Physics

TARGET : JEE 2013

SCORE

JEE (Advanced)

Home Assignment # 02

ALLEN CAREER INSTITUTE
KOTA (RAJASTHAN)
Path to Success

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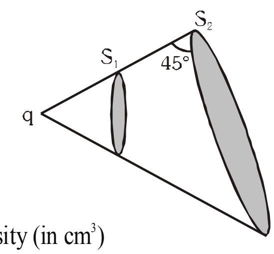
ELECTROSTATICS

EXERCISE # (O)

1. In the given figure flux through surface S_1 is ϕ_1 & through S_2 is ϕ_2. Which is correct ?



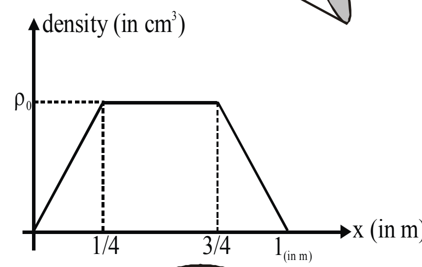
(A) $\phi_1 = \phi_2$

(B) $\phi_1 > \phi_2$

(C) $\phi_1 < \phi_2$

(D) None of these

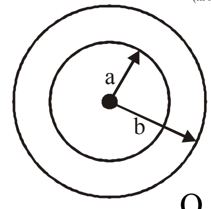
2. The volume charge density as a function of distance X from one face inside a unit cube is varying as shown in the figure. The total flux (in S.I. units) through the cube if ($\rho_0 = 8.85 \times 10^{-12}$ C/m^3) is



(A) 1/4 (B) 1/2

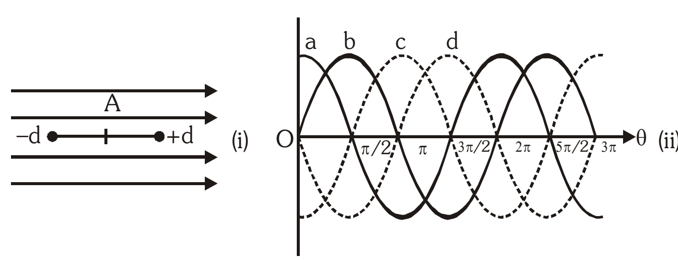
(C) 3/4 (D) 1

3. In a spherical distribution the charge density varies as ρ (r) = A/r for a < r<b(as shown) where A is a constant. A point charge Q lies at the centre of the sphere at r = 0. The electric field in the region a < r<b has a constant magnitude for



(A) A = 0 (B) A = Q (C) $A = \dfrac{Q}{2\pi a^2}$ (D) $A = \dfrac{Q}{4\pi a^2}$

4. The electric dipole is situated in an electric field as shown in figure (i). The dipole and electric field are both in the plane of paper. The dipole is rotated about an axis perpendicular to the paper at point A in anticlockwise direction. If the angle of rotation is measured with respect to the direction of the electric field then the torque for different values of the angle of rotation θ will be as represented in Fig. (ii) take direction inside the paper as postive.

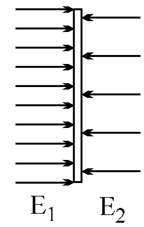


(A) a (B) b (C) c (D) d

5. A system consists of uniformly charged sphere of radius R and a surrounding medium filled by a charge with the volume density $\rho = \dfrac{\alpha}{r}$, where α is a positive constant and r is the distance from the centre of the sphere. The charge of the sphere for which electric field intensity E outside the sphere is independent of r is

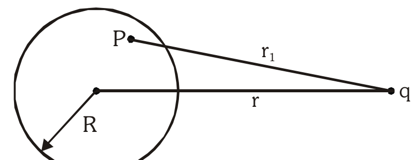
(A) $\dfrac{\alpha}{2\epsilon_0}$ (B) $\dfrac{2}{\alpha\epsilon_0}$ (C) $2\pi\alpha R^2$ (D) αR^2

6. A charged large metal sheet is placed into uniform electric field, perpendicularly to the electric field lines. After placing the sheet into the field, the electric field on the left side of the sheet is $E_1 = 5 \times 10^5$ V/m and on the right it is $E_2 = 3 \times 10^5$ V/m. The sheet experiences a net electric force of 0.08 N. Find the area of one face of the sheet. Assume external field to remain constant after introducing the large sheet. Use $\left(\frac{1}{4\pi\varepsilon_0}\right) = 9 \times 10^9$ Nm^2/C^2



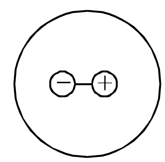
(A) $3.6\,\pi \times 10^{-2}$ m^2 (B) $0.9\,\pi \times 10^{-2}$ m^2 (C) $1.8\,\pi \times 10^{-2}$ m^2 (D) none

7. A point charge q is placed at a distance r from center of a conducting neutral sphere of radius R (r>R). The potential at any point P inside the sphere at a distance r_1 from point charge due to induced charge of the sphere is given by



(A) $\frac{Kq}{r_1} - \frac{Kq}{R}$ (B) $\frac{Kq}{r_1} - \frac{Kq}{R}$ (C) $\frac{Kq}{r} - \frac{Kq}{r_1}$ (D) $-\frac{Kq}{r_1} + \frac{Kq}{R}$

8. Consider a gaussian spherical surface, covering a dipole of charge q and –q, then

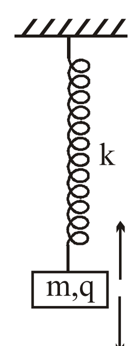


(A) $q_{in} = 0$ (Net charge enclosed by the spherical surface)
(B) $\phi_{net} = 0$ (Net flux coming out the spherical surface)
(C) E = 0 at all points on the spherical surface
(D) $\int \vec{E}\cdot d\vec{s} = 0$ (Surface integral of $\vec{E}$ over the spherical surface)

9. A large insulating thick sheet of thickness 2d carries a uniform charge per unit volume ρ. A particle of mass m, carrying a charge q having a sign opposite to that of the sheet, is released from the surface of the sheet. The sheet does not offer any mechanical resistance to the motion of the particle. Find the oscillation frequency ν of the particle inside the sheet.

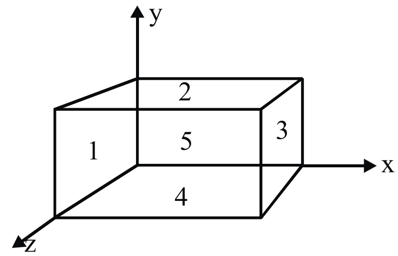
(A) $\nu = \frac{1}{2\pi}\sqrt{\frac{q\rho}{m\varepsilon_0}}$ (B) $\nu = \frac{1}{2\pi}\sqrt{\frac{2q\rho}{m\varepsilon_0}}$ (C) $\nu = \frac{1}{4\pi}\sqrt{\frac{q\rho}{m\varepsilon_0}}$ **(D)** $\nu = \frac{1}{2\pi}\sqrt{\frac{q\rho}{m\varepsilon_0}}$

10. The following figure shows a block of mass m suspended from a fixed point by means of a vertical spring. The block is oscillating simple harmonically and carries a charge q. There also exists a uniform electric field in the region. Consider four different cases. The electric field is zero, in case-1, $\frac{mg}{q}$ downward in case-2, $\frac{mg}{q}$ upward in case-3 and $\frac{2mg}{q}$ downward in case-4. The speed at mean position is same in all cases. Select the correct alternative(s).



(A) Time periods of oscillation are equal in case-1 and case-3
(B) Amplitudes of displacement are same in case-2 and case-3
(C) The maximum elongation (increment in length from natural length) is maximum in case-4.
(D) Time periods of oscillation are equal in case-2 and case-4

11. In a region of space, the electric field $\vec{E} = E_0 x\hat{i} + E_0 y\hat{j}$. Consider an imaginary cubical volume of edge 'a' with its edges parallel to the axes of coordinates. Now,



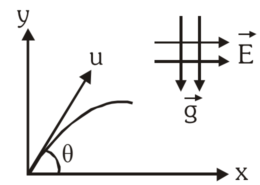
(A) the total electric flux through the faces 1 and 3 is E_0a^3

(B) the charge inside the cubical volume is $2\varepsilon_0E_0a^3$

(C) the total electric flux through the faces 2 and 4 is $2E_0a^3$

(D) the charge inside the cubical volume is $\varepsilon_0E_0a^3$

12. A particle of mass m and charge –q has been projected from ground as shown in the figure below. Mark out the correct statements (s) :-



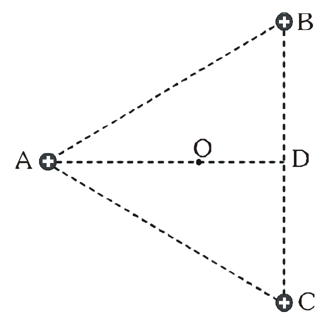
(A) The path of motion of the particle is parabolic

(B) The path of motion of the particle is a straight line

(C) Time of flight of particle is $\dfrac{2u\sin\theta}{g}$

(D) Range of motion of the particle will be less than $\dfrac{u^2\sin 2\theta}{g}$

13. Three identical point charges are placed on the vertices of an equilateral triangle ABC as shown in the figure. Consider a median AD, where point O is the centroid. As we move form point A to point D



(A) Electric field vanishes only once at O, between points A and D.

(B) Electric field vanishes two times, first at O and then somewhere between O & D.

(C) Electric field vanishes two times, first at a point somewhere between A & O and then at O.

(D) Electric field vector changes direction more than once.

14. If the flux of the electric field through a closed surface is zero,

(A) The electric field must be zero everywhere on the surface

(B) The electric field may be zero everywhere on the surface

(C) The net charge inside the surface must be zero

(D) The net charge in the vicinity of the surface must be zero.

15. A thin–walled, spherical conducting shell S of radius R is given charge Q. The same amount of charge is also placed at its centre C. Which of the following statement(s) are correct ?

(A) On the outer surface of S, the charge density is $\dfrac{Q}{2\pi R^2}$.

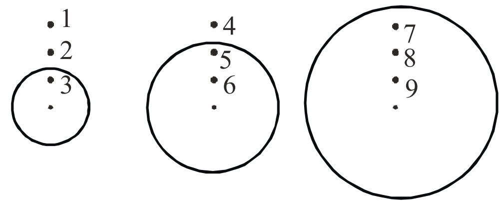
(B) The electric field is zero at all points inside S.

(C) At a point just outside S, the electric field is double the field at a point just inside S.

(D) At any point inside S, the electric field is inversely proportional to the square of its distance from centre C.

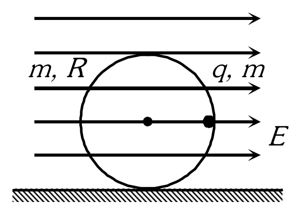
16. Figure shows three spherical shells in separate situations, with each shell having the same uniform positive net charge. Points 1, 4 and 7 are at the same radial distances from the centre of the their respective shells; so are points 2, 5 and 8 ; and so are points 3, 6 and 9. With the electric potential taken equals to zero at an infinite distance, choose correct statement.

(A) Point 3 has highest potential
(B) point 1, 4 and 7 are at same potential
(C)Point 9 has lowest potential
(D) point 5 and 8 are at same potential



Paragraph for Question No. 17 to 19

A particle of charge q and mass m is clamped rigidly at the circumference of a ring with mass m and radius R. Initially ring is in vertical plane resting on a sufficiently rough horizontal surface with charge q at the same horizontal level as that of the centre of the ring. There exists uniform horizontal electric fields as shown.



Sufficiently rough to avoid slipping

At t = 0 the system is let free. (Given that qE = mg, $\pi = \frac{22}{7}$)

17. The magnitude of the friction force at t = 0 is

(A) mg (B) $\sqrt{2}$ mg (C) 0 (D) $\frac{mg}{2}$

18. Work done by the electric field when the ring has rotated through 90° is

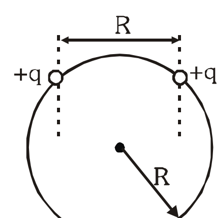
(A) $\frac{2}{7}mgR$ (B) $\frac{4}{7}mgR$ (C) – mgR (D) $mg\sqrt{2}R$

19. Speed of the centre of mass of the system after 90° rotation is

(A) $\sqrt{\frac{11}{28}Rg}$ (B) $\sqrt{\frac{2}{28}Rg}$ (C) $\sqrt{\frac{4}{28}Rg}$ (D) $\sqrt{\frac{11}{56}Rg}$

Paragraph for Question No. 20 & 21

A smooth circular wire track of radius R and mass m is lying in gravity free space. Two small conduting rings each of charge +q and mass m which can slide freely on circular track are released from rest when shortest distance between them is 'R' as shown in figure. At the instant when the two rings come to diametrically opposite points



20. Displacement of wire track is

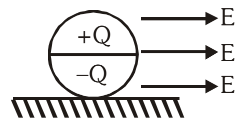
(A) $\frac{R}{2}$ (B) $\frac{R}{\sqrt{3}}$ (C) $\frac{\sqrt{3}}{2}R$ (D) zero

21. Velocity of wire track is

(A) $\sqrt{\frac{q^2}{6\pi \epsilon_0 mR}}$ (B) $\frac{q}{\sqrt{24\pi \epsilon_0 mR}}$ (C) $\frac{q}{\sqrt{8\pi \epsilon_0 mR}}$ (D) $\frac{q}{\sqrt{16\pi \epsilon_0 mR}}$

Paragraph for Question 22 to 24

A uniform disc of mass m and radius R is made up of two halves, one half has charge +Q uniformly distributed over it & another half has charge –Q uniformly distributed over it. This system is kept on rough surface in a uniform horizonal field E in a way so that line of seperation become parallel to field, system is released from rest, at t = 0 as shown in figure.



22. Torque of the electrostatic force about centre of mass at t = 0 is-

(A) $\frac{8QER}{3\pi}$ (B) $\frac{QER}{9}$ (C) $\frac{16QER}{9\pi}$ (D) QER

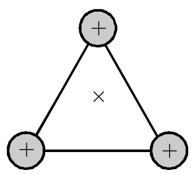
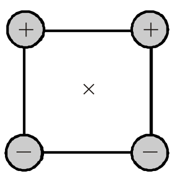
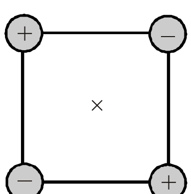
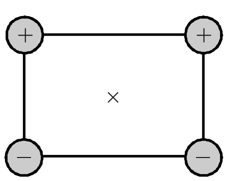
23. Acceleration of centre of the disc at t = 0, if friction is sufficient to prevent slippling, is-

(A) $\frac{4QE}{9\pi m}$ (B) $\frac{8QE}{9\pi m}$ (C) $\frac{16QE}{9\pi m}$ (D) $\frac{2QE}{3m}$

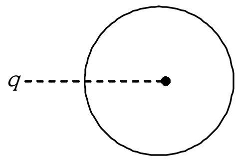
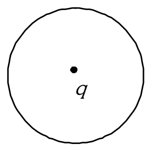
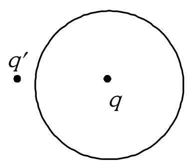
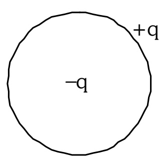
24. Minimum value of coefficient of friction to prevent slippling at t = 0, is-

(A) $\frac{4QE}{9\pi mg}$ (B) $\frac{8QE}{9\pi mg}$ (C) $\frac{16QE}{9\pi mg}$ (D) $\frac{2QE}{3mg}$

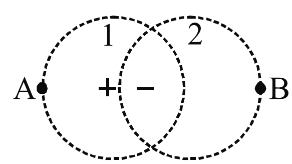
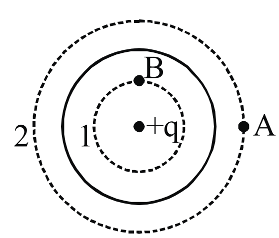
25. In the following diagrams, all the charges have equal magnitude

Column-I	**Column-II**
(A)  Equilateral triangle	(P) The potential is zero at the centre
(B)  Square	(Q) The electric field is zero at the centre
(C)  Square	(R) The electric field at a point on the axis passing through the centre perpendicular to the plane of the figure is along the axis.
(D)  Rectangle	(S) The electric field at a point on the axis passing through the centre perpendicular to the plane of the figure is perpendicular to the axis.
	(T) The potential energy of the system is negative.

26. Column I shows a hollow neutral spherical conductor in different situation. Match the situation of column I with column II.

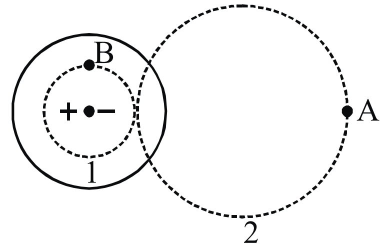
	Column I		**Column II**
(A)		(P)	$\vec{E}$ inside the cavity of conductor is zero.
(B)		(Q)	$\lvert\vec{E}\rvert$ outside the conductor is varying.
(C)		(R)	$\lvert\vec{E}\rvert$ inside the cavity of conductor is varying
(D)	 Given charge on conductor is +q and –q is kept at the centre.	(S)	Potential inside the cavity of conductor is varying
		(T)	Potential inside the cavity of conductor is uniform.

27. Dotted surfaces are Gaussian surfaces and solid surfaces are material bodies. All the surfaces are spherical.

	Column I		**Column II**
(A)	Electric field at point A is zero.	(P)	A dipole is placed as shown 
(B)	Electric field at point B is zero.	(Q)	A point charge kept at centre of neutral conducting shell as shown 

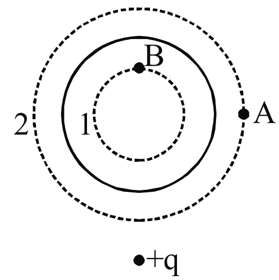
(C) Flux through surface 1 is zero

(R) A dipole kept at centre of neutral conducting shell as shown

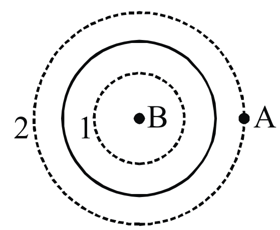


(D) Flux through surface 2 is zero

(S) A point charge kept outside of neutral conducting shell as shown



(T) Non-conducting shell carrying non-uniformly distributed +ve charge.

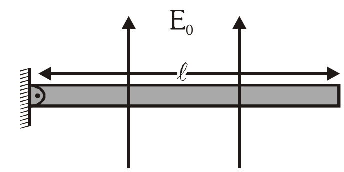


EXERCISE # (S)

1. A nonconducting disc of radius R and uniform positive surface charge density σ is placed on the ground with its axis vertical. A particle of specific charge $\frac{q}{m} = \frac{4 \in_0 g}{\sigma}$ is dropped along the axis of the disc from a height h. The value of h if the particle just reaches the disc is $\left(2\sqrt{\frac{R}{3}}\right)^m$. Determine the value of m.

2. A ball of mass 2 kg having charge 1 μC is dropped from the top of a very high tower. In space electric field exist in horizontal direction away from tower which varies as $E = (5-2x)\times 10^6$ V/m (where x is horizontal distance from tower). Find the maximum horizontal distance (in m) ball can go from the tower. (no air resistance)

3. A thin insulating rod is hinged about one of its ends. It can rotate on a smooth horizonal surface. The charge density on the rod is defined as

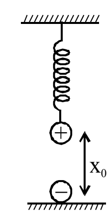


$\lambda = 15x^2,\ 0 < x \le \frac{\ell}{2}\ = -\,bx^n,\ \frac{\ell}{2} < x \le \ell$

where b is a positive constant.

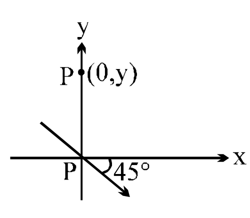
An electric field E_0 in the horizontal direction and perpendicular to the rod is switched on. Find the value of $(b+n)^2$, if the rod has to remain stationary.

4. A positive charged sphere of mass m = 5 kg is attached by a spring of force constant $K = 10^4$ N/m. The sphere is tied with a thread so that the spring is in its natural length. Another identical, negatively charged sphere is fixed to the floor, vertically below the positively charged sphere as shown in figure. Initial seperation between spheres is $x_0 = 0.5$ m. Now thread is burnt and maximum elongation of the spring is 0.1 m. If charge on each sphere is $(\alpha \times 25)$ μC then find the value of α.



Initial position

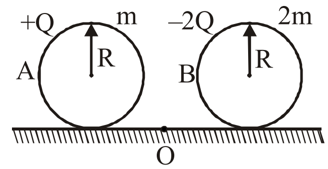
5. A dipole is placed at origin of coordinate system as shown in figure, find the electric field at point P (0, y).



6. Electric dipole of moment $P = P\,\hat{i}$ is kept at a point (x,y) in an electric field, $E = 4\,xy^2\,\hat{i} + 4\,x^2y\,\hat{j}$. Find the forces on the dipole.

7. A positively charged particle starts at rest 25cm from a second positively charged particle which is held stationary throughout the experiment. The first particle is released and accelerates directly away from the second particle. When the first particle has moved 25cm, it has reached a velocity of $10\sqrt{2}$ m/s. What is the maximum velocity (in m/s) that the first particle will reach ?

8. A hollow non conducting sphere A and a solid non conducting sphere B of equal radius 'R' and masses m and 2m are kept at a large distance apart on a rough horizontal surface. Charge on the two spheres A and B are Q and –2Q respectively. Charges are distributed uniformly and remain constant and uniform as the spheres come closer. Friction is sufficient to support pure rolling and the kinetic energy of the two spheres just before collision is K_A and K_B.



Find $100 \times \dfrac{K_A}{K_B}$.

ANSWER KEY

EXERCISE # (O)

1. Ans. (A)	**2. Ans. (C)**	**3. Ans. (C)**	**4. Ans. (B)**
5. Ans. (C)	**6. Ans. (A)**	**7. Ans. (C)**	**8. Ans. (A, B, D)**
9. Ans. (A, D)	**10. Ans. (A, B, C, D)**	**11. Ans. (A,B)**	**12. Ans. (A,C,D)**
13. Ans. (B,D)	**14. Ans. (B,C)**	**15. Ans. (ACD)**	**16. Ans. (A,C)**
17. Ans. (C)	**18. Ans. (B)**	**19. Ans. (A)**	**20. Ans. (B)**
21. Ans. (A)	**22. Ans. (A)**	**23. Ans. (C)**	**24. Ans. (C)**

25. Ans. (A) $\rightarrow$ (Q,R) ; (B) $\rightarrow$ (P,S,T) ; (C) $\rightarrow$ (P,Q,T) ; (D) $\rightarrow$ (P,S)

26. Ans. (A) $\rightarrow$ (P,Q,T) ; (B) $\rightarrow$ (Q,R,S) ; (C) $\rightarrow$ (Q,R,S) ; (D) $\rightarrow$ (R,S)

27. Ans. (A) $\rightarrow$ (R) ; (B) $\rightarrow$ (S) ; (C) $\rightarrow$ (P,R,S,T) ; (D) $\rightarrow$ (S)

EXERCISE # (S)

1. Ans. 2

2. Ans. 5

3. Ans. 9

4. Ans. 4

5. Ans. $\frac{kP}{\sqrt{2}\,y^3}(-\hat{i}-2\hat{j})$

6. Ans. $4\,py\ (y^2+4x^2)^{1/2}$

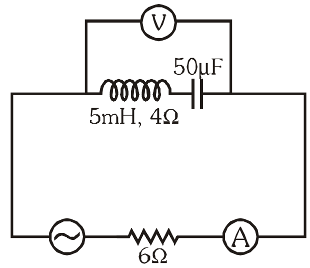
7. Ans. V_{max} = 20 m/s

8. Ans. 168

EMI & AC

EXERCISE # (O)

1. In the circuit shown in the figure, the A.C. source gives a voltage $V = 20 \cos(2000\,t)$ volt. Neglecting source resistance, the voltmeter and ammeter readings will be :–

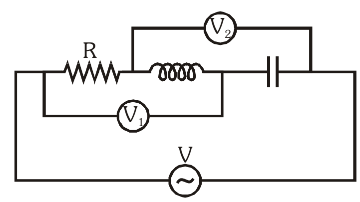


(A) 0V, 2A (B) 0 V, 1.4A (C) 5.6 V, 0.47 A (D) 1.68 V, 0.47 A

2. An AC source producing e.m.f. $V = V_0 (\sin\omega t + \sin 3\omega t)$ is connected in series with a capacitor and a resistor. The current in the circuit is found to be $i = i_1 \sin(\omega t + \phi_1) + i_2 \sin(3\omega t + \phi_2)$. Then

(A) $i_1 > i_2$ (B) $i_1 = i_2$ (C) $i_1 < i_2$ (D) any of the above may be true

3. In a RLC series circuit shown, the readings of voltmeters V_1 and V_2 are 100 V and 120 V, respectively. The source voltage is 130 V. For this situtation mark out the correct statement (s)



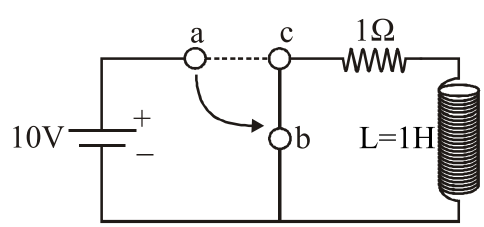
(A) Voltage across resistor, inductor and capacitor are 50 V, 86.6 V and 206.6 V, respectively

(B) Voltage across resistor, inductor and capacitor are 10 V, 90 V and 30 V, respectively

(C) Power factor of the circuit is $\frac{5}{13}$

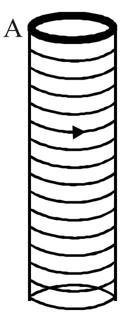
(D) Circuit is capactivite in nature

4. In the given circuit, the switch is closed to the position bc from the earlier position of ac at $t = 0$. The current in the inductor after 2s of closing the switch between b and c is



(A) $\frac{1}{10e^2}$ A (B) $10e^{-2}$ A (C) 10e A (D) $10e^2$ A

5. Two metallic rings A and B, identical in shape and size but having different resistivities ρ_A and ρ_B, are kept on top of two identical solenoids as shown in the figure. When current I is switched on in both the solenoids in identical manner, the rings A and B jump to heights h_A and h_B, respectively, with $h_A > h_B$. The possible relation(s) between their resistivities and their masses m_A and m_B is(are) **[JEE-2009]**



(A) $\rho_A > \rho_B$ and $m_A = m_B$ (B) $\rho_A < \rho_B$ and $m_A = m_B$

(C) $\rho_A > \rho_B$ and $m_A > m_B$ (D) $\rho_A < \rho_B$ and $m_A < m_B$

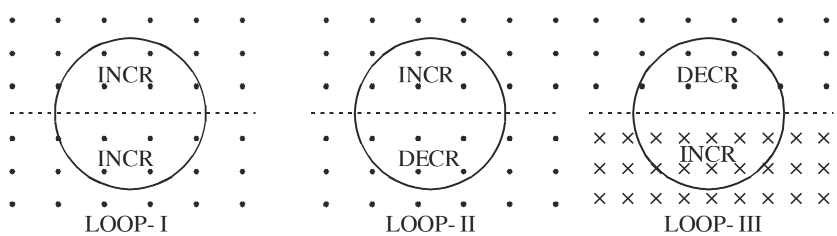
6. A rod of length ℓ is oscillating as a physical pendulum about one of its end with small angular amplitude α in a crossed magnetic field B. The maximum emf induced in the rod will be

(A) $B\alpha\sqrt{\frac{1}{2}g\ell^3}$ (B) $B\alpha\sqrt{\frac{3}{8}g\ell^3}$ (C) $B\alpha\sqrt{\frac{1}{3}g\ell^3}$ (D) $B\alpha\sqrt{g\ell^3}$

7. A flexible wire loop in the shape of a circle has a radius that grows linearly with time. There is a magnetic field perpendicular to the plane of the loop that has a magnitude inversely proportional to the distance from the centre of loop i.e. $B(r) \propto \frac{1}{r}$. How does the emf E vary with time?

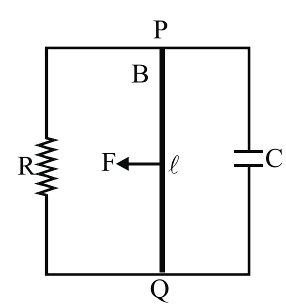
(A) $E \propto t^2$ (B) $E \propto t$ (C) $E \propto \sqrt{t}$ (D) E is constant

8. Three identical conducting circular loops are placed in uniform magnetic fields. Inside each loop, there are two magnetic field regions, separated by dashed line that coincides with a diameter, as shown. Magnetic fields may either be increasing (marked as INCR) or decreasing (marked as DECR) in magnitude at the same rates. If I_A, I_B and I_C are the magnitudes of the induced currents in the loops I, II and III respectively then



(A) $I_A > I_B = I_C$ (B) $I_A = I_C > I_B$ (C) $I_A = I_B = I_C$ (D) $I_C > I_A > I_B$

9. A conducting rod PQ of length ℓ is dogged with a constant force F along two smooth parallel rails separated by a distance ℓ as shown in the adjacent figure. Then choose the correct statement(s).



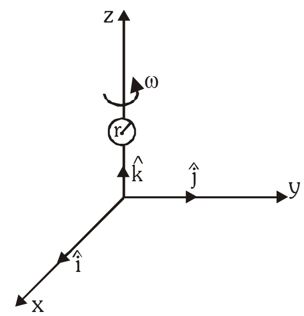
(A) terminal velocity of the rod, $v_t = \frac{2FR}{B^2\ell^2}$

(B) terminal velocity of the rod, $v_t = \frac{FR}{B^2\ell^2}$

(C) maximum charge on the capacitor, $q_{\max} = \frac{FCR}{B\ell}$

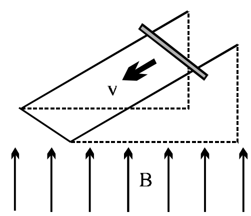
(D) maximum charge on the capacitor, $q_{\max} = \frac{2FCR}{B\ell}$

10. A circular loop wire of radius r rotates about the z–axis with angular velocity ω. The normal to the loop is always perpendicular to the z–axis. At time t=0, the normal is parallel to the y–axis. An external magnetic field $\vec{B} = B_y\hat{j} + B_z\hat{k}$ is applied. The EMF $\varepsilon(t)$ induced in the loop is



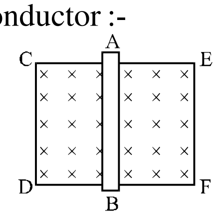
(A) $\pi r^2 \omega B_y \sin\omega t$
(B) $\pi r^2 \omega B_z \cos\omega t$
(C) $\pi r^2 \omega B_z \sin\omega t$
(D) $\pi r^2 \omega B_y \cos\omega t$

11. A conducting bar rolls down a slope made of conducting rails. The bottom ends of the rails are connected by another conducting rail as shown in the figure. There is a uniform magnetic field B pointing upward. Due to the bar's motion, there is an induced current in the bar-rail circuit. What is the direction of the magnetic force on the bar ?



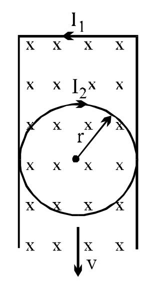
(A) Up along the slope
(B) Down the slope
(C) Towards left (horizontal)
(D) Towards right (horizontal)

12. A resistanceless conductor moves in uniform magnetic field on a uniform rectangular loop of resistance R with constant velocity. In moving from CD to EF, current through conductor :-



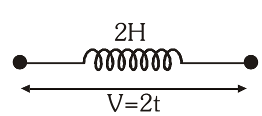
(A) increases & then decreases
(B) decreases & then increases
(C) remains constant
(D) decreases continuously

13. Figure shows a uniform cross-sectional conducting ring of radius r and total resistance R in contact with two vertical conducting rails, which are joined at the top. The rails have no friction and resistance. There is a uniform magnetic field B perpendicular to the plane of rails. If ring falls with the velocity v, then



(A) $I_1 = O;\ I_2 = \dfrac{4Bvr}{R}$
(B) $I_1 = \dfrac{4Bvr}{R};\ I_2 = O$
(C) $I_1 = \dfrac{4Bvr}{R},\ I_2 = \dfrac{2Bvr}{R}$
(D) None

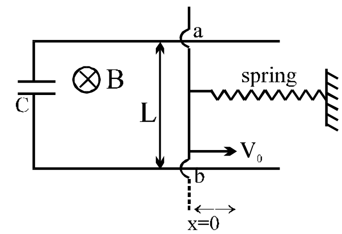
14. A time varying voltage V = 2t volt is applied across an ideal inductor of inductance L = 2H as shown in figure. Then select incorrect statement



(A) current versus time graph is a parabola
(B) energy stored in magnetic field at t = 2 s is 4J
(C) potential energy at time t = 1 s in magnetic field is increasing at a rate of 1 J/s
(D) energy stored in magnetic field is zero all the time

Paragraph for Question No. 15 to 17 (3 questions)

The conducting connector ab mass m and length L can freely slide on a horizontal long conducting parallel rails connected by capacitor C at one ends (as shown in figure). A non conducting light spring (spring const. K) connected to the connector ab and it is in a relaxed state. The whole system is placed in uniform magnetic field of strength B directed into the plane of rails (as shown in figure) Now at time t = 0, connector is suddenly given a velocity V_0 in rightward direction. If resistance of circuit is negligible then



15. The acceleration of connector as a function of x

(A) $\frac{Kx}{m}$ (B) $\frac{Kx}{m-B^2L^2C}$ (C) $\frac{Kx}{m+B^2L^2C}$ (D) none

16. The rod will execute (after projecting it at t = 0)

(A) SHM

(B) harmonic motion but not SHM

(C) The rod will come at rest at certain position then afterward it will not move

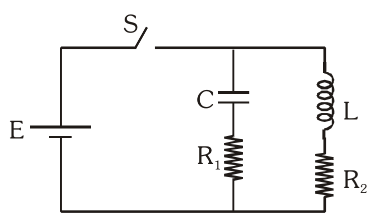
(D) none of these

17. The maximum compression in the spring

(A) $V_0\sqrt{\frac{m-B^2L^2C}{K}}$ (B) $V_0\sqrt{\frac{m+B^2L^2C}{K}}$ (C) $V_0\sqrt{\frac{m}{K}}$ (D) none

Paragraph for Question No. 18 to 20

In the circuit shown in figure E=25V, L=2H, C=60 μF, R_1 = 5Ω and R_2 = 10Ω. Switch S is closed at t = 0.



18. Current through R_1 at t = 0 is

(A) 0 (B) 5 A (C) 2.5 A (D) 4A

19. Current through R_1 at t = ∞ is

(A) 0 (B) 5 A (C) 2.5 A (D) 4A

20. Current through R_2 at t = ∞ is

(A) 0 (B) 5 A (C) 2.5 A (D) 4A

Paragraph for Question No. 21 & 22

An inductor of inductance 2.0 mH is connected across a charged capacitor of capacitance 5 μF and the resulting L–C circuit is set oscillating at its natural frequency. Let Q denote the instantaneous charge on the capacitor and i the current in the circuit. It is found that the maximum value of Q is 200μC.

21. When Q = 100 μC, the value of $\left|\frac{di}{dt}\right|$ is

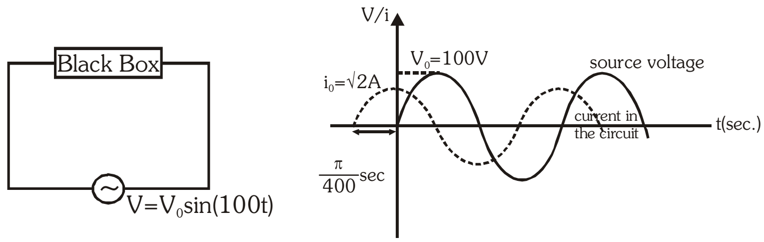
(A) zero (B) 10^4 A/s (C) 10^{-4} A/s (D) 10^2 A/s

22. When i is half of its maximum value, the value of $|Q|$ is

(A) $\sqrt{3}$ C (B) $\sqrt{3} \times 10^{-8}$ C (C) $\sqrt{3} \times 10^{-4}$ C (D) 100 C

Paragraph for Question No. 23 to 25

A voltage source $V = V_0 \sin(100\,t)$ is connected to a black box in which there can be either one element out of L,C,R or any two of them connected in series.



At steady state the variation of current in the circuit and the source voltage are plotted together with time, using an oscilloscope, as shown.

23. The element(s) present in black box is/are :

(A) only C (B) LC (C) L and R (D) R and C

24. Values of the parameters of the elements, present in the black box are :

(A) R = 50Ω, C=200 μF (B) R = 50Ω, L = 2mH

(C) R = 400 Ω, C = 50μF (D) None of these

25. If AC source is removed, the circuit is shorted and then at t=0, a battery of constant EMF is connected across the black box. The current in the circuit will-

(A) Increases exponentially with constant = 0.02 sec.

(B) Decrease exponentially with time constant = 0.01 sec.

(C) Oscillate with angular frequency 20 sec^{-1}

(D) First increase and then decrease.

Paragraph for Question No.26 & 27 (2 questions)

A student constructs a series RLC circuit. While operating the circuit at a frequency f, he uses an AC voltmeter and measures the potential difference across each device as $(\Delta V_R)_{max} = 4.8$ V, $(\Delta V_L)_{max} = 29$ V, and $(\Delta V_C)_{max} = 20$ V.

26. How should the frequency of this circuit be changed to increase the current i_m through the circuit?

(A) Increase f

(B) Decrease f

(C) The current is already at a maximum

(D) There is not enough information to answer the question

27. What will happen to the value of $(\Delta V_L)_{max}$ if the frequency is adjusted to increase the current through the circuit?

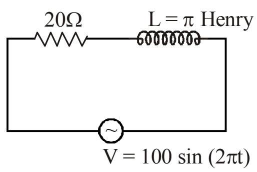
(A) $(\Delta V_L)_{max}$ will increase

(B) $(\Delta V_L)_{max}$ will decrease

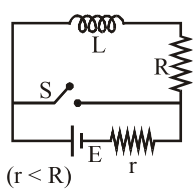
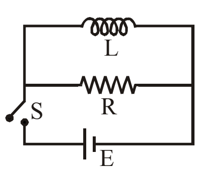
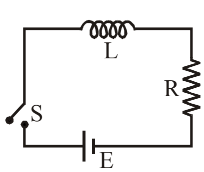
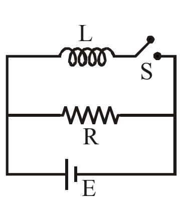
(C) $(\Delta V_L)_{max}$ will remain the same regardless of any changes to f.

(D) The current is already at a maximum

28. In column-I a situation is shown. Column-II has different values of phase difference. Match them [Take $\pi^2 = 10$ wherever required]

Column-I	Column-II
(A) Phase difference between current through circuit and voltage across source 	(P) $\frac{\pi}{3}$
(B) Two pendulum of length 1m and 4m start oscillating in same phase. The phase difference between them after 1 sec. is.	(Q) $\frac{\pi}{4}$
(C) A progressive wave of frequency 100 Hz is travelling in a taut string with tension 100N and mass/length 10gm/m. The phase difference between two points at a distance of 0.5m.	(R) $\frac{\pi}{2}$
	(S) π

29. In column–I some circuit are given. In all the circuits except in (A) switch S remains closed for long time and then it is opened at t = 0 while for (A), the situation is reversed. Column–II tells something about the circuit quantities. Match the entries of column–I with the entries of column–II.

Column-I	Column-II
(A) 	(P) Voltage across inductor can be greater than E at t =0.
(B) 	(Q) Voltage across inductor would be less than E at t =0.
(C) 	(R) After long time, energy stored in inductor is zero.
(D) 	(S) After long time, energy sotred in inductor is non-zero
	(T) Voltage across inductor increases as time progress.

EXERCISE # (S)

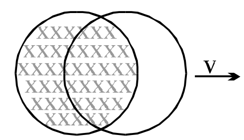
1. A uniform but time varying magnetic field B = C – Kt, where K & C are positive constants and t is time (in seconds), is applied perpendicular to the plane of a circular loop of radius 'a' and resistance R. Find the total charge (in coulomb) that will pass through any point of the loop by the time B becomes zero. [Given a = 2m, R = $\pi\Omega$, C = 2T]

2. A conducting disc of conductivity σ has a radius a and thickness t. If the magnetic field B is applied in a direction perpendicular to the plane of the disc, changes with time at the rate of $\frac{dB}{dt} = \alpha$. Calculate the power dissipated (in mW) in the disc due to the induced current.

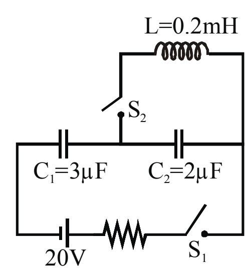
[Take : α =2 T/s, a = 1 cm, t = 2mm and $\sigma = \frac{4}{\pi}\times 10^8\ \Omega^{-1}m^{-1}$]

3. Two identical coils 1 and 2 lie closed to each other such that 50% of the magnetic flux generated by one links with the other. A current of 1 A in coil (1) generate in it flux of 10^{-5} Wb. If this current is reversed in 0.1 sec., determine the average induced emf in coil 2. Also calculate self inductances of coils and mutual inductance between them.

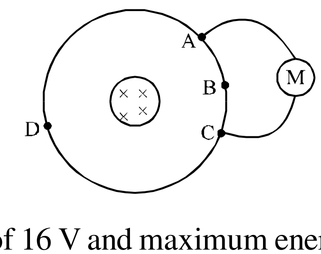
4. A uniform magnetic field exists in a circular region of radius R. A loop of radius R encloses the magnetic field at t = 0 and then pulled at uniform speed v in the plane of the paper. The direction of the induced current is _______. Find the induced emf in the loop as a function of time.



5.. The circuit shown in figure is in the steady state with switch S_1 closed and S_2 to open. At t =0, S_1 is opened and S_2 is closed. The first instant t, when the energy in the inductor becomes one-third of that in the capacitor C_2 is $\frac{\pi}{\alpha}$ millisecond. Find the value of α.



6. A variable magnetic field creates a constant emf E in a conductor ABCDA. The resistances of portion ABC, CDA and AMC are R_1, R_2 and R_3 respectively. What current will be shown by meter M? The magnetic field is concentrated near the axis of the circular conductor.



7. The inductor in a L–C oscillation has a maximum potential difference of 16 V and maximum energy of 160 μJ. Find the value of capacitor in pF in L–C circuit.

8. An LCR series circuit with 100Ω resistance is connected to an AC source of 200V and angular frequency 300 rad/s. When only capacitance is removed, the current lags behind the voltage by 60°. When only the inductance is removed the current leads the voltage by 60°. Calculate the power dissipated in watt in the LCR circuit.

ANSWER KEY

EXERCISE # (O)

1. Ans. (B,C)	**2. Ans. (C)**	**3. Ans. (A,C,D)**	**4. Ans. (B)**
5. Ans. (B, D)	**6. Ans. (B)**	**7. Ans. (D)**	**8. Ans. (B)**
9. Ans. (B,C)	**10. Ans. (A)**	**11. Ans. (D)**	**12. Ans. (B)**
13. Ans. (C)	**14. Ans. (D)**	**15. Ans. (C)**	**16. Ans. (A)**
17. Ans. (B)	**18. Ans. (B)**	**19. Ans. (A)**	**20. Ans. (C)**
21. Ans. (B)	**22. Ans. (C)**	**23. Ans. (D)**	**24. Ans. (A)**
25. Ans. (B)	**26. Ans. (B)**	**27. Ans. (B)**	

28. Ans. (A) $\rightarrow$ (Q) ; (B) $\rightarrow$ (R) ; (C) $\rightarrow$ (S)

29. Ans. (A) $\rightarrow$ (Q,R) ; (B) $\rightarrow$ (S) ; (C) $\rightarrow$ (S) ; (D) $\rightarrow$ (S)

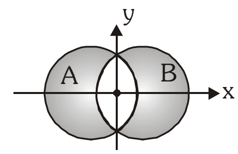
EXERCISE # (S)

1. **Ans. 8**
2. **Ans. 4**
3. **Ans.** $L = 10\ \mu H$, $V = 100\ \mu V$, $M = 5\ \mu H$
4. **Ans.** clockwise, $BV\sqrt{4R^2 - v^2t^2}$
5. **Ans. 300**
6. **Ans.** $\dfrac{E\,R_1}{R_1R_2 + R_2R_3 + R_3R_1}$
7. **Ans. 125 or 1250**
8. **Ans. 400**

MAGNETIC EFFECT OF CURRENT

EXERCISE # (O)

1. Two cylindrical straight and very long non magnetic conductors A and B, insulated from each other, carry a current I in the positive and the negative z–direction respectively. The direction of magnetic field at origin is :–



(A) $-\hat{i}$ (B) $+\hat{i}$ (C) $\hat{j}$ (D) $-\hat{j}$

2. A particle of positive charge q and mass m enters with velocity $V\hat{j}$ at the origin in a magnetic field $B(-\hat{k})$ which is present in the whole space. The charge makes a perfectly inelastic collision with identical uncharged particle at rest but free to move at its maximum y-coordinate. After collision the combined charge will move on trajectory: (where $r = \frac{mV}{qB}$) [Neglect earth's gravity]

(A) $y = \frac{mV}{qB}(-\hat{i})$ (B) $(x+r)^2 + (y-r/2)^2 = r^2/4$

(C) $(x-r)^2 + (y-r)^2 = r^2$ (D) $(x-r)^2 + (y+r/2)^2 = r^2/4$

3. Current I is flowing along the path ABCD, along the four edges of the cube (figure-a), creates a magnetic field in the centre of the cube of B_0. Find the magnetic field B created at the center of the cube by a current I flowing along the path of the six edges ABCGHEA (figure-b)

(A) $\sqrt{\frac{3}{2}} B_0$ Towards corner G

(B) $\sqrt{3} B_0$ Towards corner E

(C) $\sqrt{\frac{3}{2}} B_0$ Towards corner H

(D) $\sqrt{3} B_0$ Towards corner F

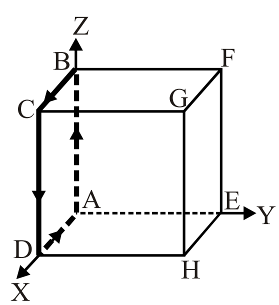


Figure-(a)

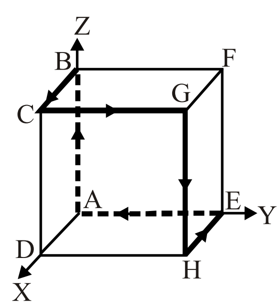
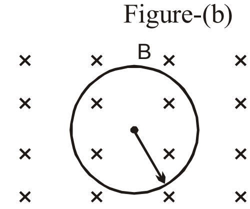


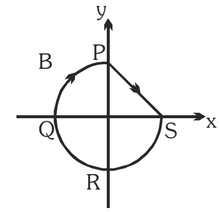
Figure-(b)

4. A non conducting ring (of mass m, radius r, having charge Q) is placed on a rough horizontal surface (in a region with transverse magnetic field). The field is increasing with time at the rate R and coefficient of friction between the surface and the ring is μ. For ring to remain in equilibrium μ should be greater than



(A) $\frac{QrR}{mg}$ (B) $\frac{QrR}{2mg}$ (C) $\frac{QrR}{3mg}$ (D) $\frac{2QrR}{mg}$

5. A current carrying loop is placed in a uniform magnetic field pointing in negative z direction. Branch PQRS is a three quarter circle, while branch PS is straight. If force on branch PS is F, force on branch PQR is

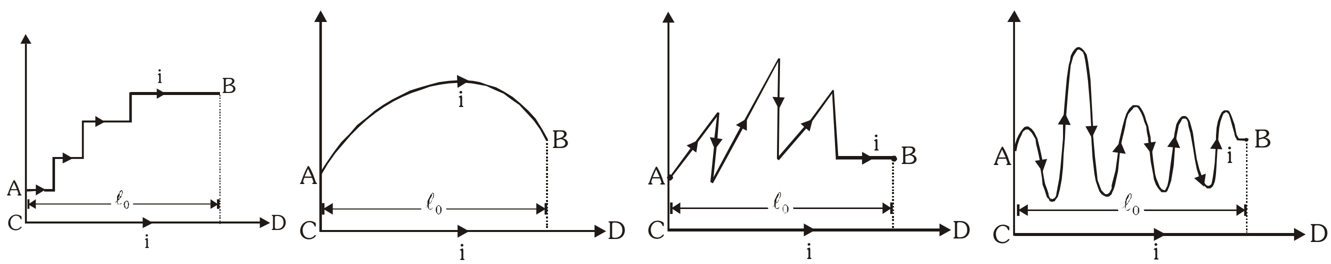


(A) $\sqrt{2}\,F$ (B) $\frac{F}{\sqrt{2}}$ (C) $\frac{\pi F}{\sqrt{2}}$ (D) $\sqrt{2}\,\pi F$

6. A straight wire of length L carries a current I in the positive z direction in a region where the magnetic field is uniform and specified by $B_x = 3B$, $B_y = -2B$, and $B_z = B$, where B is a constant. What is the magnitude of the magnetic force on the wire?

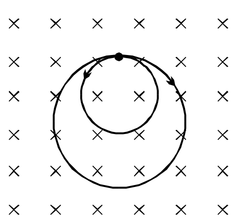
(A) 1.0 ILB (B) 5.0 ILB (C) 3.6 ILB (D) 4.2 ILB

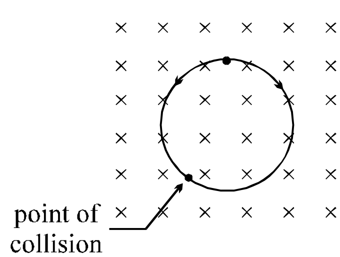
7. Figure shows a pair of wires AB and CD in four different configurations carrying the same current i. The force acting on the wire AB in each configuration is

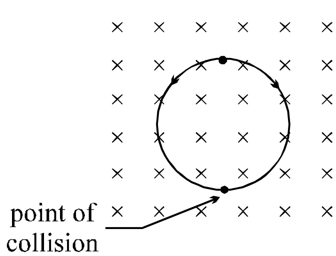


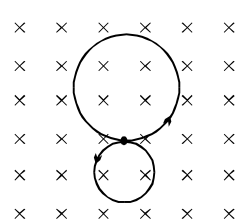
(A) zero (B) same
(C) different in magnitude & direction (D) different in direction only.

8. A neutral particle at rest in a magnetic field decays into two charged particles of different mass. The energy released goes into their kinetic energy. Then what can be the path of the two particles. Neglect any interaction between the two charges.

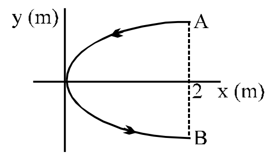
(A)


(B)


(C)


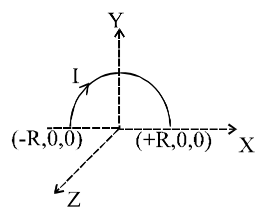
(D)


9. A conducting wire bent in the form of a parabola $y^2 = 2x$ carries a current $i = 2$ A as shown in figure. This wire is placed in a uniform magnetic field $\vec{B} = -4\hat{k}$ Tesla. The magnetic force on the wire is (in newton)



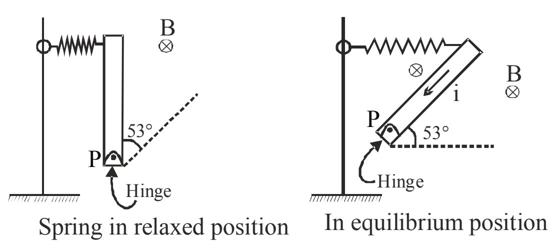
(A) $-16\hat{i}$ (B) $32\hat{i}$ (C) $-32\hat{i}$ (D) $16\hat{i}$

10. A semi circular current carrying wirehaving radius R is placed in x-y plane with its centre at origin 'O'. There is non-uniform magnetic field $\vec{B} = \frac{B_o x}{2R}\hat{k}$ (here B_o is +ve constant) is existing in the region. The magnetic force acting on semi circular wire will be along



(A) – x-axis (B) + y-axis (C) – y-axis (D) + x-axis

11. A thin uniform rod with negligible mass and length ℓ is attached to the floor by a frictionless hinge at point P. A horizontal spring with force constant k connects the other end to wall. The rod is in a uniform magnetic field B directed into the plane of paper. What is extension in spring in equilibrium when a current *i* is passed through the rod in direction shown. Assuming spring to be in natural length initially.



(A) $\frac{5i\ell B}{8k}$ (B) $\frac{3i\ell B}{8k}$ (C) $\frac{5i\ell B}{4k}$ (D) $\frac{5i\ell B}{6k}$

12. A long straight wire carries a constant current I. A north pole of unit strength is moved along a circular path whose axis coincides with the wire. The work done by magnetic field is(in one rotation).
(A) $\mu_0 I$ (B) 0 (C) $\mu_0 I/2\pi$ (D) data is insufficient

Paragraph for question nos. 13 to 15

If the velocity of a charged particle moving through a uniform magnetic field has a component parallel to that field the particle will move in a helical path as shown in figure 1. The net force F on the particle can be described by the equation.

$$F = qvB\sin\theta$$

where q is the charge on the particle, v is the velocity of the charge, B is the magnetic field strength, and θ is the angle between the velocity and the magnetic field. The pitch p of the helix is the distance between adjacent turns. The radius r of the helix is determined by the component of velocity of the charge perpendicular to the magnetic field and is independent of the component of the velocity parallel to the magnetic field.

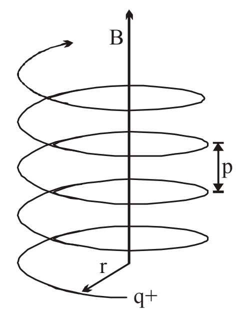


Figure 1

A nonuniform magnetic field that is stronger at its ends than at its middle can trap a charged particle by reflecting it back and forth between ends. Such a situation is shown in figure 2.

In a similar phenomenon electrons and protons above the atmosphere are reflected back and forth between the north and south poles of the earth's magnetic field forming the two Van Allen belts high above the atmosphere. Occasionally a solar flare shoots additional electrons and protons into the Van Allen belts. This pushes the electrons to a lesser height. The repulsion due to additional electrons drives the charged particles along the earth's magnetic field lines into the atmosphere where they collide with the air molecules forcing them to a higher energy level emitting photons. Oxygen atoms emit green light and nitrogen atoms emit pink. This light forms the curtain of lights in the sky known in the northern hemisphere as the aurora borealis

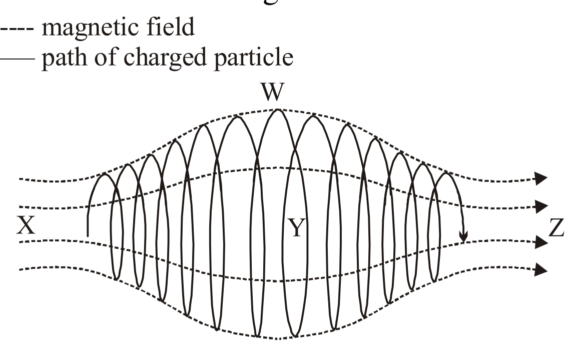


Figure 2 : Path of a charged particle trapped in a changing magnetic field

13. If the magnetic field in figure-2 represents a portion of the Earth's magnetic field, at which labelled point would you except to find the aurora borealis?

(A) W (B) X (C) Y (D) Z

14. Which of the following most accurately describes the change in the pitch and period of the helical path traveled by a negatively charged particle moving through a magnetic field that is gradually increasing?

(A) The pitch increases and the period decreases

(B) The pitch increases and the period increases

(C) The pitch decreases and the period remains the same

(D) Both the pitch and the period decrease.

15. The electrons and protons caught in the Van Allen belt reflect from one pole to the other. Looking up from the North pole, if electrons rotate counterclockwise then protons rotate

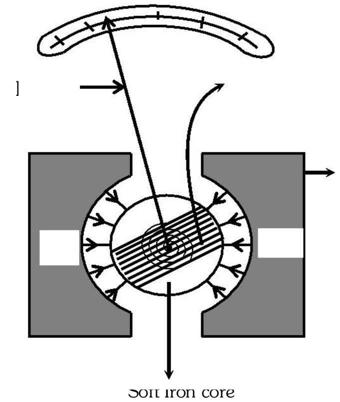
(A) counterclockwise both when looking up from the north pole or when looking up from the south pole.

(B) clockwise both when looking up from the north pole of when looking up from the south pole.

(C) clockwise when looking up from the north pole but counterclockwise when looking up from the south pole.

(D) counterclockwise when looking up from the north pole but clockwise when looking up from the south pole.

Paragraph for Question No. 16 to 18



Analog voltmeters and ammeters work by measuring the torque exerted by a magnetic field on a current carrying coil. The reading is displayed by means of the deflection of a pointer over a scale. The adjacent figure shows the essentials of a galvanometer, on which both analog ammeters and analog voltmeters are based. Assume that the coil is 2.1 cm high, 1.2 cm wide, has 250 turns and is mounted so that it can rotate about an axis (into the page) in a uniform radial magnetic field with B = 0.23 T. For any orientation of the coil, the net magnetic field through the coil is perpendicular to the normal vector of the coil (and thus parallel to the plane of coil). A spring S_p provides a counter torque that balances the magnetic torque, so that a given steady current I in the coil results in a steady angular deflection ϕ. The greater the current is, greater the deflection is, and thus greater the torque required of the spring is. A current of 100 μA produces an angular deflection of 28°.

16. What must be the torsional constant K of the spring?

(A) 2.6×10^{-8} Nm/degree
(B) 5.2×10^{-8} Nm/degree
(C) 2.6×10^{-4} Nm/degree
(D) 5.2×10^{-4} Nm/degree

17. If we reduce the value of this K to half of its value, then the deflection would be

(A) 28° (B) 56° (C) 14° (D) none of these

18. If the value of magnetic field is put equal to 0.69 T and K = 15.6×10^{-8} Nm/degree. Then, the deflection would be

(A) < 28° (B) =28° (C) 14° (D) none of these

Paragraph for Question No. 19 to 21

As a charged particle q moving with a velocity $\vec{v}$ enters a uniform magnetic field $\vec{B}$, it experiences a force $\vec{f} = q(\vec{v} \times \vec{B})$. For θ = 0º or 180º, θ being the angle between $\vec{v}$ and $\vec{B}$, force experienced is zero and the particle passes undeflected. For θ = 90º, the particle moves along a circular arc and the magnetic force (qvB) provides the necessary centripetal force $\left(\frac{mv^2}{r}\right)$. For other values of θ ($\theta \neq$ 0º, 180º, 90º), the charged particle moves along a helical path which is the resultant motion of simultaneous circular and translational motions.

Suppose a particle, that carries a charge of magnitude q and has a mass 4×10^{-15} kg, is moving in a region containing a uniform magnetic field $\vec{B} = -0.4\hat{k}T$. At a certain instant, velocity of the particle is $\vec{v} = (8\hat{i} - 6\hat{j} + 4\hat{k}) \times 10^6$ m/s and force acting on it has a magnitude 1.6 N.

Answer the following :

19. Which of the three components of acceleration have non–zero values ?

(A) x and y (B) y and z (C) z and x (D) x, y and z

20. Which of the following is correct ?

(A) motion of the particle is non–periodic but y and z – position co–ordinates vary in a periodic manner

(B) motion of the particle is non–periodic but x and y – position co–ordinates vary in a periodic manner

(C) motion of the particle is non–periodic but x and z – position co–ordinates vary in a periodic manner

(D) motion of the particle is periodic and all the position co–ordinates vary in a periodic manner

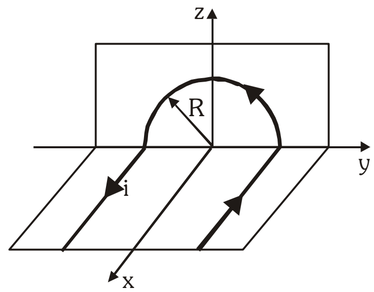
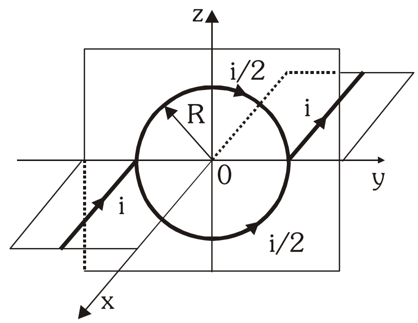
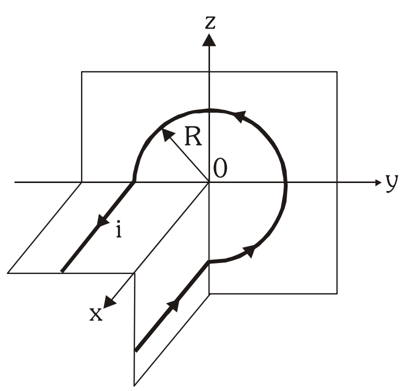
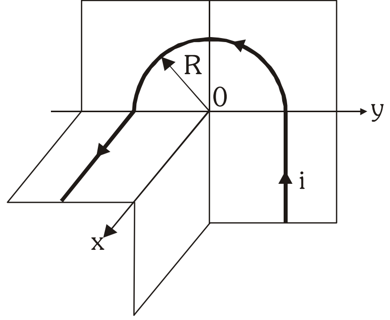
21. If the co–ordinates of the particle at t = 0 are (2m, 1m, 0), co–ordinates at a time t = 3T, where T is the time period of circular component of motion, will be

(A) (2m, 1m, 400m) (B) (0.142m, 120m, 0) (C) (2m, 1m, 1.884m) (D) (142m, 130m, 628m)

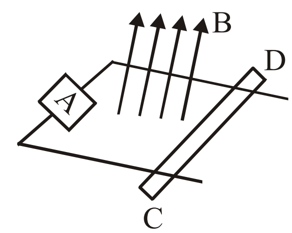
22. Column-I gives some current distributions and a point P in the space around these current distributions. Column-II gives some expressions of magnetic field strength. Match column-I to corresponding field strength at point P given in column-II

Column – I	**Column – II**
(A) A conducting loop shaped as regular hexagon of side x, carrying current i. P is the centroid of hexagon	(P) $\frac{3\mu_0 i}{32\pi x}$
(B) A cylinder of inner radius x and outer radius 3x, carrying current i. Point P is at a distance 2x from the axis of the cylinder	(Q) $\frac{\sqrt{3}\mu_0 i}{\pi x}$
(C) Two coaxial cylinders of radii x and 2x, each carrying current i, but in opposite is hollow. P is a point at distance 1.5x from the axis of the cylinders	(R) $\frac{\mu_0 i}{2x}$
(D) Magnetic field at the centre of an n-sided regular polygon, of circum circle of radius x, carrying current i, $n \to \infty$, P is centroid of the polygon.	(S) $\frac{\mu_0 i}{3\pi x}$

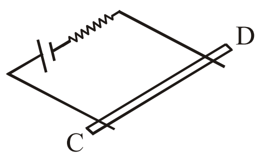
23. Column I shows four current configurations. Match each entry of column I with those axes in column II along which the magnetic field at origin has positive component.

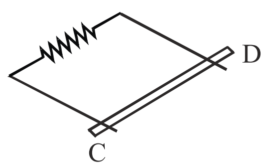
Column I		**Column II** [+ve component of magnetic field at origin]	
(A)		(P)	x
(B)		(Q)	y
(C)		(R)	z
(D)		(S)	None

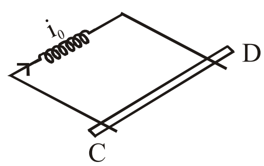
24. A homogeneous magnetic field B is perpendicular to a sufficiently long track of width ℓ which is horizontal. A frictionless rod of mass m straddles the two rail of the track as shown in the figure. Entire arrangement lies in horizontal plane. For the situation suggested in column-II match the appropriate entries in column-I. The rails are also resistanceless.



Column-I	Column-II
(A) A is a battery of emf V and internal resistance R. The conducting rod is initially at rest.	(P) Energy is dissipated during the motion.
(B) A is a resistance. The non-conducting rod is projected to the right with a velocity V_0	(Q) The rod moves with a constant velocity after a long time.
(C) A is an inductor having with initial current i_0. It is having no resistance and CD is a conducting rod.	(R) After a certain time interval rod will change its direction of motion.
(D) A is a resistance. The conducting rod is projected to the right with a velocity V_0.	(S) If a constant force is applied on the rod to the right, it can move with a constant velocity.
	(T) The rod stops after some time in absence of an external force.

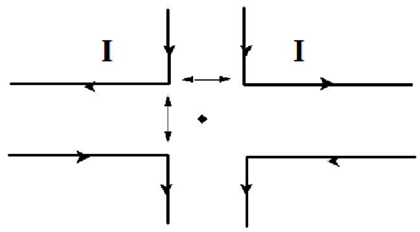




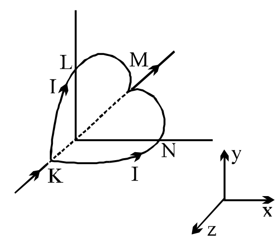


EXERCISE # (S)

1. Four infinitely long 'L' shaped wires , each carrying a current i have been arranged as shown in the figure. Obtain the magnetic field intensity at the point 'O' equidistant from all the four corners



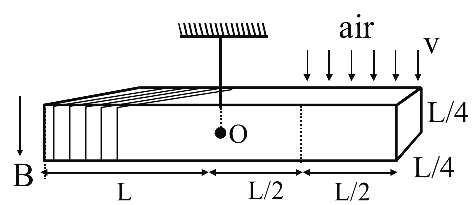
2. A circular loop of radius R is bent along a diameter and given a shape as shown in the figure. One of the semicircles (KNM) lies in the $x-z$ plane and the other one (KLM) in the $y-z$ plane with their centers at the origin . Current I is flowing through each of the semicircles as shown in figure .



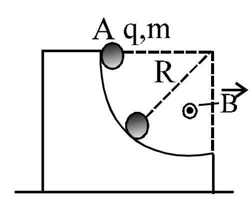
(i) A particle of charge q is released at the origin with a velocity $v = -v_0\hat{i}$. Find the instantaneous force f on the particle. Assume that space is gravity free.

(ii) If an external uniform magnetic field $B\hat{j}$ is applied, determine the forces F_1 and F_2 on the semicircles KLM and KNM due to this field and the net force F on the loop. **[JEE 2000 Mains, 4 + 6]**

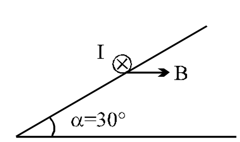
3. A non conducting non-magnetic rod having square cross-section of side L/4 is suspended from a rigid support as shown in the figure. A light and small coil of 600 turns is wrapped tightly at the left end of the rod where uniform magnetic field B exists in vertically downward direction. Air of density ρ hits the half of the right part of the rod with velocity v as shown in the figure. What should be the current (in mA) in the coil so that rod remains horizontal? [Assume air particles come to rest after colliding with the rod] [Take : $\rho = 1.05$ kg/m^3, v = 10 m/s, B = 1T, L = 2m]



4. In the figure a charged small sphere of mass m and the charge q starts sliding from rest on a vertical fixed circular smooth track of radius R from the position A shown. There exist a uniform magnetic field of B. Find the maximum force exerted by track on the sphere during its motion.



5. The figure shows a conductor of weight 1.0 N and length L = 0.5 m placed on a rough inclined plane making an angle 30^0 with the horizontal so that conductor is perpendicular to a uniform horizontal magnetic field of induction B = 0.10 T. The coefficient of static friction between the conductor and the plane is 0.1. A current of I = 10 A flows through the conductor inside the plane of this paper as shown. What is the force needed to be the applied parallel to the inclined plane to sustaining the conductor at rest ?



ANSWER KEY

EXERCISE # (O)

1. Ans. (C)	**2. Ans. (B)**	**3. Ans. (D)**	**4. Ans. (B)**
5. Ans. (A)	**6. Ans. (C)**	**7. Ans. (B)**	**8. Ans. (B)**
9. Ans. (B)	**10. Ans. (A)**	**11. Ans. (A)**	**12. Ans. (A)**
13. Ans. (D)	**14. Ans. (D)**	**15. Ans. (C)**	**16. Ans. (B)**
17. Ans. (B)	**18. Ans. (B)**	**19. Ans. (A)**	**20. Ans. (B)**

21. Ans. (C)

22. Ans. (A) $\rightarrow$ (Q) ; (B) $\rightarrow$ (P) ; (C) $\rightarrow$ (S) ; (D) $\rightarrow$ (R)

23. **Ans. (A)$\rightarrow$(P,R), (B)$\rightarrow$(S), (C)$\rightarrow$(P,Q,R), (D)$\rightarrow$(P,R)**

24. Ans. (A) $\rightarrow$(PQ); (B) $\rightarrow$(Q); (C) $\rightarrow$(R); (D) $\rightarrow$(PST)

EXERCISE # (S)

1. **Ans. 0**
2. **Ans.** (i) $-\dfrac{\mu_0 I}{4R} q v_0 \hat{k}$ (ii) $F_1 = 2IRB$ $F_2 = 2IRB$, Net force $= F_1 + F_2 = 4IRB\ \hat{i}$
3. **Ans. 525**
4. **Ans. $N_{max} = 3mg + qB\sqrt{2gR}$**
5. **Ans. $0.62\ N < F < 0.88\ N$**