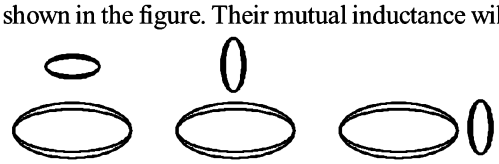
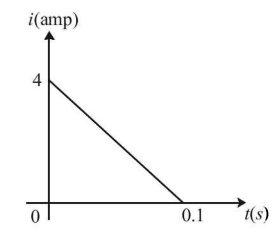
20 Electromagnetic Induction

Conceptual MCQs

1. If the number of turns per unit length of a coil of solenoid is doubled, the self-inductance of the solenoid will
   (a) remain unchanged (b) be halved
   (c) be doubled (d) become four times
2. The coefficient of mutual induction due to two circuits is 0.09 henry. Average e.m.f. induced in the secondary by a change of current from 0 to 20 ampere in 0.006 second in the primary will be
   (a) 120 V (b) 80 V (c) 200 V (d) 300 V
3. The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt. Then the total quantity of electric charge Q that passes any point in the circuit during the time Δt is represented by
   (a) $Q = R.\frac{\Delta\phi}{\Delta t}$ (b) $Q = \frac{1}{R}.\frac{\Delta\phi}{\Delta t}$
   (c) $Q = \frac{\Delta\phi}{R}$ (d) $Q = \frac{\Delta\phi}{\Delta t}$
4. According to Faraday's law of electromagnetic induction
   (a) the direction of induced current is such that it opposes the cause producing it
   (b) the magnitude of induced e.m.f. produced in a coil is directly proportional to the rate of change of magnetic flux
   (c) the direction of induced e.m.f. is such that it opposes the cause producing it
   (d) None of these
5. Lenz's law gives
   (a) the magnitude of the induced e.m.f.
   (b) the direction of the induced current
   (c) both the magnitude and direction of the induced current
   (d) the magnitude of the induced current
6. Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be



   (a) maximum in situation (A) (b) maximum in situation (B)
   (c) maximum in situation (C) (d) the same in all situation
7. In a magnetic field with the value of induction is 0.9 Wb/m^2 a simple wire conductor 0.4 metre long is moving with the velocity of 7 m/s. The value of maximum induced electromotive force will be
   (a) 3 volt (b) 2.52 volt (c) 2 volt (d) 1 volt
8. Two identical circular loops of metal wire are lying on a table. Loop A carries a current which increases with time. In responses, the loop B
   (a) is attracted by the loop A (b) is repelled by the loop A
   (c) remains stationary (d) None of these
9. A conducting circular loop is placed in a uniform magnetic field of 0.04 T with its plane perpendicular to the magnetic field. The radius of the loop starts shrinking at 2 mm/s. The induced emf in the loop when the radius is 2 cm is
   (a) $4.8\pi\mu V$ (b) $0.8\pi\mu V$ (c) $1.6\pi\mu V$ (d) $3.2\pi\mu V$
10. In a coil of resistance 10 Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in weber is
   (a) 8
   (b) 2
   (c) 6
   (d) 4



11. In an AC generator, a coil with N turns, all of the same area A and total resistance R, rotates with frequency ω in a magnetic field B. The maximum value of emf generated in the coil is
   (a) N.A.B.R.ω (b) N.A.B.
   (c) N.A.B.R. (d) N.A.B.ω
12. The flux linked with a coil at any instant 't' is given by
   $\phi = 10t^2 - 50t + 250$
   The induced emf at $t = 3s$ is
   (a) –190 V (b) –10 V (c) 10 V (d) 190 V
13. In a coil of area 10 cm^2 and 10 turns with magnetic field directed perpendicular to the plane and is changing at the rate of 10^8 gauss/second. The resistance of the coil is 20Ω. The current in the coil will be
   (a) 0.5 A (b) 5 A (c) 50 A (d) 5×10^8 A
14. If rotational velocity of a dynamo armature is doubled, then induced e.m.f. will become
   (a) half (b) two times
   (c) four times (d) unchanged
15. A coil having n turns and resistance $R\Omega$ is connected with a galvanometer of resistance $4R\Omega$. This combination is moved in time t seconds from a magnetic flux W_1 weber to W_2 weber. The induced current in the circuit is
   (a) $-\frac{(W_2 - W_1)}{Rnt}$ (b) $-\frac{n(W_2 - W_1)}{5\ Rt}$
   (c) $-\frac{(W_2 - W_1)}{5\ Rnt}$ (d) $-\frac{n(W_2 - W_1)}{Rt}$

Application Based MCQs

16. A magnetic field of 2×10^{-2} T acts at right angles to a coil of area 100 cm^2, with 50 turns. The average e.m.f. induced in the coil is 0.1 V, when it is removed from the field in t sec. The value of t is

(a) 10 s (b) 0.1 s (c) 0.01 s (d) 1 s

17. A current carrying infinitely long wire is kept along the diameter of a circular wire loop, without touching it, the correct statement is

(a) The emf induced in the loop is zero if the current is constant.

(b) The emf induced in the loop is finite if the current is constant.

(c) The emf induced in the loop is zero if the current decreases at a steady rate.

(d) The emf induced in the loop is infinite if the current decreases at a steady rate.

18. A rectangular coil of 100 turns and size 0.1 m × 0.05 m is placed perpendicular to a magnetic field of 0.1 T. The induced e.m.f. when the field drops to 0.05 T in 0.05s is

(a) 0.5V (b) 1.0V (c) 1.5V (d) 2.0V

19. A copper rod of length l is rotated about one end perpendicular to the magnetic field B with constant angular velocity ω. The induced e.m.f. between the two ends is

(a) $\frac{1}{2}B\omega l^2$ (b) $\frac{3}{4}B\omega l^2$ (c) $B\omega l^2$ (d) $2B\omega l^2$

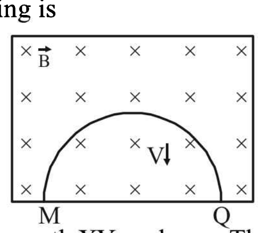
20. A thin semicircular conducting ring of radius R is falling with its plane vertical in a horizontal magnetic induction B. At the position MNQ, the speed of the ring is V, the potential difference developed across the ring is

(a) Zero

(b) $B v\pi R^2 / 2$ and M is at higher potential

(c) πRBV and Q is at higher potential

(d) $-2RBV$ and Q is at higher potential



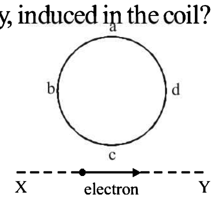
21. An electron moves on a straight line path XY as shown. The abcd is a coil adjacent to the path of electron. What will be the direction of current if any, induced in the coil?

(a) adcb

(b) The current will reverse its direction as the electron goes past the coil

(c) No current induced

(d) abcd



22. Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin \omega t$, where $I_0 = 10A$ and $\omega = 100\pi$ radian/sec. The maximum value of e.m.f. in the second coil is

(a) 2π (b) 5π (c) π (d) 4π

23. A rectangular coil of 20 turns and area of cross-section 25 sq. cm has a resistance of 100Ω. If a magnetic field which is perpendicular to the plane of coil changes at a rate of 1000 tesla per second, the current in the coil is

(a) 1 A (b) 50 A (c) 0.5 A (d) 5 A

24. In an induction coil the current increases from 0 to 6 A in 0.3 sec by which induced emf of 30 volt is produced in it. Then the value of coefficient of self inductance of coil will be

(a) 3 henry (b) 2 henry (c) 1 henry (d) 1.5 henry

25. A varying current in a coil changes from 10A to zero in 0.5 sec. If the average e.m.f induced in the coil is 220V, the self-inductance of the coil is

(a) 5 H (b) 6 H (c) 11 H (d) 12 H

26. Two coils of self inductances 2 mH and 8 mH are placed so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is

(a) 6mH (b) 4mH (c) 16mH (d) 10mH

27. The mutual inductance between two planar concentric rings of radii r_1 and r_2 $(r_1 > r_2)$ placed in air is given by

(a) $\frac{\mu_0 \pi r_2^2}{2r_1}$ (b) $\frac{\mu_0 \pi r_1^2}{2r_2}$

(c) $\frac{\mu_0 \pi (r_1 + r_2)^2}{2r_1}$ (d) $\frac{\mu_0 \pi (r_1 + r_2)^2}{2r_2}$

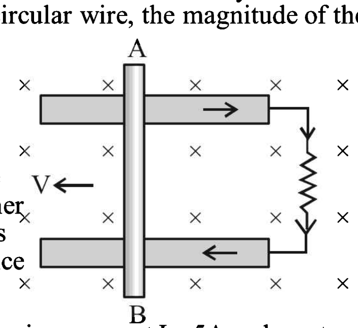
28. Consider the situation shown in the figure. The wire AB is sliding on the fixed rails with a constant velocity. If the wire AB is replaced by semicircular wire, the magnitude of the induced current will

(a) increase

(b) remain the same

(c) decrease

(d) increase or decrease depending on whether the semicircle buiges towards the resistance or away from it



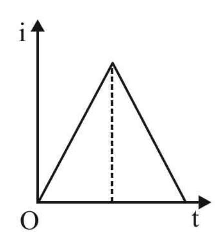
29. A coil of N = 100 turns carries a current I = 5A and creates a magnetic flux $\phi = 10^{-5} Tm^2$ per turn. The value of its inductance L will be

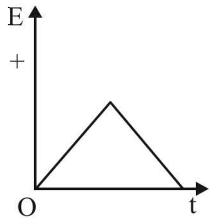
(a) 0.05 mH (b) 0.10 mH (c) 0.15 mH (d) 0.20 mH

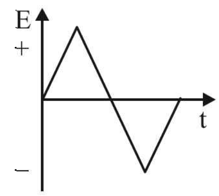
30. A wire of length 1 m is moving at a speed of $2ms^{-1}$ perpendicular to its length in a homogeneous magnetic field of 0.5 T. The ends of the wire are joined to a circuit of resistance 6Ω. The rate at which work is being done to keep the wire moving at constant speed is

(a) $\frac{1}{12}W$ (b) $\frac{1}{6}W$ (c) $\frac{1}{3}W$ (d) 1W

31. The current i in an inductance coil varies with time t according to the graph shown in fig. Which one of the following plots shows the variation of vobltage in the coil with time?



(a)


(b)


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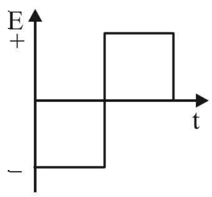
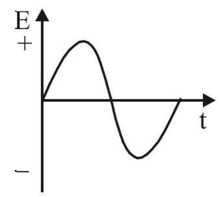
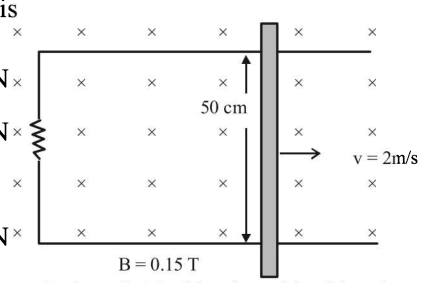


(d)


32. An AC generator of 220 V having internal resistance $r = 10\Omega$ and external resistance $R = 100\Omega$. What is the power developed in the external circuit?
(a) 484 W (b) 400 W (c) 441 W (d) 369 W

33. The magnetic potential energy stored in a certain inductor is 25 mJ, when the current in the inductor is 60 mA. This inductor is of inductance
(a) 0.138 H (b) 138.88 H (c) 13.89 H (d) 1.389 H

34. As shown in the figure a metal rod makes contact and completes the circuit. The circuit is perpendicular to the magnetic field with B = 0.15 tesla. If the resistance is 3Ω, force needed to move the rod as indicated with a constant speed of 2 m/sec is

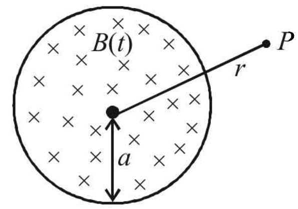


(a) 3.75×10^{-3} N
(b) 3.75×10^{-2} N
(c) 3.75×10^{2} N
(d) 3.75×10^{-4} N

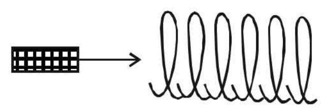
35. A small square loop of wire of side l is placed inside a large square loop of wire of side L (L > l). The loop are coplanar and their centre coincide. The mutual inductance of the system is proportional to
(a) l/L (b) l^2/L (c) L/l (d) L^2/l

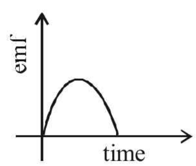
36. A metal conductor of length 1 m rotates vertically about one of its ends at angular velocity 5 radians per second. If the horizontal component of earth's magnetic field is 0.2×10^{-4}T, then the e.m.f. developed between the two ends of the conductor is
(a) 5mV (b) 50μV (c) 5μV (d) 50mV

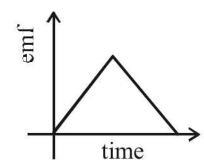
37. A uniform but time-varying magnetic field B(t) exists in a circular region of radius a and is directed into the plane of the paper, as shown. The magnitude of the induced electric field at point P at a distance r from the centre of the circular region
(a) is zero
(b) decreases as $\frac{1}{r}$
(c) increases as r
(d) decreases as $\frac{1}{r^2}$

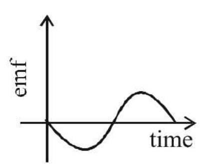


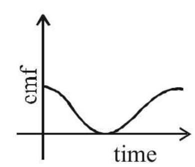
38. A small bar magnet is being slowly inserted with constant velocity inside a solenoid as shown in figure. Which graph best represents the relationship between emf induced with time



(a)


(b)


(c)


(d)


39. A coil having 100 turns and area of 0.001 metre^2 is free to rotate about an axis. The coil is placed perpendicular to a magnetic field of 1.0 weber/metre^2. If the coil is rotate rapidly through an angle of 180°, how much charge will flow through the coil? The resistance of the coil is 10 ohm.
(a) 0.01 coulomb (b) 0.1 coulomb
(c) 1 coulomb (d) 2 coulomb

40. A wire of length 1m is perpendicular to x-y plane. It is moved with velocity $\vec{v} = (3\hat{i} + 3\hat{j} + 2\hat{k})$ m/s through a region of uniform induction $\vec{B} = (\hat{i} + 2\hat{j})$ T. The potential difference between the ends of the wire is
(a) 1V (b) 1.5V (c) 2.5V (d) 3V

Skill Based MCQs

41. Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area $A = 10$ cm^2 and length = 20 cm. If one of the solenoid has 300 turns and the other 400 turns, their mutual inductance is
$(\mu_0 = 4\pi \times 10^{-7}\ \text{Tm A}^{-1})$
(a) $2.4\pi \times 10^{-5}$ H (b) $4.8\pi \times 10^{-4}$ H
(c) $4.8\pi \times 10^{-5}$ H (d) $2.4\pi \times 10^{-4}$ H

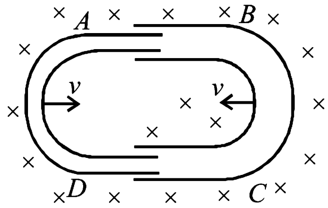
42. One conducting U tube can slide inside another as shown in figure, maintaining electrical contacts between the tubes. The magnetic field B is perpendicular to the plane of the figure. If each tube moves towards the other at a constant speed v then the emf induced in the circuit in terms of B, l and v where l is the width of each tube, will be

(a) Zero

(b) $2Blv$

(c) Blv

(d) $-Blv$



43. In a uniform magnetic field of induction B a wire in the form of a semicircle of radius r rotates about the diameter of the circle with an angular frequency ω. The axis of rotation is perpendicular to the field. If the total resistance of the circuit is R, the mean power generated per period of rotation is

(a) $\dfrac{(B\pi r\omega)^2}{2R}$ (b) $\dfrac{(B\pi r^2\omega)^2}{8R}$

(c) $\dfrac{B\pi r^2\omega}{2R}$ (d) $\dfrac{(B\pi r\omega^2)^2}{8R}$

44. A copper wire of length 40cm, diameter 2mm and resistivity $1.7 \times 10^{-8}\ \Omega$m forms a square frame. If a uniform magnetic field B exists in a direction perpendicular to the plane of square frame and it changes at a steady rate $\dfrac{dB}{dt} = 0.02\ T/s$, then find the current induced in the frame.

(a) 9.3×10^{-2} amp (b) 9.3×10^{-1} amp

(c) 3.3×10^{-2} amp (d) 19.3×10^{-2} amp

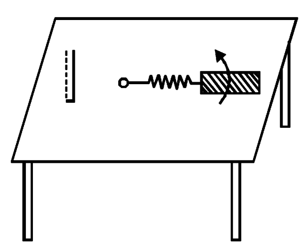
45. A metallic rod of length 'ℓ' is tied to a string of length 2ℓ and made to rotate with angular speed ω on a horizontal table with one end of the string fixed. If there is a vertical magnetic field 'B' in the region, the e.m.f. induced across the ends of the rod is

(a) $\dfrac{2B\omega\ell^2}{2}$

(b) $\dfrac{3B\omega\ell^2}{2}$

(c) $\dfrac{4B\omega\ell^2}{2}$

(d) $\dfrac{5B\omega\ell^2}{2}$



46. A 10-meter wire is kept in east-west direction. It is falling down with a speed of 5.0 meter/second, perpendicular to the horizontal component of earth's magnetic field of 0.30×10^{-4} weber/meter^2. The momentary potential difference induced between the ends of the wire will be

(a) 0.0015V (b) 0.015V (c) 0.15V (d) 1.5V

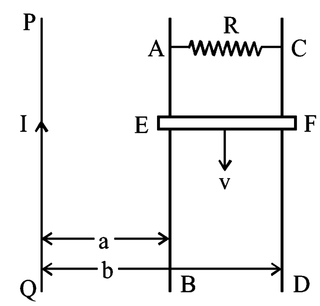
47. PQ is an infinite current carrying conductor. AB and CD are smooth conducting rods on which a conductor EF moves with constant velocity v as shown. The force needed to maintain constant speed of EF is

(a) $\dfrac{1}{vR}\left[\dfrac{\mu_0 Iv}{2\pi}\ln\left(\dfrac{b}{a}\right)\right]^2$

(b) $\left[\dfrac{\mu_0 Iv}{2\pi}\ln\left(\dfrac{b}{a}\right)\right]^2\dfrac{1}{vR}$

(c) $\left[\dfrac{\mu_0 Iv}{2\pi}\ln\left(\dfrac{b}{a}\right)\right]^2\dfrac{v}{R}$

(d) $\dfrac{v}{R}\left[\dfrac{\mu_0 Iv}{2\pi}\ln\left(\dfrac{b}{a}\right)\right]^2$



48. A short- circuited coil 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, the electrical power dissipated would be

(a) halved (b) the same (c) doubled (d) quadrupled

49. An inductor coil dissipates energy as heat at the rate of 320W, when a current of 4A is passed through it. At this instant, the inductor coil stores 32 J of magnetic field energy. Find the time constant of the coil when it is joined across a battery of zero internal resistance.

(a) 0.1s (b) 0.2s (c) 0.5s (d) 0.3s

50. A square coil of side 25cm having 1000 turns is rotated with a uniform speed in a magnetic field about an axis perpendicular to the direction of the field. At an instant t, the emf induced in the coil is $e = 200 \sin 100\pi t$. The magnetic induction is

(a) 0.50T (b) 0.02T (c) 0.01T (d) 0.1T

ANSWER KEY

Conceptual MCQs																			
1	(d)	**3**	(c)	**5**	(b)	**7**	(b)	**9**	(d)	**11**	(d)	**13**	(b)	**15**	(b)				
2	(d)	**4**	(b)	**6**	(a)	**8**	(b)	**10**	(b)	**12**	(b)	**14**	(b)						
Application Based MCQs																			
16	(b)	**19**	(a)	**22**	(b)	**25**	(c)	**28**	(b)	**31**	(c)	**34**	(a)	**37**	(b)	**40**	(d)		
17	(a)	**20**	(d)	**23**	(c)	**26**	(b)	**29**	(d)	**32**	(b)	**35**	(b)	**38**	(c)				
18	(a)	**21**	(b)	**24**	(d)	**27**	(a)	**30**	(b)	**33**	(c)	**36**	(b)	**39**	(a)				
Skill Based MCQs																			
41	(d)	**42**	(b)	**43**	(b)	**44**	(a)	**45**	(d)	**46**	(a)	**47**	(a)	**48**	(b)	**49**	(b)	**50**	(c)