DPP - Daily Practice Problems

Chapter-wise Sheets

Date : | **Start Time :** | **End Time :**

PHYSICS (CP18)

SYLLABUS : Moving Charges and Magnetism

Max. Marks : 180 **Marking Scheme :** (+4) for correct & (–1) for incorrect answer **Time : 60 min.**

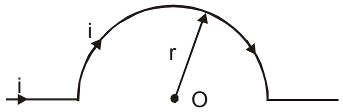
INSTRUCTIONS : This Daily Practice Problem Sheet contains 45 MCQs. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

1. An insulating rod of length ℓ carries a charge q distributed uniformly on it. The rod is pivoted at its mid point and is rotated at a frequency f about a fixed axis perpendicular to rod and passing through the pivot. The magnetic moment of the rod system is $\frac{1}{2a}\pi qf\ell^2$. Find the value of a.

(a) 6 (b) 4

(c) 5 (d) 8

2. A portion of a conductive wire is bent in the form of a semicircle of radius r as shown below in fig. At the centre of semicircle, the magnetic induction will be



(a) zero (b) infinite

(c) $\frac{\mu_0}{4\pi}.\frac{2\pi i}{r}$ (d) $\frac{\mu_0}{4\pi}.\frac{\pi i}{r}$

3. A closely wound solenoid of 2000 turns and area of cross-section 1.5×10^{-4} m^2 carries a current of 2.0 *A*. It suspended through its centre and perpendicular to its length, allowing it to turn in a horizontal plane in a uniform magnetic field 5×10^{-2} tesla making an angle of 30° with the axis of the solenoid. The torque on the solenoid will be:

(a) 3×10^{-2} N-m (b) 3×10^{-3} N-m

(c) 1.5×10^{-3} N-m (d) 1.5×10^{-2} N-m

4. An alternating electric field, of frequency v, is applied across the dees (radius = R) of a cyclotron that is being used to accelerate protons (mass = m). The operating magnetic field (B) used in the cyclotron and the kinetic energy (K) of the proton beam, produced by it, are given by :

(a) $B = \frac{mv}{e}$ and $K = 2m\pi^2 v^2 R^2$

(b) $B = \frac{2\pi mv}{e}$ and $K = m^2 \pi v R^2$

(c) $B = \frac{2\pi mv}{e}$ and $K = 2m\pi^2 v^2 R^2$

(d) $B = \frac{mv}{e}$ and $K = m^2 \pi v R^2$

5. A galvanometer of 50 ohm resistance has 25 divisions. A current of 4×10^{-4} ampere gives a deflection of one per division. To convert this galvanometer into a voltmeter having a range of 25 volts, it should be connected with a resistance of

(a) 2450 Ω in series (b) 2500 Ω in series.

(c) 245 Ω in series. (d) 2550 Ω in series.

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

6. If we double the radius of a coil keeping the current through it unchanged, then the magnetic field at any point at a large distance from the centre becomes approximately
(a) double (b) three times
(c) four times (d) one-fourth

7. A particle of mass m, charge Q and kinetic energy T enters a transverse uniform magnetic field of induction $\vec{B}$. After 3 seconds, the kinetic energy of the particle will be:
(a) 3T (b) 2T
(c) T (d) 4T

8. A 10 eV electron is circulating in a plane at right angles to a uniform field at magnetic induction 10^{-4} Wb/m^2 (= 1.0 gauss). The orbital radius of the electron is
(a) 12 cm (b) 16 cm
(c) 11 cm (d) 18 cm

9. A uniform electric field and a uniform magnetic field exist in a region in the same direction. An electron is projected with velocity pointed in the same direction. The electron will
(a) turn to its right
(b) turn to its left
(c) keep moving in the same direction but its speed will increase
(d) keep moving in the same direction but its speed will decrease

10. Proton, deuteron and alpha particle of same kinetic energy are moving in circular trajectories in a constant magnetic field. The radii of proton, deuteron and alpha particle are respectively r_p, r_d and r_α. Which one of the following relation is correct?
(a) $r_\alpha = r_p = r_d$ (b) $r_\alpha = r_p < r_d$
(c) $r_\alpha > r_d > r_p$ (d) $r_\alpha = r_d > r_p$

11. A moving coil galvanometer has 150 equal divisions. Its current sensitivity is 10-divisions per milliampere and voltage sensitivity is 2 divisions per millivolt. In order that each division reads 1 volt, the resistance in ohms needed to be connected in series with the coil will be
(a) 10^5 (b) 10^3 (c) 9995 (d) 99995

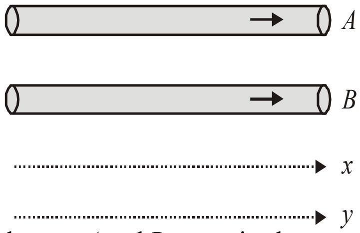
12. A 2 μC charge moving around a circle with a frequency of 6.25×10^{12} Hz produces a magnetic field 6.28 tesla at the centre of the circle. The radius of the circle is
(a) 2.25 m (b) 0.25 m (c) 13.0 m (d) 1.25 m

13. A charged particle with charge q enters a region of constant, uniform and mutually orthogonal fields $\vec{E}$ and $\vec{B}$ with a velocity $\vec{v}$ perpendicular to both $\vec{E}$ and $\vec{B}$, and comes out without any change in magnitude or direction of $\vec{v}$. Then
(a) $\vec{v} = \vec{B} \times \vec{E} / E^2$ (b) $\vec{v} = \vec{E} \times \vec{B} / B^2$
(c) $\vec{v} = \vec{B} \times \vec{E} / B^2$ (d) $\vec{v} = \vec{E} \times \vec{B} / E^2$

14. A square current carrying loop is suspended in a uniform magnetic field acting in the plane of the loop. If the force on one arm of the loop is $\vec{F}$, the net force on the remaining three arms of the loop is
(a) $3\,\vec{F}$ (b) $-\vec{F}$
(c) $-3\,\vec{F}$ (d) $\vec{F}$

15. A straight section PQ of a circuit lies along the X-axis from $x = -\frac{a}{2}$ to $x = \frac{a}{2}$ and carries a steady current i. The magnetic field due to the section PQ at a point $X = +a$ will be
(a) proportional to a (b) proportional to a^2
(c) proportional to $1/a$ (d) zero

16. A and B are two conductors carrying a current i in the same direction. x and y are two electron beams moving in the same direction. Then

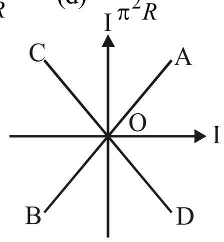


(a) there will be repulsion betwen A and B, attraction between x and y
(b) there will be attraction between A and B, repulsion between x and y
(c) there will be repulsion between A and B and also x and y
(d) there will be attraction between A and B and also x and y

17. A galvanometer of resistance, G is shunted by a resistance S ohm. To keep the main current in the circuit unchanged, the resistance to be put in series with the galvanometer is
(a) $\frac{S^2}{(S+G)}$ (b) $\frac{SG}{(S+G)}$ (c) $\frac{G^2}{(S+G)}$ (d) $\frac{G}{(S+G)}$

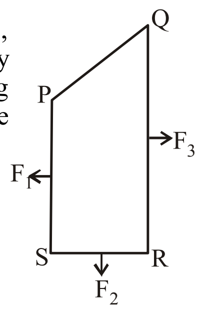
18. A current I flows in an infinitely long wire with cross section in the form of a semi-circular ring of radius R. The magnitude of the magnetic induction along its axis is:
(a) $\frac{\mu_0 I}{2\pi^2 R}$ (b) $\frac{\mu_0 I}{2\pi R}$ (c) $\frac{\mu_0 I}{4\pi R}$ (d) $\frac{\mu_0 I}{\pi^2 R}$

19. Two equal electric currents are flowing perpendicular to each other as shown in the figure. AB and CD are perpendicular to each other and symmetrically placed with respect to the current flow. Where do we expect the resultant magnetic field to be zero?



(a) On AB (b) On CD
(c) On both AB and CD (d) On both OD and BO

20. A closed loop PQRS carrying a current is placed in a uniform magnetic field.
If the magnetic forces on segments PS, SR, and RQ are F_1, F_2 and F_3 respectively and are in the plane of the paper and along the directions shown, the force on the segment QP is



(a) $F_3 - F_1 - F_2$
(b) $\sqrt{(F_3 - F_1)^2 + F_2^2}$
(c) $\sqrt{(F_3 - F_1)^2 - F_2^2}$
(d) $F_3 - F_1 + F_2$

RESPONSE GRID					
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	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ

Space for Rough Work

21. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is double and the number of turns per cm is halved, the new value of the magnetic field is

(a) $4B$ (b) $B/2$ (c) B (d) $2B$

22. A particle of charge q and mass m moves in a circular orbit of radius r with angular speed ω. The ratio of the magnitude of its magnetic moment to that of its angular momentum depends on

(a) ω and q (b) ω, q and m
(c) q and m (d) ω and m

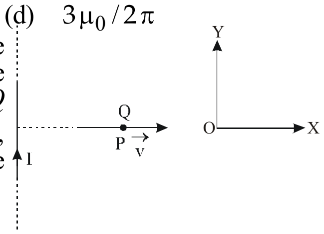
23. A current loop in a magnetic field

(a) can be in equilibrium in one orientation
(b) can be in equilibrium in two orientations, both the equilibrium states are unstable
(c) can be in equilibrium in two orientations, one stable while the other is unstable
(d) experiences a torque whether the field is uniform or non-uniform in all orientations

24. Two long parallel wires P and Q are held perpendicular to the plane of paper with distance of 5 m between them. If P and Q carry current of 2.5 amp. and 5 amp. respectively in the same direction, then the magnetic field at a point half-way between the wires is

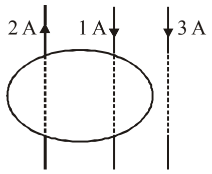
(a) $\mu_0/17$ (b) $\sqrt{3}\mu_0/2\pi$
(c) $\mu_0/2\pi$ (d) $3\mu_0/2\pi$

25. A very long straight wire carries a current I. At the instant when a charge $+Q$ at point P has velocity $\vec{v}$, as shown, the force on the charge is



(a) along OY (b) opposite to OY
(c) along OX (d) opposite to OX

26. Two wires with currents 2 A and 1 A are enclosed in a circular loop. Another wire with current 3 A is situated outside the loop as shown. The $\oint \vec{B}.d\vec{l}$ around the loop is



(a) μ_0
(b) $3\mu_0$
(c) $6\mu_0$
(d) $2\mu_0$

27. If in a circular coil A of radius R, current I is flowing and in another coil B of radius $2R$ a current $2I$ is flowing, then the ratio of the magnetic fields B_A and B_B, produced by them will be

(a) 1 (b) 2 (c) 1/2 (d) 4

28. A charged particle moves through a magnetic field perpendicular to its direction. Then

(a) kinetic energy changes but the momentum is constant
(b) the momentum changes but the kinetic energy is constant
(c) both momentum and kinetic energy of the particle are not constant
(d) both momentum and kinetic energy of the particle are constant

29. The deflection in a galvanometer falls from 50 division to 20 when a 12 ohm shunt is applied. The galvanometer resistance is

(a) 18 ohm (b) 36 ohm (c) 24 ohm (d) 30 ohm

30. When a long wire carrying a steady current is bent into a circular coil of one turn, the magnetic induction at its centre is B. When the same wire carrying the same current is bent to form a circular coil of n turns of a smaller radius, the magnetic induction at the centre will be

(a) B/n (b) nB (c) B/n^2 (d) n^2B

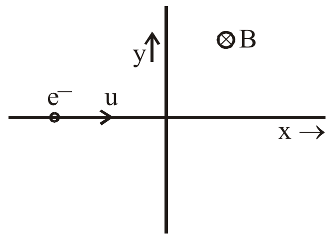
31. The magnetic field due to a current carrying circular loop of radius 3 cm at a point on the axis at a distance of 4 cm from the centre is 54 μT. What will be its value at the centre of loop ?

(a) 125 μT (b) 150 μT
(c) 250 μT (d) 75 μT

32. A charge moving with velocity v in X-direction is subjected to a field of magnetic induction in negative X-direction. As a result, the charge will

(a) remain unaffected
(b) start moving in a circular path Y–Z plane
(c) retard along X-axis
(d) move along a helical path around X-axis

33. An electron travelling with a speed u along the positive x-axis enters into a region of magnetic field where $B = -B_0\hat{k}$ $(x > 0)$. It comes out of the region with speed v then

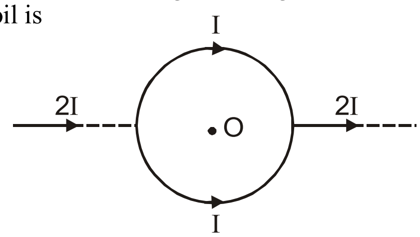


(a) $v = u$ at $y > 0$
(b) $v = u$ at $y < 0$
(c) $v > u$ at $y > 0$
(d) $v > u$ at $y < 0$

34. If an ammeter is to be used in place of a voltmeter, then we must connect with the ammeter a

(a) low resistance in parallel
(b) high resistance in parallel
(c) high resistance in series
(d) low resistance in series

35. An infinite straight conductor carrying current 2 I is split into a loop of radius r as shown in fig. The magnetic field at the centre of the coil is



(a) $\frac{\mu_0}{4\pi}\frac{2(\pi+1)}{r}$

(b) $\frac{\mu_0}{4\pi}\frac{2(\pi-1)}{r}$

(c) $\frac{\mu_0}{4\pi}\frac{(\pi+1)}{r}$

(d) zero

RESPONSE GRID					
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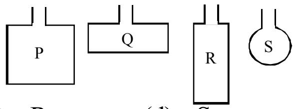
	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ
	31. ⓐⓑⓒⓓ	32. ⓐⓑⓒⓓ	33. ⓐⓑⓒⓓ	34. ⓐⓑⓒⓓ	35. ⓐⓑⓒⓓ

Space for Rough Work

36. A parallel plate capacitor of area 60 cm^2 and separation 3 mm is charged initially to 90 μC. If the medium between the plate gets slightly conducting and the plate loses the charge initially at the rate of 2.5×10^{-8} C/s, then what is the magnetic field between the plates ?
(a) 2.5×10^{-8} T (b) 2.0×10^{-7} T
(c) 1.63×10^{-11} T (d) Zero

37. Four wires, each of length 2.0 m, are bent into four loops P, Q, R and S and then suspended in a uniform magnetic field. If the same current is passed in each, then the torque will be maximum on the loop

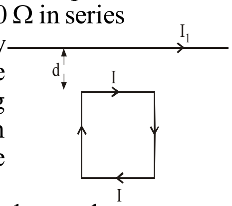


(a) P (b) Q (c) R (d) S

38. A certain region has an electric field $\vec{E} = (2\hat{i} - 3\hat{j})$ N/C and a uniform magnetic field $\vec{B} = (5\hat{i} + 3\hat{j} + 4\hat{k})$ T. The force experienced by a charge 1C moving with velocity $(\hat{i} + 2\hat{j})$ ms^{-1} is
(a) $(10\hat{i} - 7\hat{j} - 7\hat{k})$ (b) $(10\hat{i} + 7\hat{j} + 7\hat{k})$
(c) $(-10\hat{i} + 7\hat{j} + 7\hat{k})$ (d) $(10\hat{i} + 7\hat{j} - 7\hat{k})$

39. A galvanometer of resistance 100 Ω gives a full scale deflection for a current of 10^{-5} A. To convert it into a ammeter capable of measuring upto 1 A, we should connect a resistance of
(a) 1 Ω in parallel (b) 10^{-3} Ω in parallel
(c) 10^5 Ω in series (d) 100 Ω in series

40. A square loop, carrying a steady current I, is placed in a horizontal plane near a long straight conductor carrying a steady current I_1 at a distance d from the conductor as shown in figure. The loop will experience

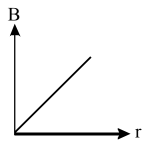


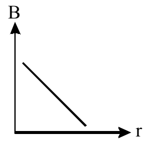
(a) a net repulsive force away from the conductor
(b) a net torque acting upward perpendicular to the horizontal plane
(c) a net torque acting downward normal to the horizontal plane
(d) a net attractive force towards the conductor

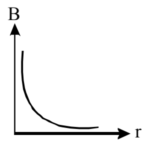
41. Two coaxial solenoids of different radius carry current I in the same direction. $\vec{F_1}$ be the magnetic force on the inner solenoid due to the outer one and $\vec{F_2}$ be the magnetic force on the outer solenoid due to the inner one. Then :
(a) $\vec{F_1}$ is radially inwards and $\vec{F_2} = 0$
(b) $\vec{F_1}$ is radially outwards and $\vec{F_2} = 0$
(c) $\vec{F_1} = \vec{F_2} = 0$
(d) $\vec{F_1}$ is radially inwards and $\vec{F_2}$ is radially outwards

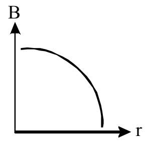
42. A beam of electrons is moving with constant velocity in a region having simultaneous perpendicular electric and magnetic fields of strength 20 Vm^{-1} and 0.5 T respectively at right angles to the direction of motion of the electrons. Then the velocity of electrons must be
(a) 8 m/s (b) 20 m/s (c) 40 m/s (d) $\frac{1}{40}$ m/s

43. The magnetic flux density B at a distance r from a long straight wire carrying a steady current varies with r as

(a)


(b)


(c)


(d)


44. The AC voltage across a resistance can be measured using a :
(a) hot wire voltmeter
(b) moving coil galvanometer
(c) potential coil galvanometer
(d) moving magnet galvanometer

45. When a charged particle moving with velocity $\vec{v}$ is subjected to a magnetic field of induction $\vec{B}$, the force on it is non-zero. This implies that
(a) angle between $\vec{v}$ and $\vec{B}$ is necessarily 90°
(b) angle between $\vec{v}$ and $\vec{B}$ can have any value other than 90°
(c) angle between $\vec{v}$ and $\vec{B}$ can have any value other than zero and 180°
(d) angle between $\vec{v}$ and $\vec{B}$ is either zero or 180°

RESPONSE GRID					
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	41. ⓐⓑⓒⓓ	42. ⓐⓑⓒⓓ	43. ⓐⓑⓒⓓ	44. ⓐⓑⓒⓓ	45. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM DPP CHAPTERWISE CP18 - PHYSICS			
Total Questions	45	Total Marks	180
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	45	Qualifying Score	60
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

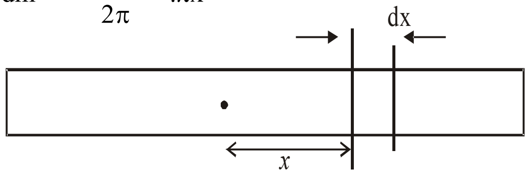
PHYSICS SOLUTIONS

DPP/CP18

1. **(a)** At a distance x consider small element of width dx.

Magnetic moment of the small element is

$$dm = \frac{\left(\frac{q}{\ell}dx\right)\omega}{2\pi}.\pi x^2$$



$$M = \int_{-\ell/2}^{\ell/2} \frac{q\omega}{2\ell}x^2 dx \;;\; M = \frac{q\omega\ell^2}{24} = \frac{q\pi f\ell^2}{12}$$

2. **(d)** The straight part will not contribute magnetic field at the centre of the semicircle because every element of the straight part will be 0º or 180º with the line joining the centre and the element

Due to circular portion, the field is $\frac{1}{2}\frac{\mu_0 i}{2r} = \frac{\mu_0 i}{4r}$

Hence total field at $O = \frac{\mu_0 i}{4r}$ tesla

3. **(d)** Torque on the solenoid is given by

$\tau = MB\sin\theta$

where θ is the angle between the magnetic field and the axis of solenoid.

$M = $ niA

$\therefore\ \tau = \text{niA B} \sin 30°$

$$= 2000 \times 2 \times 1.5 \times 10^{-4} \times 5 \times 10^{-2} \times \frac{1}{2}$$

$$= 1.5 \times 10^{-2}\ N - m$$

4. **(c)** Time period of cyclotron is

$$T = \frac{1}{\upsilon} = \frac{2\pi m}{eB}\;;\; B = \frac{2\pi m}{e}\upsilon\;;\; R = \frac{m\upsilon}{eB} = \frac{p}{eB}$$

$$\Rightarrow \quad p = eBR = e \times \frac{2\pi m\upsilon}{e}R = 2\pi m\upsilon R$$

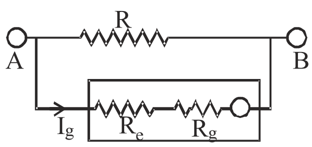
$$\text{K.E.} = \frac{p^2}{2m} = \frac{(2\pi m\upsilon R)^2}{2m} = 2\pi^2 m\upsilon^2 R^2$$

5. **(a)** $R_g = 50\Omega, I_g = 25 \times 4 \times 10^{-A}\Omega = 10^{-2}$ A

Range of $V = 25$ volts

$V = I_g(R_e + R_g)$

$$\therefore R_e = \frac{V}{I_g} - R_g = 2450\Omega$$



6. **(c)** $B_{axis} = \left(\frac{\mu_0 NI}{2x^3}\right)R^2$

$B \propto R^2$

So, when radius is doubled, magnetic field becomes four times.

7. **(c)** When a charged particle enters a transverse magnetic field it traverse a circular path. Its kinetic energy remains constant.

8. **(c)** K.E. of electron = 10 eV

$$\Rightarrow \frac{1}{2}mv^2 = 10 \text{ eV}$$

$$\Rightarrow \frac{1}{2}(9.1 \times 10^{-31})v^2 = 10 \times 1.6 \times 10^{-19}$$

$$\Rightarrow v^2 = \frac{2 \times 10 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}$$

$\Rightarrow v^2 = 3.52 \times 10^{12} \Rightarrow v = 1.88 \times 10^6$ m

Also we know that for circular motion

$$\frac{mv^2}{r} = Bev \Rightarrow r = \frac{mv}{Be} = 11 \text{ cm}$$

9. **(d)** No magnetic force acts on the electron and force due to electric field will act opposite to its initial direction of motion. Hence its velocity decreases in magnitude.

10. **(b)** $\frac{mv^2}{r} = qvB \quad \Rightarrow r = \frac{mv}{qB}$

$$\Rightarrow r_p = \frac{m_p v_p}{q_p B};$$

$$r_d = \frac{m_d v_d}{q_d B}; \quad r_\alpha = \frac{m_\alpha v_\alpha}{q_\alpha B}$$

$m_\alpha = 4m_p,\ m_d = 2m_p$

$q_\alpha = 2q_p,\ q_d = q_p$

From the problem

$$E_p = E_d = E_\alpha = \frac{1}{2}m_p v_p^2$$

$$= \frac{1}{2}m_d v_d^2 = \frac{1}{2}m_\alpha v_\alpha^2$$

$$\Rightarrow \quad v_p^2 = 2v_d^2 = 4mv_2^2$$

Thus we have, $r_\alpha = r_p < r_d$

11. **(c)** Resistance of Galvanometer,

$$G = \frac{\text{Current sensitivity}}{\text{Voltage sensitivity}} \Rightarrow G = \frac{10}{2} = 5\Omega$$

Here i_g = Full scale deflection current

$$= \frac{150}{10} = 15 \text{ mA}$$

V = voltage to be measured = 150 volts
(such that each division reads 1 volt)

$$\Rightarrow R = \frac{150}{15\times10^{-3}} - 5 = 9995\Omega$$

12. (d) Magnetic field at the centre of the current loop is

$$B = \frac{\mu_0 2\pi I}{4\pi R}$$

$$\text{or, } B = \frac{\mu_0 2\pi q\upsilon}{4\pi R}, \quad R = \frac{\mu_0 2\pi q\upsilon}{4\pi B}$$

Substituting the given values, we get

$$R = \frac{4\pi\times10^{-7}\times2\pi\times2\times10^{-6}\times6.25\times10^{12}}{4\pi\times6.28} = 1.25\text{ m}$$

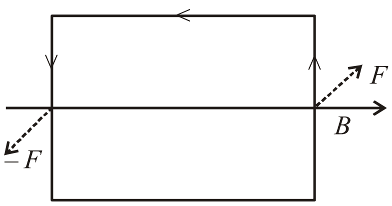
13. (b) Here, $\vec{E}$ and $\vec{B}$ are perpendicular to each other and the velocity $\vec{v}$ does not change; therefore

$$qE = qvB \Rightarrow v = \frac{E}{B}$$

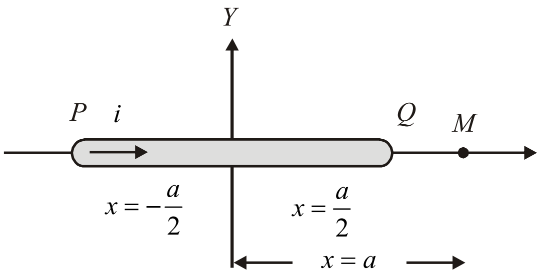
Also,

$$\left|\frac{\vec{E}\times\vec{B}}{B^2}\right| = \frac{E\ B\sin\theta}{B^2} = \frac{E\ B\ \sin 90°}{B^2} = \frac{E}{B} = |\vec{v}| = v$$

14. (b) The force on the two arms parallel to the field is zero.



15. (d) Magnetic field at a point on the axis of a current carrying wire is always zero.



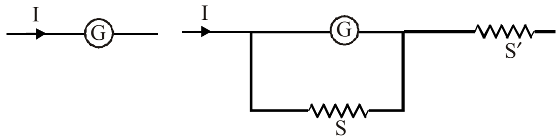
16. (b) Current carrying conductors will attract each other, while electron beams will repel each other.

17. (c) To keep the main current in the circuit unchanged, the resistance of the galvanometer should be equal to the net resistance.

$$\therefore G = \left(\frac{GS}{G+S}\right) + S'$$

$$\Rightarrow G - \frac{GS}{G+S} = S'$$

$$\therefore S' = \frac{G^2}{G+S}.$$



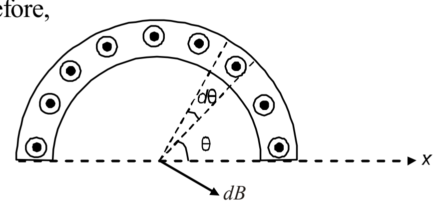
18. (d) Current in a small element, $dI = \frac{d\theta}{\pi} I$

Magnetic field due to the element

$$dB = \frac{\mu_0}{4\pi}\frac{2dI}{R}$$

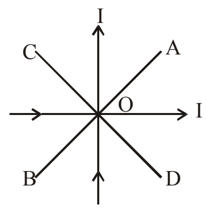
The component $dB\cos\theta$, of the field is cancelled by another opposite component.

Therefore,



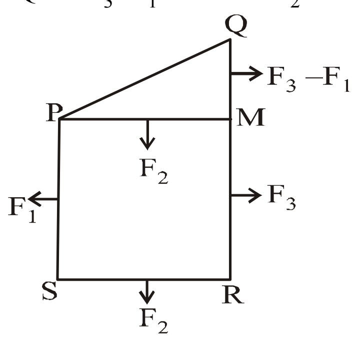
$$B_{net} = \int dB\sin\theta = \frac{\mu_0 I}{2\pi^2 R}\int_0^{\pi}\sin\theta d\theta = \frac{\mu_0 I}{\pi^2 R}$$

19. (a)



Net magnetic field on AB is zero because magnetic field due to both current carrying wires is equal in magnitude but opposite in direction.

20. (b) According to the figure the magnitude of force on the segment QM is $F_3 - F_1$ and PM is F_2.



Therefore, the magnitude of the force on segment PQ is $\sqrt{(F_3 - F_1)^2 + F_2^2}$

21. (c) $B = \mu_0 ni$

$$B_1 = (\mu_0)\left(\frac{n}{2}\right)(2\ i) = \mu_0 ni = B$$

$$\Rightarrow B_1 = B$$

22. (c) The angular momentum L of the particle is given by $L = mr^2\omega$ where $\omega = 2\pi n$.

$\therefore$ Frequency $n = \frac{\omega}{2\pi}$; Further $i = q \times n = \frac{\omega q}{2\pi}$

Magnetic moment, $M = iA = \frac{\omega q}{2\pi} \times \pi r^2$;

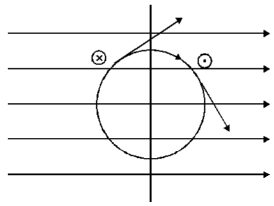
$\therefore M = \frac{\omega q r^2}{2}$ So, $\frac{M}{L} = \frac{\omega q r^2}{2mr^2\omega} = \frac{q}{2m}$

23. (c) A current loop in a magnetic field is in equilibrium in two orientations one is stable and another unstable.

$\because \quad \vec{\tau} = \vec{M} \times \vec{B} = MB\sin\theta$

If $\theta = 0° \Rightarrow \tau = 0$ (stable)

If $\theta = \pi \Rightarrow \tau = 0$ (unstable)



Do not experience a torque in some orientations

Hence option (c) is correct.

24. (c) $B = \frac{\mu_0}{4\pi}\frac{2i_2}{(r/2)} - \frac{\mu_0}{4\pi}\frac{2i_1}{(r/2)} = \frac{\mu_0}{4\pi}\frac{4}{r}(i_2 - i_1)$

$= \frac{\mu_0}{4\pi}\frac{4}{5}(5 - 2.5) = \frac{\mu_0}{2\pi}$.

25. (a) The direction of $\vec{B}$ is along $(-\hat{k})$

$\therefore$ The magnetic force

$\vec{F} = Q(\vec{v} \times \vec{B}) = Q(v\hat{i}) \times B(-\hat{k}) = QvB\hat{j}$

$\Rightarrow \vec{F}$ is along OY.

26. (a) According to Ampere's circuit law

$\oint \vec{B}.d\vec{l} = \mu_0 I_{enclosed} = \mu_0(2A - 1A) = \mu_0$

27. (a) We know that the magnetic field produced by a current carrying circular coil of radius r at its centre is

$B = \frac{\mu_0}{4\pi}\frac{I}{r} \times 2\pi$

Here $B_A = \frac{\mu_0}{4\pi}\frac{I}{R} \times 2\pi$

and $B_B = \frac{\mu_0}{4\pi}\frac{2I}{2R} \times 2\pi$

$\Rightarrow \frac{B_A}{B_B} = 1$

28. (b) When a charged particle enters a magnetic field at a direction perpendicular to the direction of motion, the path of the motion is circular. In circular motion the direction of velocity changes at every point (the magnitude remains constant).

Therefore, the tangential momentum will change at every point. But kinetic energy will remain constant as it is given by $\frac{1}{2}mv^2$ and v^2 is the square of the magnitude of velocity which does not change.

29. (a) $I = 50$ k; $I_g = 20$k, where k is the figure of merit of galvanometer; $S = I_g R_g (I - I_g)$; so $12 = \frac{20k.R_g}{(50k - 20k)}$

On solving we get $R_g = 18\,\Omega$.

30. (d) Let I be current and l be the length of the wire.

For Ist case : $B = \frac{\mu_0 In}{2r} = \frac{\mu_0 I \times \pi}{l}$ where $2\pi r = l$

and n = 1

For IInd case : $l = n(2\pi r') \Rightarrow r' = \frac{l}{2n\pi}$

$B' = \frac{\mu_0 nI}{2r'} = \frac{\mu_0 nI}{2\frac{l}{2n\pi}} = \frac{n^2\mu_0\pi I}{l} = n^2 B$

31. (c) $B = \frac{\mu_0 i\, a^2}{2(x^2 + a^2)^{3/2}}$

$B' = \frac{\mu_0 i}{2a} = \frac{\mu_0 i\, a^2}{2a(x^2 + a^2)^{3/2}}\left(\frac{(x^2 + a^2)^{3/2}}{a^2}\right)$

$B' = \frac{B.(x^2 + a^2)^{3/2}}{a^3}$

Put $x = 4$ & $a = 3 \Rightarrow B' = \frac{54(5^3)}{3 \times 3 \times 3} = 250\mu T$

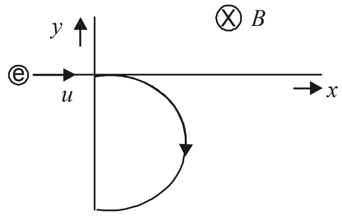
32. (a) The force acting on a charged particle in magnetic field is given by

$F = q(\vec{v} \times \vec{B})$ or $F = qvB\sin\theta$

when angle between v and B is 180°,

F = 0

33. (b) The force acting on electron will be perpendicular to the direction of velocity till the electron remains in the magnetic field. So the electron will follow the path as given.



34. (c) A voltmeter is a high resistance galvanometer and is connected in parallel to circuit and ammeter is a low resitance galvanometer so if we connect high resistance in series with ammeter its resistance will be much high.

35. **(d)** Here, the wire does not produce any magnetic field at O because the conductor lies on the line of O. Also, the loop does not produce magnetic field at O.

36. **(d)** Magnetic field between the plates in this case is zero.

37. **(d)** For a given perimeter the area of circle is maximum. So magnetic moment of (S) is greatest.

38. **(a)** Lorentz force, $\vec{F} = q\,\{\vec{E} + (\vec{v} \times \vec{B})\}$

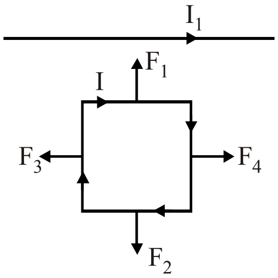
$$\vec{v} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & 0 \\ 5 & 3 & 4 \end{vmatrix} = 8\hat{i} - 4\hat{j} - 7\hat{k}$$

$$\vec{F} = 1\,(2\hat{i} - 3\hat{j} + 8\hat{i} - 4\hat{j} - 7\hat{k}) = (10\hat{i} - 7\hat{j} - 7\hat{k})$$

39. **(b)** Here, $R_g = 100\,\Omega;\ I_g = 10^{-5}\,A;\ I = 1A;\ S = ?$

$$S = \frac{I_g R_g}{I - I_g} = \frac{10^{-5} \times 100}{1 - 10^{-5}} = 10^{-3}\,\Omega \text{ in parallel}$$

40. **(d)**



$F_1 > F_2$ as $F \propto \frac{1}{d}$, and F_3 and F_4 are equal and opposite.

Hence, the net attraction force will be towards the conductor.

41. **(c)** $\vec{F}_1 = \vec{F}_2 = 0$

because of action and reaction pair

42. **(c)** As electron move with constant velocity without deflection. Hence, force due to magnetic field is equal and opposite to force due to electric field.

$$qvB = qE \Rightarrow v = \frac{E}{B} = \frac{20}{0.5} = 40 \text{ m/s}$$

43. **(c)**

44. **(b)** To measure AC voltage across a resistance a moving coil galvanometer is used.

45. **(c)** As $\vec{F} = q\vec{V}\vec{B}\sin\theta$

F is zero for sin 0° or sin 180° and is non-zero for angle between $\vec{V}$ and $\vec{B}$ any value other than zero and 180°.