**7** **(a)** Define magnetic flux density.

.....

.....

..... [2]

**(b)** A particle of mass $m$ and charge $+Q$ moves at speed $v$ into a region where there is a uniform magnetic field, as shown in Fig. 7.1.

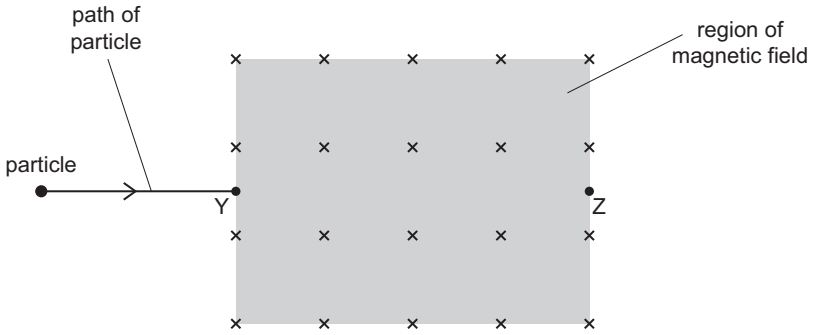


**Fig. 7.1**

The uniform magnetic field is into the page and has flux density $B$. The particle enters the region of the field at point Y.





**(i)** State an expression, in terms of some or all of $m$, $Q$, $B$ and $v$, for the magnetic force $F$ that acts on the particle when it is at point Y.

$F$ = ..... [1]

**(ii)** On Fig. 7.1, draw an arrow at point Y to indicate the direction of the force in **(b)(i)**. [1]

**(iii)** On Fig. 7.1, draw a line to show a possible path for the particle through the region of the magnetic field. [1]

**(c)** **(i)** Explain how an electric field can be used with the magnetic field to ensure that the particle in **(b)** now passes through point Z.

.....

.....

.....

.....

..... [3]

**(ii)** Derive an expression for $v$ in terms of $B$ and the electric field strength $E$.

$v$ = ..... [2]

[Total: 10]

**6** A rectangular coil PQRS of wire is free to rotate about its axis XY, as shown in Fig. 6.1.

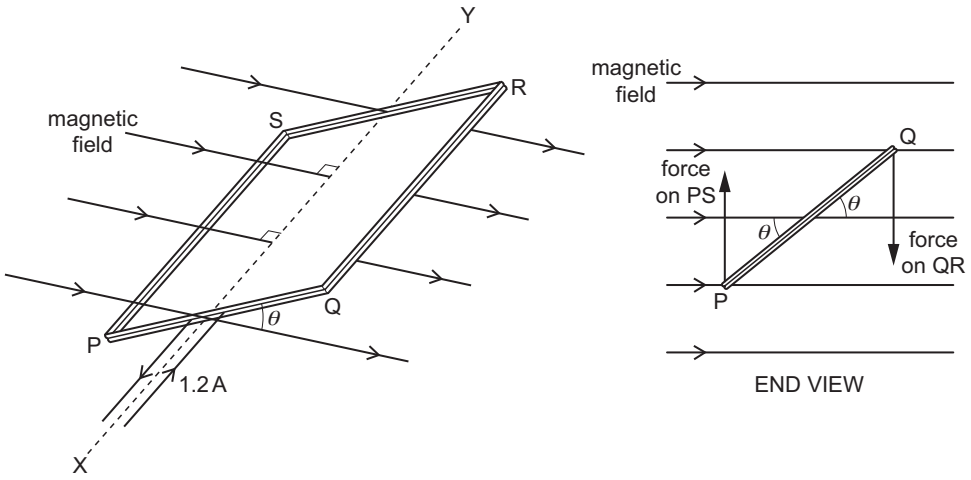


**Fig. 6.1** (not to scale)

The coil has length QR of 5.4 cm, width PQ of 2.5 cm and has 190 turns of wire.
The plane of the coil is at an angle $\theta$ to a uniform magnetic field of flux density $5.2 \times 10^{-3}$ T.
The axis XY of the coil is normal to the field.
The current in the coil is 1.2 A.

**(a) (i)** Calculate the magnitude of the force on side QR of the coil.

force = ..... N [3]





**(ii)** Use your answer in **(a)(i)** to show that the torque $\tau$ on the coil is given by

$$\tau = 1.6 \times 10^{-3} \cos\theta \text{ N m}.$$

[2]

**(iii)** Using the expression in **(a)(ii)** sketch, on the axes of Fig. 6.2, a graph to show the variation of the torque $\tau$ with angle $\theta$ for values of $\theta$ between 0 and 360°. Label the $\tau$ axis with an appropriate scale.

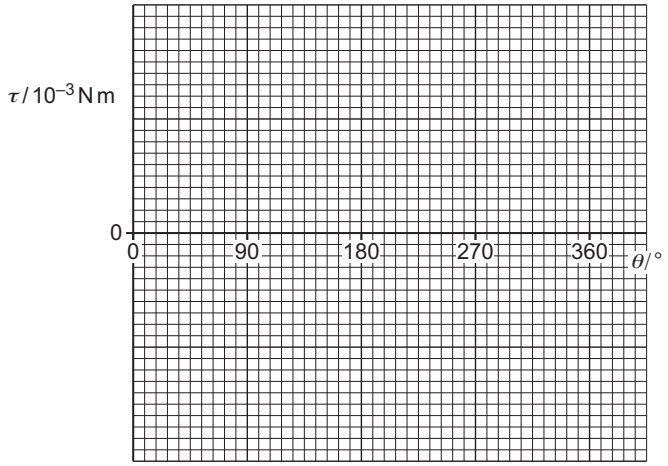


**Fig. 6.2**

[3]

**(b)** The coil is now replaced by an identical coil wound on a ferrous core.

Suggest, with a reason, how the torque on this coil compares with the torque on the original coil.

.....

.....

..... [2]

[Total: 10]