SRIGAYATRI EDUCATIONAL INSTITUTIONS

INDIA

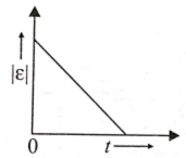
ELECTRO MAGNATIC INDUCTION (UT-04)

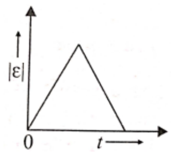
PHYSICS

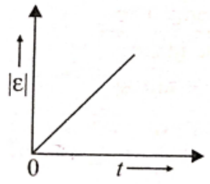
1. **A circular disc of radius 0.2 m is placed in a uniform magnetic field of induction** $\left(\frac{1}{\pi}\right)\text{Wbm}^{-2}$ **in such a way that axis makes an angle of 60^0 with $\vec{B}$ The magnetic flux linked with the disc is**

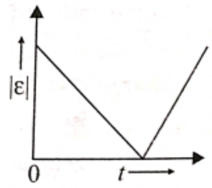
1) 0.02 Wb 2) 0.06 Wb 3) 0.08 Wb 4) 0.01WB

2. **A long solenoid S has n turns per metre with diameter a. At the centre of this coil, we place a smaller coil of N turns and diameter b(b<a). If current in the solenoid increases with time then the emf will be induced in the smaller coil. Which of the following is the correct graph showing $|\varepsilon|$ verses t if current varies as a function of mt^2+C ?**

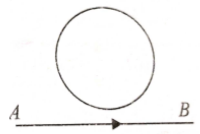
1) 

2) 

3) 

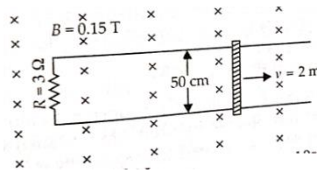
4) 

3. **In the given figure, current from A to B in the straight wire is decreasing. The direction of induced current in the loop is**



1) clockwise 2) anticlockwise 3) changing 4) nothing can be said

4. **As shown in the figure, a metal rod makes contact with a partial circuit and completes the circuit. The circuit area is perpendicular to a magnetic field with B=0.15 T. If the resistance of the total circuit is 3Ω the force needed to move the rod as indicated with a constant speed of 2 m s^{-1} will be equal to**



1) 3.75×10^{-3}N 2) 2.75×10^{-3}N 3) 6.57×10^{-4}N 4) 4.36×10^{-4}N

5. **A sliding rod AB resistance R is shown in the figure. Here magnetic field B is constant and is out of the paper. Parallel wires have no resistance and the rod is moving with constant velocity v. The current in the sliding i s rod AB when switch S is closed at the t =0 s**

1) $\frac{vBd}{R}e^{-t/C}$ 2) $\frac{vBd}{R}e^{-t/RC}$ 3) $\frac{vBd}{R}e^{RtC}$ 4) $\frac{vBd}{R}e^{t/RC}$

6. **A conducting metal circular-wire-loop of radius r is placed perpendicular to a magnetic field which varies with time as $B=B_0e^{-\frac{t}{\tau}}$ where B_0 and τ are constants, at time t=0. If the resistance of the loop is R then the heat generated in the loop after a long time $(t\to\infty)$ is**

1) $\frac{\pi^2r^4B_0^4}{2\tau R}$ 2) $\frac{\pi^2r^4B_0^2}{2\tau R}$ 3) $\frac{\pi^2r^4B_0^2R}{\tau}$ 4) $\frac{\pi^2r^4B_0^2}{\tau R}$

7. **If number of turns in primary and secondary coils is increased to two times each, the mutual inductance**

1) becomes 4 times 2) becomes 2 times 3) becomes ¼ times 4) remains unchanged

8. Two conducting circular loops of radii R_1 and R_2 coinciding. If $R_1>R_2$, the mutual inductances between them will be directly proportional to

1) $\frac{R_1}{R_2}$ 2) $\frac{R_2}{R_1}$ 3) $\frac{R_1^2}{R_2}$ 4) $\frac{R_2^2}{R_1}$

9. Two coils have self-inductance L_1=4 mH L_2=1 mH respectively. The currents in the two coils are increased at the same rate. At a certain instant of time both coils are given the same power. If I_1 and I_2 are the currents in the two coils at that instant of time respectively, then the value of $\frac{I_1}{I_2}$ is

1) $\frac{1}{8}$ 2) $\frac{1}{4}$ 3) $\frac{1}{2}$ 4) 1

10. The self inductance of an inductor coil having 100 turns is 20 mH. The magnetic flux through the cross-section of the coil corresponding to a current of 4 mA is

1) 2×10^{-5} Wb 2) 4×10^{-7} Wb 3) 8×10^{-7} Wb 4) 8×10^{-5} Wb

11. In an inductor of self-inductance L = 2 mH, current changes with time according to relation, $I = t^2e^{-t}$. At what time emf is zero?

1) 4s 2) 3 s 3) 2 s 4) 1s

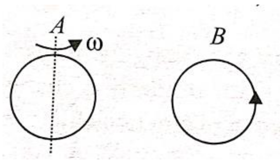
12. A current of 1 A through a coil of inductance of 200 mH is increasing at a rate of 0.5 As^{-1}. The energy stored in the inductor per second is

1) 0.5Js^{-1} 2) 0.5 Js^{-1} 3) 0.1 Js^{-1} 4) 2.0Js^{-1}

13. An a.c. generator consists of a coil of 100 turns and cross-sectional area of 3 m^2, rotating at a constant angular speed of 60 radian/sec in a uniform magnetic field of 0.04 T. The resistance of the coil is 500 ohm. What is the maximum power dissipation in the coil?

1) 518.4W 2) 1036 W 3) 259.2W 4) zero

14. Same as problem 4 except the coil A is made to rotate about a vertical axis. No current flows in B if A is at rest. The current in coil A, when the current in B (at t=0) is counter clock coil A is as shown at this instant t=0 is

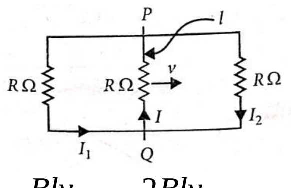


1) constant current clockwise. 2) varying current clockwise.
3) varying current counterclockwise. 4) constant current counter clockwise

15. Find the inductance of unit length of two long parallel wires, each of radius a, whose centers are a distance d a part and carry equal currents in opposite directions. Neglect the flux with in the wire.

1) $\frac{\mu_0}{2\pi}\ln\left(\frac{d-a}{a}\right)$ 2) $\frac{\mu_0}{\pi}\ln\left(\frac{d-a}{a}\right)$ 3) $\frac{3\mu_0}{\pi}\ln\left(\frac{d-a}{a}\right)$ 4) $\frac{\mu_0}{3\pi}\ln\left(\frac{d-a}{a}\right)$

16. A rectangular loop has a sliding connector PQ of length *l* and resistance R Ω and it is moving with a speed v as shown. The set-up is placed in a uniform magnetic field going into the plane of the paper. The three currents I_1, I_2 and I are

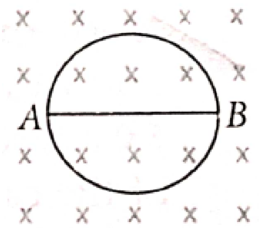


1) $I_1 = I_2 = \frac{Blv}{6R}, I = \frac{Blv}{3R}$ 2) $I_1 = -I_2 = \frac{Blv}{R}, I = \frac{2Blv}{R}$ 3) $I_1 = I_2 = \frac{Blv}{3R}, I = \frac{2Blv}{3R}$ 4) $I_1 = I_2 = I = \frac{Blv}{R}$

17. 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 $0.3\times10^{-4}\,Wb/m^2$. The value of the induced emf in wire is

1) 0.3×10^{-3}V 2) 2.5×10^{-3}V 3) 1.5×10^{-3}V 4) 1.1×10^{-3}V

18. The radius of the circular conducting loop shown in figure is R. Magnetic field is decreasing at a constant rate α. Resistance per unit length of the loop is ρ. Then current in wire AB is (AB is one of the diameters)

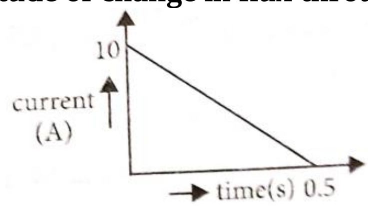


1) $\frac{R\alpha}{2\rho}$ from B to A 2) $\frac{R\alpha}{2\rho}$ from A to B 3) $\frac{2R\alpha}{\rho}$ from A to B 4) zero

19. A cycle wheel of radius 0 5 m is rotated with constant angular velocity of 10 rad/s in a region of magnetic field of 0.1 T which is perpendicular to the plane of the wheel. The EMF generated between its centre and the rim is

1) 0.25 V 2) 0.125V 3)0.5V 4) Zero

20. In a coil of resistance 100 Ω. 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



1)200 WB 2)225 WB 3) 250 Wb 4) 275 Wb

21. A long solenoid with 15 turns per cm gas a small loop of area 4.0 cm^2 placed inside the solenoid normal to its axis. If the current carried by the solenoid changes steadily from 2A to 4A in 0.1 sec. What is the induced emf in the loop while the current is changing (in 10^{-6})

22. A 1.0 m long metallic rod is rotated with an angular frequency of 200 rad/s about an axis normal to the rod passing through its one end. The other end of the rod is in contact with a circular metallic ring. A constant and uniform magnetic field of 0.5T parallel to the axis exists every where. Calculate the emf developed between the centre and the ring.

23. Current in a circuit falls from 4.0 A to 0.0A in 0.1 sec. If an average emf of 200V induced give an estimate of the self inductance of the circuit.

24. A jet plane is travelling towards west at a speed of 1800 km/h. What is the voltage difference developed between the ends of the wing having a span of 24 m. If the earth's magnetic field at the location phasa magnitude of 5×10^{-4} T and the di angle is 30^0.

25. Suppose the loop of dimension 8cm & 2cmstationary but the current feeding the electromagnet that produces the magnetic filed is gradually reduced so that the field decreases from its initial value of 0.3 T at the rate of 0.2 T/s If the cut is joined and the loop has resistance of 1.6Ω. How much power is dissipated by the loop as heat ? (in 10^0)

26. A square loop of side 11 cm with its sides parallel to x & y axes is moved with a velocity of 8 cm/s. in the positive x – direction in an environment containing a magnetic field in the positive z-direction. The field is neither uniform in space nor constant in time. It has a gradient of 10^{-3} T/cm along the negative X- direction and it is decreasing in time at the rate of 10^{-3} T/S. Determine the magnitudes of the induced current in the loop if its resistance is 4.50 mΩ

27. Now assume that the straight wire carries a current of 50 A and the loop is moved to the right a constant velocity V =10 m/s. Calculate the induced emf in the loop at the instant when x = 0.2 m take a = 0.1 m and assume that the loop has a large resistance

28. **Kamla peddles stationary bicycle. The pedals of the bicycle are attached to a 100 turn coil of area $0.10m^2$. The coil rotates at half a revolution per second and it is placed in a uniform magnetic field of 0.02 T perpendicular to the axis of rotation of the coil. What is the maximum voltage generated in the coil ?**

29. **A wheel with 10 metallic spokes each 0.4 m long is rotated with a speed f 120 rev/min in a plane normal to the horizontal component of earth's magnetic field H_E at a place. If H_E=0.4G (gauss) at the place, what is the induced emf between the axle and the rim of the wheel ? Not that 1G = 10^{-4}T**

30. **An anir-core solenoid with length 20 cm, area of cross- section 25 cm^2 and number of turns 500, carries a current of 2.5 A. The current in the solenoid drops to zero in 10^{-3}s when the solenoid is detached from the source of emf. How much is the average back emf induced across the ends of the open switch in the circuit / Ignore the variation in magnetic filed near the ends of the solenoid.**

KEY

PHYSICS

1) **1**	2) **3**	3) **2**	4) **1**	5) **2**	6) **2**	7) **1**	8) **4**	9) **2**	10) **3**
11) **3**	12) **3**	13) **1**	14) **1**	15) **2**	16) **3**	17) **3**	18) **4**	19) **2**	20) **3**
21) **15**	22) **50**	23) **L=5 μ**	24) **3**	25) 6.4×10^{-8}					
26) 2.42×10^{-2}A	27) 5×10^{-5}	28) **0.628**	29) 6.28×10^{-5}	30) **6.5**					

SOLUTION

1. $\phi = BA\cos\theta$

$\phi = B\pi r^2 \cos\theta$

2. $e = \dfrac{-d\phi}{dt}$

$\phi = NB\pi b^2$

$B = \mu_0 \eta I$

$I = \eta t^2 + C$

$e = -N\mu_0 \eta \pi b^2 \dfrac{dI}{dt}$

3. Conceptual

4. $e = B\ell\upsilon$

$I=\frac{|e|}{R}$

$F=Bi\ell\sin 90^0$

5. $I=\frac{dq}{dt}=\frac{Bdu}{R}-\frac{q}{RC}$

$\frac{q}{RC}+\frac{dq}{dt}=\frac{Bdv}{R}$

$q=vBdc+Ae^{-t/RC}$

$I=\frac{dq}{dt}$

6. $B=B_0e^{-t/T}$

A= πr^2

ϕ =BA

$s=\frac{-d\phi}{dt}$

Heat generated in the loop

$Q=\int_0 \frac{E^2}{R}dt$

7. Conceptual

8. $B_1=\frac{\mu_0 I_1}{2R_1}$

$\phi_2=B_1\pi R_2^2$

$\mu=\frac{\phi_2}{\phi_1}$

9. $\in|=L\frac{di}{dt}$

$L=\frac{|\in|}{\frac{dI}{dt}}=\frac{IR}{\frac{dI}{dt}}$

$L=\frac{\cancel{I}p/I^{\cancel{2}}}{\frac{dI}{dt}}=\frac{p}{I\frac{dI}{dt}}$

10. $N\phi=LI$

$\phi=\frac{LI}{N}$

11. $I=t^2e^{-t}$

$\frac{dI}{dt}=\frac{d}{dt}(t^2e^{-t})$

$e=L\frac{dI}{dt}$

12. $U=\frac{1}{2}LI^2$

$\frac{dU}{dt}=\frac{1}{2}\frac{Ld(I^2)}{dt}$

13. Making power dissipation = EI

$=\frac{E_0}{\sqrt{2}}\frac{I_0}{\sqrt{2}}=\frac{I_0^2R}{2}$

$$I_0 = \frac{NBAw}{2}$$

14. Conceptual

15.

$$\phi = \int_{a}^{d-a} \frac{M_0 I}{2\pi r}\ell dr$$

$$\phi_{Total} = \frac{M_0 I\ell}{2\pi}\ell n\left(\frac{d-a}{a}\right)$$

$$L = \frac{\phi_{Total}}{I}$$

$$\frac{L}{\ell} = \frac{M_0}{2\pi}\ell n\left(\frac{d-a}{a}\right)$$

16.

$$e = B\ell\mu$$

$$I = \frac{e}{Rest}$$

17.

$$e = |v(\vec{\ell}\times\vec{B})|$$

$$e = B\ell\mu\sin\theta$$

18. Conceptual

19. $e = \frac{1}{2}Br^2\mu\ell$

20. $e = \frac{d\phi}{dt}$

$$IR = \frac{d\phi}{dt}$$

$$\int d\phi = \int IRdt$$

$$\phi = R\int Idt$$

21. $\frac{N}{l} = 15\text{tur}/\text{cm}$

$$e = \frac{d\phi}{dt} = A\frac{dB}{dt} \qquad (B = \text{Moni})$$

$$e = \mu_0 A\left(\frac{N}{l}\right)\frac{di}{dt} = 15\times10^{-6}\,\text{V}$$

22. $v = r\omega \quad (r = 1)$

$$V = lw$$

$$\text{Average linear velocity} = \frac{lw}{2}$$

$$e = \frac{Blw}{2}l$$

$$e=\frac{Bl^2\omega}{2}$$

$$e=\frac{0.5\times1^2\times200}{2}$$

$$e=50V$$

23. $|e|=L\frac{di}{dt}$

$$200=L\left[\frac{4-0}{0.1}\right]$$

$$L=5\mu$$

24. $v=1800\times\frac{5}{15}=50014\text{m1}$

$$e=Blv$$

$$e=B_V lv$$

$$e=B\sin\theta dv$$

25. $e=\frac{d\phi}{dt}=A\frac{dB}{dt}$

$$e=16\times10^{-4}\times0.2=3-2\times10^{-4}$$

$$I=\frac{e}{R}=\frac{3.2\times10^{-4}}{1.6}=2\times10^{-4}$$

Power dissipated of heat

$$=i^2R$$

$$=4\times10^{-8}\times1.6=6.4\times10^{-8}\text{w}$$

26. Rate of change of Magnetic flux due to explicit time variable in 'B'

$$\frac{d\phi}{dt}=\frac{dx}{dt}A=10^{-3}\times121\times10^{-4}=1.21\times10^{-5}\text{wb/s}$$

Rate of Change if magnetic flux due to Motion of the loop in a non - uniform Magnetic field.

$$\frac{d\phi}{dt}=121\times10^{-4}\times10^{3}\times8=9.68\times10^{-5}\text{wb}$$

$$e=1.21\times10^{-5}+9.68\times10^{-5}=10.89\times10^{5}\text{volt}$$

$$I=\frac{e}{R}=\frac{10\cdot89\times10^{-5}}{4\cdot5\times10^{-3}}=2.42\times10^{2}$$

27. $e=Blv=\left(\frac{\mu_0 I}{2\pi x}\right)lv$

28. $e=NBA2\pi\eta$

$$e=100\times0.1\times0.02\times2\times3.14\times0.5$$

$$c=0.628\text{v}$$

29. $e=\frac{1}{2}BR^2\omega$

30. $e=AN\frac{dB}{dt}\quad\left(B=\frac{MONi}{l}\right)=6.5\text{V}$