5 (a) An electron moves in a vacuum at an angle of 20° to a magnetic field of magnetic flux density 0.088 T, as shown in Fig. 5.1.

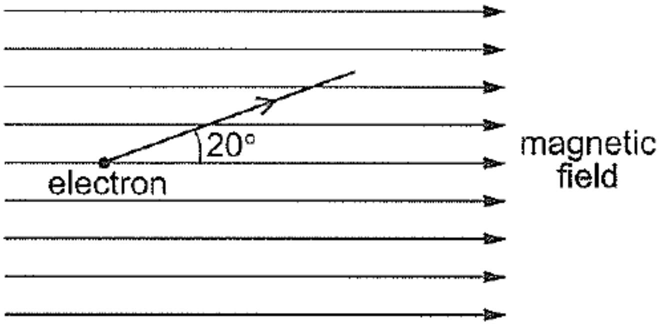

Fig. 5.1

The force on the electron is 4.3×10^{-14} N.

(i) Explain why the electron follows a helical path in the magnetic field.

....

....

....

....

.... [2]

(ii) Calculate the speed of the electron.

speed = ... m s^{-1} [2]

(iii)

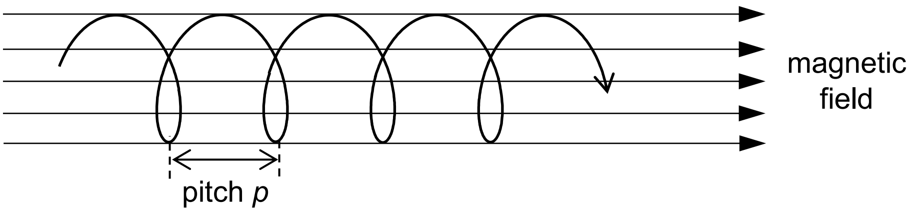

Fig. 5.2

Fig. 5.2 shows the pitch p of the helical path taken by the electron, which is given by the product of the period of the circular motion and the velocity component of the electron parallel to the magnetic field.

Calculate the pitch p.

p = ... m [4]

(b) Fig. 5.3 shows the coil of a simple electric motor between the poles of a magnet.

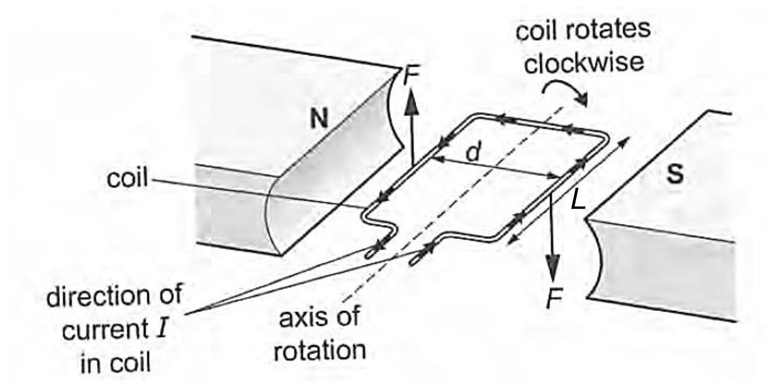

Fig. 5.3

The coil has length L and width d. The entire coil lies within the magnetic field. The magnetic flux density between the poles of the magnet is B. There is a current I in the coil.

Two forces, each of magnitude F, act in opposite directions on the two sides of the coil, as shown in Fig. 5.3. This produces a torque that causes the coil to rotate.

The current I in the coil is 96 A. The area of the rectangular coil in the magnetic field of the magnet is 6.1×10^{-3} m^2 and the coil contains 1200 turns. The maximum output torque given to the coil is 395 Nm.

Calculate the magnetic flux density B needed to produce the maximum output torque.

B = …………………. T [2]

[Total: 10 marks]