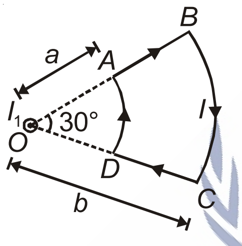
Moving Charges and Magnetism

Directions : Question numbers 1 and 2 are based on the following paragraph.

A current loop $ABCD$ is held fixed on the plane of the paper as shown in the figure. The arcs BC (radius $= b$) and DA (radius $= a$) of the loop are joined by two straight wires AB and CD. A steady current I is flowing in the loop. Angle made by AB and CD at the origin O is 30°. Another straight thin wire with steady current I_1 flowing out of the plane of the paper is kept at the origin. **[AIEEE-2009]**



1. The magnitude of the magnetic field (B) due to the loop $ABCD$ at the origin (O) is

(1) $\dfrac{\mu_0 I(b-a)}{24ab}$

(2) $\dfrac{\mu_0 I}{4\pi}\left[\dfrac{b-a}{ab}\right]$

(3) $\dfrac{\mu_0 I}{4\pi}\left[2(b-a)+\dfrac{\pi}{3}(a+b)\right]$

(4) Zero

2. Due to the presence of the current I_1 at the origin

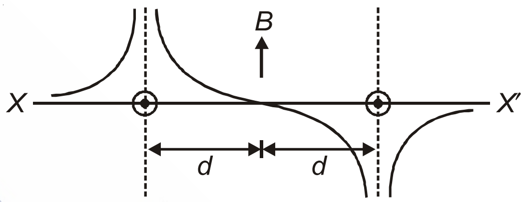
(1) The forces on AD and BC are zero

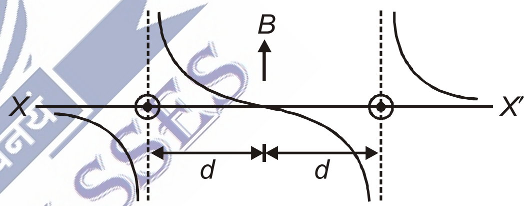
(2) The magnitude of the net force on the loop is given by $\dfrac{I_1 I}{4\pi}\mu_0\left[2(b-a)+\dfrac{\pi}{3}(a+b)\right]$

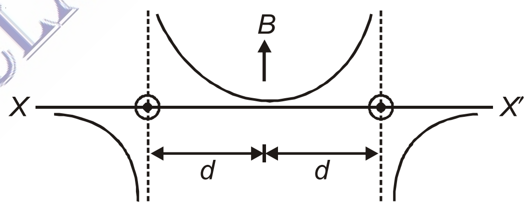
(3) The magnitude of the net force on the loop is given by $\dfrac{\mu_0 I I_1}{24ab}(b-a)$

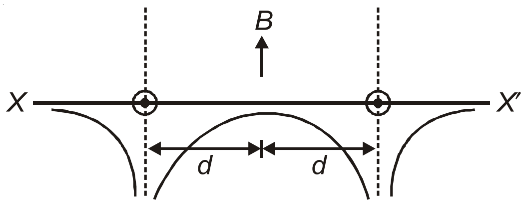
(4) The forces on AB and DC are zero

3. Two long parallel wires are at a distance $2d$ apart. They carry steady equal currents flowing out of the plane of the paper as shown. The variation of the magnetic field B along the line XX' is given by **[AIEEE-2010]**

(1) 

(2) 

(3) 

(4) 

4. A thin circular disk of radius R is uniformly charged with density $\sigma > 0$ per unit area. The disk rotates about its axis with a uniform angular speed ω. The magnetic moment of the disk is **[AIEEE-2011]**

(1) $\dfrac{\pi R^4}{4}\sigma\omega$ (2) $2\pi R^4\sigma\omega$

(3) $\pi R^4\sigma\omega$ (4) $\dfrac{\pi R^4}{2}\sigma\omega$

5. An electric charge $+q$ moves with velocity $\vec{V} = 3\hat{i} + 4\hat{j} + \hat{k}$, in an electromagnetic field given by $\vec{E} = 3\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{B} = \hat{i} + \hat{j} - 3\hat{k}$. The y-component of the force experienced by $+q$ is **[AIEEE-2011]**

(1) $3q$ (2) $2q$

(3) $11q$ (4) $5q$

6. Proton, deuteron and alpha particle of the 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 relations is correct? **[AIEEE-2012]**

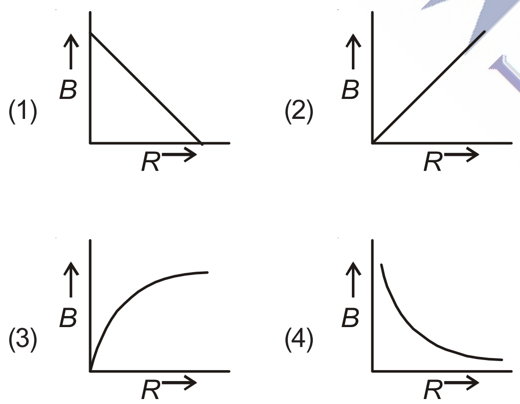
(1) $r_\alpha = r_p < r_d$

(2) $r_\alpha > r_d > r_p$

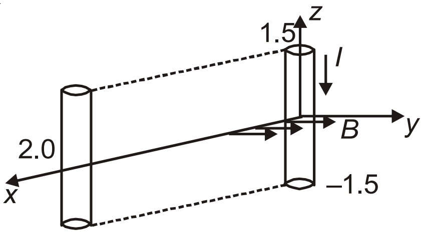
(3) $r_\alpha = r_d > r_p$

(4) $r_\alpha = r_p = r_d$

7. A charge Q is uniformly distributed over the surface of non-conducting disc of radius R. The disc rotates about an axis perpendicular to its plane and passing through its centre with an angular velocity ω. As a result of this rotation a magnetic field of induction B is obtained at the centre of the disc. If we keep both the amount of charge placed on the disc and its angular velocity to be constant and vary the radius of the disc then the variation of the magnetic induction at the centre of the disc will be represented by the figure **[AIEEE-2012]**



8. A conductor lies along the z-axis at $-1.5 \le z < 1.5$ m and carries a fixed current of 10.0 A in $-\hat{a}_z$ direction (see figure). For a field $\vec{B} = 3.0 \times 10^{-4}\, e^{-0.2x}\, \hat{a}_y$ T, find the power required to move the conductor at constant speed to x = 2.0 m, y = 0 m in 5×10^{-3} s. Assume parallel motion along the x-axis **[JEE (Main)-2014]**



(1) 1.57 W (2) 2.97 W

(3) 14.85 W (4) 29.7 W

9. Two coaxial solenoids of different radii carry current I in the same direction. Let $\vec{F}_1$ 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 **[JEE (Main)-2015]**

(1) $\vec{F}_1 = \vec{F}_2 = 0$

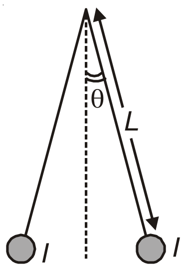
(2) $\vec{F}_1$ is radially inwards and $\vec{F}_2$ is radially outwards

(3) $\vec{F}_1$ is radially inwards and $\vec{F}_2 = 0$

(4) $\vec{F}_1$ is radially outwards and $\vec{F}_2 = 0$

10. Two long current carrying thin wires, both with current I, are held by insulating threads of length L and are in equilibrium as shown in the figure, with threads making an angle θ with the vertical. If wires have mass λ per unit length then the value of I is

(g = gravitational acceleration) **[JEE (Main)-2015]**

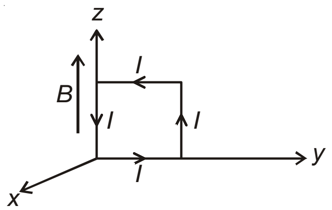


(1) $\sin\theta\sqrt{\dfrac{\pi\lambda gL}{\mu_0\cos\theta}}$ (2) $2\sin\theta\sqrt{\dfrac{\pi\lambda gL}{\mu_0\cos\theta}}$

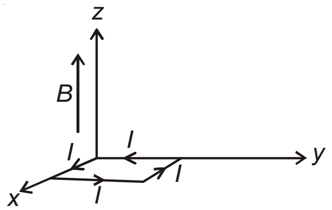
(3) $2\sqrt{\dfrac{\pi gL}{\mu_0}\tan\theta}$ (4) $\sqrt{\dfrac{\pi\lambda gL}{\mu_0}\tan\theta}$

11. A rectangular loop of sides 10 cm and 5 cm carrying a current I of 12 A is placed in different orientations as shown in the figures below:

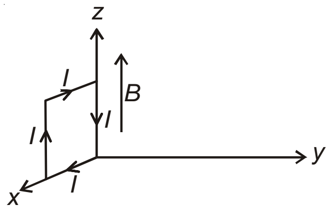
(a)



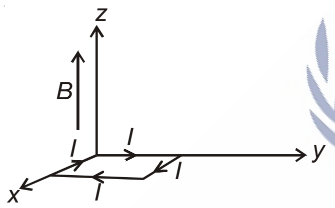
(b)



(c)



(d)



If there is a uniform magnetic field of 0.3 T in the positive z direction, in which orientations the loop would be in (i) stable equilibrium and (ii) unstable equilibrium? **[JEE (Main)-2015]**

(1) (a) and (b), respectively

(2) (a) and (c), respectively

(3) (b) and (d), respectively

(4) (b) and (c), respectively

12. Two identical wires A and B, each of length 'l' carry the same current I. Wire A bent into a circle of radius R and wire B is bent to form a square of side 'a'. If B_A and B_B are the values of magnetic field at the centres of the circle and square respectively, then the ratio $\frac{B_A}{B_B}$ is

[JEE (Main)-2016]

(1) $\frac{\pi^2}{16\sqrt{2}}$ (2) $\frac{\pi^2}{16}$

(3) $\frac{\pi^2}{8\sqrt{2}}$ (4) $\frac{\pi^2}{8}$

13. An electron, a proton and an alpha particle having the same kinetic energy are moving in circular orbits of radii r_e, r_p, r_α respectively in a uniform magnetic field B. The relation between r_e, r_p, r_α is **[JEE (Main)-2018]**

(1) $r_e > r_p = r_\alpha$ (2) $r_e < r_p = r_\alpha$

(3) $r_e < r_p < r_\alpha$ (4) $r_e < r_\alpha < r_p$

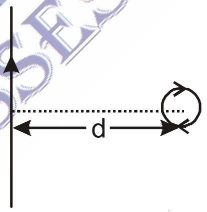
14. The dipole moment of a circular loop carrying a current I, is m and the magnetic field at the centre of the loop is B_1. When the dipole moment is doubled by keeping the current constant, the magnetic field at the centre of the loop is B_2. The ratio $\frac{B_1}{B_2}$ is **[JEE (Main)-2018]**

(1) 2 (2) $\sqrt{3}$

(3) $\sqrt{2}$ (4) $\frac{1}{\sqrt{2}}$

15. An infinitely long current carrying wire and a small current carrying loop are in the plane of the paper as shown. The radius of the loop is a and distance of its centre from the wire is d (d>>a). If the loop applies a force F on the wire then

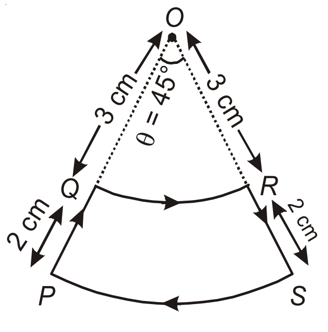
[JEE (Main)-2019]



(1) $F = 0$ (2) $F \propto \left(\frac{a}{d}\right)^2$

(3) $F \propto \left(\frac{a}{d}\right)$ (4) $F \propto \left(\frac{a^2}{d^3}\right)$

16. A current loop, having two circular arcs joined by two radial lines is shown in the figure. It carries a current of 10 A. The magnetic field at point O will be close to **[JEE (Main)-2019]**



i = 10 A

(1) 1.5×10^{-7} T (2) 1.0×10^{-5} T

(3) 1.5×10^{-5} T (4) 1.0×10^{-7} T

17. One of the two identical conducting wires of length L is bent in the form of a circular loop and the other one into a circular coil of N identical turns. If the same current is passed in both, the ratio of the magnetic field at the central of the loop (B_L) to that at the centre of the coil (B_C), i.e. $\frac{B_L}{B_C}$ will be

[JEE (Main)-2019]

(1) $\frac{1}{N}$ (2) N^2

(3) N (4) $\frac{1}{N^2}$

18. A particle having the same charge as of electron moves in a circular path of radius 0.5 cm under the influence of a magnetic field of 0.5 T. If an electric field of 100 V/m makes it to move in a straight path, then the mass of the particle is (Given charge of electron = 1.6×10^{-19} C)

[JEE (Main)-2019]

(1) 9.1×10^{-31} kg (2) 1.6×10^{-27} kg

(3) 1.6×10^{-19} kg (4) 2.0×10^{-24} kg

19. An insulating, thin rod of length l has a linear charge density $\rho(x) = \rho_0 \frac{x}{l}$ on it. The rod is rotated about an axis passing through the origin (x = 0) and perpendicular to the rod. If the rod makes n rotations per second, then the time averaged magnetic moment of the rod is **[JEE (Main)-2019]**

(1) $\pi n \rho l^3$ (2) $n \rho l^3$

(3) $\frac{\pi}{4} n \rho l^3$ (4) $\frac{\pi}{3} n \rho l^3$

20. In an experiment, electrons are accelerated, from rest, by applying a voltage of 500 V. Calculate the radius of the path if a magnetic field 100 mT is then applied. [Charge of the electron = 1.6×10^{-19} C, Mass of the electron = 9.1×10^{-31} kg]

[JEE (Main)-2019]

(1) 7.5×10^{-3} m (2) 7.5 m

(3) 7.5×10^{-2} m (4) 7.5×10^{-4} m

21. The region between y = 0 and y = d contains a magnetic field $\vec{B} = B\hat{z}$. A particle of mass m and charge q enters the region with a velocity $\vec{v} = v\hat{i}$. if $d = \frac{mv}{2qB}$, the acceleration of the charged particle at the point of its emergence at the other side is **[JEE (Main)-2019]**

(1) $\frac{qvB}{m}\left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right)$ (2) $-\frac{qvB}{m}\left(\frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j}\right)$

(3) $\frac{qvB}{m}\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$ (4) $\frac{qvB}{m}\left(\frac{-\hat{j}+\hat{i}}{\sqrt{2}}\right)$

22. A particle of mass m and charge q is in an electric and magnetic field given by

$\vec{E} = 2\hat{i} + 3\hat{j}$; $\vec{B} = 4\hat{j} + 6\hat{k}$

The charged particle is shifted from the origin to the point P(x = 1 ; y = 1) along a straight path. The magnitude of the total work done is

[JEE (Main)-2019]

(1) (0.15)q (2) 5q

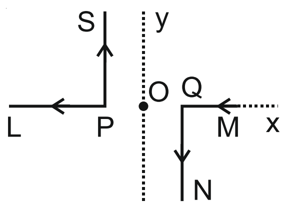
(3) (0.35)q (4) (2.5)q

23. A proton and an α-particle (with their masses in the ratio of 1 : 4 and charges in the ratio of 1 : 2) are accelerated from rest through a potential difference V. If a uniform magnetic field (B) is set up perpendicular to their velocities, the ratio of the radii $r_p : r_\alpha$ of the circular paths described by them will be **[JEE (Main)-2019]**

(1) 1 : 3 (2) 1 : 2

(3) 1 : $\sqrt{3}$ (4) 1 : $\sqrt{2}$

24. As shown in the figure, two infinitely long, identical wires are bent by 90° and placed in such a way that the segments LP and QM are along the x-axis, while segments PS and QN are parallel to the y-axis. If OP = OQ = 4 cm, and the magnitude of the magnetic field at O is 10^{-4} T, and the two wires carry equal currents (see figure), the magnitude of the currents in each wire and the direction of the magnetic field at O will be ($\mu_0 = 4\pi \times 10^{-7}$ NA^{-2}) **[JEE (Main)-2019]**



(1) 40 A, perpendicular into the page

(2) 20 A, perpendicular into the page

(3) 40 A, perpendicular out of the page

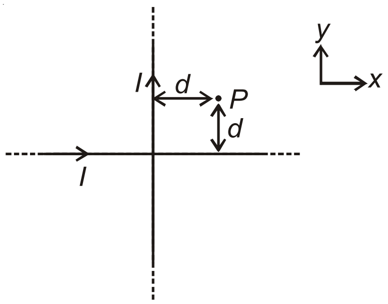
(4) 20 A, perpendicular out of the page

25. A circular coil having N turns and radius r carries a current I. It is held in the XZ plane in a magnetic field $B\hat{i}$. The torque on the coil due to the magnetic field is **[JEE (Main)-2019]**

(1) $\frac{B\pi r^2 I}{N}$ (2) $\frac{Br^2 I}{\pi N}$

(3) $B\pi r^2 I N$ (4) Zero

26. Two very long, straight, and insulated wires are kept at 90° angle from each other in xy-plane as shown in the figure. **[JEE (Main)-2019]**



These wires carry currents of equal magnitude I, whose directions are shown in the figure. The net magnetic field at point P will be

[JEE (Main)-2019]

(1) Zero (2) $\frac{+\mu_0 I}{\pi d}(\hat{z})$

(3) $-\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$ (4) $\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$

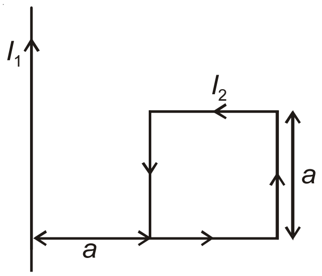
27. A rectangular coil (Dimension 5 cm × 2.5 cm) with 100 turns, carrying a current of 3 A in the clock-wise direction, is kept centered at the origin and in the X-Z plane. A magnetic field of 1 T is applied along X-axis. If the coil is tilted through 45° about Z-axis, then the torque on the coil is

[JEE (Main)-2019]

(1) 0.55 Nm (2) 0.27 Nm

(3) 0.42 Nm (4) 0.38 Nm

28. A rigid square loop of side a and carrying current I_2 is lying on a horizontal surface near a long current I_1 carrying wire in the same plane as shown in figure. The net force on the loop due to the wire will be **[JEE (Main)-2019]**



(1) Repulsive and equal to $\frac{\mu_0 I_1 I_2}{4\pi}$

(2) Repulsive and equal to $\frac{\mu_0 I_1 I_2}{2\pi}$

(3) Zero

(4) Attractive and equal to $\frac{\mu_0 I_1 I_2}{3\pi}$

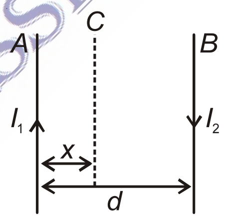
29. A moving coil galvanometer has a coil with 175 turns and area 1 cm^2. It uses a torsion band of torsion constant 10^{-6} N-m/rad. The coil is placed in a magnetic field B parallel to its plane. The coil deflects by 1° for a current of 1 mA. The value of B (in Tesla) is approximately **[JEE (Main)-2019]**

(1) 10^{-4} (2) 10^{-2}

(3) 10^{-1} (4) 10^{-3}

30. Two wires A and B are carrying currents I_1 and I_2 as shown in the figure. The separation between them is d. A third wire C carrying a current I is to be kept parallel to them at a distance x from A such that the net force acting on it is zero. The possible values of x are :

[JEE (Main)-2019]



(1) $x = \pm\frac{I_1 d}{(I_1 - I_2)}$

(2) $x = \left(\frac{I_1}{I_1+I_2}\right)d$ and $x = \left(\frac{I_2}{I_1-I_2}\right)d$

(3) $x = \left(\frac{I_2}{I_1+I_2}\right)d$ and $x = \left(\frac{I_2}{I_1-I_2}\right)d$

(4) $x = \left(\frac{I_1}{I_1-I_2}\right)d$ and $x = \left(\frac{I_2}{I_1+I_2}\right)d$

31. The magnitude of the magnetic field at the center of an equilateral triangular loop of side 1 m which is carrying a current of 10 A is **[JEE (Main)-2019]**

[Take, $\mu_0 = 4\pi \times 10^{-7}$ NA^{-2}]

(1) 18 μT (2) 1 μT

(3) 3 μT (4) 9 μT

32. A square loop is carrying a steady current I and the magnitude of its magnetic dipole moment is m. If this square loop is changed to a circular loop and it carries the same current, the magnitude of the magnetic dipole moment of circular loop will be:

[JEE (Main)-2019]

(1) $\frac{2m}{\pi}$ (2) $\frac{4m}{\pi}$

(3) $\frac{m}{\pi}$ (4) $\frac{3m}{\pi}$

33. A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of 40 π rad s^{-1} about its axis, perpendicular to its plane. If the magnetic field at its centre is 3.8×10^{-9} T, then the charge carried by the ring is close to ($\mu_0 = 4\pi \times 10^{-7}$ N/A^2).

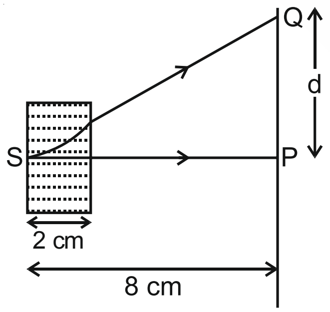
[JEE (Main)-2019]

(1) 4×10^{-5} C (2) 3×10^{-5} C

(3) 7×10^{-6} C (4) 2×10^{-6} C

34. An electron, moving along the x-axis with an initial energy of 100 eV, enters a region of magnetic field $\vec{B} = (1.5 \times 10^{-3}\ \text{T})\,\hat{k}$ at S (See figure). The field extends between x = 0 and x = 2 cm. The electron is detected at the point Q on a screen placed 8 cm away from the point S. The distance d between P and Q (on the screen) is

(electron's charge = 1.6×10^{-19} C, mass of electron = 9.1×10^{-31} kg) **[JEE (Main)-2019]**

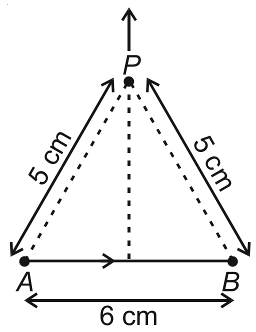


(1) 11.65 cm (2) 12.87 cm

(3) 2.25 cm (4) 1.22 cm

35. Find the magnetic field at point P due to a straight line segment AB of length 6 cm carrying a current of 5 A. (See figure) **[JEE (Main)-2019]**

($\mu_0 = 4\pi \times 10^{-7}$ N-A^{-2})



(1) 2.5×10^{-5} T (2) 1.5×10^{-5} T

(3) 3.0×10^{-5} T (4) 2.0×10^{-5} T

36. A particle of mass m and charge q has an initial velocity $\vec{\upsilon} = \upsilon_0 \hat{j}$. If an electric field $\vec{E} = E_0 \hat{i}$ and magnetic field $\vec{B} = B_0 \hat{i}$ act on the particle, its speed will double after a time **[JEE (Main)-2020]**

(1) $\frac{3m\upsilon_0}{qE_0}$ (2) $\frac{\sqrt{3}m\upsilon_0}{qE_0}$

(3) $\frac{2m\upsilon_0}{qE_0}$ (4) $\frac{\sqrt{2}m\upsilon_0}{qE_0}$

37. Proton with kinetic energy of 1 MeV moves from south to north. It gets an acceleration of 10^{12} m/s^2 by an applied magnetic field (west to east). The value of magnetic field

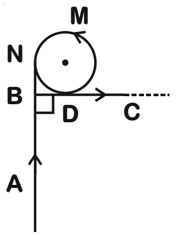
(Rest mass of proton is 1.6×10^{-27} kg)

[JEE (Main)-2020]

(1) 0.071 mT (2) 0.71 mT

(3) 71 mT (4) 7.1 mT

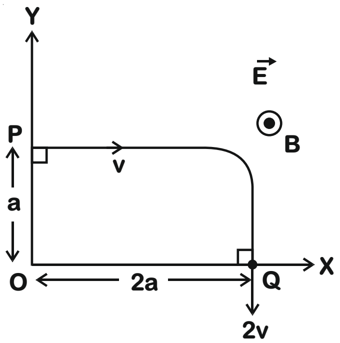
38. A very long wire $ABDMNDC$ is shown in figure carrying current I. AB and BC parts are straight, long and at right angle. At D wire forms a circular turn $DMND$ of radius R. AB, BC parts are tangential to circular turn at N and D. Magnetic field at the centre of circle is **[JEE (Main)-2020]**



(1) $\frac{\mu_0 I}{2\pi R}(\pi + 1)$ (2) $\frac{\mu_0 I}{2R}$

(3) $\frac{\mu_0 I}{2\pi R}\left(\pi + \frac{1}{\sqrt{2}}\right)$ (4) $\frac{\mu_0 I}{2\pi R}\left(\pi - \frac{1}{\sqrt{2}}\right)$

39. A charged particle of mass 'm' and charge 'q' moving under the influence of uniform electric field $E\vec{i}$ and a uniform magnetic field $B\vec{k}$ follows a trajectory from point P to Q as shown in figure. The velocities at P and Q are respectively, $v\vec{i}$ and $-2v\vec{j}$. Then which of the following statements (A, B, C, D) are the correct? (Trajectory shown is schematic and not to scale) **[JEE (Main)-2020]**



A. $E = \frac{3}{4}\left(\frac{mv^2}{qa}\right)$

B. Rate of work done by the electric field at P is $\frac{3}{4}\left(\frac{mv^3}{a}\right)$

C. Rate of work done by both the fields at Q is zero

D. The difference between the magnitude of angular momentum of the particle at P and Q is 2 mav.

(1) A, B, C (2) A, C, D

(3) A, B, C, D (4) B, C, D

40. A long straight wire of radius a carries a current distributed uniformly over its cross- section. The ratio of the magnetic fields due to the wire at distance $\frac{a}{3}$ and $2a$, respectively from the axis of the wire is **[JEE (Main)-2020]**

(1) $\frac{1}{2}$ (2) $\frac{3}{2}$

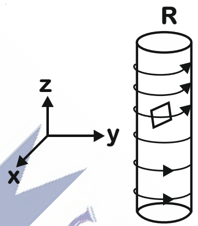
(3) 2 (4) $\frac{2}{3}$

41. A small circular loop of conducting wire has radius a and carries current I. It is placed in a uniform magnetic field B perpendicular to its plane such that when rotated slightly about its diameter and released, it starts performing simple harmonic motion of time period T. If the mass of the loop is m then **[JEE (Main)-2020]**

(1) $T = \sqrt{\frac{2\pi m}{IB}}$ (2) $T = \sqrt{\frac{\pi m}{IB}}$

(3) $T = \sqrt{\frac{2m}{IB}}$ (4) $T = \sqrt{\frac{\pi m}{2IB}}$

42. An electron gun is placed inside a long solenoid of radius R on its axis. The solenoid has n turns/length and carries a current I. The electron gun shoots an electron along the radius of the solenoid with speed v. If the electron does not hit the surface of the solenoid, maxium possible value of v is (all symboils have their standard meaning) **[JEE (Main)-2020]**



(1) $\frac{2e\mu_0 nIR}{m}$ (2) $\frac{e\mu_0 nIR}{m}$

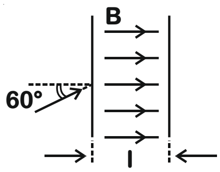
(3) $\frac{e\mu_0 nIR}{2m}$ (4) $\frac{e\mu_0 nIR}{4m}$

43. A beam of protons with speed $4 \times 10^5\ ms^{-1}$ enters a uniform magnetic field of 0.3 T at an angle of 60° to the magnetic field. The pitch of the resulting helical path of protons is close to (Mass of the proton = 1.67×10^{-27} kg, charge of the proton = 1.69×10^{-19} C) **[JEE (Main)-2020]**

(1) 2 cm (2) 12 cm

(3) 5 cm (4) 4 cm

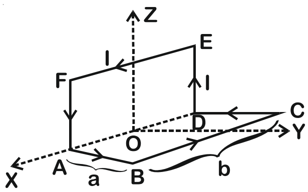
44. The figure shows a region of length 'l' with a uniform magnetic field of 0.3 T in it and a proton entering the region with velocity $4 \times 10^5\ ms^{-1}$ making an angle 60° with the field. If the proton completes 10 revolution by the time it cross the region shown, 'l' is close to (mass of proton = 1.67×10^{-27} kg, charge of the proton = 1.6×10^{-19} C) **[JEE (Main)-2020]**



(1) 0.22 m (2) 0.11 m

(3) 0.88 m (4) 0.44 m

45. A wire carrying current I is bent in the shape $ABCDEFA$ as shown, where rectangle $ABCDA$ and $ADEFA$ are perpendicular to each other. If the sides of the rectangles are of lengths a and b, then the magnitude and direction of magnetic moment of the loop $ABCDEFA$ is **[JEE (Main)-2020]**



(1) abI, along $\left(\frac{\hat{j}}{\sqrt{5}}+\frac{2\hat{k}}{\sqrt{5}}\right)$

(2) $\sqrt{2}\, abI$, along $\left(\frac{\hat{j}}{\sqrt{2}}+\frac{\hat{k}}{\sqrt{2}}\right)$

(3) abI, along $\left(\frac{\hat{j}}{\sqrt{2}}+\frac{\hat{k}}{\sqrt{2}}\right)$

(4) $\sqrt{2}\, abI$, along $\left(\frac{\hat{j}}{\sqrt{5}}+\frac{2\hat{k}}{\sqrt{5}}\right)$

46. A charged particle carrying charge 1 μC is moving with velocity $(2\hat{i}+3\hat{j}+4\hat{k})$ ms^{-1}. If an external magnetic field of $(5\hat{i}+3\hat{j}-6\hat{k})\times 10^{-3}$ T exists in the region where the particle is moving then the force on the particle is $\vec{F}\times 10^{-9}$ N. The vector $\vec{F}$ is **[JEE (Main)-2020]**

(1) $-3.0\hat{i}+3.2\hat{j}-0.9\hat{k}$

(2) $-300\hat{i}+320\hat{j}-90\hat{k}$

(3) $-0.30\hat{i}+0.32\hat{j}-0.09\hat{k}$

(4) $-30\hat{i}+32\hat{j}-9\hat{k}$

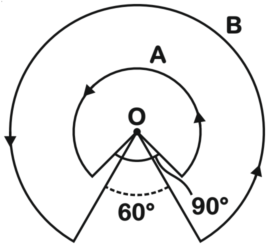
47. Magnitude of magnetic field (in SI units) at the centre of a hexagonal shape coil of side 10 cm, 50 turns and carrying current I (Ampere) in units of $\frac{\mu_0 I}{\pi}$ is **[JEE (Main)-2020]**

(1) $500\sqrt{3}$ (2) $250\sqrt{3}$

(3) $50\sqrt{3}$ (4) $5\sqrt{3}$

48. A wire A, bent in the shape of an arc of a circle, carrying a current of 2 A and having radius 2 cm and another wire B, also bent in the shape of arc of a circle, carrying a current of 3 A and having radius of 4 cm, are placed as shown in the figure. The ratio of the magnetic fields due to the wires A and B at the common centre O is

[JEE (Main)-2020]



(1) 2 : 5 (2) 6 : 5

(3) 4 : 6 (4) 6 : 4

49. An electron is constrained to move along the y-axis with a speed of 0.1 c (c is the speed of light) in the presence of electromagnetic wave, whose electric field is

$\vec{E}=30\hat{j}\sin(1.5\times 10^{7}t-5\times 10^{-2}x)$ V/m.

The maximum magnetic force experienced by the electron will be

(given $c = 3\times 10^{8}$ ms^{-1} and electron charge = 1.6×10^{-19} C) **[JEE (Main)-2020]**

(1) 4.8×10^{-19} N (2) 2.4×10^{-18} N

(3) 3.2×10^{-18} N (4) 1.6×10^{-19} N

50. A square loop of side $2a$, and carrying current I, is kept in XZ plane with its centre at origin. A long wire carrying the same current I is placed parallel to the z-axis and passing through the point (0, b, 0), ($b >> a$). The magnitude of the torque on the loop about z-axis is given by **[JEE (Main)-2020]**

(1) $\frac{2\mu_0 I^2 a^2}{\pi b}$ (2) $\frac{\mu_0 I^2 a^2}{2\pi b}$

(3) $\frac{\mu_0 I^2 a^3}{2\pi b^2}$ (4) $\frac{2\mu_0 I^2 a^3}{\pi b^2}$

51. A ring is hung on a nail. It can oscillate, without slipping or sliding (*i*) in its plane with a time period T_1 and, (ii) back and forth in a direction perpendicular to its plane, with a period T_2. The ratio $\frac{T_1}{T_2}$ will be **[JEE (Main)-2020]**

(1) $\frac{\sqrt{2}}{3}$ (2) $\frac{2}{\sqrt{3}}$

(3) $\frac{2}{3}$ (4) $\frac{3}{\sqrt{2}}$

52. A particle of charge q and mass m is moving with a velocity $-v\hat{i}\,(v \neq 0)$ towards a large screen placed in the Y - Z plane at a distance d. If there is a magnetic field $\vec{B} = B_0\hat{k}$, the minimum value of v for which the particle will not hit the screen is

[JEE (Main)-2020]

(1) $\dfrac{2qdB_0}{m}$ (2) $\dfrac{qdB_0}{3m}$

(3) $\dfrac{qdB_0}{2m}$ (4) $\dfrac{qdB_0}{m}$

53. An electron is moving along $+x$ direction with a velocity of 6×10^6 ms^{-1}. It enters a region of uniform electric field of 300 V/cm pointing along $+y$ direction. The magnitude and direction of the magnetic field set up in this region such that the electron keeps moving along the x direction will be

[JEE (Main)-2020]

(1) 5×10^{-3} T, along + z direction

(2) 5×10^{-3} T, along – z direction

(3) 3×10^{-4} T, along + z direction

(4) 3×10^{-4} T, along – z direction

54. A square loop of side $2a$ and carrying current I is kept in xz plane with its centre at origin. A long wire carrying the same current I is placed parallel to z-axis and passing through point (0, b, 0), ($b >> a$). The magnitude of torque on the loop about z-axis will be **[JEE (Main)-2020]**

(1) $\dfrac{\mu_0 I^2 a^2}{2\pi b}$ (2) $\dfrac{2\mu_0 I^2 a^2 b}{\pi(a^2+b^2)}$

(3) $\dfrac{\mu_0 I^2 a^2 b}{2\pi(a^2+b^2)}$ (4) $\dfrac{2\mu_0 I^2 a^2}{\pi b}$

55. A charged particle going around in a circle can be considered to be a current loop. A particle of mass m carrying charge q is moving in a plane with speed v under the influence of magnetic field $\vec{B}$. The magnetic moment of this moving particle

[JEE (Main)-2020]

(1) $-\dfrac{mv^2\vec{B}}{2B^2}$ (2) $\dfrac{mv^2\vec{B}}{2B^2}$

(3) $-\dfrac{mv^2\vec{B}}{2\pi B^2}$ (4) $-\dfrac{mv^2\vec{B}}{B^2}$

56. A loop $ABCDEFA$ of straight edges has six corner points A(0, 0, 0), B(5, 0, 0), C(5, 5, 0), D(0, 5, 0), E(0,5, 5) and F(0, 0, 5). The magnetic field in this region is $\vec{B} = (3\hat{i} + 4\hat{k})$ T. The quantity of flux through the loop $ABCDEFA$ (in Wb) is _________.

[JEE (Main)-2020]

57. A galvanometer coil has 500 turns and each turn has an average area of 3×10^{-4} m^2. If a torque of 1.5 Nm is required to keep this coil parallel to a magnetic field when a current of 0.5 A is flowing through it, the strength of the field (in T) is _________. **[JEE (Main)-2020]**

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