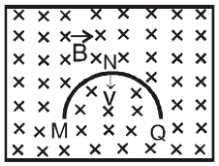
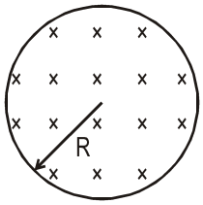
Self Practice Paper (SPP)

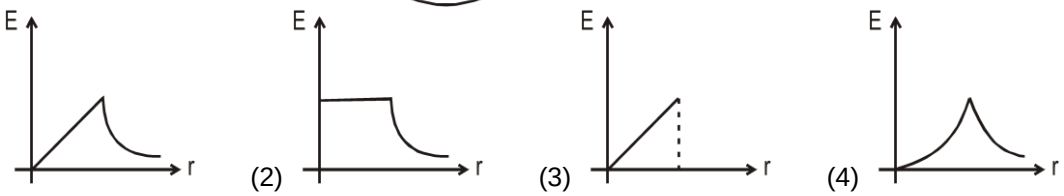
1. A thin semicircular conducting ring of radius R is falling with its plane vertical in a horizontal magnetic induction $\vec{B}$. At the position MNQ the speed of the ring is v then the potential difference developed across the ring is: **[JEE - 1996]**



(1) zero (2) $\frac{Bv\pi R^2}{2}$ and M is at higher potential
(3) π RBV and Q is at higher potential (4) 2 RBV and Q is at higher potential.

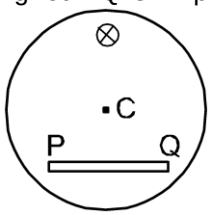
2. A cylindrical space of radius R is filled with a uniform magnetic induction B parallel to the axis of the cylinder. If B changes at a constant rate, the graph showing the variation of induced electric field with distance r from the axis of cylinder is





(1) (2) (3) (4)

3. In a cylindrical region uniform magnetic field which is perpendicular to the plane of the figure is increasing with time and a conducting rod PQ is placed in the region. If C is the centre of the circle then

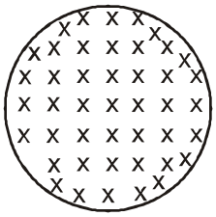


(1) P will be at higher potential than Q.
(2) Q will be at higher potential than P.
(3) Both P and Q will be equipotential.
(4) no emf will be developed across rod as it is not crossing / cutting any line of force.

4. In a series L–R growth circuit, if maximum current and maximum induced emf in an inductor of inductance 3mH are 2A and 6V respectively, then the time constant of the circuit is :
(1) 1 ms. (2) 1/3 ms. (3) 1/6 ms (4) 1/2 ms

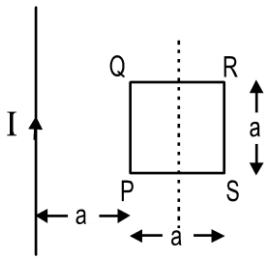
5. Two coils of self inductance 100 mH and 400 mH are placed very close to each other. Find the maximum mutual inductance between the two when 4 A current passes through them
(1) 200 mH (2) 300 mH (3) $100\sqrt{2}$ mH (4) none of these

6. A non conducting ring of radius R and mass m having charge q uniformly distributed over its circumference is placed on a rough horizontal surface. A vertical time varying uniform magnetic field $B = 4t_2$ is switched on at time t=0. The coefficient of friction between the ring and the table, if the ring starts rotating at t =2 sec, is :



(1) $\frac{4qmR}{g}$ (2) $\frac{2qmR}{g}$ (3) $\frac{8qR}{mg}$ (4) $\frac{qR}{2mg}$

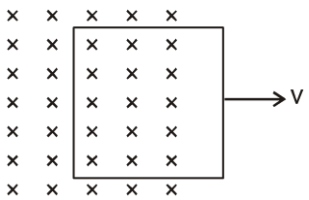
7. In the figure shown a square loop PQRS of side 'a' and resistance 'r' is placed near an infinitely long wire carrying a constant current I. The sides PQ and RS are parallel to the wire. The wire and the loop are in the same plane. The loop is rotated by 180º about an axis parallel to the long wire and passing through the mid points of the side QR and PS. The total amount of charge which passes through any point of the loop during rotation is :

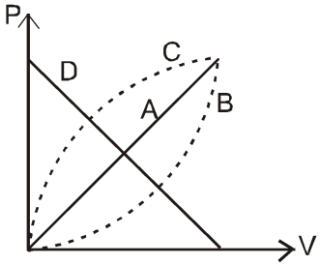


(1) $\frac{\mu_0 Ia}{2\pi r}\ell n2$ (2) $\frac{\mu_0 Ia}{\pi r}\ell n2$ (3) $\frac{\mu_0 Ia^2}{2\pi r}$

(4) cannot be found because time of rotation not give.

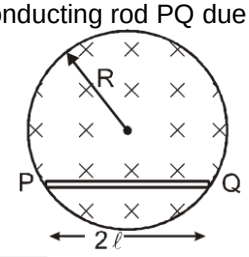
8. Fig. shows a conducting loop being pulled out of a magnetic field with a constant speed v. Which of the four plots shown in fig. may represent the power delivered by the pulling agent as a function of the constant speed v.





(1) A (2) B (3) C (4) D

9. A uniform magnetic field, $B = B_0 t$ (where B_0 is a positive constant), fills a cylindrical volume of radius R, then the potential difference in the conducting rod PQ due to electrostatic field is :

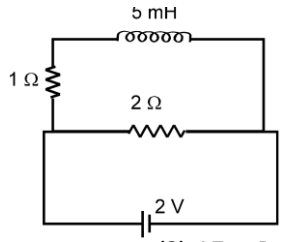


(1) $B_0\ell\sqrt{R^2+\ell^2}$ (2) $B_0\ell\sqrt{R^2-\frac{\ell^2}{4}}$ (3) $B_0\ell\sqrt{R^2-\ell^2}$ (4) $B_0R\sqrt{R^2-\ell^2}$

10. An LR circuit has L = 1 H and R = 1 Ω. It is connected across an emf of 2 V. The maximum rate at which energy is stored in the magnetic field is :

(1) 1 W (2) 2 W (3) 1/4 W (4) 4 W

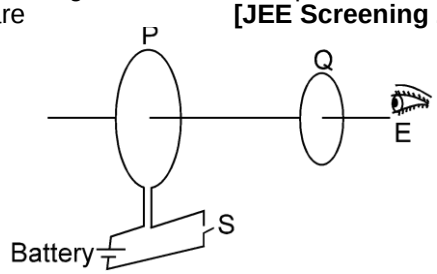
11. When induced emf in inductor coil is 50% of its maximum value then stored energy in inductor coil in the given circuit will be : -



(1) 2.5 mJ (2) 5mJ (3) 15 mJ (4) 20 mJ

12. A bar magnet is released from rest coaxially along the axis of a very long, vertical copper tube. After some time the magnet
(1) will move with an acceleration g (2) will move with almost constant speed
(3) will stop in the tube (4) will oscillate

13. As shown in the fig. P and Q are two coaxial conducting loops separated by some distance. When the switch S is closed, a clockwise current I_P flows in P (as seen by E) and an induced current I_{Q1} flows in Q. The switch remains closed for a long time. When S is opened, a current I_{Q2} flows in Q. Then the directions of I_{Q1} and I_{Q2} (as seen by E) are **[JEE Screening 2002, 3/90, –1]**

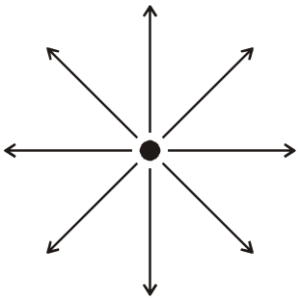


(1) respectively clockwise and anti-clockwise (2) both clockwise
(3) both anti-clockwise (4) respectively anti-clockwise and clockwise.

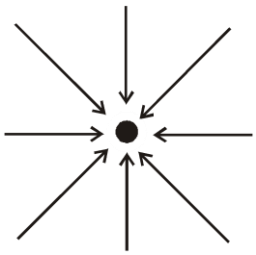
14. An infinitely long cylindrical conducting rod is kept along + Z direction. A constant magnetic field is also present in + Z direction. Then current induced will be **[JEE (Scr. 2005) 3/84, –1]**
(1) 0 (2) along +z direction
(3) along clockwise as seen from + Z (4) along anticlockwise as seen from + Z

15. Which of the field patterns given below is valid for electric field as well as for magnetic field? **[JEE - 2011' 3/160, –1]**

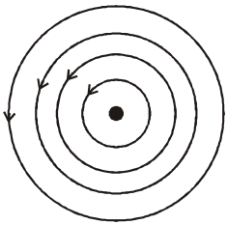
(1)



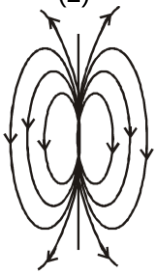
(2)



(3)



(4)



1.	(4)	**2.**	(1)	**3.**	(2)	**4.**	(1)	**5.**	(1)	**6.**	(3)	**7.**	(2)
8.	(2)	**9.**	(3)	**10.**	(1)	**11.**	(1)	**12.**	(2)	**13.**	(4)	**14.**	(1)
15.	(3)												

SPP Solutions

1. Induced motional emf in MNQ is equivalent to the motional emf in an imaginary wire MQ i.e.,

$e_{MNQ} = e_{MQ} = Bv\ell = Bv\ (2R)$

$[\ell = MQ = 2\ R]$

Therefore , potential difference developed across the ring is 2RBv with Q at higher potential.

2. $EMF = -\frac{d\phi}{dt} = -\frac{dB\pi r^2}{dt} = -\pi r_2 \frac{dB}{dt}$ or $E = \left(\frac{EMF}{2\pi r}\right) = \left(\frac{dB}{dt}\right)\frac{r}{2}$

or $E \propto r$ for $r \le R$.

$E \propto \frac{1}{r}$ for $r > R$.

3. If the circuit Q C P containing rod PQ is completed then the direction of induced current will be from Q to C to P hence Q will be at higher potential than P.

4. $R = \frac{v}{I}$

$\tau = \frac{L}{R} = 1$ ms.

5. $M_{max} = \sqrt{L_1 L_2} = \sqrt{100 \times 400}$ mH = 200 mH.

6. $\int E.d\ell = -\frac{d\phi}{dt}$

$E \times 2\pi R = \pi R_2 \frac{dB}{dt}$.

$E = \frac{R}{2} \times 8t = R8$

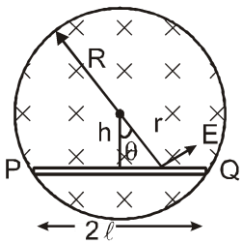
$(qE)R = (\mu mg)\ R$

$\mu = \frac{8qR}{mg}$

7. $q = \int Idt = \int -\frac{1}{r}\frac{d\phi}{dt}\,dt = -\frac{\Delta\phi}{r} = \frac{\mu_0 Ia}{\pi r}\ell n2$.

8. $P = F.V = Bi\ell V = B\left(\frac{Bv\ell}{R}\right)\ell\ V,\ P \propto V_2$

9. $\int Ed\ell = \varepsilon$, $E = \frac{r}{2}\frac{dB}{dt}$, $E\cos\theta = \frac{r\cos\theta}{2}$ $B_0 = \frac{h}{2}$ B_0



$V_Q - V_P = \left(\frac{h}{2}B_0\right) 2\ell = B_0\ \ell\ \sqrt{R^2 - \ell^2}$

10. $U = \frac{1}{2} LI_2$

$\frac{dU}{dt} = LI\ \frac{dI}{dt} = RI_{02}\ (1 - e^{-t/\tau})e^{-t/\tau}$

$\frac{dU}{dt}$ is maximum when $e^{-t/\tau} = \frac{1}{2}$ or $\left(\frac{dU}{dt}\right)_{max} = \frac{E^2}{4R} = 1$ W.

11. $E = \frac{1}{2} LI_2$ $\quad E = \frac{1}{2} L \frac{V^2}{R^2}$

$= \frac{1}{2} \times 5 \times 10^{-3} \times (1)^2$

= 2.5 mJ.

12. Since the tube is very long the force on magnet due to induced current will continue to oppose its motion till it acquires a constant speed.

13. When switch S is closed magnetic field lines passing through Q increases in the direction from right to left. So, according to Lenz's law induced current in Q i.e. I_{Q1} will flow in such a direction so that the magnetic field lines due to I_{Q1} passes from left to right through Q. This is possible when I_{Q1} flows in anticlockwise direction as seen by E. Opposite is the case when switch S is opened i.e. I_{Q2} will be clockwise as seen by E.

14. zero, as there is no flux change.

15. True for induced electric field and magnetic field.