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Class 12 Physics Chapterwise PYQs

2026 – 2003 | All CBSE Board Papers

Chapter-wise previous year questions, sorted by marks and year

Chapter 4: Moving Charges and Magnetism

Table of Contents

1-Mark Questions (105 questions · Section A · MCQ)

Q1. The torque on the coil remains constant irrespective of the coil's orientation during rotation due to:

(A) use of soft iron core which increases the magnetic field.
(B) radial magnetic field
(C) hair spring which provides the counter torque
(D) eddy current in the iron core which causes damping.

[2026 • Set 55-1-1]

Q2. The best way to increase current sensitivity of a galvanometer is by:

(A) increasing number of turns of the coil
(B) increasing area of coil and magnetic field strength
(C) decreasing area of coil and magnetic field strength
(D) increasing torsional constant of the hair spring

[2026 • Set 55-1-1]

Q3. A moving coil galvanometer has a coil with area of cross-section 4.0×10^{-3} m^2 and number of turns 50. The coil is rotating in a magnetic field of 0.25 T. The torque acting on the coil when a current of 5 A passes through it is:

(A) 1.0 N m
(B) 2.0 N m
(C) 0.50 N m
(D) 0.25 N m

[2026 • Set 55-1-1]

Q4. (OR variant for Q29(iv)) A galvanometer coil has a resistance of 15 Ω and the meter shows full scale deflection for a current of 3 mA. The value of resistance required to convert it into a voltmeter of range $(0 - 12\text{ V})$ is: OR A galvanometer with coil of resistance 20 Ω shows full scale deflection for a current of 5 mA. To convert it into an ammeter of range $(0 - 10\text{ A})$, a resistance of:

(A) 4015 Ω / 0.05 Ω should be connected in series with it
(B) 3985 Ω / 0.05 Ω should be connected in parallel with it
(C) 415 Ω / 0.01 Ω should be connected in parallel with it
(D) 385 Ω / 0.01 Ω should be connected in series with it

[2026 • Set 55-1-1]

Q5. A long straight wire of circular cross-section (radius a) carries a steady current I. The current is uniformly distributed across this cross-section. The magnitude of the magnetic field produced at a point at a distance $(a/2)$ from the axis of the wire will be:

(A) Zero
(B) $\dfrac{\mu_0 I}{2\pi a}$
(C) $\dfrac{\mu_0 I}{4\pi a}$
(D) $\dfrac{\mu_0 I}{6\pi a}$

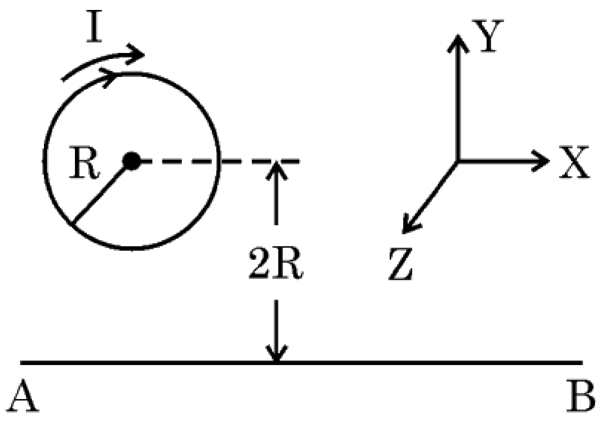
[2026 • Set 55-1-1]

Q6. A straight conductor lies along x-axis. It carries a current of 10 A along $+x$ direction. The magnetic field $\vec{B}$ due to 1 cm segment of this conductor, centred at the origin, at a point $(0, 1\text{ m}, 0)$ is:

(A) $(1\,\text{nT})\,\hat{j}$
(B) $(10\,\text{nT})\,\hat{k}$
(C) $-(10\,\text{nT})\,\hat{k}$
(D) $-(1\,\text{nT})\,\hat{j}$

[2026 • Set 55-1-2]

Q7. A circular loop has radius R and carries current I as shown in figure. In order that the net magnetic field at the centre of the loop is zero, the current in wire AB should have magnitude:



(A) $2\pi I$, along $+X$-axis
(B) $2\pi I$, along $-X$-axis
(C) πI, along $+X$-axis
(D) πI, along $-X$-axis

[2026 • Set 55-1-3]

Q8. A straight long wire lying along y-axis, carries a current of 1 A along $-y$ direction. The magnetic field due to the conductor at a point $(50 \text{ cm}, 0, 0)$ will point along:

(A) z-axis
(B) $-z$-axis
(C) x-axis
(D) $-x$-axis

[2026 • Set 55-2-1]

Q9. A person is standing facing geographic north and a vertical wire in front of him is carrying a current in downward direction. The direction of magnetic field at a point on the right side of wire is:

(A) South
(B) East
(C) West
(D) North

[2026 • Set 55-2-3]

Q10. Assertion (A): The cylindrical soft iron core in a moving coil galvanometer only makes the magnetic field radial and does not affect the strength of the magnetic field. Reason (R): In a moving coil galvanometer, the plane of the coil is always perpendicular to the magnetic field. Select the correct answer from the codes (A), (B), (C) and (D) given below:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct

explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are false.

[2026 • Set 55-3-1]

Q11. Case Study: A charged particle $+q$ in an electric field $\vec{E}$ experiences a force in the direction of the electric field. As a result, its kinetic energy changes. Similarly, the charged particle also experiences a force when it moves in a magnetic field $\vec{B}$. But this magnetic force is perpendicular to both velocity $\vec{v}$ of the charged particle and the magnetic field $\vec{B}$, so it cannot change the kinetic energy of the charged particle. Consider two charged particles 1 and 2 of masses m and $\frac{m}{2}$ having charges $-q$ and $+2q$ respectively. They are accelerated from rest through the same potential difference V and acquire kinetic energy K_1 and K_2. Then they enter in a region of uniform magnetic field $\vec{B}$ perpendicular to their velocities. The ratio of their kinetic energies $\left(\frac{K_1}{K_2}\right)$ is:

(A) $\frac{1}{2}$

(B) $\frac{1}{4}$

(C) 4

(D) 1

[2026 • Set 55-3-1]

Q12. The ratio of the radii of the circular paths described by them $\left(\frac{r_1}{r_2}\right)$ is:

(A) $\frac{1}{\sqrt{2}}$

(B) $\sqrt{2}$

(C) $\frac{1}{2}$

(D) 2

[2026 • Set 55-3-1]

Q13. Suppose particles 1 and 2 enter the magnetic field $\vec{B} = B_0\hat{k}$ with velocities $\vec{v}_1 = v_0\hat{i}$ and $\vec{v}_2 = v_0\hat{i}$. Then:

(A) both particles revolve clockwise

(B) both particles revolve anticlockwise

(C) particle 1 revolves clockwise while particle 2 revolves anticlockwise

(D) particle 1 revolves anticlockwise while particle 2 revolves clockwise

[2026 • Set 55-3-1]

Q14. If period of revolution for particle 1 is 4 s, then for particle 2, the period will be:

(A) 1 s

(B) 2 s

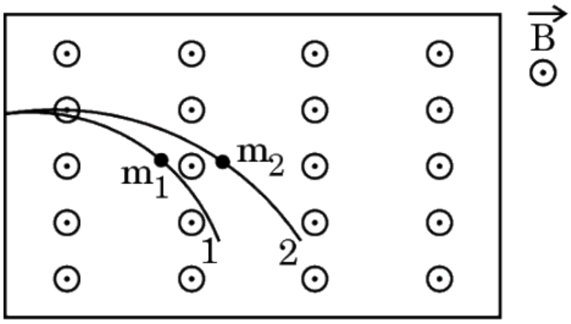
(C) 4 s
(D) 8 s

[2026 • Set 55-3-1]

Q15. If the value of momentum for particles 1 and 2 are p_1 and p_2, then:
(A) $p_1 = \frac{p_2}{2}$
(B) $p_1 = p_2$
(C) $p_1 = 2p_2$
(D) $p_1 = 4p_2$

[2026 • Set 55-3-1]

Q16. Two particles of masses m_1 and m_2 having charges q_1 and q_2 respectively are projected with the same velocity in a region of uniform magnetic field $\vec{B}$ pointing vertically upward. If they describe circular paths as shown in the figure, one may conclude that:



(A) $\frac{m_1}{m_2} > \frac{q_1}{q_2}$
(B) $\frac{m_1}{m_2} > \frac{q_2}{q_1}$
(C) $\frac{m_1}{m_2} < \frac{q_1}{q_2}$
(D) $\frac{m_1}{m_2} < \frac{q_2}{q_1}$

[2026 • Set 55-4-1]

Q17. An electron moves around the nucleus in a circular orbit of radius r and makes n revolutions per second. The value of equivalent current in the orbit is:
(A) $\frac{e}{n}$
(B) ne
(C) $\frac{2\pi e}{r}$
(D) $\frac{e}{nr}$

[2026 • Set 55-4-1]

Q18. A coil having 100 closely wound turns and area of cross-section 300 mm^2 carries a current of 5 mA. The magnitude of the magnetic moment associated with the coil is:
(A) 6×10^{-4} A m^2

(B) 3×10^{-5} A m^2
(C) $1 \cdot 5 \times 10^{-4}$ A m^2
(D) 5×10^{-5} A m^2

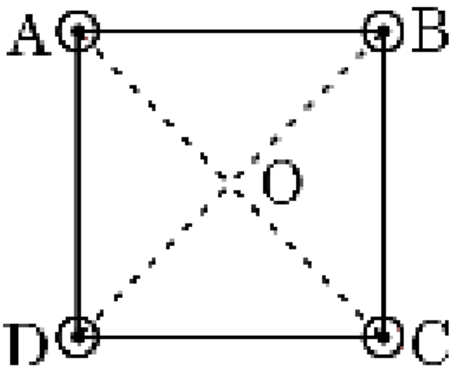
[2026 • Set 55-4-2]

Q19. A galvanometer of resistance G is converted into a voltmeter of range (0 - V) by connecting a resistor of 250 Ω with it. If resistor of 250 Ω is replaced by another resistor of 900 Ω, its range becomes (0 - 3 V). The resistance G of the galvanometer is:

(A) 150 Ω
(B) 125 Ω
(C) 100 Ω
(D) 75 Ω

[2026 • Set 55-4-3]

Q20. Four long straight thin wires are held vertically at the corners A, B, C and D of a square of side $'a'$, kept on a table and carry equal current $'I'$. The wire at A carries current in upward direction whereas the current in the remaining wires flows in downward direction. The net magnetic field at the centre of the square will have the magnitude:



(A) $\frac{\mu_0 I}{\pi a}$ and directed along OC
(B) $\frac{\mu_0 I}{\pi a\sqrt{2}}$ and directed along OD
(C) $\frac{\mu_0 I\sqrt{2}}{\pi a}$ and directed along OB
(D) $\frac{2\mu_0 I}{\pi a}$ and directed along OA

[2026 • Set 55-5-1]

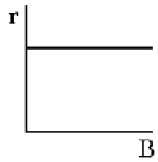
Q21. A charged particle of mass m having kinetic energy K passes undeflected through a region with electric field $\vec{E}$ and magnetic field $\vec{B}$ acting perpendicular to each other. The mass m of the particle will be:

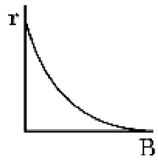
(A) $\frac{KB^2}{2E^2}$

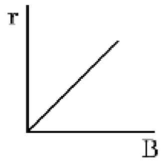
(B) $\dfrac{2KB^2}{E^2}$
(C) $\dfrac{q^2}{B^2}$
(D) $\dfrac{KB^2}{2B^2}$

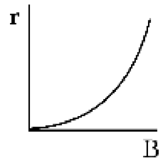
[2026 • Set 55-5-2]

Q22. A charged particle is moving in a uniform magnetic field $\vec{B}$ with a constant speed v in a circular path of radius r. Which of the following graphs represents the variation of radius of the circle, with the magnitude of magnetic field $\vec{B}$?

(A) 

(B) 

(C) 

(D) 

(A) Graph A
(B) Graph B
(C) Graph C
(D) Graph D

[2026 • Set 55-5-3]

Q23. Assertion (A): The deflection in a galvanometer is directly proportional to the current passing through it. Reason (R): The coil of a galvanometer is suspended in a uniform radial magnetic field.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false and Reason (R) is also false.

[2025 • Set 55-1-1]

Q24. A $1\,\text{cm}$ segment of a wire lying along x-axis carries current of $0.5\,\text{A}$ along $+x$ direction. A magnetic field $\vec{B} = (0.4\,\text{mT})\,\hat{j} + (0.6\,\text{mT})\,\hat{k}$ is switched on in the region. The force acting on the segment is:

(A) $(-2\hat{j} + 3\hat{k})\,\mu\text{N}$
(B) $(-3\hat{j} + 2\hat{k})\,\mu\text{N}$

(C) $(-6\hat{j} + 4\hat{k})\ \mu$N
(D) $(-4\hat{j} + 6\hat{k})\ \mu$N

[2025 • Set 55-1-1]

Q25. A 1 cm straight segment of a conductor carrying 1 A current in x direction lies symmetrically at origin of Cartesian coordinate system. The magnetic field due to this segment at point (1 m, 1 m, 0) is

(A) $1.0 \times 10^{-9}\,\hat{k}$ T
(B) $-1.0 \times 10^{-9}\,\hat{k}$ T
(C) $\frac{5.0}{\sqrt{2}} \times 10^{-10}\,\hat{k}$ T
(D) $-\frac{5.0}{\sqrt{2}} \times 10^{-10}\,\hat{k}$ T

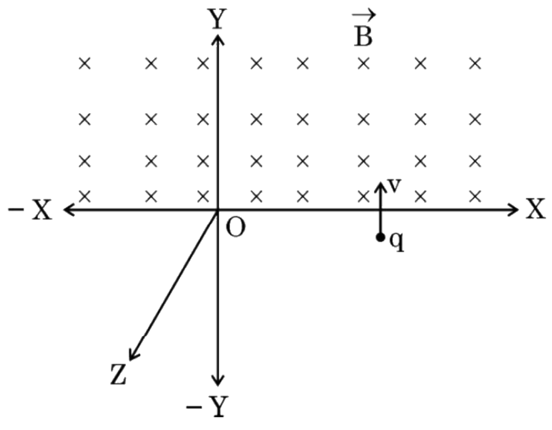
[2025 • Set 55-2-1]

Q26. A long straight wire is held vertically and carries a steady current in upward direction. The shape of magnetic field lines produced by the current-carrying wire are :

(A) horizontal straight lines directed radially out from the wire.
(B) straight lines parallel to the current-carrying wire.
(C) concentric horizontal circles around the wire.
(D) coaxial helixes around the wire.

[2025 • Set 55-4-1]

Q27. A particle having charge $+q$ enters a uniform magnetic field $\vec{B}$ as shown in the figure. The particle will describe :



(A) a circular path in XZ plane
(B) a semicircular path in XY plane
(C) a helical path with its axis parallel to Y-axis
(D) a semicircular path in YZ plane

[2025 • Set 55-4-1]

Q28. A particle with charge q moving with velocity $\vec{v} = v_0\hat{i}$ enters a region with magnetic field

$\vec{B} = B_1\hat{j} + B_2\hat{k}$. The magnitude of force experienced by the particle is :

(A) $qv_0(B_1 + B_2)$

(B) $qv_0^2(B_1 + B_2)$

(C) $qv_0\sqrt{B_1^2 + B_2^2}$

(D) $qv_0^2\sqrt{B_1^2 + B_2^2}$

[2025 • Set 55-4-2]

Q29. A particle of mass m and charge q moves along y-axis in a region in which a uniform magnetic field $\vec{B}$ is pointing along x-axis. The Lorentz force acting on the charge will point along :

(A) x-axis

(B) y-axis

(C) z-axis

(D) negative z-axis

[2025 • Set 55-4-3]

Q30. Case Study: A galvanometer is an instrument used to show the direction and strength of the current passing through it. In a galvanometer, a coil placed in a magnetic field experiences a torque and hence gets deflected when a current passes through it. The name is derived from the surname of Italian scientist L. Galvani, who in 1791 discovered that electric current makes a dead frog's leg jerk. A spring attached with the coil provides a counter torque. In equilibrium, the deflecting torque is balanced by the restoring torque of the spring and we have: $NBAI = k\phi$, where N is the total number of turns in the coil, A is the area of cross-section of each turn, B is the radial magnetic field, k is the torsional constant of the spring, ϕ is the angular deflection of the coil. As the current (I_g) which produces full scale deflection in the galvanometer is very small, the galvanometer cannot as such be used to measure current in electric circuits. A small resistance, called shunt, of a suitable value is connected with the galvanometer to convert it into an ammeter of desired range. By using a higher resistance, a galvanometer can also be converted into a voltmeter. (i) The value of the current sensitivity of a galvanometer is given by:

(A) $\dfrac{k}{NBA}$

(B) $\dfrac{NBA}{k}$

(C) $\dfrac{kBA}{N}$

(D) $\dfrac{kNB}{A}$

[2025 • Set 55-5-1]

Q31. (ii) A galvanometer of resistance $6\ \Omega$ shows full scale deflection for a current of 0.2 A. The value of shunt to be used with this galvanometer to convert it into an ammeter of range $(0 - 5\text{ A})$ is:

(A) $0.25\ \Omega$

(B) $0.30\ \Omega$
(C) $0.50\ \Omega$
(D) $6.0\ \Omega$

[2025 • Set 55-5-1]

Q32. (iii) The value of resistance of the ammeter in case (ii) will be:
(A) $0.20\ \Omega$
(B) $0.24\ \Omega$
(C) $6.0\ \Omega$
(D) $6.25\ \Omega$

[2025 • Set 55-5-1]

Q33. (iv) (a) A galvanometer is converted into a voltmeter of range $(0 - V)$ by connecting with it, a resistance R_1. If R_1 is replaced by R_2, the range becomes $(0 - 2V)$. The resistance of the galvanometer is: OR (b) A current of 5 mA flows through a galvanometer. Its coil has 100 turns, each of area of cross-section 18 cm^2 and is suspended in a magnetic field 0.20 T. The deflecting torque acting on the coil will be:
(A) (a) $(R_2 - 2R_1)$ OR (b) 3.6×10^{-2} Nm
(B) (a) $(R_2 - R_1)$ OR (b) 1.8×10^{-4} Nm
(C) (a) $(R_1 + R_2)$ OR (b) 2.4×10^{-3} Nm
(D) (a) $(R_1 - 2R_2)$ OR (b) 1.2×10^{-4} Nm

[2025 • Set 55-5-1]

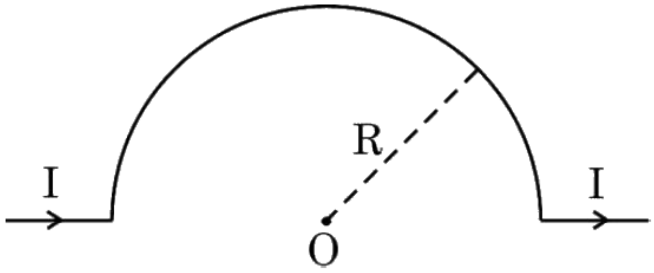
Q34. A charged particle gains a speed of 10^7 ms^{-1}, when accelerated from rest through a potential difference 10 kV. It enters a region of magnetic field of 0.4 T such that $\vec{V} \perp \vec{B}$. The radius of circular path described by it is:
(A) 2.5 cm
(B) 5 cm
(C) 8 cm
(D) 10 cm

[2025 • Set 55-5-1]

Q35. A current of $\left(\frac{10}{\pi}\right)$ A is maintained in a circular loop of radius 14 cm. The value of dipole moment associated with the loop is:
(A) 0.019 Am^2
(B) 0.14 Am^2
(C) 0.196 Am^2
(D) 0.615 Am^2

[2025 • Set 55-5-1]

Q36. The value of magnetic field at point O in the given figure is:



(A) $\frac{\mu_0 I}{2\pi R}$
(B) $\frac{\mu_0 I}{\pi R}$
(C) $\frac{\mu_0 I}{4R}$
(D) $\frac{\mu_0 I}{R}$

[2025 • Set 55-6-1]

Q37. A galvanometer can be converted into an ammeter of desired range by connecting a:
(A) small resistance in series
(B) large resistance in series
(C) small resistance in parallel
(D) large resistance in parallel

[2025 • Set 55-6-1]

Q38. A proton and an α-particle enter with the same velocity $\vec{V}$ in a uniform magnetic field $\vec{B}$ such that $\vec{V} \perp \vec{B}$. The ratio of the radii of their paths is:
(A) 2
(B) $\frac{1}{2}$
(C) $\frac{1}{4}$
(D) 4

[2025 • Set 55-6-1]

Q39. A straight conductor is carrying a current of $2\,\text{A}$ in $+x$ direction along it. A uniform magnetic field $\vec{B} = (0{\cdot}6\,\hat{j} + 0{\cdot}8\,\hat{k})\,\text{T}$ is switched on, in the region. The force acting on $10\,\text{cm}$ length of the conductor is:
(A) $(0{\cdot}12\,\hat{j} - 0{\cdot}16\,\hat{k})\,\text{N}$
(B) $(-0{\cdot}16\,\hat{j} + 0{\cdot}12\,\hat{k})\,\text{N}$
(C) $(0{\cdot}12\,\hat{j} + 0{\cdot}16\,\hat{k})\,\text{N}$
(D) $(0{\cdot}16\,\hat{j} - 0{\cdot}12\,\hat{k})\,\text{N}$

[2025 • Set 55-6-2]

Q40. Assertion (A): A charged particle is moving with velocity v in x-y plane, making an angle θ $(0 < \theta < \frac{\pi}{2})$ with x-axis. If a uniform magnetic field $\vec{B}$ is applied in the region, along y-axis, the particle will move in a helical path with its axis parallel to x-axis. Reason (R): The direction of the magnetic force acting on a charged particle moving in a magnetic field is along the velocity of the particle. Select the correct answer:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

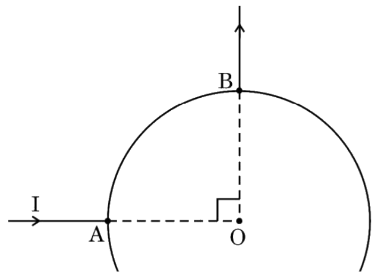
(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are false.

[2025 • Set 55-7-1]

Q41. In a circular loop of radius R, current I enters at point A and exits at point B, as shown in the figure. The value of the magnetic field at the centre O of the loop is:

से बाहर निकलती है। इस पाश के केन्द्र O पर चुम्बकीय क्षेत्र का मान है :



(A) $\dfrac{\mu_0 I}{R}$

(B) zero

(C) $\dfrac{\mu_0 I}{2R}$

(D) $\dfrac{\mu_0 I}{4R}$

[2025 • Set 55-7-2]

Q42. Assertion (A): Two long parallel wires, freely suspended and connected in series to a battery, move apart. Reason (R): Two wires carrying current in opposite directions repel each other.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2024 • Set 55-1-1]

Q43. A loop carrying a current I clockwise is placed in $x - y$ plane, in a uniform magnetic field directed along z-axis. The tendency of the loop will be to:

(A) move along x-axis
(B) move along y-axis
(C) shrink
(D) expand

[2024 • Set 55-1-1]

Q44. A 10 cm long wire lies along y-axis. It carries a current of $1.0\,\text{A}$ in positive y-direction. A magnetic field $\vec{B} = (5\,\text{mT})\hat{j} - (8\,\text{mT})\hat{k}$ exists in the region. The force on the wire is:

(A) $(0.8\,\text{mN})\hat{i}$
(B) $-(0.8\,\text{mN})\hat{i}$
(C) $(8.0\,\text{mN})\hat{i}$
(D) $-(8.0\,\text{mN})\hat{i}$

[2024 • Set 55-1-1]

Q45. A galvanometer of resistance $G\,\Omega$ is converted into an ammeter of range 0 to I A. If the current through the galvanometer is 0.1% of I A, the resistance of the ammeter is:

(A) $\frac{G}{999}\,\Omega$
(B) $\frac{G}{1000}\,\Omega$
(C) $\frac{G}{1001}\,\Omega$
(D) $\frac{G}{100.1}\,\Omega$

[2024 • Set 55-1-1]

Q46. A piece of wire bent in the form of a circular loop A carries a current I. The wire is then bent into a circular loop B of two turns and carries the same current. The ratio of magnetic fields at the centre of loop A to that of loop B will be:

(A) $\frac{1}{16}$
(B) 16
(C) 4
(D) $\frac{1}{4}$

[2024 • Set 55-1-2]

Q47. Two charged particles, P and Q, each having charge q but of masses m_1 and m_2, are accelerated through the same potential difference V. They enter a region of magnetic field $\vec{B}$ $(\perp \vec{v})$ and describe the circular paths of radii a and b respectively. Then $\left(\frac{m_1}{m_2}\right)$ is equal to:

(A) $\frac{a}{b}$

(B) $\dfrac{b}{a}$

(C) $\left(\dfrac{a}{b}\right)^2$

(D) $\left(\dfrac{b}{a}\right)^2$

[2024 • Set 55-1-3]

Q48. Assertion (A): An electron and a proton enter with the same momentum $\vec{p}$ in a magnetic field $\vec{B}$ such that $\vec{p} \perp \vec{B}$. Then both describe a circular path of the same radius. Reason (R): The radius of the circular path described by the charged particle (charge q, mass m) moving in the magnetic field $\vec{B}$ is given by $r = \dfrac{mv}{qB}$.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2024 • Set 55-2-1]

Q49. A wire of length 4.4 m is bent round in the shape of a circular loop and carries a current of 1.0 A. The magnetic moment of the loop will be:

(A) $0.7\ Am^2$

(B) $1.54\ Am^2$

(C) $2.10\ Am^2$

(D) $3.5\ Am^2$

[2024 • Set 55-2-1]

Q50. Assertion (A): A proton and an electron enter a uniform magnetic field $\vec{B}$ with the same momentum $\vec{p}$ such that $\vec{p}$ is perpendicular to $\vec{B}$. They describe circular paths of the same radius. Reason (R): In a magnetic field, orbital radius r is equal to $\dfrac{p}{qB}$.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

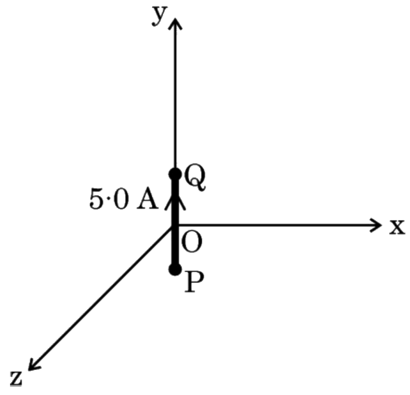
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2024 • Set 55-3-1]

Q51. A 2.0 cm segment of wire, carrying 5.0 A current in positive y-direction lies along y-axis, as shown in the figure. The magnetic field at a point $(3\text{ m}, 4\text{ m}, 0)$ due to this segment (part of a circuit) is:



(A) $(0.12\text{ nT})\,\hat{j}$
(B) $-(0.10\text{ nT})\,\hat{j}$
(C) $-(0.24\text{ nT})\,\hat{k}$
(D) $(0.24\text{ nT})\,\hat{k}$

[2024 • Set 55-3-1]

Q52. A circular loop of wire, carrying a current I is lying in xy-plane with its centre coinciding with the origin. It is subjected to a uniform magnetic field pointing along $+z$-axis. The loop will:

(A) move along x-axis
(B) move along $-y$-axis
(C) move along z-axis
(D) remain stationary

[2024 • Set 55-3-1]

Q53. Two thin long parallel wires separated by a distance 'a' carry current I in opposite directions. The wires will:

(A) Repel each other with a force $\frac{\mu_0 I^2}{2\pi a^2}$ per unit length.
(B) Attract each other with a force $\frac{\mu_0 I^2}{2\pi a^2}$ per unit length.
(C) Attract each other with a force $\frac{\mu_0 I^2}{2\pi a}$ per unit length.
(D) Repel each other with a force $\frac{\mu_0 I^2}{2\pi a}$ per unit length.

[2024 • Set 55-3-2]

Q54. A straight wire is kept horizontally along east-west direction. If a steady current flows in wire from east to west, the magnetic field at a point above the wire will point towards

(A) East
(B) West
(C) North
(D) South

[2024 • Set 55-4-1]

Q55. A galvanometer of resistance $100\,\Omega$ is converted into an ammeter of range $(0–1\,\text{A})$ using a resistance of $0.1\,\Omega$. The ammeter will show full scale deflection for a current of about

(A) $0.1\,\text{mA}$

(B) $1\,\text{mA}$

(C) $10\,\text{mA}$

(D) $0.1\,\text{A}$

[2024 • Set 55-4-1]

Q56. A circular loop A of radius R carries a current I. Another circular loop B of radius $\left(\frac{R}{2}\right)$ is placed concentrically in the plane of A. The magnetic flux linked with loop B is proportional to

(A) R

(B) $\sqrt{R}$

(C) $R^{\frac{3}{2}}$

(D) R^2

[2024 • Set 55-4-1]

Q57. A particle of mass m and charge q is moving with velocity $\vec{v} = v_x\hat{i} + v_y\hat{j}$. If it is subjected to a magnetic field $\vec{B} = B_0\hat{i}$, it will move in a

(A) straight line path

(B) circular path

(C) helical path

(D) parabolic path

[2024 • Set 55-4-2]

Q58. Two long straight parallel conductors A and B, kept at a distance r, carry current I in opposite directions. A third identical conductor C, kept at a distance $\left(\frac{r}{2}\right)$ from A carries current I, in the same direction as in A. The net magnetic force on unit length of C is

(A) $\frac{5\mu_0 I^2}{2\pi r}$ towards A

(B) $\frac{5\mu_0 I^2}{2\pi r}$ towards B

(C) $\frac{3\mu_0 I^2}{4\pi r}$ towards A

(D) $\frac{3\mu_0 I^2}{4\pi r}$ towards B

[2024 • Set 55-4-3]

Q59. Assertion (A): The energy of a charged particle moving in a magnetic field does not change. Reason (R): It is because the work done by the magnetic force on the charge moving in a magnetic field is zero.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).
(B) Both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of Assertion (A).
(C) Assertion (A) is true but Reason (R) is false.
(D) Both Assertion (A) and Reason (R) are false.

[2024 • Set 55-5-1]

Q60. A particle of mass m and charge q describes a circular path of radius R in a magnetic field. If its mass and charge were $2m$ and $\frac{q}{2}$ respectively, the radius of its path would be:

(A) $\frac{R}{4}$
(B) $\frac{R}{2}$
(C) $2R$
(D) $4R$

[2024 • Set 55-5-1]

Q61. A galvanometer of resistance $50\,\Omega$ is converted into a voltmeter of range $(0\text{-}2\,\text{V})$ using a resistor of $1.0\,\text{k}\Omega$. If it is to be converted into a voltmeter of range $(0\text{-}10\,\text{V})$, the resistance required will be:

(A) $4.8\,\text{k}\Omega$
(B) $5.0\,\text{k}\Omega$
(C) $5.2\,\text{k}\Omega$
(D) $5.4\,\text{k}\Omega$

[2024 • Set 55-5-1]

Q62. A galvanometer shows full scale deflection for a current I_g. If a shunt of resistance S_1 is connected to the galvanometer, it gets converted into an ammeter of range $(0\text{-}I)$. When resistance of the shunt is made S_2, its range becomes $(0\text{-}2I)$. Then $\frac{S_1}{S_2}$ is:

(A) $\frac{I + I_g}{I - I_g}$
(B) $\frac{I - I_g}{I + I_g}$
(C) $\frac{2I - I_g}{I - I_g}$
(D) $\frac{I - I_g}{2I - I_g}$

[2024 • Set 55-5-2]

Q63. Two insulated concentric coils, each of radius R, placed at right angles to each other, carry currents I and $\sqrt{3}\,I$ respectively. The magnitude of the net magnetic field at their common centre will be:

(A) $\frac{\mu_0 I}{R}$
(B) $\frac{\mu_0 I}{2R}$
(C) $\frac{\mu_0 I}{4R}$
(D) $\frac{2\mu_0 I}{R}$

[2024 • Set 55-5-3]

Q64. A galvanometer of resistance $100\,\Omega$ gives full scale deflection for a current of $1.0\,$mA. It is converted into an ammeter of range $(0\text{-}1\,\text{A})$. The resistance of the ammeter will be close to:
(A) $0.1\,\Omega$
(B) $0.8\,\Omega$
(C) $1.0\,\Omega$
(D) $10\,\Omega$

[2024 • Set 55-5-3]

Q65. Beams of electrons and protons move parallel to each other in the same direction. They
(A) attract each other.
(B) repel each other.
(C) neither attract nor repel.
(D) force of attraction or repulsion depends upon speed of beams.

[2023 • Set 55-2-1]

Q66. A long straight wire of radius 'a' carries a steady current 'I'. The current is uniformly distributed across its area of cross-section. The ratio of magnitude of magnetic field B_1 at $\frac{a}{2}$ and B_2 at distance $2a$ is
(A) $\frac{1}{2}$
(B) 1
(C) 2
(D) 4

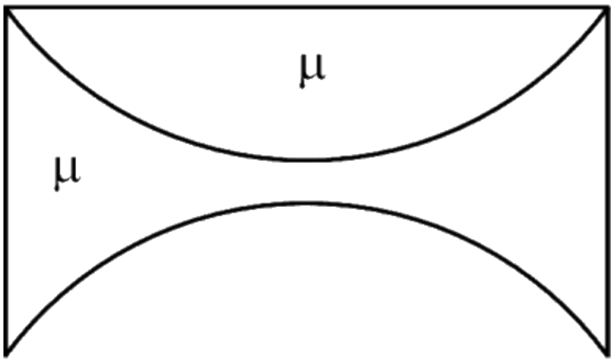
[2023 • Set 55-2-1]

Q67. Assertion (A): When radius of a circular loop carrying a steady current is doubled, its magnetic moment becomes four times. Reason (R): The magnetic moment of a circular loop carrying a steady current is proportional to the area of the loop.
(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false and Reason (R) is also false.

[2023 • Set 55-3-1]

Q68. Which of the following graphs correctly represents the variation of the magnitude of the magnetic field outside a straight infinite current-carrying wire of radius 'a', as a function of distance 'r' from the centre of the wire?



(A) Graph (a)
(B) Graph (b)
(C) Graph (c)
(D) Graph (d)

[2023 • Set 55-3-1]

Q69. A particle of mass m and charge q moving with a uniform velocity $\vec{v} = v_{0x}\,\hat{i} + v_{0y}\,\hat{j}$ enters a region with a magnetic field $\vec{B} = B_0\,\hat{j}$. After some time, an electric field $\vec{E} = E_0\,\hat{j}$ is also switched on in the region. The resulting path described by the particle will be:

(A) a circle in x-z plane
(B) a parabola in x-y plane
(C) a helix with constant pitch
(D) a helix with increasing pitch

[2023 • Set 55-3-1]

Q70. In a moving coil galvanometer, the deflecting torque τ acting on the coil is related to the current I flowing through it as:

(A) $\tau \propto I^3$
(B) $\tau \propto I^2$
(C) $\tau \propto I$
(D) $\tau \propto \sqrt{I}$

[2023 • Set 55-3-2]

Q71. Two thin long parallel wires A and B are separated by a distance r and carry current I

each in the same direction. The force per unit length exerted by A on wire B is:

(A) $\frac{\mu_0 I^2}{2r}$, attractive

(B) $\frac{\mu_0 I^2}{r}$, repulsive

(C) $\frac{\mu_0 I^2}{2\pi r}$, attractive

(D) $\frac{\mu_0 I^2}{2\pi r}$, repulsive

[2023 • Set 55-3-3]

Q72. Assertion (A): A current carrying square loop made of a wire of length L is placed in a magnetic field. It experiences a torque which is greater than the torque on a circular loop made of the same wire carrying the same current in the same magnetic field. Reason (R): A square loop occupies more area than a circular loop, both made of wire of the same length.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2023 • Set 55-4-1]

Q73. An electron enters a uniform magnetic field with speed v. It describes a semicircular path and comes out of the field. The final speed of the electron is:

(A) Zero

(B) v

(C) $\frac{v}{2}$

(D) $2v$

[2023 • Set 55-4-1]

Q74. Assertion (A): The deflecting torque acting on a current carrying loop is zero when its plane is perpendicular to the direction of magnetic field. Reason (R): The deflecting torque acting on a loop of magnetic moment $\vec{m}$ in a magnetic field $\vec{B}$ is given by the dot product of $\vec{m}$ and $\vec{B}$.

(A) Both Assertion (A) and Reason (R) are true and (R) is the correct explanation of (A).

(B) Both Assertion (A) and Reason (R) are true and (R) is NOT the correct explanation of (A).

(C) Assertion (A) is true and Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2023 • Set 55-5-1]

Q75. Two long parallel wires kept 2 m apart carry 3A current each, in the same direction. The force per unit length on one wire due to the other is

(A) 4.5×10^5 N/m, attractive
(B) 4.5×10^{-7} N/m, repulsive
(C) 9×10^{-7} N/m, repulsive
(D) 9×10^5 N/m, attractive

[2023 • Set 55-5-1]

Q76. Two horizontal thin long parallel wires, separated by a distance r carry current I each in the opposite directions. The net magnetic field at a point midway between them, will be

(A) zero
(B) $\frac{\mu_0 I}{\pi r}$, vertically downward
(C) $\frac{2\mu_0 I}{\pi r}$, vertically upward
(D) $\frac{\mu_0 I}{\pi r}$, vertically downward

[2023 • Set 55-5-3]

Q77. Two statements are given - one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to this question from the codes (A), (B), (C) and (D) as given below: (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A). (B) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A). (C) Assertion (A) is true but Reason (R) is false. (D) Assertion (A) is false and Reason (R) is also false. Assertion (A): Higher the range of an ammeter, smaller is its resistance. Reason (R): To increase the range of the ammeter, additional shunt needs to be connected across it.

[2021]

Q78. The magnetic dipole moment of a current carrying coil does not depend upon

(A) number of turns of the coil.
(B) cross-sectional area of the coil.
(C) current flowing in the coil.
(D) material of the turns of the coil.

[2020 • Set 55-1-1]

Q79. An electron is released from rest in a region of uniform electric and magnetic fields acting parallel to each other. The electron will

(A) move in a straight line.
(B) move in a circle.
(C) remain stationary.
(D) move in a helical path.

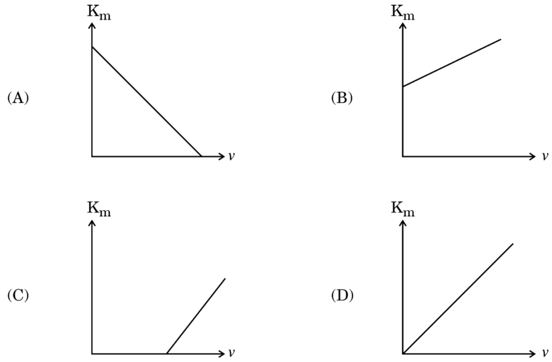
[2020 • Set 55-2-1]

Q80. A straight current carrying conductor is placed inside a uniform magnetic field. The force per unit length acting on the conductor is

(A) maximum when the conductor is perpendicular to the direction of magnetic field.
(B) maximum when the conductor is along the direction of magnetic field.
(C) minimum when the conductor is perpendicular to the direction of magnetic field.
(D) minimum when the conductor makes an angle of $45°$ with the direction of magnetic field.

[2020 • Set 55-2-3]

Q81. An isosceles right angled current carrying loop PQR is placed in a uniform magnetic field $\vec{B}$ pointing along PR. If the magnetic force acting on the arm PQ is F, then the magnetic force which acts on the arm QR will be



(A) F
(B) $\frac{F}{\sqrt{2}}$
(C) $\sqrt{2}\,F$
(D) $-F$

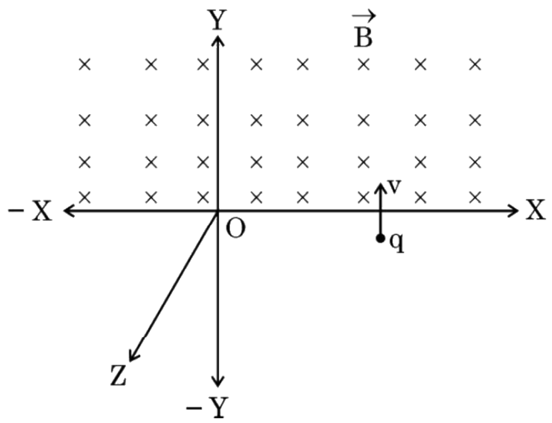
[2020 • Set 55-3-1]

Q82. A region has a uniform magnetic field in it. A proton enters into the region with velocity making an angle of $45°$ with the direction of the magnetic field. In this region the proton will move on a path having the shape of a

(A) straight line
(B) circle
(C) spiral
(D) helix

[2020 • Set 55-3-1]

Q83. A current I flows through a long straight conductor which is bent into a circular loop of radius R in the middle as shown in the figure. The magnitude of the net magnetic field at point O will be



(A) Zero

(B) $\dfrac{\mu_0 I}{2R}\left(1+\dfrac{1}{\pi}\right)$

(C) $\dfrac{\mu_0 I}{4\pi R}$

(D) $\dfrac{\mu_0 I}{2R}\left(1-\dfrac{1}{\pi}\right)$

[2020 • Set 55-4-1]

Q84. A circular loop of radius r, carrying a current I lies in y-z plane with its centre at the origin. The net magnetic flux through the loop is:

(A) directly proportional to r

(B) zero

(C) inversely proportional to r

(D) directly proportional to I

[2020 • Set 55-4-1]

Q85. A current of 10 A is flowing from east to west in a long straight wire kept on a horizontal table. The magnetic field developed at a distance of 10 cm due north on the table is:

(A) 2×10^{-5} T, acting downwards

(B) 2×10^{-5} T, acting upwards

(C) 4×10^{-5} T, acting downwards

(D) 4×10^{-5} T, acting upwards

[2020 • Set 55-4-1]

Q86. An electron and a proton are moving along the same direction with the same kinetic energy. They enter a uniform magnetic field acting perpendicular to their velocities. The dependence of radius of their paths on their masses is:

(A) $r \propto m$

(B) $r \propto \sqrt{m}$

(C) $r \propto \dfrac{1}{m}$

(D) $r \propto \dfrac{1}{\sqrt{m}}$

[2020 • Set 55-4-2]

Q87. There are uniform electric and magnetic fields in a region pointing along X-axis. An α-particle is projected along Y-axis with a velocity v. The shape of the trajectory will be

(A) circular in XZ plane

(B) circular in YZ plane

(C) helical with its axis parallel to X-axis

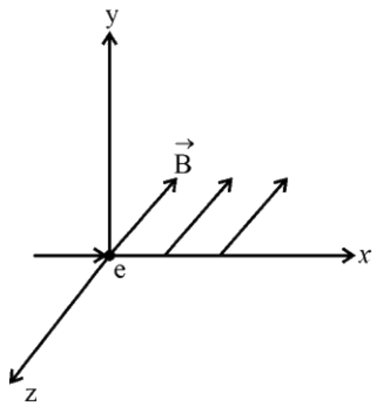
(D) helical with its axis parallel to Y-axis

[2020 • Set 55-4-3]

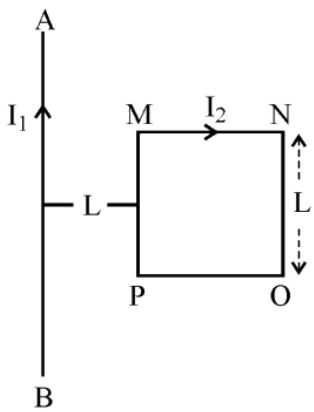
Q88. Define the term 'current sensitivity' of a moving coil galvanometer.

[2020 • Set 55-5-1]

Q89. An electron moves along $+x$ direction. It enters into a region of uniform magnetic field B directed along $-z$ direction as shown in fig. Draw the shape of trajectory followed by the electron after entering the field.



OR A square shaped current carrying loop $MNOP$ is placed near a straight long current carrying wire AB as shown in the fig. The wire and the loop lie in the same plane. If the loop experiences a net force F towards the wire, find the magnitude of the force on the side NO of the loop.



[2020 • Set 55-5-1]

Q90. A charge particle after being accelerated through a potential difference V enters in a uniform magnetic field and moves in a circle of radius r. If V is doubled, the radius of the circle will become

(A) $2r$
(B) $\sqrt{2}\,r$
(C) $4r$
(D) $r/\sqrt{2}$

[2020 • Set 55-5-1]

Q91. A proton is accelerated through a potential difference V, subjected to a uniform magnetic field acting normal to the velocity of the proton. If the potential difference is doubled, how will the radius of the circular path described by the proton in the magnetic field change?

[2019 • Set 55-2-1]

Q92. Write the relation for the force acting on a charged particle q moving with velocity $\vec{v}$ in the presence of a magnetic field $\vec{B}$.

[2019 • Set 55-2-2]

Q93. When a charge q is moving in the presence of electric ($\vec{E}$) and magnetic ($\vec{B}$) fields which are perpendicular to each other and also perpendicular to the velocity $\vec{v}$ of the particle, write the relation expressing $\vec{v}$ in terms of $\vec{E}$ and $\vec{B}$.

[2019 • Set 55-2-3]

Q94. A proton and an electron travelling along parallel paths enter a region of uniform magnetic field, acting perpendicular to their paths. Which of them will move in a circular path with higher frequency ?

[2018]

Q95. What can be the cause of helical motion of a charged particle?

[2016]

Q96. Write the expression, in a vector form, for the Lorentz magnetic force $\vec{F}$ due to a charge moving with velocity $\vec{V}$ in a magnetic field $\vec{B}$. What is the direction of the magnetic force ?

[2014]

Q97. Using the concept of force between two infinitely long parallel current carrying conductors, define one ampere of current.

[2014]

Q98. An electron and a proton, moving parallel to each other in the same direction with equal momenta, enter into a uniform magnetic field which is at right angles to their velocities. Trace their trajectories in the magnetic field.

[2013]

Q99. A narrow beam of protons and deuterons, each having the same momentum, enters a region of uniform magnetic field directed perpendicular to their direction of momentum. What would be the ratio of the radii of the circular paths described by them?

[2011 • Set 55-2-1]

Q100. Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid. Why?

[2009]

Q101. An electron does not suffer any deflection while passing through a region of uniform magnetic field. What is the direction of the magnetic field?

[2009]

Q102. What is the direction of the force acting on a charged particle q, moving with a velocity $\vec{v}$ in a uniform magnetic field $\vec{B}$?

[2008]

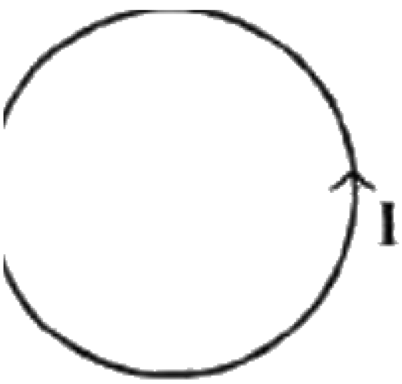
Q103. An electron is moving along $+\text{ve}$ x-axis in the presence of uniform magnetic field along $+\text{ve}$ y-axis. What is the direction of the force acting on it?

[2007]

Q104. An electron beam projected along $+X$-axis, experiences a force due to a magnetic field along the $+Y$-axis. What is the direction of the magnetic field?

[2005]

Q105. In the diagram below is shown a circular loop carrying current I. Show the direction of the magnetic field with the help of lines of force.



[2004]

2-Mark Questions (43 questions · Section B · VSA)

Q1. A wire of length L is bent round into (i) a square coil having N turns and (ii) a circular coil having N turns. The coil in both cases is free to turn about a vertical axis coinciding with the plane of the coil, in a uniform, horizontal magnetic field and carry the same currents. Find the ratio of the maximum value of the torque acting on the square coil to that on the circular coil.

[2026 • Set 55-1-1]

Q2. A voltmeter of resistance $1000\ \Omega$ can measure up to 25 V. How will you convert it so that it can read up to 250 V?

[2025 • Set 55-5-1]

Q3. A circular coil of wire having 200 turns, each of radius 4.0 cm is placed in a horizontal plane. It carries a current of 0.40 A in clockwise direction. Find the magnitude and direction of the magnetic field at the centre of the coil.

[2025 • Set 55-5-2]

Q4. A current of 5 A is passing along $+X$ direction through a wire lying along X-axis. Find the magnetic field $\vec{B}$ at a point $\vec{r} = (3\hat{i} + 4\hat{j})$ m due to 1 cm element of the wire, centered at origin.

[2025 • Set 55-5-3]

Q5. Derive an expression for magnetic force $\vec{F}$ acting on a straight conductor of length L carrying current I in an external magnetic field $\vec{B}$. Is it valid when the conductor is in zig-zag form? Justify.

[2024 • Set 55-5-1]

Q6. An alpha particle is projected with velocity $\vec{V} = (3.0 \times 10^5\ \text{m/s})\,\hat{i}$ into a region in which magnetic field $\vec{B} = [(0.4\,\text{T})\,\hat{i} + (0.3\,\text{T})\,\hat{j}]$ exists. Calculate the acceleration of the particle in the region. $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along x, y and z axis respectively and charge to mass ratio for alpha particle is 4.8×10^7 C/kg.

[2023 • Set 55-1-1]

Q7. Briefly explain why and how a galvanometer is converted into an ammeter.

[2023 • Set 55-2-1]

Q8. A wire of length l is in the form of a circular loop A of one turn. This loop is reshaped into loop B of three turns. Find the ratio of the magnetic fields at the centres of loop A and loop B for the same current through them.

[2023 • Set 55-3-1]

Q9. Two wires of equal lengths are shaped in the form of a square loop and a circular loop.

Both loops are suspended in a uniform magnetic field. Prove that for the same current, the circular loop will experience larger torque.

[2023 • Set 55-3-2]

Q10. A wire of length L is bent round in the form of (i) a square, and then (ii) an equilateral triangle. If current I is passed through each of them, find the ratio of magnetic moment of the square loop to that of the triangle.

[2023 • Set 55-3-3]

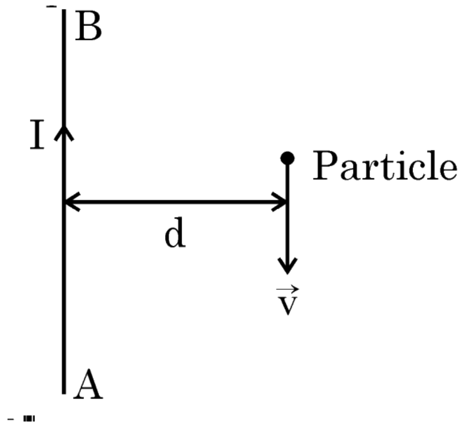
Q11. A particle of charge q and mass m starts moving with uniform velocity $v\hat{i}$. Specify the direction of magnetic field which should be set up in the region so that the particle moves (a) straight undeviated, and (b) in a circle. Justify your answers.

[2023 • Set 55-4-3]

Q12. (a) Write the expression for the Lorentz force on a particle of charge q moving with a velocity $\vec{v}$ in a magnetic field $\vec{B}$. When is the magnitude of this force maximum? Show that no work is done by this force on the particle during its motion from a point $\vec{r_1}$ to point $\vec{r_2}$.

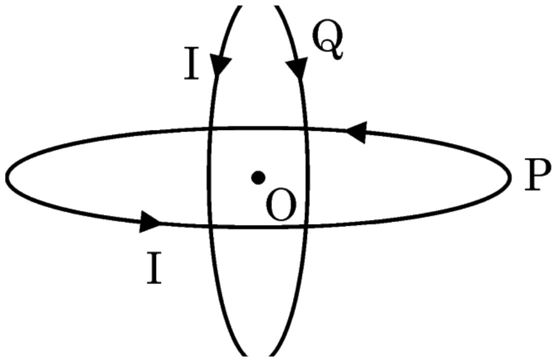
OR

(b) A long straight wire AB carries a current I. A particle (mass m and charge q) moves with a velocity $\vec{v}$, parallel to the wire, at a distance d from it as shown in the figure. Obtain the expression for the force experienced by the particle and mention its directions.



[2023 • Set 55-5-1]

Q13. (a) Two identical circular loops P and Q, each of radius R carrying current I are kept in perpendicular planes such that they have a common centre O as shown in the figure. Find the magnitude and direction of the net magnetic field at the point O.



OR

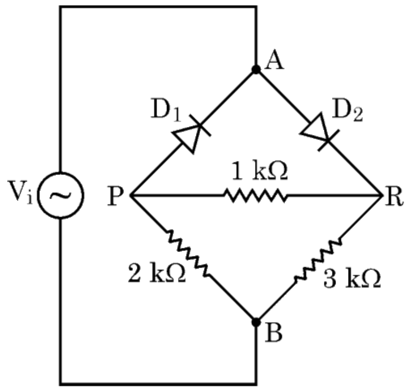
(b) A long straight conductor kept along $X'X$ axis, carries a steady current I along $+x$ direction. At an instant t, a particle of mass m and charge q at point (x, y) moves with a velocity v along $+y$ direction. Find the magnitude and direction of the force on the particle due to the conductor.

[2023 • Set 55-5-3]

Q14. Two long straight parallel wires A and B separated by a distance d, carry equal current I flowing in same direction as shown in the figure.

(a) Find the magnetic field at a point P situated between them at a distance x from one wire.

(b) Show graphically the variation of the magnetic field with distance x for $0 < x < d$.



[2020 • Set 55-1-1]

Q15. An ammeter of resistance $0.8\ \Omega$ can measure a current up to 1.0 A. Find the value of shunt resistance required to convert this ammeter to measure a current up to 5.0 A.

[2020 • Set 55-2-1]

Q16. A galvanometer of resistance $16\ \Omega$ shows full scale deflection for a current of 4 mA. How will you convert it into a voltmeter to measure a voltage up to 3 V?

[2020 • Set 55-2-2]

Q17. A circular loop carrying a current 5 A, produces a magnetic field of π mT, at its centre.

Find the value of the magnetic moment of the loop.

[2020 • Set 55-2-3]

Q18. An α-particle and a proton of the same kinetic energy are in turn allowed to pass through a magnetic field $\vec{B}$, acting normal to the direction of motion of the particles. Calculate the ratio of radii of the circular paths described by them.

[2019 • Set 55-1-1]

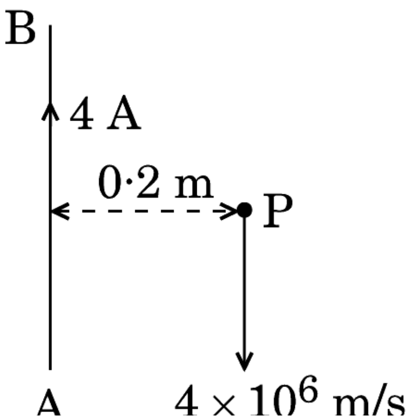
Q19. A deuteron and an alpha particle having same momentum are in turn allowed to pass through a magnetic field $\vec{B}$, acting normal to the direction of motion of the particles. Calculate the ratio of the radii of the circular paths described by them.

[2019 • Set 55-1-2]

Q20. A charged particle q is moving in the presence of a magnetic field $\vec{B}$ which is inclined to an angle $30°$ with the direction of the motion of the particle. Draw the trajectory followed by the particle in the presence of the field and explain how the particle describes this path.

[2019 • Set 55-1-3]

Q21. A long straight wire AB carries a current of 4 A. A proton P travels at 4×10^6 m s^{-1} parallel to the wire 0.2 m from it and in a direction opposite to the current as shown in the figure. Calculate the force which the magnetic field due to the current carrying wire exerts on the proton. Also specify its direction.



[2019 • Set 55-4-1]

Q22. Two long straight wires carrying currents of 2 A and 5 A in the same direction are kept parallel, 10 cm apart from each other. Calculate the force acting between them and write its nature.

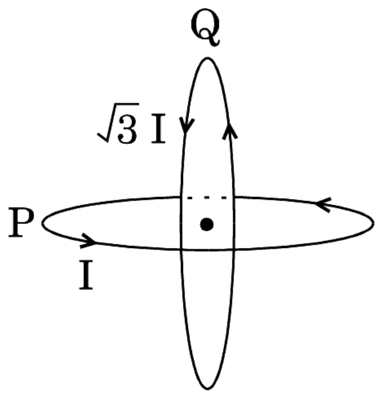
[2019 • Set 55-4-3]

Q23. (a) Obtain the conditions under which an electron does not suffer any deflection while passing through a magnetic field.

(b) Two protons P and Q moving with the same speed pass through the magnetic fields $\vec{B_1}$ and $\vec{B_2}$ respectively, at right angles to the field directions. If $|\vec{B_1}| > |\vec{B_2}|$, which of the two protons will describe the circular path of smaller radius? Explain.

[2019 • Set 55-5-1]

Q24. Two identical coils P and Q each of radius R are lying in perpendicular planes such that they have a common centre. Find the magnitude and direction of the magnetic field at the common centre when they carry currents equal to I and $\sqrt{3}\,I$ respectively.



[2019 • Set 55-5-1]

Q25. Two coils P and Q of radius R and 2R respectively are lying in perpendicular planes having a common centre. Find the magnitude and direction of the resultant magnetic field at the common centre, if they carry the currents I and $2\sqrt{3}\,I$ respectively.

[2019 • Set 55-5-2]

Q26. Two coils P and Q of radius R and 2R are lying in the same plane with their centres coinciding. Find the magnitude and direction of the resultant magnetic field at the common centre if they respectively carry currents $3I$ and $2I$ in opposite directions.

[2019 • Set 55-5-3]

Q27. Find the condition under which the charged particles moving with different speeds in the presence of electric and magnetic field vectors can be used to select charged particles of a particular speed.

[2017]

Q28. State the underlying principle of a cyclotron. Write briefly how this machine is used to accelerate charged particles to high energies.

[2014]

Q29. An ammeter of resistance $0.80\,\Omega$ can measure current upto 1.0 A.

(i) What must be the value of shunt resistance to enable the ammeter to measure current upto 5.0 A?

(ii) What is the combined resistance of the ammeter and the shunt?

[2013]

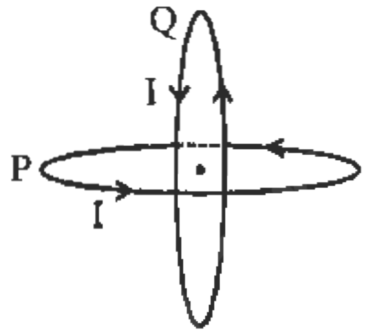
Q30. Deduce the expression for the magnetic dipole moment of an electron orbiting around the central nucleus.

[2012]

Q31. A circular coil of N turns and radius R carries a current I. It is unwound and rewound to make another coil of radius $R/2$, current I remaining the same. Calculate the ratio of the magnetic moments of the new coil and the original coil.

[2012]

Q32. Two identical circular wires P and Q each of radius R and carrying current 'I' are kept in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude and direction of the net magnetic field at the common centre of the two coils.

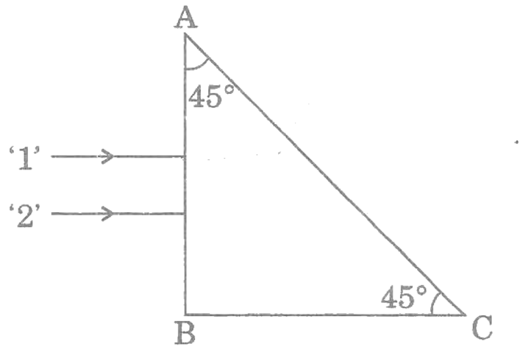


[2012]

Q33. A particle of charge 'q' and mass 'm' is moving with velocity $\vec{V}$. It is subjected to a uniform magnetic field $\vec{B}$ directed perpendicular to its velocity. Show that it describes a circular path. Write the expression for its radius.

[2012]

Q34. Two identical circular loops, P and Q, each of radius r and carrying currents I and $2I$ respectively are lying in parallel planes such that they have a common axis. The direction of current in both the loops is clockwise as seen from O which is equidistant from the both loops. Find the magnitude of the net magnetic field at point O.



[2012]

Q35. Write the expression for Lorentz magnetic force on a particle of charge q moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. Show that no work is done by this force on the charged particle.

[2011]

Q36. A steady current (I_1) flows through a long straight wire. Another wire carrying steady current (I_2) in the same direction is kept close and parallel to the first wire. Show with the help of a diagram how the magnetic field due to the current I_1 exerts a magnetic force on the second wire. Write the expression for this force.

[2011]

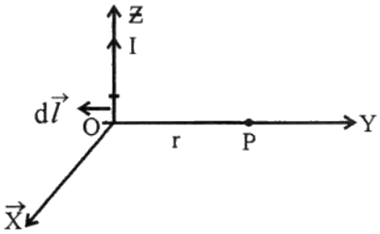
Q37. A charge q moving along the X-axis with a velocity $\vec{v}$ is subjected to a uniform magnetic field $\vec{B}$ acting along the Z-axis as it crosses the origin O.

(i) Trace its trajectory.

(ii) Does the charge gain kinetic energy as it enters the magnetic field? Justify your answer.

[2009]

Q38. State Biot-Savart law. A current I flows in a conductor placed perpendicular to the plane of the paper. Indicate the direction of the magnetic field due to a small element $d\vec{l}$ at point P situated at a distance $\vec{r}$ from the element as shown in the figure.



[2009]

Q39. Define current sensitivity and voltage sensitivity of a galvanometer. Increasing the current sensitivity may not necessarily increase the voltage sensitivity of a galvanometer. Justify.

[2009]

Q40. Using Ampere's circuital law, derive an expression for the magnetic field along the axis of a toroidal solenoid.

[2008]

Q41. Write the relation for the force acting on a charge carrier q moving with a velocity $\vec{v}$ through a magnetic field $\vec{B}$ in vector notation. Using this relation, deduce the conditions under which this force will be (i) maximum (ii) minimum.

[2007]

Q42. A galvanometer has a resistance of 30 Ω. It gives full scale deflection with a current of 2 mA. Calculate the value of the resistance needed to convert it into an ammeter of range 0-0.3 A.

[2007]

Q43. State the principle of working of a cyclotron. Write two uses of this machine.

[2006]

3-Mark Questions (77 questions · Section C · SA)

Q1. Two long straight parallel conductors A and B carrying steady currents I_1 and I_2 in the same direction are separated by a distance d. Deduce the expressions for the force acting on length L of conductor B due to conductor A and show it in figure. Write the expression for the force acting on length L of conductor A due to conductor B and show that it follows Newton's third law.

[2026 • Set 55-2-1]

Q2. Derive an expression for the magnetic field $\vec{B}$, due to a circular coil of N turns, each of radius r carrying current I, at a distance x from the centre along its axis.

[2026 • Set 55-2-1]

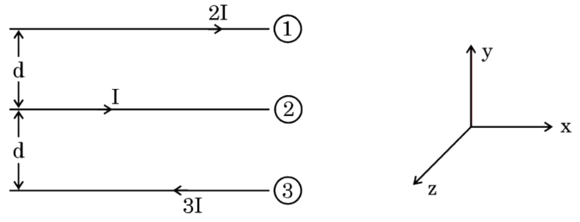
Q3. A circular coil of 30 turns and radius $8{\cdot}0$ cm carrying a current of 6 A is suspended vertically in a uniform horizontal magnetic field of $1{\cdot}0$ T. The field lines make an angle of 30° with the plane of the coil. Calculate the magnitude of the external torque that must be applied to prevent the coil from turning. What would happen if the circular coil is replaced by a planar coil of irregular shape that encloses the same area, keeping other parameters unchanged?

[2026 • Set 55-3-1]

Q4. An alpha particle (mass $6{\cdot}4 \times 10^{-27}$ kg and charge $3{\cdot}2 \times 10^{-19}$ C) having $8{\cdot}0$ MeV energy, enters a region of a uniform magnetic field of $0{\cdot}5$ T. If the field is directed perpendicular to the velocity of the particle, find the radius of the circular path described by the particle. Mention the condition under which the particle in this region (i) describes a helical path, and (ii) goes straight undeviated.

[2026 • Set 55-3-1]

Q5. (a) The figure given below shows three straight long parallel conductors (1), (2) and (3) kept in x-y plane, carrying currents $2I$, I and $3I$ respectively as shown in figure.



Find the magnitude and direction of: (i) net magnetic field at a point on conductor (1) and (ii) net magnetic force acting on unit length of conductor (1), due to conductors (2) and (3).

OR

(b) A rectangular loop of sides l and b and resistance 'R' is kept in a region in which the magnetic field varies as $B = B_0 \sin \omega t$. (i) Derive expression for the emf induced in the loop. (ii) Find the effective value of current that flows in the loop.

[2026 • Set 55-4-1]

Q6. Write the expression for the magnetic field due to a current element in vector form. Consider a $1\,\text{cm}$ segment of a wire, centered at the origin, carrying a current of $10\,\text{A}$ in positive x-direction. Calculate the magnetic field $\vec{B}$ at a point $(1\,\text{m},\ 1\,\text{m},\ 0)$.

[2026 • Set 55-5-1]

Q7. Using Biot-Savart law, derive expression for the magnetic field $(\vec{B})$ due to a circular current carrying loop at a point on its axis and hence at its centre.

[2025 • Set 55-1-1]

Q8. (a) Define magnetic moment of a current-carrying coil. Write its SI unit.

(b) A coil of 60 turns and area $1.5 \times 10^{-3}\,\text{m}^2$ carrying $2\,\text{A}$ current lies in a vertical plane. It experiences a torque of $0.12\,\text{Nm}$ when placed in a uniform horizontal magnetic field. The torque acting on the coil changes to $0.05\,\text{Nm}$ after the coil is rotated about its diameter by $90°$, in the magnetic field. Find the magnitude of the magnetic field.

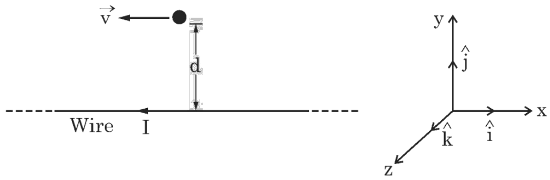
[2025 • Set 55-1-2]

Q9. As shown in figure, a particle of charge q is moving with velocity $\vec{v}$ at a distance 'd' from a long straight wire carrying a current 'I'. At this instant, it is subjected to a uniform electric field $\vec{E}$ such that the particle keeps moving undeviated. In terms of unit vectors $\hat{i}$, $\hat{j}$ and $\hat{k}$, find:

(a) the magnetic field $\vec{B}$,

(b) the magnetic force $\vec{F}_m$, and

(c) the electric field $\vec{E}$ acting on the charge.



[2025 • Set 55-1-3]

Q10. In a region of a uniform electric field $\vec{E}$, a negatively charged particle is moving with a constant velocity $\vec{v} = -v_y\,\hat{j}$ near a long straight conductor coinciding with XX' axis and carrying current I towards $-X$ axis. The particle remains at a distance d from the conductor.

(i) Draw diagram showing direction of electric and magnetic fields.

(ii) What are the various forces acting on the charged particle?

(iii) Find the value of v_y in terms of E, d and I.

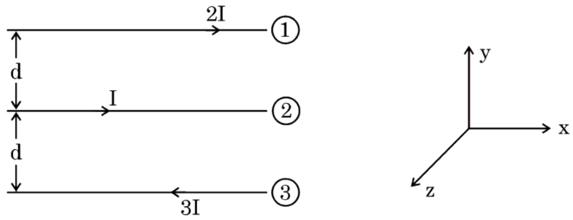
[2025 • Set 55-2-1]

Q11. Two infinitely long conductors kept along XX' and YY' axes are carrying current I_1 and I_2 along $-X$ axis and $-Y$ axis respectively. Find the magnitude and direction of the net magnetic field produced at point P(X, Y).

[2025 • Set 55-2-1]

Q12. (a) Write vector form of Biot-Savart law.

(b) Two insulated long straight wires, each carrying $2.0\,\text{A}$ current are kept along xx' and yy' axis as shown in the figure. Find the magnitude and direction of resultant magnetic field at point $P(4\,\text{m},\,5\,\text{m})$.



[2025 • Set 55-4-1]

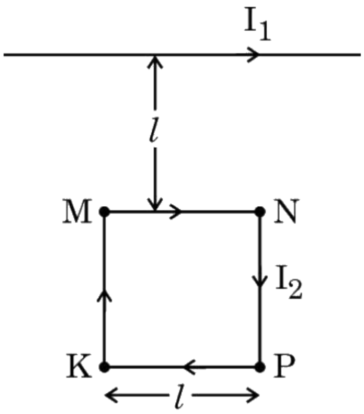
Q13. (a) A charged particle q moving with a velocity $\vec{v}$ is subjected to a uniform magnetic field $\vec{B}$ acting perpendicular to $\vec{v}$. If a uniform electric field $\vec{E}$ is also set up in the region along the direction of $\vec{B}$, describe the path followed by the particle and draw its shape.

(b) How will the magnetic field inside a long solenoid be affected when : (i) the radius of the turns of the solenoid is increased, (ii) the length of solenoid as well as the total number of its turns are doubled ?

[2025 • Set 55-4-2]

Q14. (a) In which cases does a charged particle not experience a force in a magnetic field ?

(b) A square loop $MNPK$ of side 'l' carrying a current 'I_2' is kept close to a long straight wire in the same plane and the wire carries a steady current I_1, as shown in the figure. Obtain the magnitude of magnetic force exerted by the wire on the loop.



[2025 • Set 55-4-3]

Q15. An electron of mass m and charge $-e$ is revolving anticlockwise around the nucleus of an atom.

(a) Obtain the expression for the magnetic dipole moment ($\vec{\mu}$) of the atom.

(b) If $\vec{L}$ is the angular momentum of electron, show that $\vec{\mu} = -\left(\frac{e}{2m}\right)\vec{L}$.

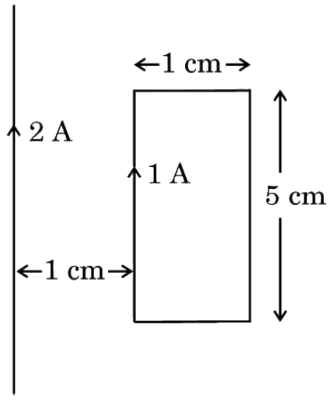
[2025 • Set 55-5-1]

Q16. (a) Use Ampere's law to derive the expression for the magnetic field due to a long straight current carrying wire of infinite length.

(b) Why is Ampere's law used for the derivation in (a) above and not Biot-Savart's law? Explain.

[2025 • Set 55-5-2]

Q17. A rectangular loop carries a current of $1\,\text{A}$. A straight long wire carrying $2\,\text{A}$ current is kept near the loop in the same plane as shown in the figure.



Find:

(i) the torque acting on the loop, and

(ii) the magnitude and direction of the net force on the loop.

[2025 • Set 55-6-1]

Q18. (a) (i) Write Biot-Savart's law in vector form. (ii) Two identical circular coils A and B, each of radius R, carrying currents I and $\sqrt{3}\,I$ respectively, are placed concentrically in XY and YZ planes respectively. Find the magnitude and direction of the net magnetic field at their common centre.

OR

(b) (i) A rectangular loop of sides l and b carries a current I clockwise. Write the magnetic moment $\vec{m}$ of the loop and show its direction in a diagram. (ii) The loop is placed in a uniform magnetic field $\vec{B}$ and is free to rotate about an axis which is perpendicular to $\vec{B}$. Prove that the loop experiences no net force, but a torque $\vec{\tau} = \vec{m} \times \vec{B}$.

[2025 • Set 55-7-1]

Q19. A proton with kinetic energy 1.3384×10^{-14} J moving horizontally from north to south, enters a uniform magnetic field B of 2.0 mT directed eastward. Calculate:

(a) the speed of the proton

(b) the magnitude of acceleration of the proton

(c) the radius of the path traced by the proton [Take (q/m) for proton $= 1.0 \times 10^{8}$ C/kg]

[2024 • Set 55-1-1]

Q20. A circular coil with cross-sectional area $0.2\,\text{cm}^2$ carries a current of $4\,$A. It is kept in a uniform magnetic field of magnitude $0.5\,$T normal to the plane of the coil. Calculate:

(a) the net force on the coil.

(b) the torque on the coil.

(c) the average force on each electron in the coil due to the magnetic field. The free electron density in the material of the coil is $10^{28}\,\text{m}^{-3}$.

[2024 • Set 55-1-3]

Q21. (a) Two long, straight, parallel conductors carry steady currents in opposite directions. Explain the nature of the force of interaction between them. Obtain an expression for the magnitude of the force between the two conductors. Hence define one ampere.

OR

(b) Obtain an expression for the torque $\vec{\tau}$ acting on a current carrying loop in a uniform magnetic field $\vec{B}$. Draw the necessary diagram.

[2024 • Set 55-2-1]

Q22. Two long straight parallel conductors carrying currents, exert a force on each other. Why? Derive an expression for the force per unit length between two long straight parallel conductors carrying currents in opposite directions. Explain the nature of the force between these conductors.

[2024 • Set 55-3-1]

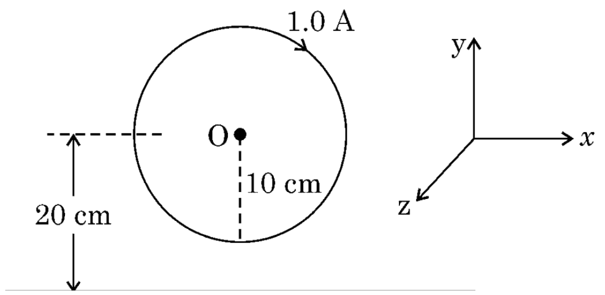
Q23. A rectangular loop of area $\vec{A}$, carrying current I, is placed in a uniform magnetic field $\vec{B}$. With the help of a suitable diagram, derive an expression, in vector form, for the torque acting on the loop.

[2024 • Set 55-3-2]

Q24. An electron (charge $-e$, mass m) is revolving around a nucleus, in a hydrogen atom, in a circle of radius r. Derive an expression, in vector form, for the magnetic dipole moment, $\vec{\mu}$, in terms of its orbital angular momentum $\vec{L}$. What is gyromagnetic ratio?

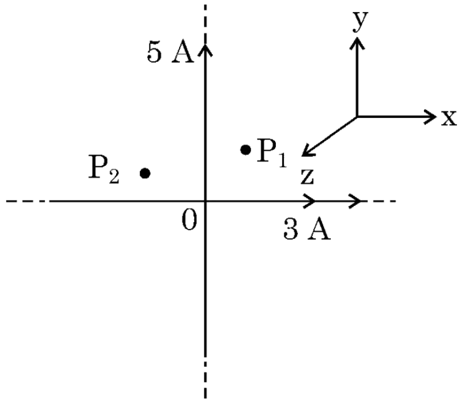
[2024 • Set 55-3-3]

Q25. A circular loop of radius $10\,\text{cm}$ carrying current of $1.0\,\text{A}$ lies in x-y plane. A long straight wire lies in the same plane parallel to x-axis at a distance of $20\,\text{cm}$ as shown in figure. Find the direction and value of current that has to be maintained in the wire so that the net magnetic field at O is zero.



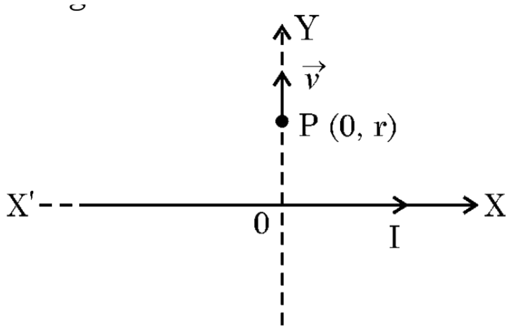
[2024 • Set 55-4-1]

Q26. Two long insulated straight wires carrying currents of $3\,\text{A}$ and $5\,\text{A}$ are arranged in XY plane as shown in figure. Find the magnitude and direction of the net magnetic fields at points $P_1(2\,\text{m}, 2\,\text{m})$ and $P_2(-1\,\text{m}, 1\,\text{m})$.



[2024 • Set 55-4-2]

Q27. An infinite straight conductor is kept along $X'X$ axis and carries a current I. A charge q at point $P(0, r)$ starts moving with velocity $\vec{v} = v_0\hat{j}$ as shown in figure. Find the direction and magnitude of force initially experienced by the charge.



[2024 • Set 55-4-3]

Q28. **(i)** State and explain Ampere's circuital law.

(ii) Two long straight parallel wires separated by $20\,\text{cm}$, carry $5\,\text{A}$ and $10\,\text{A}$ current respectively, in the same direction. Find the magnitude and direction of the net magnetic field at a point midway between them.

[2024 • Set 55-5-1]

Q29. An electron moving with a velocity $\vec{v} = (1.0 \times 10^7\ \text{m/s})\hat{i} + (0.5 \times 10^7\ \text{m/s})\hat{j}$ enters a region of uniform magnetic field $\vec{B} = (0.5\,\text{mT})\hat{j}$. Find the radius of the circular path described by it. While rotating; does the electron trace a linear path too? If so, calculate the linear distance covered by it during the period of one revolution.

[2024 • Set 55-5-1]

Q30. An electron is moving with a velocity $\vec{v} = \left(\frac{3 \times 10^8}{\pi} \text{ m/s}\right) \hat{i}$. It enters a region of magnetic field $\vec{B} = (91\,\text{mT})\hat{k}$.

(a) Calculate the magnetic force $\vec{F}$ acting on electron and the radius of its path.

(b) Trace the path described by it.

[2024 • Set 55-5-3]

Q31. Two circular loops A and B, each of radius 3 m, are placed coaxially at a distance of 4 m. They carry currents of 3 A and 2 A in opposite directions respectively. Find the net magnetic field at the centre of loop A.

[2023 • Set 55-4-1]

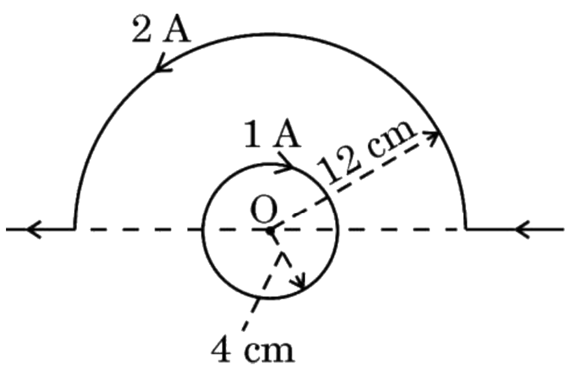
Q32. Two infinitely long parallel conductors A and B, separated by 2 cm, carry 6 A and 2 A currents in opposite directions respectively. Find:

(a) the net magnetic field at a point midway between A and B.

(b) the force acting per unit length on B.

[2023 • Set 55-4-2]

Q33. A current carrying circular loop and a straight wire bent partly in the form of a semicircle are placed as shown in the figure. Find the magnitude and direction of net magnetic field at point O.



[2023 • Set 55-4-3]

Q34. (a) Briefly describe how the current sensitivity of a moving coil galvanometer can be increased.

(b) A galvanometer shows full scale deflection for current I_g. A resistance R_1 is required to convert it into a voltmeter of range $(0 - V)$ and a resistance R_2 to convert it into a voltmeter of range $(0 - 2V)$. Find the resistance of the galvanometer.

[2023 • Set 55-5-1]

Q35. Write an expression of magnetic moment associated with a current (I) carrying circular coil of radius r having N turns.

[2020 • Set 55-1-1]

Q36. Define current sensitivity of a galvanometer. Write its expression.

[2020 • Set 55-1-1]

Q37. Consider the above mentioned coil placed in YZ plane with its centre at the origin. Derive expression for the value of magnetic field due to it at point $(x, 0, 0)$.

[2020 • Set 55-1-1]

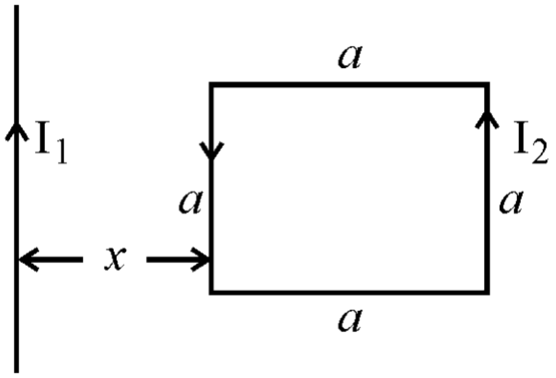
Q38. A galvanometer has resistance G and shows full scale deflection for current I_g.

(i) How can it be converted into an ammeter to measure current up to I_0 $(I_0 > I_g)$?

(ii) What is the effective resistance of this ammeter?

[2020 • Set 55-1-1]

Q39. A square loop of side 'a' carrying a current I_2 is kept at distance x from an infinitely long straight wire carrying a current I_1 as shown in the figure. Obtain the expression for the resultant force acting on the loop.



[2019 • Set 55-1-1]

Q40. Derive the expression for the torque acting on a current carrying loop placed in a magnetic field.

[2019 • Set 55-1-1]

Q41. Explain the significance of a radial magnetic field when a current carrying coil is kept in it.

[2019 • Set 55-1-1]

Q42. State the underlying principle of a moving coil galvanometer.

[2019 • Set 55-1-2]

Q43. Give two reasons to explain why a galvanometer cannot as such be used to measure the value of the current in a given circuit.

[2019 • Set 55-1-2]

Q44. Define the terms: (i) voltage sensitivity and (ii) current sensitivity of a galvanometer.

[2019 • Set 55-1-2]

Q45. State the underlying principle of a cyclotron. Explain its working with the help of a schematic diagram. Obtain the expression for cyclotron frequency.

[2019 • Set 55-1-3]

Q46. Two infinitely long straight wires A_1 and A_2 carrying currents I and $2I$ flowing in the same directions are kept 'd' distance apart. Where should a third straight wire A_3 carrying current $1.5\,I$ be placed between A_1 and A_2 so that it experiences no net force due to A_1 and A_2? Does the net force acting on A_3 depend on the current flowing through it?

[2019 • Set 55-1-3]

Q47. Draw a labelled diagram of cyclotron. Explain its working principle. Show that cyclotron frequency is independent of the speed and radius of the orbit.

OR

(a) Derive, with the help of a diagram, the expression for the magnetic field inside a very long solenoid having n turns per unit length carrying a current I.

(b) How is a toroid different from a solenoid?

[2019 • Set 55-2-1]

Q48. A proton, a deuteron and an alpha particle, are accelerated through the same potential difference and then subjected to a uniform magnetic field $\vec{B}$, perpendicular to the direction of their motions. Compare (i) their kinetic energies, and (ii) if the radius of the circular path described by proton is 5 cm, determine the radii of the paths described by deuteron and alpha particle.

[2019 • Set 55-4-1]

Q49. (a) Briefly explain how a galvanometer is converted into an ammeter.

(b) A galvanometer coil has a resistance of $15\,\Omega$ and it shows full scale deflection for a current of 4 mA. Convert it into an ammeter of range 0 to 6 A.

OR

(a) Briefly explain how a galvanometer is converted into a voltmeter.

(b) A voltmeter of a certain range is constructed by connecting a resistance of $980\,\Omega$ in series with a galvanometer. When the resistance of $470\,\Omega$ is connected in series, the range gets halved. Find the resistance of the galvanometer.

[2019 • Set 55-4-1]

Q50. A particle of charge q and mass m is moving with velocity $\vec{v}$ in the positive x-direction.

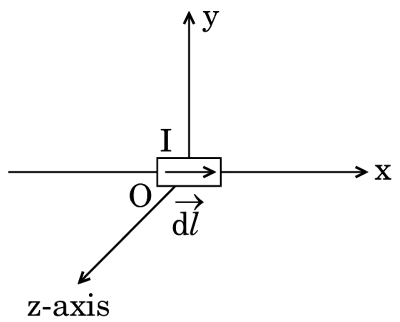
(a) It is subjected to a uniform magnetic field $\vec{B}$ directed along negative z-direction. Explain briefly the trajectory it would describe.

(b) When the particle is subjected simultaneously to both the magnetic and electric fields directed along the z-axis and y-axis respectively, obtain the condition when the particle will go undeflected.

[2019 • Set 55-4-2]

Q51. (a) Depict the magnetic field lines due to a circular current carrying loop showing the direction of field lines.

(b) A current I is flowing in a conductor placed along the x-axis as shown in the figure. Find the magnitude and direction of the magnetic field due to a small current element $d\vec{l}$ lying at the origin at points (i) $(0, d, 0)$ and (ii) $(0, 0, d)$.



[2019 • Set 55-4-3]

Q52. State the principle of a moving coil galvanometer. Explain its working and obtain the expression for the deflection produced due to the current passed through the coil. Define current sensitivity.

OR

Explain how a galvanometer can be converted into an ammeter of a given range. Derive an expression for shunt resistance and current for full scale deflection. Find the effective resistance of the ammeter.

[2019 • Set 55-5-1]

Q53. (i) Obtain the expression for the cyclotron frequency.

(ii) A deuteron and a proton are accelerated by the cyclotron. Can both be accelerated with the same oscillator frequency? Give reason to justify your answer.

[2017]

Q54. Describe the working principle of a moving coil galvanometer. Why is it necessary to use (i) a radial magnetic field and (ii) a cylindrical soft iron core in a galvanometer? Write the expression for current sensitivity of the galvanometer. Can a galvanometer as such be used for measuring the current? Explain.

OR

(a) Define the term 'self-inductance' and write its S.I. unit.

(b) Obtain the expression for the mutual inductance of two long co-axial solenoids S_1 and S_2 wound one over the other, each of length L and radii r_1 and r_2 and n_1 and n_2 number of turns per unit length, when a current I is set up in the outer solenoid S_2.

[2017]

Q55. An electron of mass m_e revolves around a nucleus of charge $+Ze$. Show that it behaves like a tiny magnetic dipole. Hence prove that the magnetic moment associated with it is expressed as $\vec{\mu} = -\frac{e}{2m_e}\vec{L}$, where $\vec{L}$ is the orbital angular momentum of the electron. Give the significance of negative sign.

[2017]

Q56. (a) Write the expression for the force $\vec{F}$ acting on a particle of mass m and charge q moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. Under what conditions will it move in (i) a circular path and (ii) a helical path?

(b) Show that the kinetic energy of the particle moving in magnetic field remains constant.

[2017]

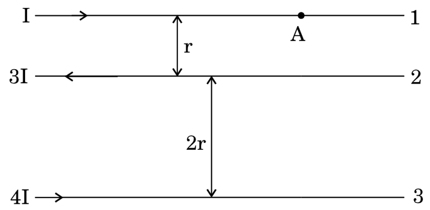
Q57. Using Biot-Savart law, deduce the expression for the magnetic field at a point (x) on the axis of a circular current carrying loop of radius R. How is the direction of the magnetic field determined at this point?

OR

The figure shows three infinitely long straight parallel current carrying conductors. Find the

(i) magnitude and direction of the net magnetic field at point A lying on conductor 1,

(ii) magnetic force on conductor 2.



[2017]

Q58. (a) State the condition under which a charged particle moving with velocity $\vec{v}$ goes undeflected in a magnetic field $\vec{B}$.

(b) An electron, after being accelerated through a potential difference of 10^4 V, enters a uniform magnetic field of $0 \cdot 04$ T, perpendicular to its direction of motion. Calculate the radius of curvature of its trajectory.

[2017]

Q59. A proton and an α-particle move perpendicular to a magnetic field. Find the ratio of radii of the circular paths described by them when both (i) have equal momenta, and (ii) were accelerated through the same potential difference.

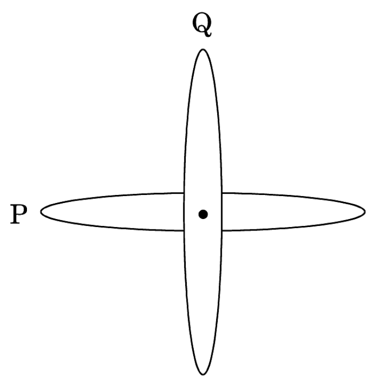
[2017]

Q60. (a) State Biot - Savart law and express this law in the vector form.

(b) Two identical circular coils, P and Q each of radius R, carrying currents 1 A and $\sqrt{3}$ A respectively, are placed concentrically and perpendicular to each other lying in the XY and YZ planes. Find the magnitude and direction of the net magnetic field at the centre of the coils.

[2017]

Q61. Two identical loops P and Q each of radius 5 cm are lying in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude and direction of the net magnetic field at the common centre of the two coils, if they carry currents equal to 3 A and 4 A respectively.



[2017]

Q62. Use Biot-Savart law to derive the expression for the magnetic field on the axis of a current carrying circular loop of radius R. Draw the magnetic field lines due to a circular wire carrying current I.

[2016]

Q63. How is a galvanometer converted into a voltmeter and an ammeter? Draw the relevant diagrams and find the resistance of the arrangement in each case. Take resistance of galvanometer as G.

[2016]

Q64. State Ampere's circuital law. Use this law to find magnetic field due to straight infinite current carrying wire. How are the magnetic field lines different from the electrostatic field lines?

[2016]

Q65. State the principle of a cyclotron. Show that the time period of revolution of particles in a cyclotron is independent of their speeds. Why is this property necessary for the operation of a cyclotron?

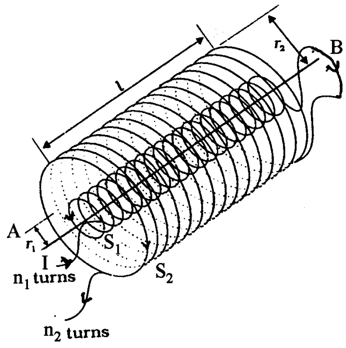
[2016]

Q66. State the principle of working of a galvanometer. A galvanometer of resistance G is converted into a voltmeter to measure upto V volts by connecting a resistance R_1 in series with the coil. If a resistance R_2 is connected in series with it, then it can measure upto V/2 volts. Find the resistance, in terms of R_1 and R_2, required to be connected to convert it into a voltmeter that can read upto 2 V. Also find the resistance G of the galvanometer in terms of R_1 and R_2.

[2015]

Q67. (a) State Ampere's circuital law, expressing it in the integral form.

(b) Two long coaxial insulated solenoids, S_1 and S_2 of equal lengths are wound one over the other as shown in the figure. A steady current "I" flow through the inner solenoid S_1 to the other end B, which is connected to the outer solenoid S_2 through which the same current "I" flows in the opposite direction so as to come out at end A. If n_1 and n_2 are the number of turns per unit length, find the magnitude and direction of the net magnetic field at a point (i) inside on the axis and (ii) outside the combined system.

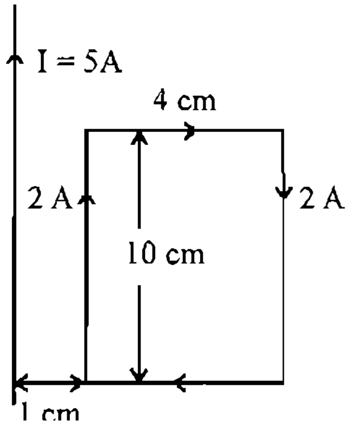


[2014]

Q68. A rectangular loop of wire of size $4\,\text{cm} \times 10\,\text{cm}$ carries a steady current of $2\,\text{A}$. A straight long wire carrying $5\,\text{A}$ current is kept near the loop as shown. If the loop and the wire are coplanar, find

(i) the torque acting on the loop and

(ii) the magnitude and direction of the force on the loop due to the current carrying wire.

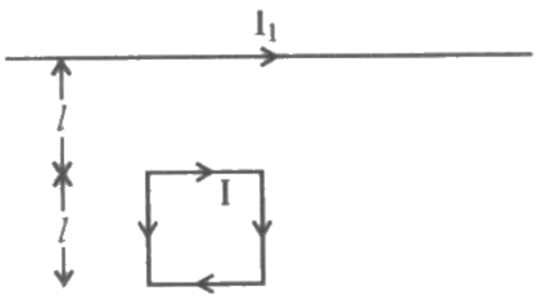


[2012]

Q69. Draw a labelled diagram of a moving coil galvanometer and explain its working. What is the function of radial magnetic field inside the coil?

[2012]

Q70. Write the expression for the magnetic moment ($\vec{m}$) due to a planar square loop of side 'l' carrying a steady current I in a vector form. In the given figure this loop is placed in a horizontal plane near a long straight conductor carrying a steady current I_1 at a distance l as shown. Give reasons to explain that the loop will experience a net force but no torque. Write the expression for this force acting on the loop.



[2010]

Q71. A long straight wire of a circular cross-section of radius 'a' carries a steady current 'I'. The current is uniformly distributed across the cross-section. Apply Ampere's circuital law to calculate the magnetic field at a point 'r' in the region for (i) $r < a$ and (ii) $r > a$.

[2010]

Q72. State the underlying principle of working of a moving coil galvanometer. Give two reasons why a galvanometer can not be used as such to measure current in a given circuit. Name any two factors on which the current sensitivity of a galvanometer depends.

[2010]

Q73. Derive the expression for force per unit length between two long straight parallel current carrying conductors. Hence define one ampere.

[2009]

Q74. Explain the principle and working of a cyclotron with the help of a schematic diagram. Write the expression for cyclotron frequency.

[2009]

Q75. If a particle of charge q is moving with velocity $\vec{v}$ along the z-axis and the magnetic field $\vec{B}$ is acting along the x-axis, use the expression $\vec{F} = q(\vec{v} \times \vec{B})$ to find the direction of the force $\vec{F}$ acting on it. A beam of proton passes undeflected with a horizontal velocity v, through a region of electric and magnetic fields, mutually perpendicular to each other and normal to the direction of the beam. If the magnitudes of the electric and magnetic fields are $50\ KV/m$ and $50\ mT$ respectively, calculate

(i) Velocity v of the beam

(ii) Force with which it strikes a target on a screen, if the proton beam current is equal to $0.80\ mA$.

[2008]

Q76. A galvanometer with a coil of resistance $120\ \Omega$ shows full scale deflection for a current of 2.5 mA. How will you convert the galvanometer into an ammeter of range 0 to 7.5 A? Determine the net resistance of the ammeter. When an ammeter is put in a circuit, does it read slightly less or more than the actual current in the original circuit? Justify your answer.

[2005]

Q77. Two straight, parallel, current carrying conductors are kept at a distance r from each other, in air. The direction of current in both the conductors is the same. Find the magnitude and direction of the force between them. Hence define one ampere.

[2003]

4-Mark Questions (3 questions · Section D · Case Study)

Q1. A galvanometer is used to detect or/and measure small currents in an electrical circuit. It essentially works on the fact that a current-carrying coil experiences a deflecting torque when placed in a magnetic field. This deflection in the coil can be measured and it is related to the current flowing in the coil, the number of turns in the coil, area of the coil and the magnetic field. A hair spring attached to the coil provides a counter torque and helps in measuring the deflection. A galvanometer can be converted to an ammeter or a voltmeter of desired range by using suitable resistances.

[2026 • Set 55-1-1]

Q2. Briefly explain various ways to increase the strength of magnetic field produced by a given solenoid.

[2023 • Set 55-2-1]

Q3. Seema's uncle was advised by his doctor to have an MRI (Magnetic Resonance Imaging) scan of his brain. Her uncle felt it to be expensive and wanted to postpone it. When Seema learnt about this, she took the help of her family and also approached the doctor, who also offered a substantial discount. She then convinced her uncle to undergo the test to enable the doctor to know the condition of his brain. The information thus obtained greatly helped the doctor to treat him properly. Based on the above paragraph, answer the following questions:

(a) What according to you are the values displayed by Seema, her family and the doctor?

(b) What could be the possible reason for MRI test to be so expensive?

(c) Assuming that MRI test was performed using a magnetic field of 0.1 T, find the minimum and maximum values of the force that the magnetic field could exert on a proton (charge $= 1.6 \times 10^{-19}$ C) moving with a speed of 10^4 m/s.

[2016]

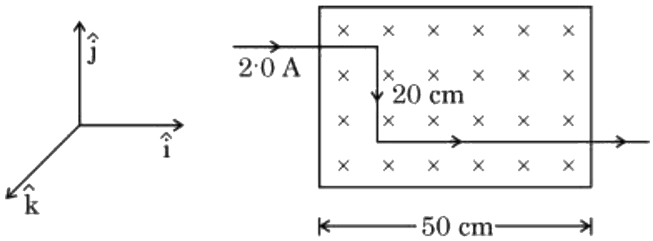
5-Mark Questions (47 questions · Section E · Long Answer)

Q1. (a) (i) A rectangular loop of sides a and b carrying current I is placed in a magnetic field

$\vec{B}$ such that its area vector $\vec{A}$ makes an angle θ with $\vec{B}$. With the help of a suitable diagram, show that the torque $\vec{\tau}$ acting on the loop is given by $\vec{\tau} = \vec{m} \times \vec{B}$, where $\vec{m}(= I\vec{A})$ is the magnetic dipole moment of the loop. (ii) A circular coil of 100 turns and radius $\left(\frac{10}{\sqrt{\pi}}\right)$ cm carrying current of $5.0\,\text{A}$ is suspended vertically in a uniform horizontal magnetic field of $2.0\,\text{T}$. The field makes an angle $30°$ with the normal to the coil. Calculate: (I) the magnetic dipole moment of the coil, and (II) the magnitude of the counter torque that must be applied to prevent the coil from turning.

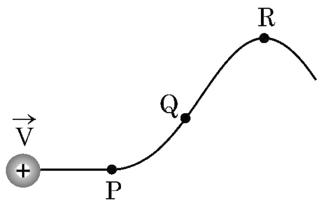
[2026 • Set 55-5-1]

Q2. (b) (i) Derive an expression for the force $\vec{F}$ acting on a conductor of length L and area of cross-section A carrying current I and placed in a magnetic field $\vec{B}$. (ii) A part of a wire carrying $2.0\,\text{A}$ current and bent at $90°$ at two points is placed in a region of uniform magnetic field $\vec{B} = -(0.50\,\text{T})\,\hat{k}$, as shown in the figure. Calculate the magnitude of the net force acting on the wire.



[2026 • Set 55-5-1]

Q3. (a) (i) A proton moving with velocity $\vec{V}$ in a non-uniform magnetic field traces a path as shown in the figure. The path followed by the proton is always in the plane of the paper. What is the direction of the magnetic field in the region near points P, Q and R? What can you say about relative magnitude of magnetic fields at these points?



(ii) A current carrying circular loop of area A produces a magnetic field B at its centre. Show that the magnetic moment of the loop is $\frac{2BA}{\mu_0}\sqrt{\frac{A}{\pi}}$.

OR

(b) (i) Derive an expression for the torque acting on a rectangular current loop suspended in a uniform magnetic field. (ii) A charged particle is moving in a circular path with velocity $\vec{V}$ in a uniform magnetic field $\vec{B}$. It is made to pass through a sheet of lead and as a consequence, it loses one half of its kinetic energy without change in its direction. How will (1) the radius of its path (2) its time period of revolution change?

[2025 • Set 55-1-1]

Q4. (i) What is the source of force acting on a current-carrying conductor placed in a magnetic field? Obtain the expression for force acting between two long straight parallel conductors carrying steady currents and hence define 'ampere'.

(ii) A point charge q is moving with velocity $\vec{v}$ in a uniform magnetic field $\vec{B}$. Find the work done by the magnetic force on the charge.

(iii) Explain the necessary conditions in which the trajectory of a charged particle is helical in a uniform magnetic field.

[2025 • Set 55-2-1]

Q5. (i) A current carrying loop can be considered as a magnetic dipole placed along its axis. Explain.

(ii) Obtain the relation for magnetic dipole moment $\vec{M}$ of current carrying coil. Give the direction of $\vec{M}$.

(iii) A current carrying coil is placed in an external uniform magnetic field. The coil is free to turn in the magnetic field. What is the net force acting on the coil? Obtain the orientation of the coil in stable equilibrium. Show that in this orientation the flux of the total field (field produced by the loop + external field) through the coil is maximum.

[2025 • Set 55-2-1]

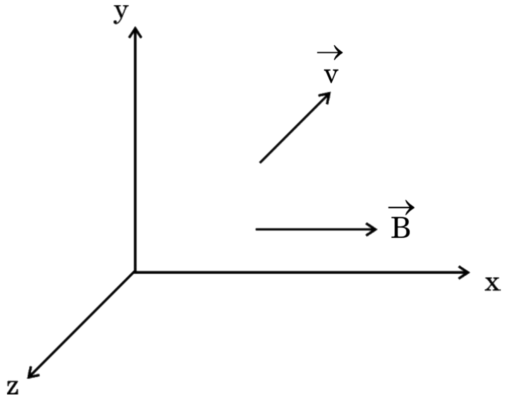
Q6. (a) (i) With the help of a labelled diagram, explain the principle of working of a moving coil galvanometer. Write the purpose of using (i) radial magnetic field, and (ii) soft iron core, in it. (ii) Define current sensitivity of a galvanometer. "Increasing the current sensitivity may not necessarily increase the voltage sensitivity." Give reason.

OR

(b) (i) (I) Write Ampere's circuital law in mathematical form and explain the terms used. (II) As the current carrying solenoid is made longer, the magnetic field produced outside it approaches zero. Why? (III) A flexible loop of irregular shape carrying current when located in an external magnetic field, changes to a circular shape. Give reason. (ii) A galvanometer of resistance G is converted into a voltmeter to measure up to V volts, by connecting a resistance R_1 in series with the coil. If R_1 is replaced by R_2, then it can only measure up to $\frac{V}{2}$ volt. Find the value of the resistance R_3 (in terms of R_1 and R_2) needed to convert it into a voltmeter that can read up to $2V$.

[2025 • Set 55-7-1]

Q7. (a) (i) A particle of mass m and charge q is moving with a velocity $\vec{v}$ in a magnetic field $\vec{B}$ as shown in the figure. Show that it follows a helical path. Hence, obtain its frequency of revolution.



(ii) In a hydrogen atom, the electron moves in an orbit of radius $2\ \mathring{A}$ making 8×10^{14} revolutions per second. Find the magnetic moment associated with the orbital motion of the electron.

OR

(b) (i) What is current sensitivity of a galvanometer? Show how the current sensitivity of a galvanometer may be increased. "Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity." Explain. (ii) A moving coil galvanometer has a resistance $15\ \Omega$ and takes 20 mA to produce full scale deflection. How can this galvanometer be converted into a voltmeter of range 0 to 100 V?

[2024 • Set 55-2-1]

Q8. (i) (1) What is meant by current sensitivity of a galvanometer? Mention the factors on which it depends. (2) A galvanometer of resistance G is converted into a voltmeter of range $(0 - V)$ by using a resistance R. Find the resistance, in terms of R and G, required to convert it into a voltmeter of range $\left(0 - \frac{V}{2}\right)$.

(ii) The magnetic flux through a coil of resistance $5\ \Omega$ increases with time as: $\phi = (2.0t^3 + 5.0t^2 + 6.0t)$ mWb. Find the magnitude of induced current through the coil at $t = 2$ s.

[2024 • Set 55-3-1]

Q9. (i) State Biot-Savart's law for the magnetic field due to a current carrying element. Use this law to obtain an expression for the magnetic field at the centre of a circular loop of radius 'a' and carrying a current 'I'. Draw the magnetic field lines for a current loop indicating the direction of magnetic field.

(ii) An electron is revolving around the nucleus in a circular orbit with a speed of 10^7 ms^{-1}. If the radius of the orbit is 10^{-10} m, find the current constituted by the revolving electron in the orbit.

[2023 • Set 55-1-1]

Q10. (i) Derive an expression for the force acting on a current carrying straight conductor kept in a magnetic field. State the rule which is used to find the direction of this force. Give the condition under which this force is (1) maximum, and (2) minimum.

(ii) Two long parallel straight wires A and B are 2.5 cm apart in air. They carry 5.0 A and 2.5 A currents respectively in opposite directions. Calculate the magnitude of the force exerted by wire A on a 10 cm length of wire B.

[2023 • Set 55-1-1]

Q11. (a) (i) Write the principle and explain the working of a moving coil galvanometer. A galvanometer as such cannot be used to measure the current in a circuit. Why? (ii) Why is the magnetic field made radial in a moving coil galvanometer? How is it achieved?

OR

(b) (i) Derive an expression for magnetic field on the axis of a current-carrying circular loop. (ii) Write any two points of difference between a diamagnetic and a paramagnetic substance.

[2023 • Set 55-3-1]

Q12. (i) An α-particle, a deuteron and a proton enter into a uniform magnetic field normally with the same kinetic energy and describe circular paths. Find the ratio of radii of their paths.

(ii) Give the direction of magnetic field acting on the current carrying coil ACDE shown in the figure so that the coil is in unstable equilibrium.

33. (a) (i) (A) Why does the electric field inside a dielectric slab decrease when

(iii) Why do we use a low resistance ammeter in a circuit to measure current?

[2021]

Q13. (i) Draw a diagram to show the magnetic field lines produced by two parallel straight wires carrying currents in the same direction. Obtain an expression for the force per unit length between these wires and hence define SI unit of current.

(ii) The figure shows a circular loop connected to a battery. The arc ACB of length ℓ_1 carries a current I_1 and arc ADB of length ℓ_2 carries a current I_2. Show that the net magnetic field at the centre of the loop is zero.

33. (a) (i) (A) Why does the electric field inside a dielectric slab decrease when

[2021]

Q14. Derive the expression for the torque acting on the rectangular current carrying coil of a galvanometer. Why is the magnetic field made radial?

[2020 • Set 55-1-1]

Q15. An α-particle is accelerated through a potential difference of $10\,$kV and moves along x-axis. It enters in a region of uniform magnetic field $B = 2 \times 10^{-3}$ T acting along y-axis. Find the radius of its path. (Take mass of α-particle $= 6{\cdot}4 \times 10^{-27}$ kg)

[2020 • Set 55-1-1]

Q16. (a) A circular loop of radius R carries a current I. Obtain an expression for the magnetic field at a point on its axis at a distance x from its centre.

(b) A conducting rod of length 2 m is placed on a horizontal table in north-south direction. It carries a current of 5 A from south to north. Find the direction and magnitude of the magnetic force acting on the rod. Given that the Earth's magnetic field at the place is 0.6×10^{-4} T and angle of dip is $\frac{\pi}{6}$.

OR

(a) Obtain the expression for the deflecting torque acting on the current carrying rectangular coil of a galvanometer in a uniform magnetic field. Why is a radial magnetic field employed in the moving coil galvanometer?

(b) Particles of mass 1.6×10^{-27} kg and charge 1.6×10^{-19} C are accelerated in a cyclotron of dee radius 40 cm. It employs a magnetic field 0.4 T. Find the kinetic energy (in MeV) of the particle beam imparted by the accelerator.

[2020 • Set 55-2-1]

Q17. (a) Derive the expression for the force acting per unit length between two long straight parallel current carrying conductors. Hence define one ampere.

(b) Two long parallel straight conductors are placed $12\,$cm apart in air. They carry equal currents of $3\,$A each. Find the magnitude and direction of the magnetic field at a point midway between them (drawing a figure) when the currents in them flow in opposite directions.

OR

(a) Draw the schematic sketch of a cyclotron. Explain the shape of the path on which charged particle moves when the particle is accelerated by it.

(b) To convert a given galvanometer into a voltmeter of ranges $2V$, V and $\frac{V}{2}$ volt, resistances R_1, R_2 and R_3 ohm respectively, are required to be connected in series with the galvanometer. Obtain the relationship between R_1, R_2 and R_3.

[2020 • Set 55-3-1]

Q18. (a) Show that a current carrying solenoid behaves like a small bar magnet. Obtain the expression for the magnetic field at an external point lying on its axis.

(b) A steady current of 2 A flows through a circular coil having 5 turns of radius 7 cm. The coil lies in X-Y plane with its centre at the origin. Find the magnitude and direction of the magnetic dipole moment of the coil.

OR

(a) Derive the expression for the force acting between two long parallel current carrying conductors. Hence, define 1 A current.

(b) A bar magnet of dipole moment 3 A m^2 rests with its centre on a frictionless pivot. A force F is applied at right angles to the axis of the magnet, 10 cm from the pivot. It is observed that an external magnetic field of 0.25 T is required to hold the magnet in equilibrium at an angle of $30°$ with the field. Calculate the value of F. How will the equilibrium be effected if F is withdrawn?

[2020 • Set 55-4-1]

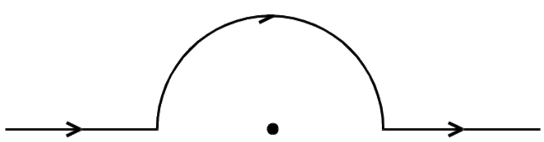
Q19. (a) State and explain the law used to determine magnetic field at a point due to a current element. Derive the expression for the magnetic field due to a circular current carrying loop of radius r at its centre.

(b) A long wire with a small current element of length 1 cm is placed at the origin and carries a current of 10 A along the X-axis. Find out the magnitude and direction of the magnetic field due to the element on the Y-axis at a distance 0.5 m from it.

OR

(a) Derive the expression for the magnetic field due to a current carrying coil of radius r at a distance x from the centre along the X-axis.

(b) A straight wire carrying a current of 5 A is bent into a semicircular arc of radius 2 cm as shown in the figure. Find the magnitude and direction of the magnetic field at the centre of the arc.



[2019 • Set 55-3-1]

Q20. **(i)** Draw a neat labeled diagram of a cyclotron.

(ii) Show that time period of ions in cyclotron is independent of both the speed of ion and radius of circular path. What is the significance of this property?

(iii) An electron after being accelerated through a potential difference of 100 V enters a uniform magnetic field of 0.004 T perpendicular to its direction of motion. Calculate the radius of the path described by the electron.

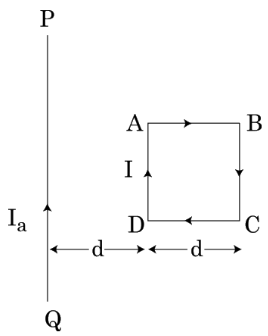
OR

(i) Depict magnetic field lines due to two straight, long, parallel conductors carrying steady currents I_1 and I_2 in the same direction.

(ii) Write the expression for the magnetic field produced by one of the conductor over the other. Deduce an expression for the force per unit length.

(iii) Determine the direction of this force.

(iv) In figure given below, wire PQ is fixed while the square loop $ABCD$ is free to move under the influence of currents flowing in them. State with reason, in which direction does the loop begin to move or rotate?



[2016]

Q21. **(i)** Express Biot-Savart law in the vector form.

(ii) Use it to obtain the expression for the magnetic field at an axial point, distance d from the centre of a circular coil of radius R carrying current I.

(iii) Also, find the ratio of the magnitudes of the magnetic field of this coil at the centre and at an axial point for which $x = R\sqrt{3}$.

OR

(a) Consider a beam of charged particles moving with varying speeds. Show how crossed electric and magnetic fields can be used to select charged particles of a particular velocity?

(b) Name another device/machine which uses crossed electric and magnetic fields. What does this machine do and what are the functions of magnetic and electric fields in this machine? Where do these field exist in this machine? Write about their natures.

[2016]

Q22. Two infinitely long straight parallel wires, '1' and '2', carrying steady currents I_1 and I_2 in the same direction are separated by a distance d. Obtain the expression for the magnetic field $\vec{B}$ due to the wire '1' acting on wire '2'. Hence find out, with the help of a suitable diagram, the magnitude and direction of this force per unit length on wire '2' due to wire '1'. How does the nature of this force change if the currents are in opposite direction? Use this expression to define the S.I. unit of current.

[2015]

Q23. (a) State Ampere's circuital law. Use this law to obtain the expression for the magnetic field inside an air cored toroid of average radius 'r', having 'n' turns per unit length and carrying a steady current I.

(b) An observer to the left of a solenoid of N turns each of cross section area 'A' observes that a steady current I in it flows in the clockwise direction. Depict the magnetic field lines due to the solenoid specifying its polarity and show that it acts as a bar magnet of magnetic moment $m = NIA$.

[2015]

Q24. (a) Deduce an expression for the frequency of revolution of a charged particle in a magnetic field and show that it is independent of velocity or energy of the particle.

(b) Draw a schematic sketch of a cyclotron. Explain, giving the essential details of its construction, how it is used to accelerate the charged particles.

OR

(a) Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working.

(b) Answer the following : (i) Why is it necessary to introduce a cylindrical soft iron core inside the coil of a galvanometer ? (ii) Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Explain, giving reason.

[2014]

Q25. (a) Derive the expression for the torque on a rectangular current carrying loop suspended in a uniform magnetic field.

(b) A proton and a deuteron having equal momenta enter in a region of uniform magnetic field at right angle to the direction of the field. Depict their trajectories in the field.

OR

(a) A small compass needle of magnetic moment 'm' is free to turn about an axis perpendicular to the direction of uniform magnetic field 'B'. The moment of inertia of the needle about the axis is 'I'. The needle is slightly disturbed from its stable position and then released. Prove that it executes simple harmonic motion. Hence deduce the expression for its time period.

(b) A compass needle, free to turn in a vertical plane orients itself with its axis vertical at a certain place on the earth. Find out the values of (i) horizontal component of earth's magnetic field and (ii) angle of dip at the place.

[2013]

Q26. (a) With the help of a diagram, explain the principle and working of a moving coil galvanometer.

(b) What is the importance of a radial magnetic field and how is it produced?

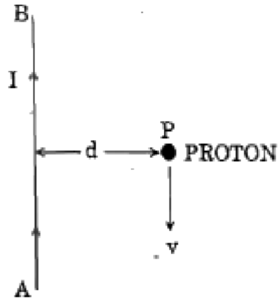
(c) Why is it that while using a moving coil galvanometer as a voltmeter a high resistance in series is required whereas in an ammeter a shunt is used?

OR

(a) Derive an expression for the force between two long parallel current carrying conductors.

(b) Use this expression to define S.I. unit of current.

(c) A long straight wire AB carries a current I. A proton P travels with a speed v, parallel to the wire, at a distance d from it in a direction opposite to the current as shown in the figure. What is the force experienced by the proton and what is its direction?



[2012]

Q27. (a) Write the expression for the force, $\vec{F}$, acting on a charged particle of charge 'q', moving with a velocity $\vec{v}$ in the presence of both electric field $\vec{E}$ and magnetic field $\vec{B}$. Obtain the condition under which the particle moves undeflected through the fields.

(b) A rectangular loop of size $l \times b$ carrying a steady current I is placed in a uniform magnetic field $\vec{B}$. Prove that the torque $\vec{\tau}$ acting on the loop is given by $\vec{\tau} = \vec{m} \times \vec{B}$, where $\vec{m}$ is the magnetic moment of the loop.

OR

(a) Explain, giving reasons, the basic difference in converting a galvanometer into (i) a voltmeter and (ii) an ammeter.

(b) Two long straight parallel conductors carrying steady currents I_1 and I_2 are separated by a distance 'd'. Explain briefly, with the help of a suitable diagram, how the magnetic field due to one conductor acts on the other. Hence deduce the expression for the force acting between the two conductors. Mention the nature of this force.

[2012]

Q28. (a) State the principle of the working of a moving coil galvanometer, giving its labelled diagram.

(b) 'Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity.' Justify this statement.

(c) Outline the necessary steps to convert a galvanometer of resistance R_g into an ammeter of a given range.

[2011]

Q29. (a) Using Ampere's circuital law, obtain the expression for the magnetic field due to a long solenoid at a point inside the solenoid on its axis.

(b) In what respect is a toroid different from a solenoid? Draw and compare the pattern of the magnetic field lines in the two cases.

(c) How is the magnetic field inside a given solenoid made strong?

[2011]

Q30. State Biot-Savart law, giving the mathematical expression for it. Use this law to derive the expression for the magnetic field due to a circular coil carrying current at a point along its axis. How does a circular loop carrying current behave as a magnet?

[2011 • Set 55-1-1]

Q31. With the help of a labelled diagram, state the underlying principle of a cyclotron. Explain clearly how it works to accelerate the charged particles. Show that cyclotron frequency is independent of energy of the particle. Is there an upper limit on the energy acquired by the particle? Give reason.

[2011 • Set 55-1-1]

Q32. (a) Show that a planar loop carrying a current I, having N closely wound turns and area of cross-section A, possesses a magnetic moment $\vec{m} = NI\vec{A}$.

(b) When this loop is placed in a magnetic field $\vec{B}$, find out the expression for the torque acting on it.

(c) A galvanometer coil of $50\,\Omega$ resistance shows full scale deflection for a current of 5 mA. How will you convert this galvanometer into a voltmeter of range 0 to 15 V?

[2011 • Set 55-2-1]

Q33. (a) Draw a schematic sketch of a cyclotron, explain its working principle and deduce the expression for the kinetic energy of the ions accelerated.

(b) Two long and parallel straight wires carrying currents of 2 A and 5 A in the opposite directions are separated by a distance of 1 cm. Find the nature and magnitude of the magnetic force between them.

[2011 • Set 55-2-1]

Q34. Derive a mathematical expression for the magnetic field strength at the center of a circular coil carrying electric current.

[2010]

Q35. A current carrying conductor is placed at an angle of $30°$ to a uniform magnetic field of strength 2×10^{-4} T. The length of the conductor inside the magnetic field is 2 m and the current flowing through it is 1.6 A. Calculate the magnitude of the force experienced by it.

[2010]

Q36. Draw a schematic sketch of a cyclotron. Explain briefly how it works and how it is used to accelerate the charged particles.

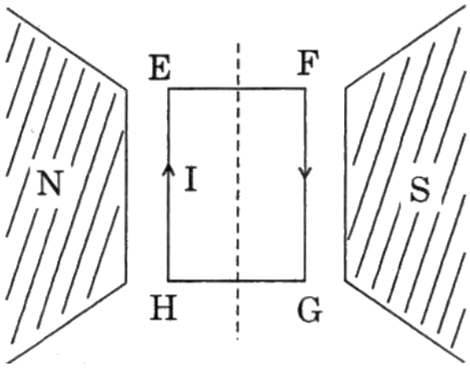
(i) Show that time period of ions in a cyclotron is independent of both the speed and radius of circular path.

(ii) What is resonance condition? How is it used to accelerate the charged particles?

[2009]

Q37. (a) Two straight long parallel conductors carry currents I_1 and I_2 in the same direction. Deduce the expression for the force per unit length between them. Depict the pattern of magnetic field lines around them.

(b) A rectangular current carrying loop $EFGH$ is kept in a uniform magnetic field as shown in the figure.



(i) What is the direction of the magnetic moment of the current loop? (ii) When is the torque acting on the loop (A) maximum, (B) zero?

[2009]

Q38. (a) Using Biot-Savart's law, derive the expression for the magnetic field at the centre of a circular coil of radius r, number of turns N, carrying current i.

(b) Two small identical circular coils marked 1, 2 carry equal currents and are placed with their geometric axes perpendicular to each other as shown in the figure. Derive an expression for the resultant magnetic field at O.

[2008]

Q39. Draw a schematic diagram of a cyclotron. Explain its underlying principle and working, stating clearly the function of the electric and magnetic fields applied on a charged particle. Deduce an expression for the period of revolution and show that it does not depend on the speed of the charged particle.

[2008]

Q40. Draw a labelled diagram of a moving coil galvanometer. State the principle on which it works. Deduce an expression for the torque acting on a rectangular current carrying loop kept in a uniform magnetic field. Write two factors on which the current sensitivity of a moving coil galvanometer depends.

[2007]

Q41. State Biot-Savart law. Use it to derive an expression for the magnetic field at the centre of a circular loop of radius R carrying a steady current I. Sketch the magnetic field lines for such a current carrying loop.

[2007]

Q42. Explain, with the help of a labelled diagram, the principle and construction of a cyclotron. Deduce an expression for the cyclotron frequency and show that it does not depend on the speed of the charged particle.

[2007]

Q43. With the help of a neat and labelled diagram, explain the underlying principle and working of a moving coil galvanometer. What is the function of:

(i) uniform radial field

(ii) soft iron core in such a device?

[2006]

Q44. Derive a mathematical expression for the force per unit length experienced by each of the two long current carrying conductors placed parallel to each other in air. Hence define one ampere of current. Explain why two parallel straight conductors carrying current in the opposite direction kept near each other in air repel?

[2006]

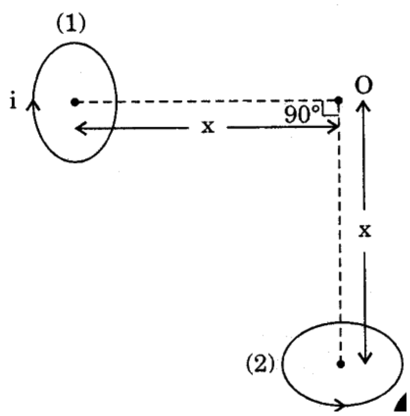
Q45. (a) With the help of a labelled diagram, explain the principle and working of a moving coil galvanometer.

(b) Two parallel coaxial circular coils of equal radius R and equal number of turns N, carry equal currents I in the same direction and are separated by a distance $2R$. Find the magnitude and direction of the net magnetic field produced at the mid-point of the line joining their centres.

[2005]

Q46. (a) State Biot-Savart's law. Using this law, derive the expression for the magnetic field due to a current carrying circular loop of radius R, at a point which is at a distance x from its centre along the axis of the loop.

(b) Two small identical circular loops, marked (1) and (2), carrying equal currents, are placed with the geometrical axes perpendicular to each other as shown in the figure. Find the magnitude and direction of the net magnetic field produced at the point O.



[2005]

Q47. Derive an expression for the torque acting on a loop of N turns, area A, carrying current i, when held in a uniform magnetic field. With the help of a circuit, show how a moving coil galvanometer can be converted into an ammeter of given range. Write the necessary mathematical formula. Or Write an expression for the force experienced by a charged particle moving in a uniform magnetic field B. With the help of a diagram, explain the principle and working of a cyclotron. Show that cyclotron frequency does not depend on the speed of the particles.

[2004]