Chapter 28 - Magnetic Fields

The Magnetic Field

Q1. A loop of wire carrying a current of 2.0 A is in the shape of a right-angle triangle with two equal sides, each 15 cm long. A 0.70-T uniform magnetic field is in the plane of the triangle and is directed as shown in figure 7. The magnetic force on side 3 is : Ans:0.21 N, into of the page

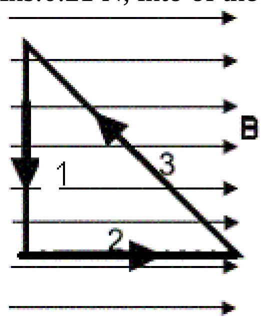


FIGURE 7

The Definition of B

Q2. An electron is projected into a uniform magnetic field B = (0.8 k) T. Find the magnitude of the magnetic force, on the electron when the velocity is:

$v = (5.0\times10^{5}\ i + 3.0\times10^{5}\ j)$ m/sec.

(i, j and k are the unit vectors in the x, y and z directions, respectively).Ans:7.5×10^{-14} N.

Q3. In figure (4), a loop of wire carrying a current, I, of 2.0 A is in the shape of a right triangle with two equal sides, each 15 cm long. A 0.7 T uniform magnetic field is in the plane of the triangle and is perpendicular to the hypotenuse. The resultant magnetic force on the two equal sides is: Ans:0.30 N, into the page.

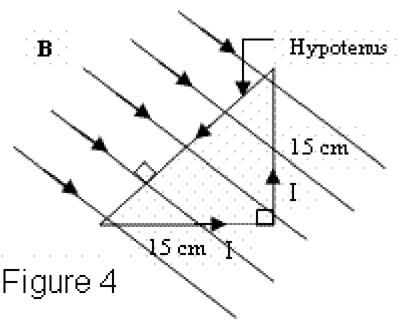


Figure 4

Q4. An electron that has velocity $v = 3.2\times10^{7}$ i m/s traveling parallel to a uniform magnetic field of strength 2.60×10^{-3} Tesla. The force on the electron is: [i is the unit vectors in the directions of x]Ans:zero.

Q5. At a point in a uniform magnetic field the acceleration of an electron is 5.0×10^{14} m/s^2 and its speed is 7.0×10^{6} m/s. If the magnitude of the magnetic field is 1.0 mT, what is the angle between the electrons velocity and the magnetic field?Ans:24 degrees.

Crossed Fields

Q6. In the velocity selector, an electron passes, without deflection, through a region where there is an electric and a magnetic field perpendicular to each other. If the electric field is $E=4.5\times10^{3}$ V/m and the magnetic field is $B=9.0\times10^{-3}$ T, what is the kinetic energy of the electron, in electron Volts? (1 eV=1.6×10^{-19} J)Ans:0.71 eV.

Q7. In a region where an electric field E and a magnetic field B are perpendicular to each other, a beam of charged particles, each of mass m and charge q, passes through this region. The kinetic energy of a particle passing undeflected normal to these two fields is:

Ans:$m\,E^2/2B^2$.

Q8. An electric field of 1.5×10^{3} V/m and a magnetic field of 0.50 T act on a moving electron to produce no net force. Calculate the minimum speed of the moving electron.

Ans:3.0×10^{3} m/s.

Q9. A proton with velocity $v = (2.0\times10^{6})$ i (m/s) moves horizontally into a region of space in which there is an electric field E = (- 5000) j (N/C) and a magnetic field B. Find the smallest magnetic field such that the

proton will continue to move horizontally undeflected. (i, j and k are unit vectors in the x, y and z directions, respectively)
Ans:- 2.5×10^{-3} k (T)

A Circulating Charged Particle

Q10. A proton with a velocity of 6×10^{6} m/s travels at right angles to a magnetic field of 0.5 Tesla. What is the frequency of the proton's orbit?Ans:7.6×10^{6} Hz.
Q11. An electron moving perpendicular to a 50 micro-T magnetic field, goes through a circular trajectory. What is the time required to complete one revolution?Ans:715 nano-seconds
Q12. A deuteron is accelerated from rest through a 10^{4} V potential difference and then moves perpendicular to a magnetic field with B = 1.6 T. What is the radius of the resulting circular path? [For deuteron: m=3.3×10^{-27} kg, q=1.6×10^{-19} C.]Ans:13×10^{-3} m.
Q13. What uniform magnetic field, applied perpendicular to a beam of electrons moving at 1.4×10^{6} m/s is required to make the electrons travel in a circular orbit of radius 0.40 m?Ans:2.0×10^{-5} T.

Magnetic Force on a Current-Carrying Wire

Q14. A wire of total length 4L and carrying a current I is placed in a uniform magnetic field B that is directed out of the page as shown in Figure 6. Determine the net magnetic force on the wire. Ans:2ILB down

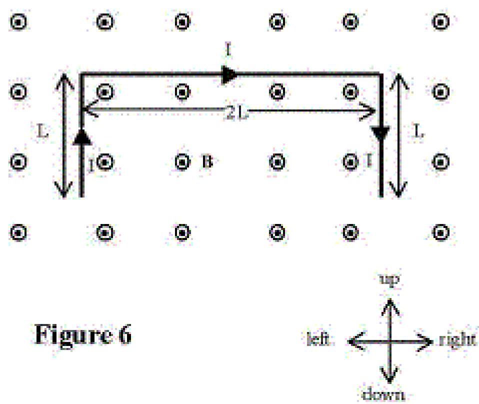


Figure 6

Q15. A segment of wire carries a current of 25 A. It is bent into the shape shown in Figure 4. The wire is placed in a uniform magnetic field of 40 mT and directed out of the page. Find the magnitude of the magnetic force on this segment of wire. Ans:5.0 N

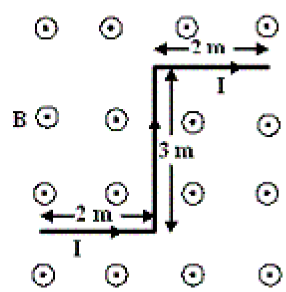


Figure 4

Q16. Two infinite wires are parallel to the y-axis. One carries current i1 = 12 A in the +y-axis at x=0; the other carries i2 at x = 8.0 cm. For what magnitude and direction of i2 will the resultant magnetic field be zero at x = 6.0 cm?Ans:4.0 A in the +y-axis.
Q17. A wire bent into a semicircle of radius R = 2.0 m forms a closed circuit and carries a current of 1.5 A. The circuit lies in the xy-plane, and a uniform magnetic field B = 3.0 T is present along the y axis, as shown in figure (6). Find the magnitude of the magnetic force on the curved portion of the wire. Ans:18 N.

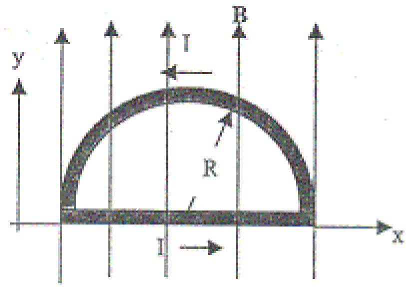


Figure (6)

Torque on a Current Loop

Q18. A 100-turn circular coil of wire with radius 1 cm carries a current of 0.5 A. What torque will be exerted on the coil when it is placed in a magnetic field of 5 mT which makes an angle of 60 degrees with the plane of the coil?Ans:3.93×10^{-5} N.m.

Q19. A square loop, of side a = 5 cm and 200 turns, carries a current of 10 A. The loop is placed in an external magnetic field of 2.0 T. Determine the magnitude of the maximum torque exerted on the loop.Ans:10 Nm

Q20. A current of 17 mA is maintained in a circular loop of 2 m circumference which is parallel to the y-z plane (see Figure 4). A magnetic field B = (- 0.8 k) T is applied. Calculate the torque exerted on the loop by the magnetic field. (i, j and k are the unit vectors in x, y and z directions, respectively). Ans:(4.33×10^{-3} j) Nm

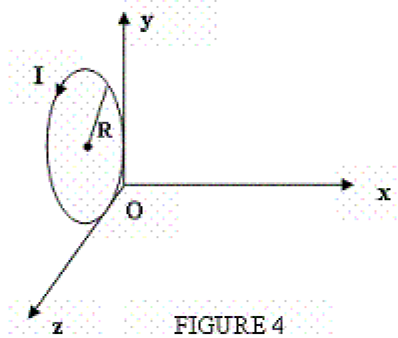
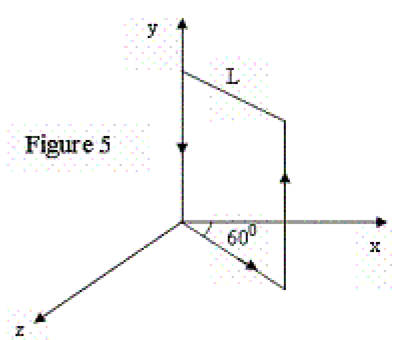


FIGURE 4

Q21. A square loop (L=1.00 m) consists of 100 closely wrapped turns of 0.20 A. The loop is oriented as shown in figure (5) in a uniform magnetic field of 0.10 T directed in the positive x- direction. What is the torque (in N.m) on the loop? (j is a unit vector in the +y-direction.) Ans:1.0 j.



The Magnetic Dipole Moment

Q22. The current loop in figure (5) consists of one loop with two semicircles of different radii. If the current in the circuit is 19 A, a = 3.0 cm and b = 5.0 cm, then the magnetic dipole moment of the current loop is: Ans:0.10 Am^2, into the page.

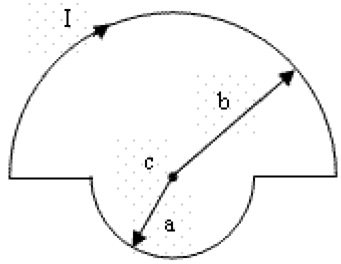


Figure 5

Q23. A closed loop has an area of 5.8×10^{-2} m^2 and carries a current of 3.0 A. It is placed in an external magnetic field, whose magnitude is 0.50 T, with its dipole moment initially making an angle of 90 degrees with the external magnetic field. How much work is done by the magnetic field as it rotates the loop from its initial orientation to the final orientation where the dipole moment is aligned with the field?Ans:+ 0.087 J