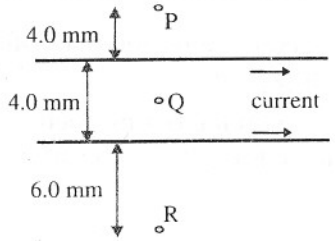

Figure 6.24 For question 4.

5 Draw the magnetic field lines that result when the magnetic field of a long straight wire carrying current into the page is superimposed on a uniform magnetic field pointing to the right that lies on the page. (See Figure 6.25.)

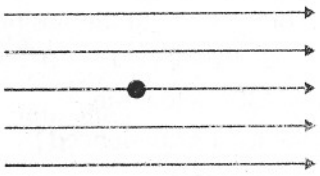

Figure 6.25 For question 5.

6 A long straight wire carries current as shown in Figure 6.26. Two electrons move with velocities that are parallel and perpendicular to the current. Find the direction of the magnetic force experienced by each electron.

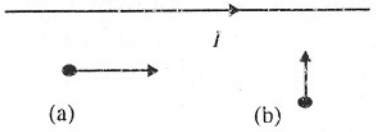

Figure 6.26 For question 6.

7 A proton moves past a bar magnet as shown in Figure 6.27. Find the direction of the force it experiences in each case.

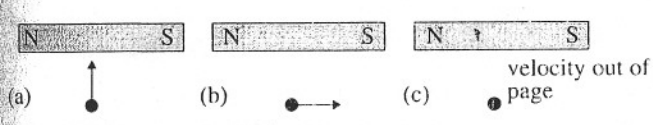

Figure 6.27 For question 7.

8 An electron is shot along the axis of a solenoid that carries current. Will it experience a magnetic force?

9 What is the direction of a magnetic field in each of the four cases in Figure 6.28 that results in a force on the current as shown?

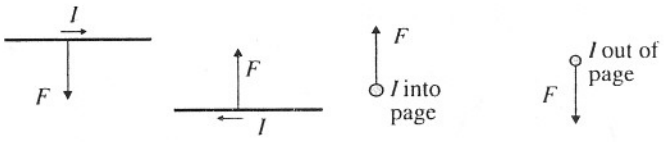

Figure 6.28 For question 9.

10 A rectangular loop of wire of size 5 cm × 15 cm is placed near a long straight wire with side CD at a distance of 5 cm from it, as shown in Figure 6.29. What is the net force exerted on the loop (magnitude and direction)? How does your answer change if the current in the loop is reversed?

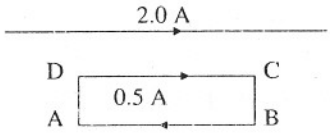

Figure 6.29 For question 10.

11 A rectangular coil of size 20 cm × 10 cm is placed in a horizontal uniform magnetic field of magnitude 0.050 T, as shown in Figure 6.30. A current of 2.0 A flows in the coil in a counter-clockwise direction as shown.

(a) Find the force on sections AB, BC, CD and DA.

(b) What is the net force on the coil?

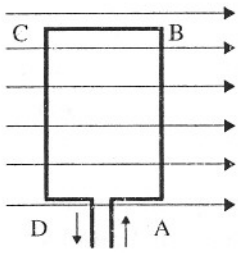

Figure 6.30 For question 11.

12 A tightly wound solenoid of length 30 cm is to produce a magnetic field of 2.26×10^{-3} T along its axis when a current of 15.0 A flows in it. If the radius of the solenoid is 12.0 cm, what length of wire is required to make the solenoid?

13 What is the direction of the magnetic field at points P and Q in the plane of a circular loop carrying a counter-clockwise current, as shown in Figure 6.31?

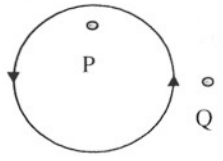

Figure 6.31 For question 13.

14 Two parallel wires a distance of 20.0 cm apart carry currents of 2.0 A and 3.0 A as shown in Figure 6.32.

(a) At which points is the magnetic field zero?

(b) How would your answer change if the direction of the 3.0 A current were reversed?

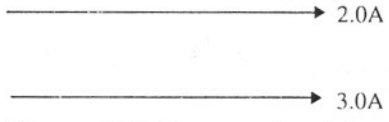

Figure 6.32 For question 14.

15 Figure 6.33 shows two parallel plates with a potential difference of 120 V a distance 5.0 cm apart. The top plate is at the higher potential and the shaded region is a region of magnetic field normal to the page.

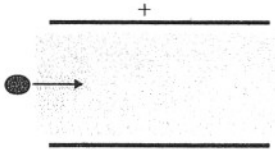

Figure 6.33 For question 15.

(a) What should the magnetic field magnitude and direction be such that an electron experiences zero net force when shot through the plates with a speed of 2×10^5 m s^{-1}.

(b) Would a proton shot with the same speed through the plates experience zero net force?

(c) If the electron's speed were doubled, would it still be undeflected if the magnetic field took the value you found in (a)?

16 A bar magnet is placed in a uniform magnetic field as shown in Figure 6.34.

(a) Is there a net force on the bar magnet?

(b) Will it move? If so, how?

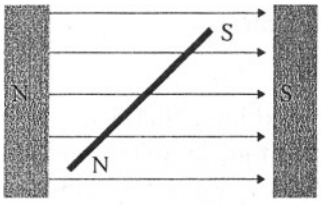

Figure 6.34 For question 16.

17 A high-tension electricity wire running along a north–south line carries a current of 3000.0 A. If the magnetic field of the earth at the position of the wire has a magnitude of 5.00×10^{-5} T and makes an angle of 30° below the horizontal, what is the force experienced by a length of 30.0 m of the wire?

HL only

18 Two circular loops of wire have their planes parallel and one is directly below the other, as shown in Figure 6.35. Current flows in a counter-clockwise direction (when looked at from above the loops) in both loops. Will there be a force between the loops? If yes, what will its direction be. If not, why is the force zero?

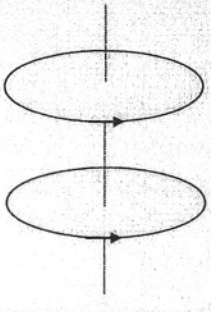

Figure 6.35 For question 18.

19 Figure 6.36 shows two parallel conductors carrying current out of the page. Conductor 1 carries double the current of conductor 2. Draw to scale the magnetic fields created by each conductor at the position of the other and the forces on each conductor.

Figure 6.36 For question 19.

20 An electron of speed v enters a region of magnetic field B directed normally to its velocity and is deflected into a circular path. Find an expression for the number of revolutions per second the electron will make. If the electron is replaced by a proton, how does your answer change?

HL only

21 A proton of velocity 1.5×10^6 m s^{-1} enters a region of uniform magnetic field $B = 0.50$ T. The magnetic field is directed vertically up (along the positive z direction) and the proton's velocity is initially on the z–x plane making an angle of 30° with the positive x axis. (See Figure 6.37.)

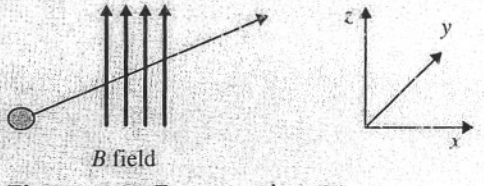

Figure 6.37 For question 21.

(a) Show that the proton will follow a helical path around the magnetic field lines.
(b) What is the radius of the helix?
(c) How many revolutions per second does the proton make?
(d) How fast is the proton moving along the field lines?
(e) What is the vertical separation of the coils of the helix?

22 An electron enters a region of uniform magnetic field $B = 0.50$ T, its velocity being normal to the magnetic field direction. The electron is deflected into a circular path and leaves the region of magnetic field after being deflected by an angle of 30° with respect to its original direction. How long was the electron in the region of magnetic field?

23 Find the magnetic field at point P due to three currents as shown in Figure 6.38.

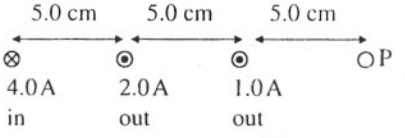

Figure 6.38 For question 23.

HL only

24 Find the magnetic field at point P due to the currents shown in Figure 6.39.

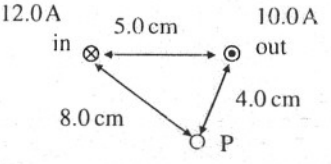

Figure 6.39 For question 24.

25 Three parallel wires carry currents as shown in Figure 6.40. Find the force per unit length that wires 1 and 3 exert on wire 2.

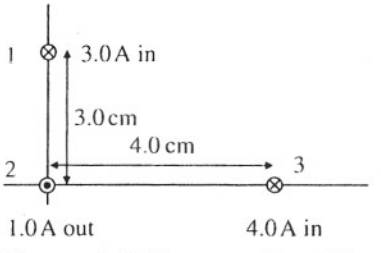

Figure 6.40 For question 25.

26 The magnetic field at the centre of a circular loop of wire of radius r carrying current I is given by the formula

$$B = \mu_0 \frac{I}{2r}$$

Use this expression to find the magnetic field created by an electron as it rotates with speed v in a circular orbit of radius r around a nucleus.

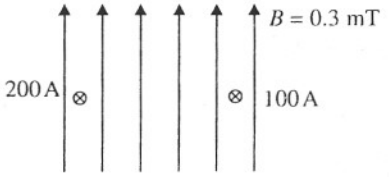

Figure 6.43 For question 30.

31 A uniform magnetic field is established in the plane of the paper as shown in Figure 6.44. Two wires carry *parallel* currents of equal magnitudes normally to the plane of the paper at P and Q. Point R is on the line joining P to Q and closer to Q. The magnetic field at position R is zero.

(a) Are the currents going into the paper or out of the paper?

(b) If the current is increased slightly, will the point where the magnetic field is zero move to the right or to the left of R?

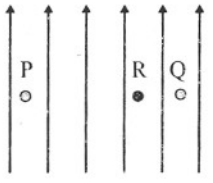

Figure 6.44 For question 31.

32 Two identical charged particles move in circular paths at right angles to a uniform magnetic field as shown in Figure 6.45. The radius of particle 2 is twice that of particle 1.

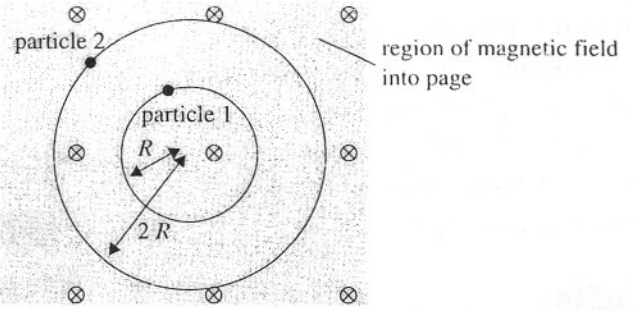

Figure 6.45 For question 32.

Determine the following ratios:

(a) $\dfrac{\text{period of particle 2}}{\text{period of particle 1}}$;

(b) $\dfrac{E_k \text{ of particle 2}}{E_k \text{ of particle 1}}$.