Additional Problems For Self Practice (APSP)

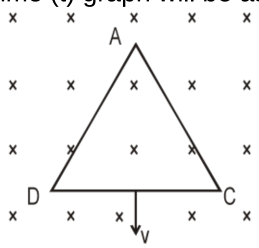
PART-I : PRACTICE TEST PAPER

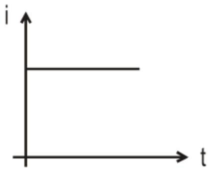
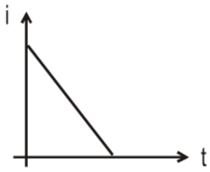
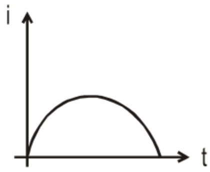
Max. Marks : 120 **Max. Time : 1 Hr.**

Important Instructions :

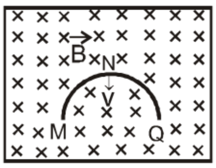
1. The test is of **1 hour** duration and max. marks 120.
2. The test consists **30** questions, **4 marks** each.
3. Only one choice is correct **1 mark** will be deducted for incorrect response. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
4. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 3 above.

1. An equilateral triangular loop ADC having some resistance is pulled with a constant velocity v out of a uniform magnetic field directed into the paper. At time t = 0, side DC of the loop is at edge of the magnetic field. The induced current (i) versus time (t) graph will be as



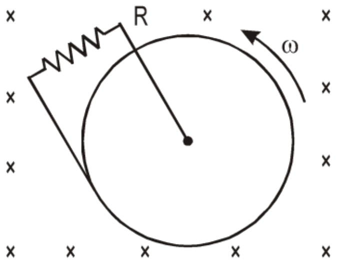
(1)  (2)  (3)  (4) 

2. 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:



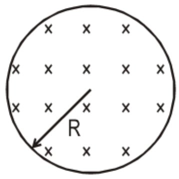
(1) zero
(2) $\frac{Bv\pi R^2}{2}$ and M is at higher potential
(3) π RBV and Q is at higher potential
(4) 2 RBV and Q is at higher potential.

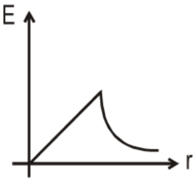
3. Figure shows a conducting disc rotating about its axis in a perpendicular magnetic field B. A resistor of resistance R is connected between the centre and the rim. The radius of the disc is 5.0 cm, angular speed ω = 40 rad/s, B = 0.10 T and R = 1 Ω. The current through the resistor is

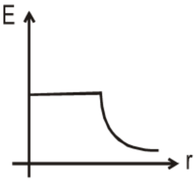


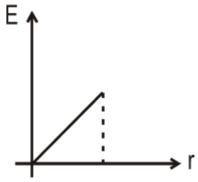
(1) 5 mA (2) 50 A (3) 5 A (4) 10 mA

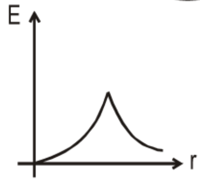
4. A cylindrical space of radius R is filled with a uniform magnetic induction B parallel to the axis of the cylinder. If B changes at a constant rate, the graph showing the variation of induced electric field with distance r from the axis of cylinder is



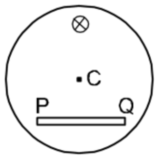
(1) 

(2) 

(3) 

(4) 

5. 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



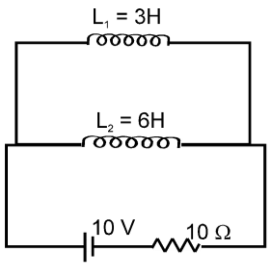
(1) P will be at higher potential than Q.
(2) Q will be at higher potential than P.
(3) Both P and Q will be equipotential.
(4) no emf will be developed across rod as it is not crossing / cutting any line of force.

6. 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

7. A rectangular loop of sides ' a ' and ' b ' is placed in xy plane. A very long wire is also placed in xy plane such that side of length ' a ' of the loop is parallel to the wire. The distance between the wire and the nearest edge of the loop is ' d '. The mutual inductance of this system is proportional to:
(1) a (2) b (3) 1/d (4) current in wire

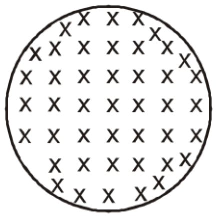
8. Two coils of self inductance 100 mH and 400 mH are placed very close to each other. Find the maximum mutual inductance between the two when 4 A current passes through them
(1) 200 mH (2) 300 mH (3) $100\sqrt{2}$ mH (4) none of these

9. Two inductor coils of self inductance 3H and 6H respectively are connected with a resistance 10Ω and a battery 10 V as shown in figure. The ratio of total energy stored at steady state in the inductors to that of heat developed in resistance in 10 seconds at the steady state is(neglect mutual inductance between L_1 and L_2):



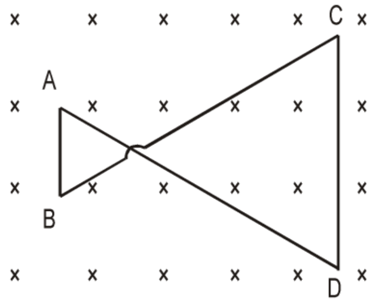
(1) $\frac{1}{10}$ (2) $\frac{1}{100}$
(3) $\frac{1}{1000}$ (4) 1

10. 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 :



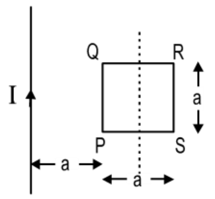
(1) $\frac{4qmR}{g}$ (2) $\frac{2qmR}{g}$ (3) $\frac{8qR}{mg}$ (4) $\frac{qR}{2mg}$

11. A conducting wire frame is placed in a magnetic field which is directed into the paper. The magnetic field is increasing at a constant rate. The directions of induced currents in wires AB and CD are :



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

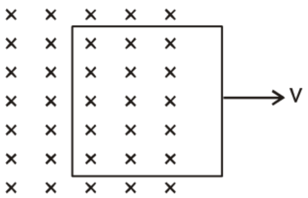
12. In the figure shown a square loop PQRS of side 'a' and resistance 'r' is placed near an infinitely long wire carrying a constant current I. The sides PQ and RS are parallel to the wire. The wire and the loop are in the same plane. The loop is rotated by 180º about an axis parallel to the long wire 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 :

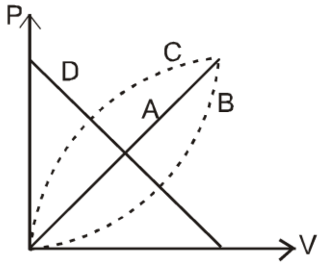


(1) $\frac{\mu_0 I a}{2\pi r}\ell n2$ (2) $\frac{\mu_0 I a}{\pi r}\ell n2$ (3) $\frac{\mu_0 I a^2}{2\pi r}$

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

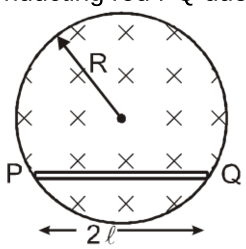
13. Fig. shows a conducting loop being pulled out of a magnetic field with a constant speed v. Which of the four plots shown in fig. may represent the power delivered by the pulling agent as a function of the constant speed v.





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

14. 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 :

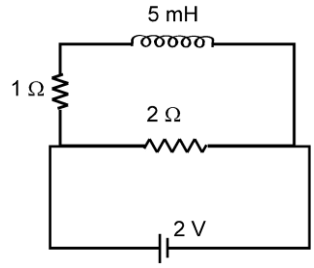


(1) $B_0\ell\sqrt{R^2+\ell^2}$ (2) $B_0\ell\sqrt{R^2-\frac{\ell^2}{4}}$ (3) $B_0\ell\sqrt{R^2-\ell^2}$ (4) $B_0R\sqrt{R^2-\ell^2}$

15. 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

16. 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

17. 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

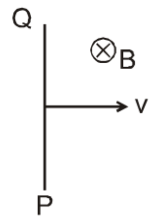
18. A solenoid has a cross sectional area of 6.0×10^{-4} m^2, consists of 400 turns per meter, and carries a current of 0.40 A. A 10 turn coil is wrapped tightly around the circumference of the solenoid. The ends of the coil are connected to a 1.5 Ω resistor. Suddenly, a switch is opened, and the current in the solenoid dies to zero in a time 0.050 s. Find the average current in the coil.

(1) 5.6×10^{-5}A (2) 1.6×10^{-4}A (3) 1.6×10^{-5}A (4) 1.6×10^{-8}A

19. A heart pacing device consists of a coil of 50 turns & radius 1 mm just inside the body with a coil of 1000 turns & radius 2 cm placed concentrically and coaxially just outside the body. Calculate the average induced EMF in the internal coil, if a current of 1A in the external coil collapses in 10 milliseconds.

(1) 493 μV (2) 594 μV (3) 795 μV (4) 396 μV

20. A metallic wire of length 1 cm moves with a velocity of 2 m/s in a direction perpendicular to its length and perpendicular to a uniform magnetic field of magnitude 0.2 T. Find the emf induced between the ends of the wire. Which end will be positively charged.

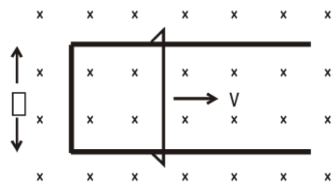


(1) 4 mV, Q (2) 4 mV, P (3) 2 mV, Q (4) 2 mV, P

21. A metallic metre stick translates in a direction making an angle of 60° with its length. The plane of motion is perpendicular to a uniform magnetic field of 0.1 T that exists in the space. Find the emf induced between the ends of the rod if the speed of translation is 0.2 m/s.

(1) $\sqrt{3}\times10^{-3}$V (2) $\sqrt{3}\times10^{-5}$V (3) $\sqrt{3}\times10^{-2}$V (4) $\sqrt{5}\times10^{-2}$V

22. A long U-shaped wire of width ℓ placed in a perpendicular magnetic field B (figure). A wire of length ℓ is slid on the U-shaped wire with a constant velocity v towards right. The resistance of all the wires is r per unit length. At t = 0, the sliding wire is close to the left edge of the U-shaped wire. Draw an equivalent circuit diagram at time t, showing the induced emf as a battery. Calculate the current in the circuit.



(1) $i = \dfrac{Bv}{2(\ell + vt)r}$ (2) $i = \dfrac{Bv\ell}{2(\ell + vt)}$ (3) $i = \dfrac{Bv\ell}{(\ell + vt)r}$ (4) $i = \dfrac{Bv\ell}{2(\ell + vt)r}$

23. The magnetic field in a region is given by $\vec{B} = \hat{k}\dfrac{B_0}{L}x$ where L is a fixed length. A conducting rod of length L lies along the X-axis between the origin and the point (L, 0, 0). If the rod moves with a velocity $\vec{v} = v_0\hat{j}$, find the emf induced between the ends of the rod.

(1) $\frac{B_0v_0L}{4}$ (2) $\frac{B_0v_0L}{2}$ (3) B_0v_0L (4) $\frac{3B_0v_0L}{2}$

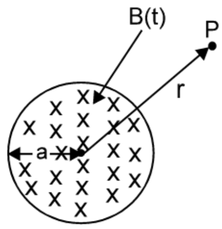
24. Two identical circular loops of metal wire are lying on a table without touching each other. Loop-A carries a current which increases with time. In response, the loop-B

(1) remains stationary (2) is attracted by the loop-A
(3) is repelled by the loop-A (4) rotates about its CM, with CM fixed

25. A coil of inductance 8.4 mH and resistance 6Ω is connected to a 12V battery. The current in the coil is 1.0 A at approximately the time

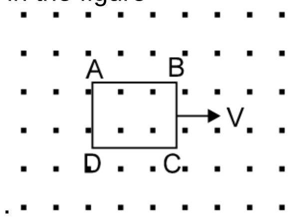
(1) 500 s (2) 20 s (3) 35 ms (4) 1 ms

26. A uniform but time-varying magnetic field B (t) exists in a circular region of radius a and is directed into the plane of the paper, as shown fig. The magnitude of the induced electric field at point P at a distance r from the centre of the circular region.



(1) is zero (2) decreases as 1/r
(3) increases as r (4) decreases as $1/r^2$

27. A metallic square loop ABCD is moving in its own plane with velocity v in a uniform magnetic field perpendicular to its plane as shown in the figure



An electric field is induced
(1) in AD, but not in BC
(2) in BC, but not in AD
(3) neither in AD nor in BC
(4) in both AD and BC

Comprehension # 1

Figure shows a conducting rod of negligible resistance that can slide on smooth U-shaped rail made of wire of resistance 1Ω/m. Position of the conducting rod at t = 0 is shown. A time t dependent magnetic field B = 2t Tesla is switched on at t = 0.

28. The current in the loop at t = 0 due to induced emf is

(1) 0.16 A, clockwise (2) 0.08 A, clockwise
(3) 0.08 A, anticlockwise (4) zero

29. At t = 0, when the magnetic field is switched on, the conducting rod is moved to the left at constant speed 5 cm/s by some external means. The rod moves, remaining perpendicular to the rails. At t = 2s, induced emf has magnitude.

(1) 0.12 V (2) 0.08 V (3) 0.04 V (4) 0.02 V

30. Following situation of the previous question, the magnitude of the force required to move the conducting rod at constant speed 5 cm/s at the same instant t = 2s, is equal to

(1) 0.16 N (2) 0.12 N (3) 0.08 N (4) 0.06 N

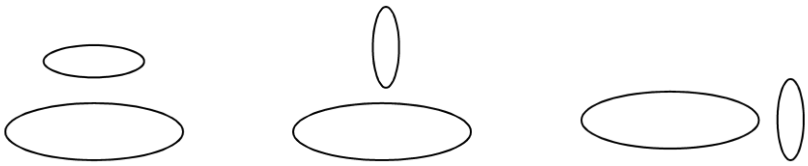
Practice Test (JEE-Main Pattern)

OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22	23	24	25	26	27	28	29	30
Ans.										

PART - II : PRACTICE QUESTIONS

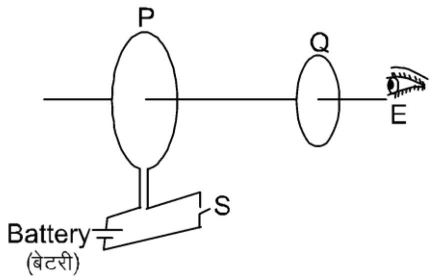
1. Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be:



(1) (2) (3)

(1) maximum in situation (1)
(2) maximum in situation (2)
(3) maximum in situation (3)
(4) the same in all situations

2. 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

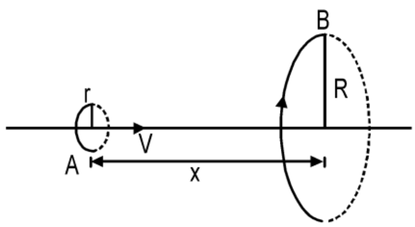


(1) respectively clockwise and anti-clockwise
(2) both clockwise
(3) both anti-clockwise
(4) respectively anti-clockwise and clockwise.

3. A close loop is placed in a time-varying magnetic field. Electrical power is dissipated due to the current induced in the coil. If the number of turns were to be quadrupled and the wire radius halved keeping the radius of the loop unchanged, the electrical power dissipated would be:

(1) halved (2) the same (3) doubled (4) quadrupled

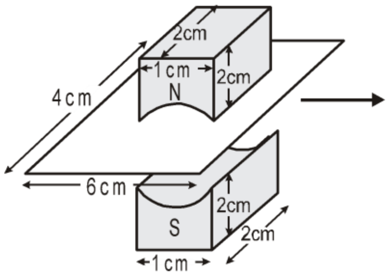
4. Loop A of radius r(r << R) moves towards loop B with a constant velocity V in such a way that their planes are always parallel. What is the distance between the two loops (x) when the induced emf in loop A is maximum.

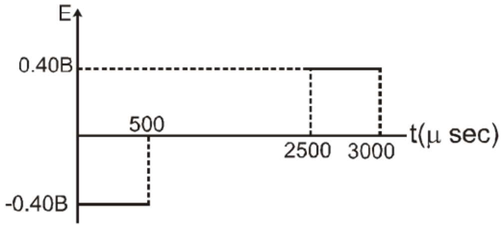


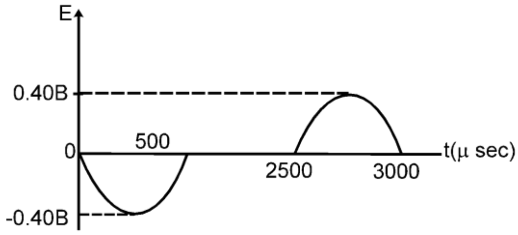
(1) R
(2) $\frac{R}{\sqrt{2}}$
(3) $\frac{R}{2}$
(4) $R\left(1-\frac{1}{\sqrt{2}}\right)$

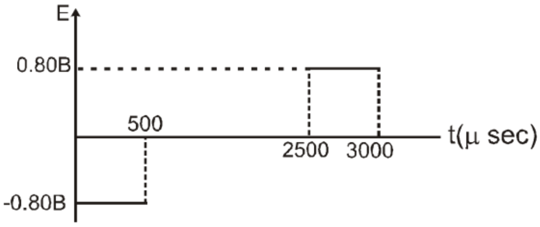
5. A magnetic field (2), uniform between two magnets can be determined measuring the induced voltage in the loop as it is pulled through the gap at uniform speed 20 m/sec. Size of magnet and coil is 2cm × 1cm

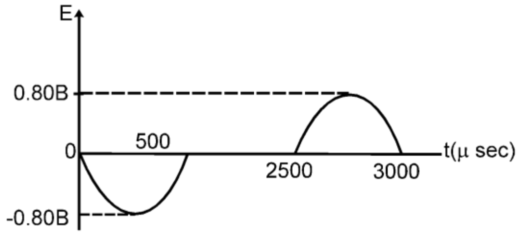
× 2cm and 4cm × 6cm as shown in figure. The correct variation of induced emf with time is : (Assume at t = 0, the coil enters in the magnetic field) :



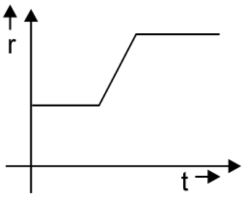
(1) 

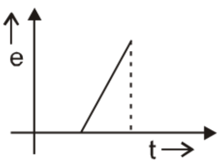
(2) 

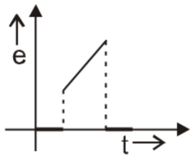
(3) 

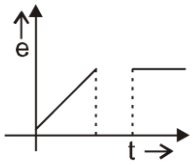
(4) 

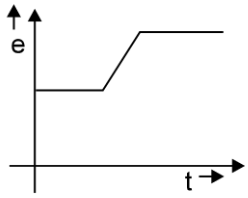
6. Radius of a circular ring is changing with time and the coil is placed in uniform magnetic field perpendicular to its plane. The variation of ' r ' with time ' t ' is shown in the figure. Then induced e.m.f. ε with time will be best represented by :



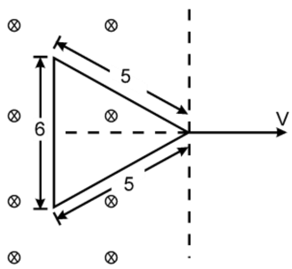
(1) 

(2) 

(3) 

(4) 

7. A triangular loop as shown in the figure is started to being pulled out at t = 0 from a uniform magnetic field with a constant velocity v. Total resistance of the loop is constant and equals to R. Then the variation of power produced in the loop with time will be :



(1) linearly increasing with time till whole loop comes out

(2) increases parabolically till whole loop comes out

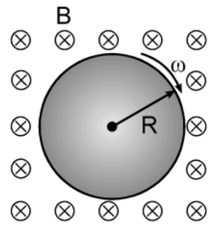
(3) P α t_3 till whole loop come out

(4) will be constant with time

8. Earth's surface is a conductor with a uniform surface charge density σ. It rotates about its axis with angular velocity ω. Suppose the magnetic field due to Sun at Earth at some instant is a uniform field B pointing along earth's axis. Then the emf developed between the pole and equator of earth due to this field is. (R_e = radius of earth)

(1) $\frac{1}{2}B\omega R_e^2$ (2) $B\omega R_e^2$ (3) $\frac{3}{2}B\omega R_e^2$ (4) zero

9. A conducting disc of radius R is placed in a uniform and constant magnetic field B parallel to the axis of the disc. With what angular speed should the disc be rotated about its axis such that no electric field develops in the disc.(the electronic charge and mass are e and m)



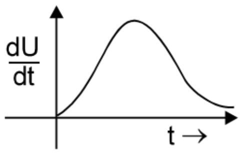
(1) $\frac{eB}{2m}$ (2) $\frac{eB}{m}$

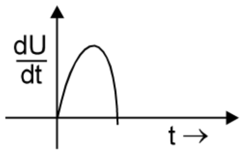
(3) $\frac{2\pi m}{eB}$ (4) $\frac{\pi m}{eB}$

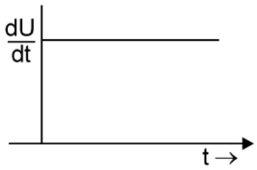
10. When the current in a certain inductor coil is 5.0 A and is increasing at the rate of 10.0 A/s, the magnitude of potential difference across the coil is 140 V. When the current is 5.0 A and decreasing at the rate of 10.0 A/s, the potential difference is 60 V. The self inductance of the coil is :

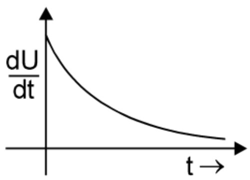
(1) 2H (2) 4H (3) 10H (4) 12H

11. Rate of increment of energy in an inductor with time in series LR circuit getting charge with battery of e.m.f. E is best represented by: [inductor has initially zero current]

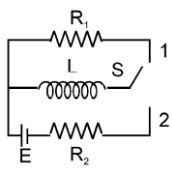
(1)


(2)


(3)


(4)


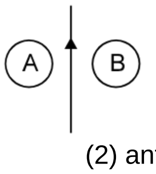
12. In the circuit shown switch S is connected to position 2 for a long time and then joined to position 1. The total heat produced in resistance R_1 is :



(1) $\frac{LE^2}{2R_2^2}$ (2) $\frac{LE^2}{2R_1^2}$

(3) $\frac{LE^2}{2R_1R_2}$ (4) $\frac{LE^2(R_1+R_2)^2}{2R_1^2R_2^2}$

13. A and B are two metallic rings placed at opposite sides of an infinitely long straight conducting wire as shown. If current in the wire is slowly decreased, the direction of induced current will be :

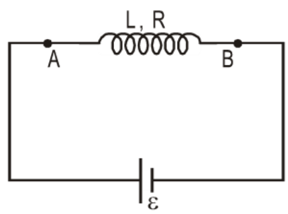


(1) clockwise in A and anticlockwise in B (2) anticlockwise in A and clockwise in B

(3) clockwise in both A and B (4) anticlockwise in both A & B

Comprehension

An inductor having self inductance *L* with its coil resistance *R* is connected across a battery of emf ε. When the circuit is in steady state at *t* = 0 an iron rod is inserted into the inductor due to which its inductance becomes n *L* (*n* > 1).



14. After insertion of rod which of the following quantities will change with time ?
(A) Potential difference across terminals *A* and *B*.
(B) Inductance.
(C) Rate of heat produced in coil
(1) only (A) (2) (A) & (C) (3) Only (C) (4) (A), (B) & (C)

15. After insertion of the rod, current in the circuit :
(1) Increases with time (2) Decreases with time
(3) Remains constant with time (4) First decreases with time then becomes constant

16. When again circuit is in steady state, the current in it is :
(1) $I < \varepsilon/R$ (2) $I > \varepsilon/R$ (3) $I = \varepsilon/R$ (4) None of these

APSP Answers

PART-I

1.	(2)	**2.**	(4)	**3.**	(1)	**4.**	(1)	**5.**	(2)	**6.**	(1)	**7.**	(1)
8.	(1)	**9.**	(2)	**10.**	(3)	**11.**	(1)	**12.**	(2)	**13.**	(2)	**14.**	(3)
15.	(1)	**16.**	(1)	**17.**	(2)	**18.**	(3)	**19.**	(1)	**20.**	(1)	**21.**	(3)
22.	(4)	**23.**	(2)	**24.**	(3)	**25.**	(4)	**26.**	(2)	**27.**	(4)	**28.**	(1)
29.	(2)	**30.**	(3)										

PART-II

1.	(1)	**2.**	(4)	**3.**	(2)	**4.**	(3)	**5.**	(1)	**6.**	(2)	**7.**	(2)
8.	(1)	**9.**	(2)	**10.**	(2)	**11.**	(1)	**12.**	(1)	**13.**	(2)	**14.**	(3)
15.	(1)	**16.**	(3)										