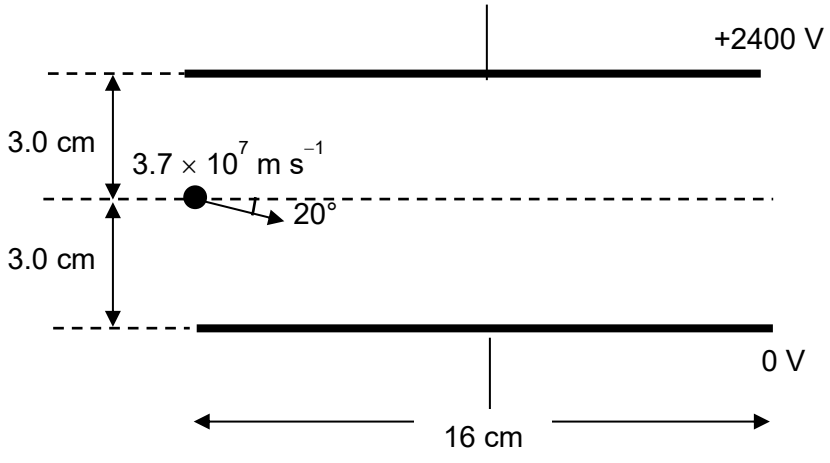

Fig. 9.1

An electron with speed 3.7×10^7 m s^{-1} enters the region between the plates. The initial direction of the electron is 20° below the midline between the plates.

(i) Calculate the acceleration of the electron and state its direction.

acceleration = ... m s^{-2}

direction = ...

[3]

(ii) Calculate the time taken for the electron to reach the other end of the plate.

time = ... s [1]

(iii) Use your answers in **(b)(i)** and **(ii)** to determine whether the electron will collide with any metal plate as it passes through the region between the plates.

[3]

(iv) Hence, sketch, on Fig. 9.1, the path of the electron. [1]

(iv) Describe the path of the electron in the field.

.....[1]

(c) Another electron of the same speed now enters a region of uniform magnetic field of flux density 4.5 mT as shown in Fig. 9.2.

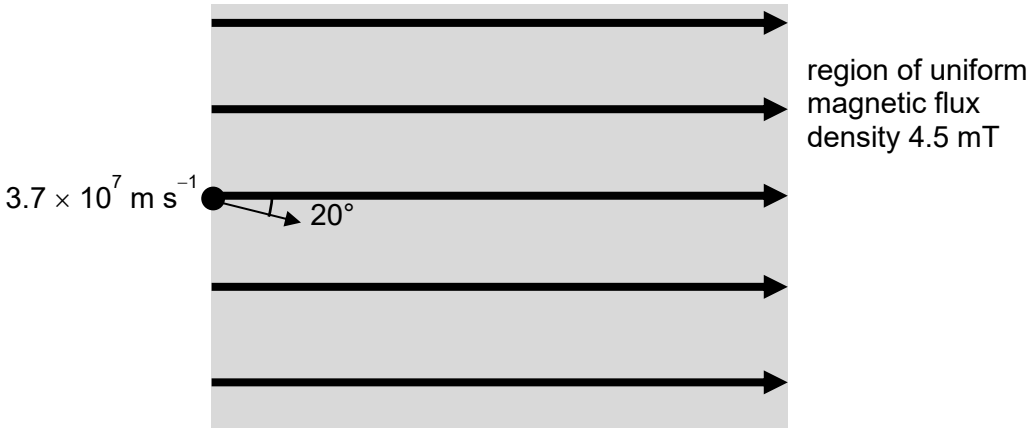

Fig. 9.2

The initial direction of the electron is at an angle of 20° to the direction of magnetic field.

(i) When the electron enters the magnetic field, the component of its velocity $v_\perp$ normal to the direction of the magnetic field causes the electron to begin to follow a circular path. Explain why.

.....

.....

.....[2]

(ii) Calculate the radius of this circular path.

radius = ... m [3]

(iii) State the magnitude of the force on the electron due to the component of its velocity along the direction of the field.

.....[1]

(iv) Use your answers in **(c)(ii)** and **(iii)** to describe the resultant path of the electron in the field.

.....[1]

(d) Another electron of the same speed is projected downwards in the magnetic field as shown in Fig. 9.3. A uniform electric field is now switched on in the same region as the magnetic field. The magnitude of the electric field is adjusted so that the electron moves undeviated through the two fields.

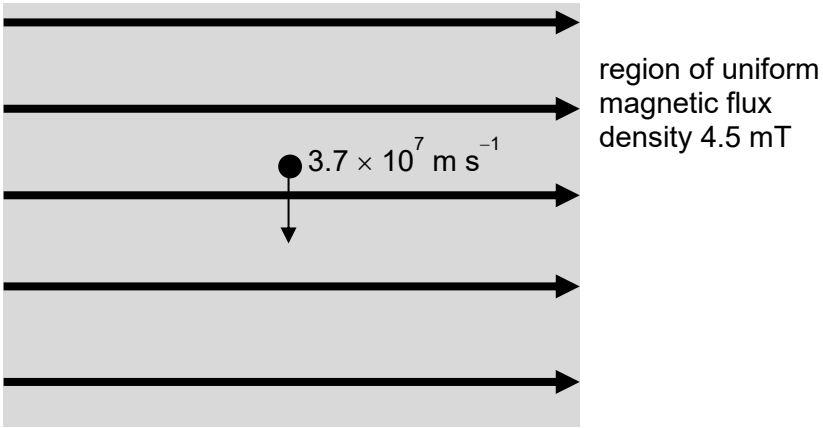

Fig. 9.3

(i) On Fig. 9.3, draw the direction of the electric field. [1]

(ii) Determine the magnitude E of the electric field strength.

E = ... V m^{-1} [2]

[Total: 20]