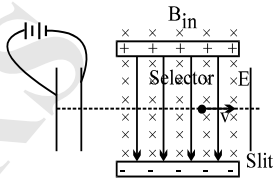
CLASS : CC (ADVANCED) **MAGNETISM** **M.M. 88** **TEST - 5**

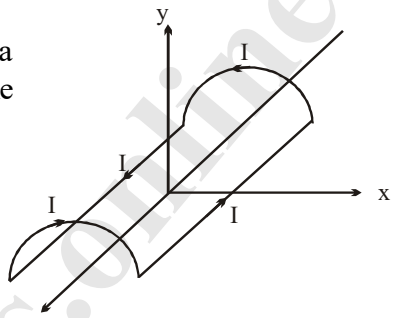
[SINGLE CORRECT CHOICE TYPE]

Q.1 The given figure shows a set-up for accelerating protons from rest, through a potential (fixed) by the battery, and then through a velocity selector. The E and B fields are carefully adjusted so that the accelerated protons go straight through the slit after exiting the selector. You want to modify this so that electrons instead of protons are used. You reverse the leads on the accelerating battery. What do you need to do to the potential difference between the plates that create the electric field in the selector? **[3]**



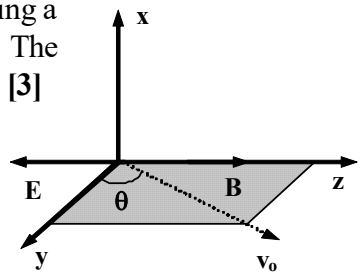
(A) Nothing
(B) Reduce its magnitude
(C) Increase its magnitude
(D) Reverse the polarity, and reduce its magnitude

Q.2 We have a uniform current carrying wire loop bent in the form of a semicircular cylinder, as shown in the diagram. The magnetic field at the origin is **[3]**



(A) directed along x-axis
(B) directed along y-axis
(C) directed along z-axis
(D) zero

Q.3 In a certain region uniform electric field E and magnetic field B are present in the opposite direction. At the instant t = 0, a particle of mass m carrying a charge q is given velocity v_0 at an angle θ, with the y axis, in the yz plane. The time after which the speed of the particle would be minimum is equal to **[3]**



(A) $\frac{mv_o}{qE}$
(B) $\frac{mv_o \sin\theta}{qE}$
(C) $\frac{mv_o \cos\theta}{qE}$
(D) $\frac{2\pi m}{qB}$

Q.4 A cyclotron accelerates a beam of protons to 24 MeV. The same cyclotron will accelerate a deuteron beam to **[3]**

(A) 6 MeV (B) 12 MeV (C) 24 MeV (D) 48 MeV

Q.5 Two very long, straight, parallel wires carry same steady current I but in opposite direction. The distance between the wires d. At a certain instant of time, a point charge q is at a point equidistant from the two wires, in the plane of the wires. Its instantaneous velocity $\vec{v}$ is perpendicular to this plane. The magnitude of the force due to the magnetic field acting on the charge at this instant is **[3]**

(A) $\frac{\mu_0 Iqv}{\pi d}$ (B) $\frac{\mu_0 Iqv}{2\pi d}$ (C) $\frac{2\mu_0 Iqv}{\pi d}$ (D) Zero

Q.6 An electron moving in a circular path of radius r makes n rotations per seconds. The magnetic field produced at the centre has the magnitude **[3]**

(A) Zero (B) $\frac{\mu_0 ne}{2r}$ (C) $\frac{\mu_0 ne}{2\pi r}$ (D) $\frac{\mu_0 n^2 e}{2r}$

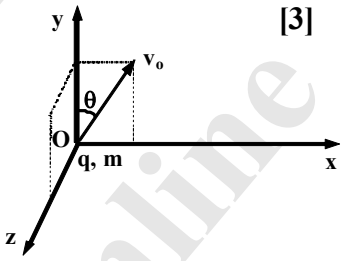
Q.7 The magnetic field in a region is given by $\vec{B} = B_0(1-\frac{x}{L})\,\hat{k}$. A straight conductor AB of length 2L placed with its ends at points A(a, 0, 0) and B (a, 2L, 0). Current I flows from A to B. The magnetic force on the conductor is **[3]**

(A) zero (B) $IB_0(2L-a)\,\hat{i}$ (C) $-IB_0(L-a)\,\hat{i}$ (D) $2IB_0(L-a)\,\hat{i}$

Q.8 Alpha particles ($m = 6.7 \times 10^{-27}$ kg, $q = +2e$) are accelerated from rest through a p.d. of 6.7 kV. Then they enter a magnetic field B = 0.2 T perpendicular to their direction of motion. The radius of the path described by them is **[3]**

(A) 8.375 m (B) 8.375 cm (C) infinity (D) none of these

Q.9 A particle of mass m, carrying a charge q, is lying at the origin in a uniform magnetic field directed along X axis. At the instant t = 0 it is given a velocity v_o at an angle θ with the y axis, in the xy plane. The coordinates of the particle after two revolutions will be **[3]**



(A) $\left(0,0,\frac{2\pi mv_o\sin\theta}{qB}\right)$ (B) $\left(\frac{2\pi mv_o\sin\theta}{qB},0,0\right)$

(C) $\left(\frac{4\pi mv_o\sin\theta}{qB},0,0\right)$ (D) (0, 0, 0)

[REASONING TYPE]

Q.10 For the following situation of (a) and (b), current is same. **[3]**

Statement-1 : In case of figure (a) and (b) $\oint \vec{B}\cdot d\vec{\ell}$ for two loops shown will be different.

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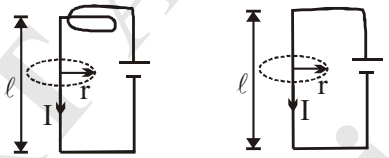

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
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[PARAGRAPH TYPE]

Paragraph for question nos. 11 to 13

Scientists have suggested that the neutrons are not fundamental particles of nature but they have an internal constitution. They are made of three quarks. Two up quarks and one down quark. The up quark has a charge of –e/3 and down quark has a charge of +2e/3. The up quarks are both revolving around the central down quark with the same speed as shown. The centripetal force required for their circular motion is given by the coulomb force of attraction. This model predicts that the net electric dipole moment of the neutron is zero but the net magnetic dipole moment of the neutron is not zero.

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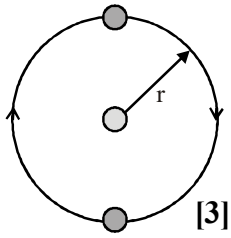

Q.11 What is the velocity of the up quark to possess the properties discussed above? **[3]**

(A) $\frac{7e^2}{36h\in_0}$ (B) $\frac{7e^2}{72h\in_0}$ (C) $\frac{3e^2}{25h\in_0}$ (D) $\frac{4e^2}{51h\in_0}$

Q.12 What is the direction of magnetic field and electric field at a point on the axis of rotation? **[3]**

(A) Electric field is along the axis of rotation but magnetic field is along the axis of rotation in direction opposite to that of angular velocity

(B) Electric field is perpendicular to axis of rotation but magnetic field is along the axis of rotation in direction same as that of angular velocity

(C) Electric field is perpendicular to axis of rotation but magnetic field is along the axis of rotation in direction opposite to that of angular velocity

(D) Electric field is along the axis of rotation but magnetic field is along the axis of rotation in direction same as that of angular velocity

Q.13 What is the ratio of electric field and magnetic field at a point on the axis at a distance x from the center? (x>>r) **[3]**

(A) $\frac{108rh}{7\mu_0 e^2 x}$ (B) $\frac{24rh}{17\mu_0 e^2 x}$ (C) $\frac{12hx}{31\mu_0 e^2 r}$ (D) None of these

[MULTIPLE CORRECT CHOICE TYPE]

Q.14 Two long parallel conductors are carrying currents in the same direction as shown in the figure. The upper conductor A carries a current of 100 A and is held firmly in position. The lower conductor B carries a current of 50 A and is free to slide up and down. The linear mass density of the lower conductor is 0.01 kg m^{-1}. **[4]**

(A) Conductor B will be in equilibrium if the distance between the conductors is 0.01 m.

(B) Conductor B performs SHM with period $\frac{\pi}{50}$ s.

(C) Equilibrium of conductor B is stable.

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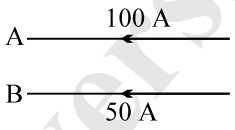
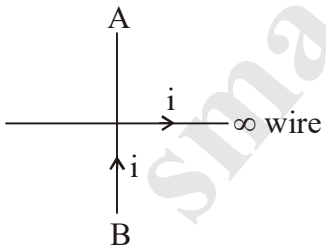


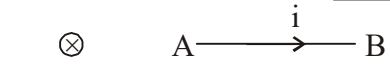
Q.15 A proton is moving in gravity free space having a uniform electric field, E, of unknown magnitude and direction. There is a uniform magnetic field of 0.01 T pointing in the y-direction. The proton moves in the x-direction at a constant velocity of 10 km/s. All directions are with respect to the usual right handed x-y-z coordinate system. Which of the following is/are correct? **[4]**

(A) $E_z = 100$ V/m (B) $E_z = -100$ V/m (C) $E_x = 100$ V/m (D) $E_x = 0$

[MATRIX TYPE]

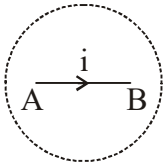
Q.16 In each of cases, assume that the wires are very thin. **[6]**

Column I	Column II
(A)  AB is a finite wire placed such that it is just touching the infinite wire. If AB is placed symmetrically	(P) The force on AB is zero (Q) The torque on AB about it's centre is zero

(B) 

infinite wire carrying current into the plane

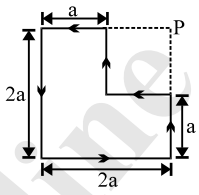
(R) The force on AB is non zero

(C) 

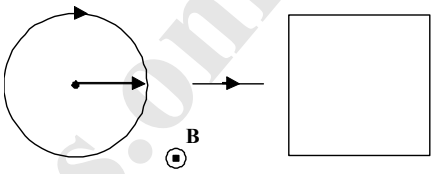
AB is kept inside an ideal solenoid along the diameter

(S) The torque on AB about its centre of mass is non zero

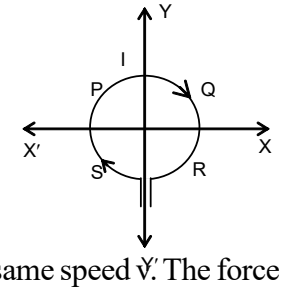
[SUBJECTIVE TYPE]



Q.17 A current I passes through a six sided rectilinear closed planar loop as in the figure. The magnetic induction produced by the loop at the point P is _____. **[5]**



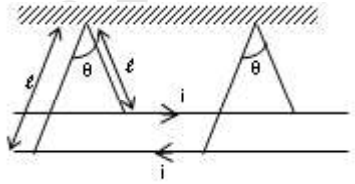
Q.18 If the shape of a circular conducting loop carring current i is changed to a square one of side l in a uniform magnetic field B, the work done in doing so will be equal to _____. **[5]**



Q.19 There is a uniform field $\vec{B} = B_0\,\hat{i}$ in the region. Loop PQRS is having a radius R and mass 'm' and is circular in shape. The loop is carrying a current I and lying in the x-y plane as shown in the figure. The loop is constrained to rotate along the y-axis. It rotates only due to the torque of the magnetic forces acting on it. Calculate its angular speed when it has rotated through an angle 90º. **[5]**

Q.20 A particle with charge q is projected successively along the x and y axes with same speed v. The force on the particle in these situations are qvB $\left(-3\hat{j}+4\hat{k}\right)$ & qvB $\left(3\hat{i}\right)$ respectively. Find the unit vector in direction of $\vec{B}$. **[5]**

Q.21 Two long indentical parallel wires carrying equal current I in opposite direction. These wires are suspended by four chords of same length 'ℓ' as shown in the figure. Find mass per unit length of each wire.



[5]

[5]

[5]

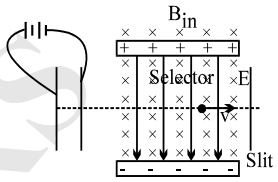
Q.22 In an infinitely long conductor of circular cross-section area of radius R, current density varies as $J = \rho_0 (r/R)$ where r is distance from centre. Parallel to this conductor another thin infinitely long current carrying wire is placed such that the distance between the axis of the conductor and wire is d ($d > R$). If on the line joining the axis of the conductor and wire at distance a ($a < R$) from axis of the conductor, magnetic field is zero, then find the current in the wire.

Q.23 A system consists of two parallel planes carrying currents producing a uniform magnetic field of induction B only between the planes. In outside space there is no magnetic field. Find the magnetic pressure on each plane.

CLASS : CC (ADVANCED) **MAGNETISM** **M.M. 88** **TEST - 5**

[SINGLE CORRECT CHOICE TYPE]

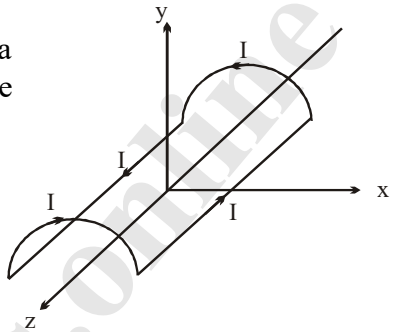
Q.1 The given figure shows a set-up for accelerating protons from rest, through a potential (fixed) by the battery, and then through a velocity selector. The E and B fields are carefully adjusted so that the accelerated protons go straight through the slit after exiting the selector. You want to modify this so that electrons instead of protons are used. You reverse the leads on the accelerating battery. What do you need to do to the potential difference between the plates that create the electric field in the selector? **[3]**



(A) Nothing (B) Reduce its magnitude

(C*) Increase its magnitude (D) Reverse the polarity, and reduce its magnitude

Q.2 We have a uniform current carrying wire loop bent in the form of a semicircular cylinder, as shown in the diagram. The magnetic field at the origin is **[3]**



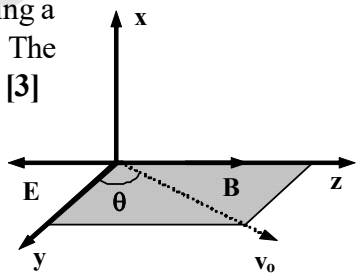
(A) directed along x-axis

(B*) directed along y-axis

(C) directed along z-axis

(D) zero

Q.3 In a certain region uniform electric field E and magnetic field B are present in the opposite direction. At the instant t = 0, a particle of mass m carrying a charge q is given velocity v_0 at an angle θ, with the y axis, in the yz plane. The time after which the speed of the particle would be minimum is equal to **[3]**



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Q.8 Alpha particles ($m = 6.7 \times 10^{-27}$ kg, $q = +2e$) are accelerated from rest through a p.d. of 6.7 kV. Then they enter a magnetic field B = 0.2 T perpendicular to their direction of motion. The radius of the path described by them is **[3]**

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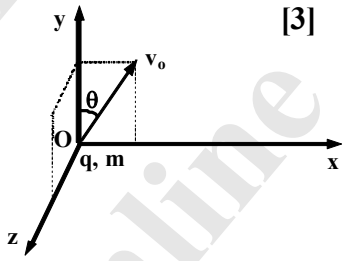

(A) $\left(0,0,\frac{2\pi mv_o\sin\theta}{qB}\right)$ (B) $\left(\frac{2\pi mv_o\sin\theta}{qB},0,0\right)$

(C*) $\left(\frac{4\pi mv_o\sin\theta}{qB},0,0\right)$ (D) (0, 0, 0)

[REASONING TYPE]

Q.10 For the following situation of (a) and (b), current is same. **[3]**

Statement-1 : In case of figure (a) and (b) $\oint \vec{B}\cdot d\vec{\ell}$ for two loops shown will be different.

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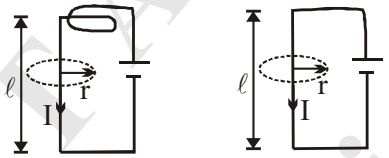

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[PARAGRAPH TYPE]

Paragraph for question nos. 11 to 13

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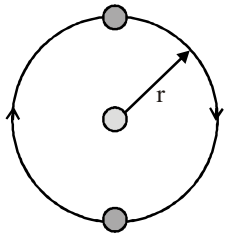

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Q.12 What is the direction of magnetic field and electric field at a point on the axis of rotation? **[3]**

(A*) Electric field is along the axis of rotation but magnetic field is along the axis of rotation in direction opposite to that of angular velocity

(B) Electric field is perpendicular to axis of rotation but magnetic field is along the axis of rotation in direction same as that of angular velocity

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[MULTIPLE CORRECT CHOICE TYPE]

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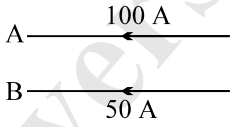

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[MATRIX TYPE]

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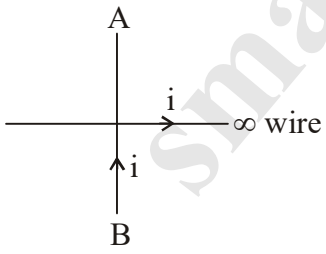
Column I	Column II
(A) 	(P) The force on AB is zero
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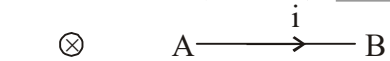
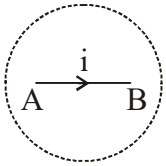
(B) 

infinite wire carrying current into the plane

(R) The force on AB is non zero

(C) 

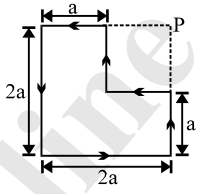
AB is kept inside an ideal solenoid along the diameter

(S) The torque on AB about its centre of mass is non zero

[Ans. (A) P,S (B) R,S (C) Q,R]

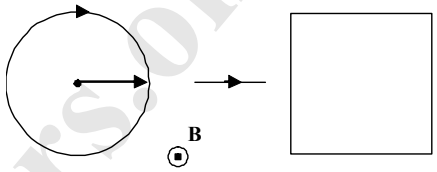
[SUBJECTIVE TYPE]

Q.17 A current I passes through a six sided rectilinear closed planar loop as in the figure. The magnetic induction produced by the loop at the point P is _____. **[5]**



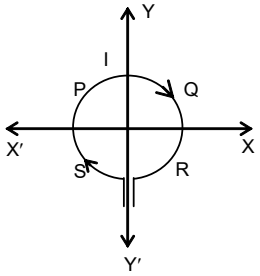
[Ans. $\frac{\mu_0}{8\pi}\sqrt{2}\frac{I}{a}$]

Q.18 If the shape of a circular conducting loop carring current i is changed to a square one of side *l* in a uniform magnetic field B, the work done in doing so will be equal to _____. **[5]**



[Ans. $i\ell^2 B\left(1-\frac{4}{\pi}\right)$]

Q.19 There is a uniform field $\vec{B} = B_0\,\hat{i}$ in the region. Loop PQRS is having a radius R and mass 'm' and is circular in shape. The loop is carrying a current I and lying in the x-y plane as shown in the figure. The loop is constrained to rotate along the y-axis. It rotates only due to the torque of the magnetic forces acting on it. Calculate its angular speed when it has rotated through an angle 90º. **[5]**

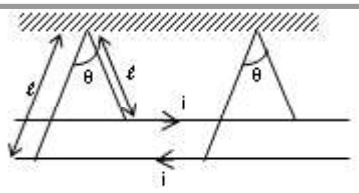


Ans. $\omega = 2\sqrt{\frac{\pi I B_0}{m}}$

Q.20 A particle with charge q is projected successively along the x and y axes with same speed v. The force on the particle in these situations are qvB $\left(-3\hat{j}+4\hat{k}\right)$ & qvB $\left(3\hat{i}\right)$respectively. Find the unit vector in direction of $\vec{B}$. **[5]**

Ans. $\vec{B} = \frac{\vec{B}}{|\vec{B}|} = \frac{4}{5}\hat{j}+\frac{3}{5}\hat{k}$

Q.21 Two long indentical parallel wires carrying equal current I in opposite direction. These wires are suspended by four chords of same length 'ℓ' as shown in the figure. Find mass per unit length of each wire.



[5]

[Ans. $\dfrac{\mu_0 i^2}{4\pi \sin\dfrac{\theta}{2}\tan\dfrac{\theta}{2}\ell g}$]

Q.22 In an infinitely long conductor of circular cross-section area of radius R, current density varies as $J = \rho_0 (r/R)$ where r is distance from centre. Parallel to this conductor another thin infinitely long current carrying wire is placed such that the distance between the axis of the conductor and wire is d (d > R). If on the line joining the axis of the conductor and wire at distance a (a < R) from axis of the conductor, magnetic field is zero, then find the current in the wire. **[5]**

Ans. $I_0 = \dfrac{2\pi\rho_0}{3R} a^2 (d - a)$

Q.23 A system consists of two parallel planes carrying currents producing a uniform magnetic field of induction B only between the planes. In outside space there is no magnetic field. Find the magnetic pressure on each plane. **[5]**

[Ans. $F_1 = B^2 / 2\mu_0$]