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ELECTROMAGNETIC INDUCTION

MCQs with One Correct Answer

1. A long solenoid has 500 turns. When a current of 2 ampere is passed through it, the resulting magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb. The self- inductance of the solenoid is

(a) 2.5 henry (b) 2.0 henry
(c) 1.0 henry (d) 40 henry

2. A very small square loop of wire of side ℓ is placed inside a large square loop of wire of side L ($L \gg \ell$). The loop are coplanar and their centre coincide. The mutual inductance of the system is equal to

(a) $\frac{\mu_0}{4\pi}(\ell / L)$ (b) $\frac{\mu_0}{4\pi} 8\sqrt{2}\,(\ell^2 / L)$

(c) $\frac{\mu_0}{4\pi}(L / \ell)$ (d) $\frac{\mu_0}{4\pi} 3\sqrt{2}\,(L^2 / \ell)$

3. A metal rod of length l moves perpendicularly across a uniform magnetic field B with a velocity v. If the resistance of the circuit of which the rod forms a part is r, then the force required to move the rod uniformly is

(a) $\frac{B^2 l^2 v}{r}$ (b) $\frac{Blv}{r}$

(c) $\frac{B^2 lv}{r}$ (d) $\frac{B^2 l^2 v^2}{r}$

4. 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

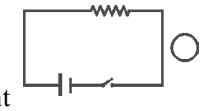
(a) $\frac{1}{2} B\omega l^2$ (b) $\frac{3}{4} B\omega l^2$
(c) $B\omega l^2$ (d) $2B\omega l^2$

5. A wire of length 1 m is moving at a speed of $2 ms^{-1}$ perpendicular to its length in a uniform 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

6. Consider the situation shown in figure. If the switch is closed and after some time it is opened again, the closed loop will show [Just after the closing and opening the switch]



(a) a clockwise current pulse
(b) an anticlockwise current pulse
(c) an anticlockwise current and then clockwise pulse
(d) a clockwise current and then an anticlock wise current pulse.

7. 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) 0.02 coulomb (b) 0.2 coulomb
(c) 3 coulomb (d) 2 coulomb

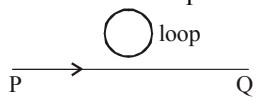
8. A thin circular ring of area A is perpendicular to uniform magnetic field of induction B. A small cut is made in the ring and a galvanometer is connected across the ends such that the total resistance of circuit is R. When the ring is suddenly squeezed to zero area, the charge flowing through the galvanometer is

(a) $\frac{BR}{A}$ (b) $\frac{AB}{R}$

(c) ABR (d) B^2A/R^2

9. An electron moves along the line PQ as shown which lies in the same plane as a circular loop of conducting wire as shown in figure. What will be the direction of the induced current initially in the loop when electron comes closer to loop?

(a) Anticlockwise
(b) Clockwise
(c) Direction can not be predicted
(d) No current will be induced



10. A straight conductor of length 2m moves at a speed of 20 m/s. When the conductor makes an angle of 30° with the direction of magnetic field of induction of 0.1 wbm^2 then induced emf

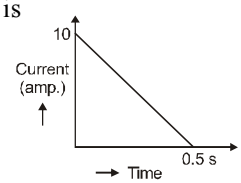
(a) 4V (b) 3V (c) 1V (d) 2V

11. The self induced emf of a coil is 25 volts. When the current in it is changed at uniiform rate from 10 A to 25 A in 1s, the change in the energy of the inductance is:

(a) 740 J (b) 437.5 J (c) 540 J (d) 637.5 J

12. In a coil of resistance 100Ω, a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is

(a) 250 Wb
(b) 275 Wb
(c) 200 Wb
(d) 225 Wb



13. When current in a coil changes from 5 A to 2 A in 0.1 s, average voltage of 50 V is produced. The self - inductance of the coil is :

(a) 6 H (b) 0.67 H (c) 3 H (d) 1.67 H

14. A solid metal cube of edge length 2 cm is moving in a positive *y*-direction at a constant speed of 6 m/s. There is a uniform magnetic field of 0.1 T in the positive *z*-direction. The potential difference between the two faces of the cube perpendicular to the *x*-axis, is:

(a) 12 mV (b) 6 mV (c) 1 mV (d) 2 mV

15. A horizontal straight wire 20 m long extending from east to west falling with a speed of 5.0 m/s, at right angles to the horizontal component of the earth's magnetic field 0.30×10^{-4} Wb/m^2. The instantaneous value of the e.m.f. induced in the wire will be

(a) 3mV (b) 4.5mV (c) 1.5mV (d) 6.0mV

16. There are two long co-axial solenoids of same length *l*. The inner and outer coils have radii r_1 and r_2 and number of turns per unit length n_1 and n_2, respectively. The ratio of mutual inductance to the self-inductance of the inner-coil is :

(a) $\frac{n_1}{n_2}$ (b) $\frac{n_2}{n_1}\cdot\frac{r_1}{r_2}$

(c) $\frac{n_2}{n_1}\cdot\frac{r_2^2}{r_1^2}$ (d) $\frac{n_2}{n_1}$

17. Two coils 'P' and 'Q' are separated by some distance. When a current of 3A flows through coil 'P', a magnetic flux of 10^{-3} Wb passes through 'Q'. No current is passed through 'Q'. When no current passes through 'P' and a current of 2A passes through 'Q', the flux through 'P' is:

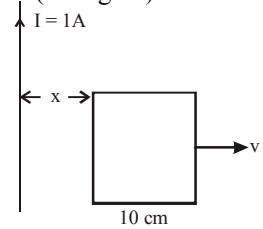
(a) 6.67×10^{-4} Wb (b) 3.67×10^{-3} Wb
(c) 6.67×10^{-3} Wb (d) 3.67×10^{-4} Wb

18. An insulating thin rod of length *l* has a linear charge density $\rho(x) = \rho_0 \frac{x}{l}$ on it. The rod is rotated about an axis passing through the origin ($x = 0$) and perpendicular to the rod. If the rod makes n rotations per second, then the time averaged magnetic moment of the rod is:

(a) $\pi n \rho l^3$ (b) $\frac{\pi}{3} n \rho l^3$

(c) $\frac{\pi}{4} n \rho l^3$ (d) $n \rho l^3$

19. A square frame of side 10 cm and a long straight wire carrying current 1 A are in the plate of the paper. Starting from close to the wire, the frame moves towards the right with a constant speed of 10 ms^{-1} (see figure).



The e.m.f induced at the time the left arm of the frame is at x = 10 cm from the wire is:

(a) 2 μV (b) 1 μV

(c) 0.75 μV (d) 0.5 μV

20. A coil of cross-sectional area A having n turns is placed in a uniform magnetic field B. When it is rotated with an angular velocity ω, the maximum e.m.f. induced in the coil will be

(a) nBAω (b) $\frac{3}{2}$nBAω

(c) 3nBAω (d) $\frac{1}{2}$nBAω

Numeric Value Answer

21. Two concentric coplanar circular loops made of wire, with resistance per unit length 10Ω/m have diameters 0.2 m and 2 m. A time varying potential difference (4 + 2.5 t) volt is applied to the larger loop. Calculate the current (in A) in the smaller loop.

22. The current in a coil of self-induction 2.0 henry is increasing according to $i = 2 \sin t^2$ ampere. Find the amount of energy (in joule) spent during the period when the current changes from 0 to 2 ampere.

23. The self induced emf of a coil is 25 volts. When the current in it is changed at uniform rate from 10 A to 25 A in 1s, the change in the energy (in joule) of the inductance is:

24. A 10 m long horizontal wire extends from North East to South West. It is falling with a speed of 5.0 ms^{-1}, at right angles to the horizontal component of the earth's magnetic field, of 0.3×10^{-4} Wb/m^2. The value of the induced emf (in V) in wire is :

25. A conducting circular loop having a radius of 5.0 cm, is placed perpendicular to a magnetic field of 0.50 T. It is removed from the field in 0.50 s. Find the average emf (in V) produced in the loop during this time.

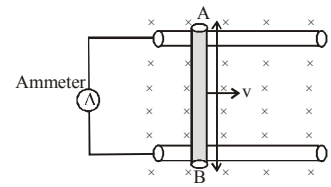
26. A uniform magnetic field B exists in a direction perpendicular to the plane of a square frame made of copper wire. The wire has a diameter of 2 mm and a total length of 40 cm. The magnetic field changes with time at a steady rate $\frac{dB}{dt} = 0.02 \frac{T}{s}$. Find the current (in A) induced in the frame. Resistivity of copper $= 1.7 \times 10^{-8}$ W-m.

27. A coil of inductance 1 H and resistance 10Ω is connected to a resistanceless battery of emf 50 V at time $t = 0$. Calculate the ratio of the rate at which magnetic energy is stored in the coil to the rate at which energy is supplied by the battery at $t = 0.1$ s.

28. A long solenoid having 200 turns per cm carries a current of 1.5 amp. At the centre of it is placed a coil of 100 turns of cross-sectional area 3.14×10^{-4} m^2 having its axis parallel to the field produced by the solenoid. When the direction of current in the solenoid is reversed within 0.05 sec, the induced e.m.f. (in V) in the coil is

29. An air plane, with a 20 m wing spread is plying at 250 m/s straight south parallel to earth's surface. The earth's magnetic field has a horizontal component of 2×10^{-5} Wb/m^2 and angle of dip is 60°. Calculate the induced emf (in V) between the plane tips.

30. If the rod is moving with a constant velocity of 12 cm/s then the power (in watt) that must be supplied by an external force in maintaining the speed will be



(Given B = 0.5 Tesla, l = 15 cm, v = 12 cm/s, Resistance of rod $R_{AB} = 9.0$ mΩ)

ANSWER KEY																			
1	(c)	**4**	(a)	**7**	(a)	**10**	(d)	**13**	(d)	**16**	(d)	**19**	(b)	**22**	(4)	**25**	(7.85×10^{-2})	**28**	(0.048)
2	(b)	**5**	(b)	**8**	(b)	**11**	(b)	**14**	(a)	**17**	(a)	**20**	(a)	**23**	(437.5)	**26**	(9.3×10^{-2})	**29**	(0.173)
3	(a)	**6**	(d)	**9**	(a)	**12**	(a)	**15**	(a)	**18**	(c)	**21**	(1.25)	**24**	(1.5×10^{-3})	**27**	(0.36)	**30**	(9×10^{-3})