PHYSICS

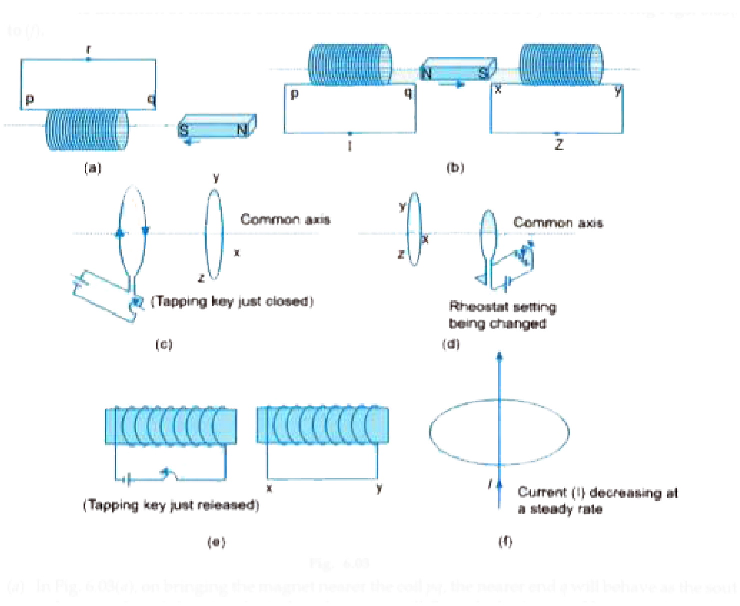
BOOKS - U-LIKE PHYSICS (HINGLISH)

ELECTROMAGNETICE INDUCTION

Ncert Textbook Exercises

1. Predict the direction of induced current in the situations described by the following Figs.

6.03(a) to (f).



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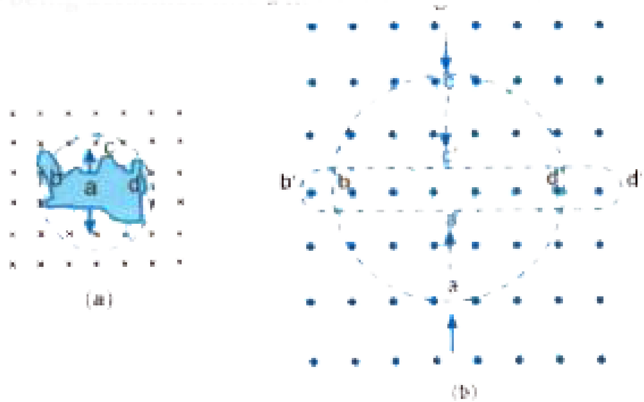
2. Use Lenz's law to determine the direction of induced current in the situations described by Fig. 6.04 :

(a). A wire of irregular shape turning into a circular shape,

(b) A circular loop being deformed into a narrow straight wire.



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3. A long solenoid with 15 turns per cm has a small loop of area 2.0 cm^2 placed inside the solenoid normal to its axis. If the current carried by the solenoid changes steadily from 2.0 A to 4.0 A in 0.1 s, what is the induced emf in the loop while the current is changing ?

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4. A rectangular wire loop of sides 8 cm and 2 cm with a small cut is moving out of a region of uniform magnetic field of magnitude 0.3 T directed normal to the loop. What is the emf developed across the cut if the velocity of the loop is 1 cm s_1 in a direction normal to the (a) longer side?

(b) shorter side of the loop ? For how long does the induced voltage last in each case ?

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5. A 1.0 m long metallic rod is rotated with an angular frequency of 400 rad s_1 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 0.5 T parallel to the axis exists everywhere. Calculate the emf developed between the centre and the ring.

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6. A circular coil of radius 8.0 cm and 20 turns is rotated about its vertical diameter with an angular speed of 50 rad s_1 in a uniform horizontal magnetic field of magnitude $3.0 \times 10^2 T$. Obtain the maximum and average emf induced in the coil. If the coil forms a closed loop of resistance 102Ω, calculate the maximum value of current in the coil. Calculate the average power loss due to Joule heating. Where does this power come from?

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7. A horizontal straight wire 10 m long extending from east to west is falling with a speed of $5.0ms^{-1}$ at right angles to the horizontal component of the earth's magnetic field, $0.30 \times 10^{4} Wbm^{-2}$.

(a) What is the instantaneous value of the emf induced in the wire ?

(b) What is the direction of the emf?

(c) Which end of the wire is at the higher electrical potential ?

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8. Current in a circuit falls from 5.0 A to 0.0 A in 0.1 s. If an average emf of 200 V is induced, give an estimate of the self-inductance of the circuit.

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9. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from to 20 A in 0.5 s, what is the change of flux linkage with the other coil ?

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10. 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 25 m, if the Earth's magnetic field at the location has a magnitude of 5×10^{-4} and the dip angle is 30°?

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Additional Exercises

1. Suppose the loop in Exercise 6.4 is stationary but the current feeding the electromagnet that produces the magnetic field is gradually reduced so that the field decreases from its initial value of 0.3 T at the rate of $0.02 T s^{1}$. If the cut is joined and the loop has a resistance of 1.6Ω, how much power is dissipated by the loop as heat? What is the source of this power ?

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2. A square loop of side 12 cm with its sides parallel to X and Y axes is moved with a velocity of 8 cm s^{-1} 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 $10^{-3} Tcm^{-1}$ along the negative x-direction (that is it increases by $10^{-3} Tcm^{-1}$ as one moves in the negative x-direction), and it is decreasing in time at the rate of $10^{-3} T s^{-1}$. Determine the direction and magnitude of the induced current in the loop if its resistance is $4.50 m\Omega$.

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3. It is desired to measure the magnitude of field between the poles of a powerful loud speaker magnet. A small flat search coil of area $2 cm^2$ with 25 closely wound turns, is positioned normal to the field direction, and then quickly snatched out of the field region. Equivalently, one can give it a quick 90° turn to bring its plane parallel to the field direction. The total charge flown in the coil (measured by a ballistic galvanometer connected to coil) is 7.5 mC. The combined resistance of the soil and the galvanometer is 0.50Ω. Estimate the field streng of magnet.

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4. Fig. 6.05 shows a metal rod PQ resting on the smooth rails AB and positioned between the poles of a permanent magnet. The rails, the rod, and the magnetic field are in three mutual perpendicular directions. A galvanometer G connects the rails through a switch K. Length of the rod = 15 cm, B = 0.50 T, resistance of the closed loop containing the rod = $9.0 m\Omega$. Assume the field to be uniform.

(a) Suppose K is open and the rod is moved with a speed of $12 cms^{-1}$ in the direction shown. Give the polarity and magnitude of the induced emf.

(b) Is there an excess charge built up at the ends of the rods when K is open ? What if K is closed

?

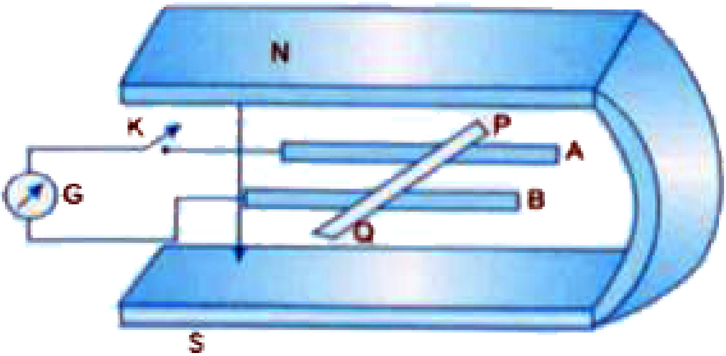
(c) With K open and the rod moving uniformly, there is no net force on the electrons in the rod PQ even though they do experience magnetic force due to the motion of the rod. Explain.

(d) What is the retarding force on the rod when'K is closed ?

(e) How much power is required (by an external agent) to keep the rod moving at the same speed $\left(=12cms^{-1}\right)$ when Kis closed ? How much power is required when K is open ?

(f) How much power is dissipated as heat in the closed circuit? What is the source of this power?

(g) What is the induced emf in the moving rod if the magnetic field is parallel to the rails instead of being perpendicular?



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5. An air-cored solenoid with length 30 cm, area of cross-section $25cm^2$ and number of turns 500, carries a current of 2.5 A. The current is

suddenly switched off in a brief time of $10^{-3}s$. How much is the average back emf induced across the ends of the open switch in the circuit? Ignore the variation in magnetic field near the ends of the solenoid.

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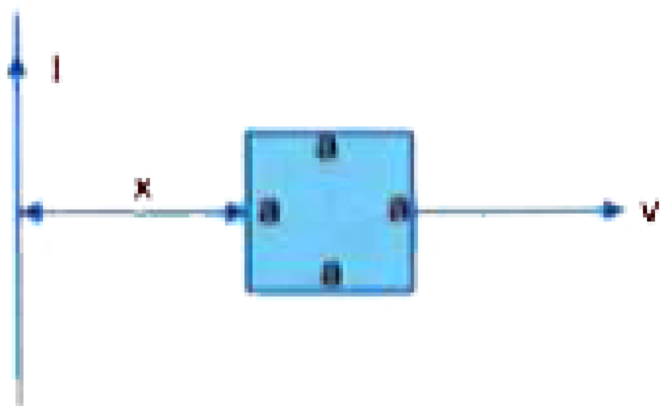
6. (a) Obtain an expression for the mutual inductance between a long straight wire and a square loop of side a as shown in Fig. 6.06.

(b) Now assume that the straight wire carries a current of 50 A and the loop is moved to the right with 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.



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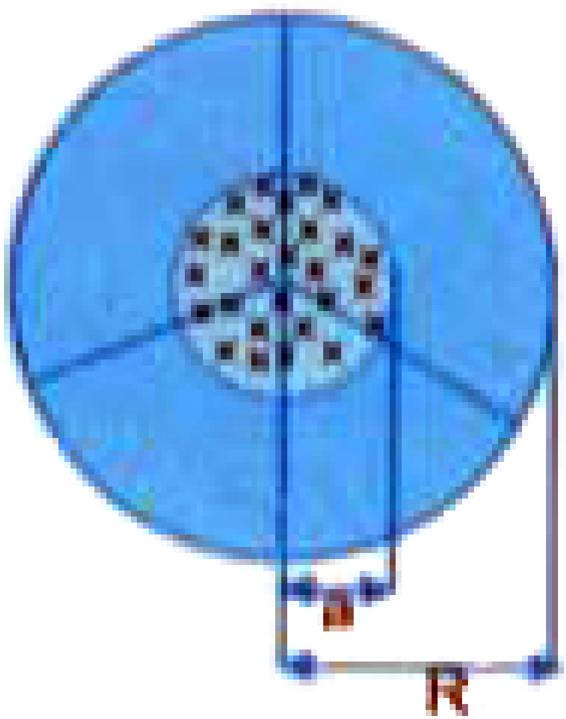
7. A line charge λ per unit length is lodged uniformly onto the rim of a wheel of mass M and radius R. The wheel has light non-conducting spokes and is free to rotate without friction about its axis (Fig. 6.08). A uniform magnetic field extends over a circular region within the rim. It is given by,

$$\vec{B} = -B_0\hat{k}(r \leq a, aItR)$$

= 0 (otherwise)

What is the angular velocity of the wheel after the field is suddenly switched off ?



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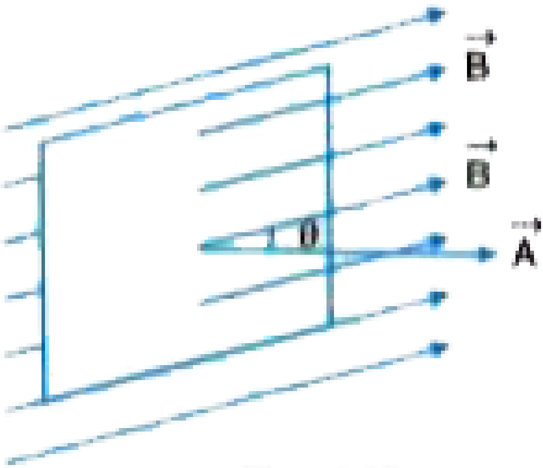
Case Based Source Based Integrated Questions

1. Magnetic flux ϕ_B through a plane of area 'A' placed in a uniform magnetic field $vceB$ is given as:

$$\phi_B = vceB . vceA = BA \cos \theta$$



where θ is the angle between $vceB$ and $vceA$. The above relatio can be extended to curved surfaces and non-uniform fields. In general, if the magnetic field has different magnitudes an directions at various parts of a surface, then the magnetic flux through the surface is given by

$$\phi_B = \int \overrightarrow{B} . d\overrightarrow{A}$$

On the basis of the experimental observations, Faraday concluded that an emf is induced in a coil when magnetic flux through the coil changes with time. Faraday stated his conclusions in the form of a law called Faraday's law of electromagnetic induction. As per this law, the induced emf is given by

$$\varepsilon = - \frac{d\phi_B}{dt}$$

The negative sign in the expression indicates the direction of induced emfe and hence the direction of current in a closed loop.

In the case of a closely would coil of N turns, change of flux associated with each turns is the same and so that total induced emf is given by

$$\varepsilon = -N\frac{d\phi_B}{dt}$$

From above relations it is clear that the magnetic flux can be changed by changing any one or more of the terms $vceB$, $vceA$ and θ.

(a) Give SI unit of magnetic flux.

(b) How is it related to tesla ?

(c) Obtain dimensional formula of magnetic flux.

(d) A loop of area $4 \times 10^{-3} m^2$ is placed with its plane perpendicular to a uniform magnetic field of 0.02 T. If the loop is quickly removed from the magnetic field within a time of 2 ms, what is the magnitude of induced emf across the two ends of the loop ?

(e) If the resistance of the loop be 0.2Ω and a sensitive milliammeter be connected between the two ends of loop, what will be the reading of milliammeter?

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2. Renowned physicist Foucault (1819 - 1868) discovered that induced currents are produced in bulk pieces of conductors on subjecting them to changing magnetic flux. Flow pattern of these induced currents resemble swirling eddies in water and due to this reason these induced currents are called 'eddy currents'.

If a freely suspended metal plate is allowed to swing like a simple pendulum between the pole pieces of a strong magnet, it is found that the motion is damped on account of setting up of eddy currents in the metal plate.

Eddy currents are undesirable since they cause dissipation of electrical energy in the form of heat. Coils of transformers, electrical motors and other such devices are wound on a metallic core and in such devices a large amount of electrical energy is wasted during their operation due to eddy curents.

However, eddy currents are used to advantage in certain applications like magnetic braking in trains, moving coil galvanometers, induction furnace, a.c. induction motors, electric power meters, inducto thermy devices etc.

(a) What are eddy currents ?

(b) Why are they termed so?

(c) Briefly explain the mechanism of eddy currents.

(d) What is electromagnetic damping ?

(e) How is electromagnetic damping utilised in a moving coil galvanometer ?

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3. As per phenomenon of electromagnetic induction an emf is induced in a coil when a magnetic flux linked with it changes. It is possible that emf is induced in single isolated coil due to change of magnetic flux through the coil by means of varying the current passing through the same coil. This phenomenon is called 'self-induction'. If we have coil of N turns closely wound together and a current I is passed through the coil then total magnetic flux associated with it

$N\phi_B \propto I$ or $N\phi_B = LI$ ...... (1)

Here ϕ_B = flux linked with each turn of a coil. The proportionality constant L is known the self-inductance of the coil and its value depends on the dimensions of the coil and nature of core material. If the current flowing through the coil changes then an induced emfe is set up as :

$$\varepsilon = -\frac{d}{dt}(N\phi_B) = -L\frac{dI}{dt}$$ ......(ii)

(a) Define self-inductance of a coil in terms of induced emf.

(b) Obtain SI unit of self inductance.

(c) Write its dimensions.

(d) Do you agree with the statement "Self-inductance is electromagnetic analogue of mass in mechanics" ?

(e) Why do we see some spark in the switch of an electric fan when a running fan is switched off?

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Multiple Choice Questions

1. A square of side L metre lies in the x - y plane in a region, where the magnetic field is given by $\overrightarrow{B} = B_0\left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)T,$ where $B_0,$ is constant. The magnitude of flux passing through the square is [Exemplar Problem]

A. $2B_0L^2Wb$

B. $3B_0L^2Wb$

C. $4B_0L^2Wb$

D. $\sqrt{49}B_0L^2Wb$

Answer: C

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2. Lenz's law is a consequence of the law of conservation of

A. charge

B. momentum

C. mass

D. energy

Answer: A::C::D

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3. A coil having an area $2m^2$ is placed in a magnetic field which changes from $1Wbm^2$ to $4Wbm^2$ in an interval of 2 s. The induced emf in the coil will be

A. 4V

B. 3V

C. 1.5 V

D. 2V

Answer: B

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4. A metal conductor of length 1 m rotates vertically about one of its ends at a constant angular velocity of 5 rad s^{-1} If the horizontal component of earth's magnetic field is $0.4 \times 10^{-4} T$, the emf developed between the two ends of the conductor is

A. 5 mV

B. $5 \times 10^{-4} V$

C. 50 mV

D. `50 muV

Answer: D

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5. The average emf induced in a coil in which the current changes from 2 A to 4 A in 0.05 s is 8 V. Self-inductance of the coil is

A. 0.1 H

B. 0.2H

C. 0.4H

D. 0.8H

Answer: B

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6. The self-inductance L of a solenoid of length l and area of cross-section A with a fixed number of turns N increases as

A. l and A increase.

B. l decreases and increases.

C. l increases and A decreases.

D. both l and A decreases.

Answer: B

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7. Eddy currents are produced, when

A. a metal is kept in a varying magnetic field.

B. a metal is kept in a steady magnetic field.

C. a circular coil is placed in a magnetic field.

D. current is passed through a circular coil.

Answer: A

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8. A long solenoid has 500 turns. When a current of 2 A 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. 4.0H

B. 2.5H

C. 2.0H

D. 1.0H

Answer: A::B::C::D

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9. A boat is moving due east in a region where the earth's magnetic field is $5.0 \times 10^{-5} NA^{-1}m^{-1}$ due north and horizontal. The boat carries a vertical aerial 2 m long. If the speed of the boat is $1.50ms^{-1}$, the magnitude of the induced emf in the wire of aerial is

A. 0.50 mV

B. 0.15 mV

C. 1 mV

D. 0.75 mV

Answer: B

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10. A rectangular, a square, a circular and an elliptical loop, all in the x-y plane, are moving out of a uniform magnetic field with a constant velocity $vcev = v_0\hat{i}$. The magnetic field is directed along the negative z-axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for

A. the rectangular, circular and elliptical loops.

B. the circular and the elliptical loops.

C. only the elliptical loop.

D. any of the four loops.

Answer: B

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11. A solenoid is placed inside another solenoid, the length of both being equal carrying same magnitude of current. The other parameters like radius and number of turns are in the ratio 1:2 for the two solenoids. The mutual inductance on each other would be

A. $M_{12} = M_{21}$

B. $M_{12} = 2M_{21}$

C. $2M_{12} = M_{21}$

D. $M_{12} = 4M_{21}$

Answer: A::B::C::D

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12. The magnetic flux through a circuit of resistance R changes by an amount Adg in time At. The total quantity of electric charge Q, which is passing during this time through any point of the circuit is given by

A. $Q = \frac{\Delta\phi_B}{\Delta t}$

B. $Q = \frac{\Delta\phi_B}{\Delta t}. R$

C. $Q = -(\Delta\phi_B)\frac{)}{\Delta t}\frac{.1}{R}$

D. $Q = -\frac{\Delta\phi_B}{R}$

Answer: A::B::D

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13. A copper ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet, while it is passing through the ring is

A. g

B. less than g.

C. greater than g.

D. depends on the diameter of the ring and the length of magnet.

Answer: B

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14. The direction of induced emf during electromagnetic induction is given by

A. Fareday's law.

B. Lenz's.

C. Maxwell's law.

D. Ampere's law.

Answer: B

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15. A coil having 500 square loops, each of side 10 cm, is placed normal to a magnetic field which increases at the rate of $1.0 T s^{-1}$. The induced emf in volts is

A. 0.1

B. 0.5

C. 1

D. 5

Answer: A::B::D

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16. The magnetic flux linked with a coil, in webers, is given by the equation $\phi_B = 3t^2 + 4t + 9$. The magnitude of induced emf at t = 2s will be

A. 2V

B. 4V

C. 8V

D. 16V

Answer: D

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17. A coil having turns and resistance R is connected with a galvanometer of resistance 4R. The combination is moved in time t s from a magnetic field W_1, weber to W^2 weber. The induced current in the circuit is

A. $-\frac{W_1 - W_2}{5Rnt}$

B. $-\frac{n(W_2 - W_1)}{Rnt}$

C. $-\frac{W_2 - W_1}{Rnt}$

D. $-n\frac{W_2 - W_1}{Rt}$

Answer: A::B::D

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18. An aeroplane, in which the distance between the tips of wings is 50 m, is flying with a speed of $360kmh^{-1}$ over a place where the vertical component of earth's magnetic field is $2.0 \times 10^{-4} T$. The potential difference between the tips of wings would be

A. 0.1V

B. 1.0V

C. 0.2 V

D. 0.01 V

Answer: B

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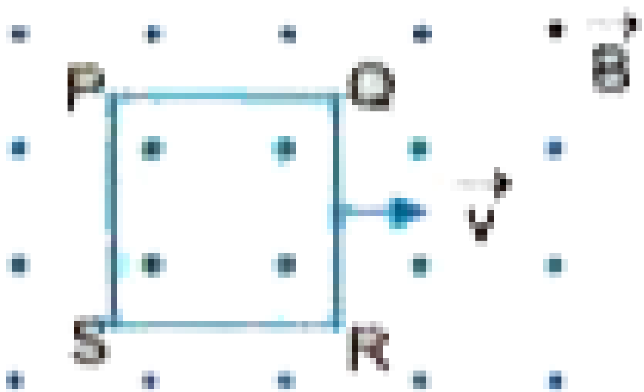
19. A conducting square loop PQRS of side L and resistance R moves in its plane with a uniform velocity $vcev$ perpendicular to one of its sides. A magnetic field $vceB$, constant in time and space, pointing perpendicular and out of the plane of loop exists everywhere.

The current induced in the loop is



A. $\dfrac{BLV}{R}$ clockwise.

B. $\frac{BLv}{R}$ anticolckwise.

C. $\frac{2BLv}{R}$ colckwise.

D. zero.

Answer: A::C::D

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20. A conducting rod of length l is falling with a velocity v perpendicular to a uniform horizontal magnetic field B. The potential difference between the two ends will be

A. 2 Blv

B. Blv

C. $\frac{1}{2}Blv$

D. $\frac{1}{2}Bl^2v^2$

Answer: B

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21. A coil of N turns and mean area A is rotating with uniform angular velocity ω about an axis ai right angles to a uniform magnetic field B. The induced emfe in the coil will be

A. $NBA \sin \omega t$

B. $NB\omega \sin \omega t$

C. $\frac{NBA}{\omega} \sin \omega t$

D. $NBA\omega \sin \omega t$

Answer: D

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22. A wheel with 10 metallic spokes, each 0.5 m long, is rotated with an angular speed of 120 rpm in a plane normal to the earth's magnetic field at the place. If the magnitude of the field is 0.4G, the magnitude of induced emf between the axle and the rim of the wheel is equal to

A. $1.256 \times 10^{-3} V$

B. $6.28 \times 10^{-4} V$

C. $1.256 \times 10^{-4} V$

D. $6.28 \times 10^{-5} V$

Answer: D

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23. When the number of turns in a coil is doubled without any change in the length of the coil, its self-inductance becomes

A. 4 times.

B. 2 times.

C. $\frac{1}{2}$ times.

D. $\frac{1}{4}$ times of previous value.

Answer: A

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24. A 50 mH coil carries a current of 2 A. The energy stored in the coil is

A. 1 J

B. 0.1 J

C. 0.05 J

D. 0.5 J

Answer: A::B::C::D

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25. SI unit of inductance is

A. henry (H)

B. weber (Wb)

C. ohm (Ω)

D. guass (G)

Answer: A

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26. The mutual inductance of a pair of coils is 5 H. In the primary coil currents falls from 5 A to zero in 10^{-3} s. The magnitude of induced emf in the secondary coil will be

A. 2500 V

B. 25000 V

C. 250 V

D. zero

Answer: A::B::C

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27. A coil of 100 turns carries a current of 5 A and creates a magnitude flux of $10^{-5} Tm^2$ per turn. The value of its inductance is

A. 0.05 mH

B. 0.10 m

C. 0.15 mH

D. 0.20 mH

Answer: D

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28. Which of the following is not an application of eddy currents ?

A. Induction Furnace.

B. Galvanometer damping.

C. Speedometer of automobiles.

D. X-ray crystallography.

Answer: D

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29. The number of turns of an a.c. generator is 5000 and the area of the coil is $0.25m^2$. The coil is rotated at the rate of 100 c.p.s, in a magnetic field of$0.2Wbm^{-2}$. The peak value of the emf generated is nearly

A. 786 kV

B. 440 kV

C. 220 kV

D. 157.1 kV

Answer: D

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30. Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to the equation $I = I_0 \sin \omega t \text{where} I_0 = 10A$ and $\omega = 100\pi rads^{-1}$. The maximum value of emf induced in the second coil is

A. $2\pi V$

B. $5\pi V$

C. πV

D. $4\pi V$

Answer: B

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Fill In The Blanks

1. When a current I is established in a coil of self-inductance L, energy stored in the inductor is ______.

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2. Magnetic breaking system in trains makes use of the ____.

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3. Dimensions of inductance are ______.

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4. Magnetic energy stored per unit volume in a magnetic field is _____.

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5. Average value of induced emf in an a.c. generator is ____.

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6. A coil of inductance L and resistance R is connected to a battery of emf E. The final current in the coil is _____.

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7. If current changes at a unit rate through a closed coil, the induced emf produced in the coil is equal _____.

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8. The motion of a copper plate is damped when it oscillates between the two poles of a horse shoe magnet. The cause of damping is _____.

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9. An induced emf of 10 mV is set up in a coil when current flowing through a neighbouring coil is $2As^{-1}$ The mutual inductance for the pair of coils is ____.

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10. The magnetic flux linked with a coil, in webers, is given as $\phi_B = 3t^2 + 4t + 9$. The magnitude of induced emf at t = 2 s will be ____.

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11. Mutual inductance for a pair of two coils is 1.5 mH. If the current in one coil is raised by 5 A in 1m s after closing the circuit, the magnitude of emf induced in the other coil is _____.

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12. Cutting slots in a copper plate, oscillating between the poles of a magnet, reduces the effect of _____.

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13. Direction of current produced in a circuit on account of motional emf is given by _____.

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14. Magnetic flux linked with a circuit of resistance 100 12 increases from 10 Wb to 60 Wb in 0.1 s. The total amount of induced charge is _____.

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15. Two coils of inductance L_1 and L_2 respectively are placed close to each other such that magnetic flux in one coil is completely linked with the other coil. Then their mutual inductance is given as M = ______.

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True Or False

1. A coil of metallic wire is held stationary in a non-uniform magnetic field. An emf is induced in the coil.

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2. Sensitive electrical instruments in the vicinity of an electromagnet may be damaged when the electromagnet is turned on or off.

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3. The magnitude of the induced current in a closed circuit is equal to the time rate of change of magnetic flux through the circuit.

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4. As per Lenz's law the induced emf tends to produce a current which opposes the change in

magnetic flux that produced it.

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5. A thin rod of copper is being moved in a uniform magnetic field such that it is cutting the magnetic field lines. An emf is induced between the ends of the rod.

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6. A metallic rod of length lis hinged at one end and the other end is rotated with a constant angular speed ω about an axis passing through the hinge. A constant and uniform magnetic field B, parallel to the axis of rotation exists everywhere. The induced emf between the two ends of rod is $\frac{1}{2}Bl\omega^2$.

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7. The self-inductance of a circular coil increases many fold if a soft iron core is introduced inside the coil.

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8. SI unit of inductance is henry, where $1H = 1\omega s^{-1}$.

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9. A metallic sheet is placed in a magnetic field. If we pull it is out of the field or want to push it into the field, we experience an opposing force.

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10. Average emf induced in an a.c. generator is zero for one complete cycle.

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Assertion Reason Type Questions

1. Assertion (A) : A changing magnetic flux may produce an induced emf.

Reason (R) : Faraday experimentally demonstrated the induced emf.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false

D. If the assertion is false but reason is true.

Answer:

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2. Assertion (A) : An induced emf is generated across the two ends of a solenoid coil when a magnet is withdrawn from the solenoid coil.

Reason (R) : The relative motion between magnet and the solenoid coil induces an emf.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false

D. If the assertion is false but reason is true.

Answer:

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3. Assertion (A) : When two coils of enamelled copper wire are wound on each other, the mutual inductance between the coils is maximum.

Reason (R) : Mutual inductance does not depend on the orientation of the coils.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false

D. If the assertion is false but reason is true.

Answer:

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4. Assertion (A) : Self-inductance of a coil is also called its 'electrical inertia'.

Reason (R) : Self-inductance is the phenomenon due to which an induced emf is set up in a coil as a result of change in current in the coil.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false

D. If the assertion is false but reason is true.

Answer:

View Text Solution

5. Assertion (A) : Direction of induced emf in a circuit is predicted by Lenz's law.

Reason (R) : Lenz's law is a consequence of the law of conservation of energy.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false

D. If the assertion is false but reason is true.

Answer: Both statements are true and self explanatory.

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Very Short Answer Questions

1. Write SI unit of magnetic flux. Is it a scalar or a vector quantity ?

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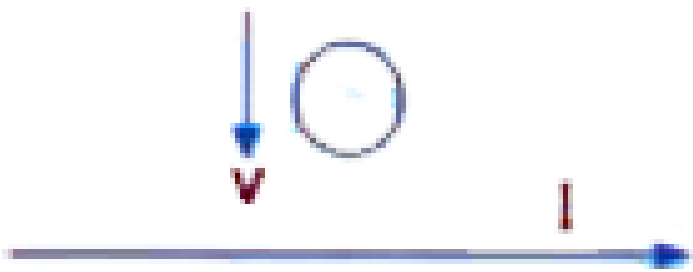
2. Predict the directions of induced currents in metal rings 1 and 2 lying in the same plane where current I in the wire is increasing steadily [Fig. 6.11].

View Text Solution

3. Predict the direction of induced current in a metal ring when the ring is moved towards a straight conductor with constant speed v. The conductor is carrying current I in the direction shown in Fig. 6.13.



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4. Two identical loops, one of copper and another of constanton, are removed from a magnetic field within the same time interval. In which loop the induced current be greater ?

View Text Solution

5. A long straight current carrying wire passes normally through the centre of circular loop. If the current through the wire increases, will there be an induced emf in the loop ? Justify.

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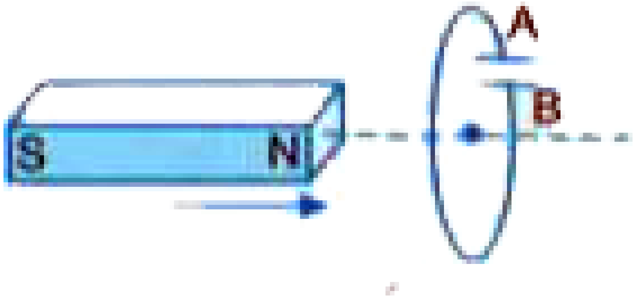
6. Predict the direction of the induced current in the rectangular loop abcd as it is moved into the region of a uniform magnetic filed $\vec{B}$ directed normal to the plane of the loop.

View Text Solution

7. Fig. 6.15 shows a current carrying solenoid moving towards a conducting loop. Find the direction of the current induced in the loop.

View Text Solution

8. In the given Fig. 6.16, a bar magnet is quickly moved towards a conducting loop having a capacitor. Predict the polarity of the plates A and B of the capacitor.



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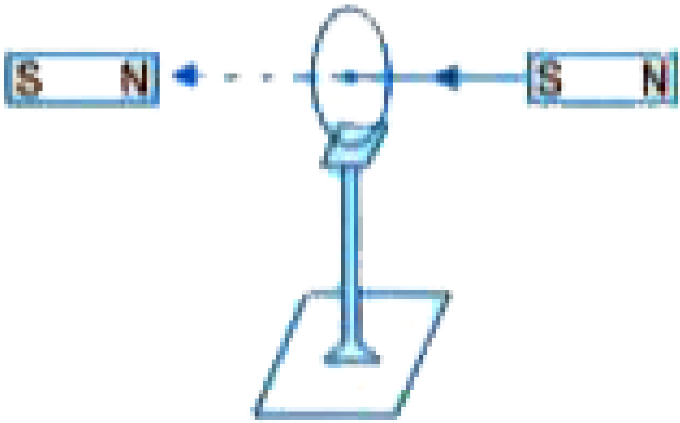
9. The electric current in a wire in the direction from B to A is decreasing. What is the direction of induced current in the metallic loop kept above the wire as shown in the Fig. 6.16?

View Text Solution

10. If the electric current flowing in wire BA is increasing, then what will be the direction of induced current in the loop shown in Fig. 6.17?

View Text Solution

11. Give the direction in which the induced current flows in the coil mounted on an insulating stand when a bar magnet is quickly moved along the axis of the coil from one side to the other as shown in the Fig. 6.18.



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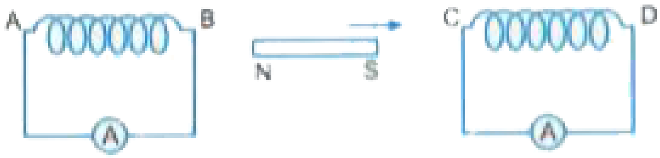
12. A magnet is moved in the direction indicated by an arrow between two coils AB and CD as shown in the Fig. 6.19. Suggest the direction of current in each coil.



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13. What is electromagnetic damping?

View Text Solution

14. The motion of copper plate is damped when it is allowed to oscillate between the two poles

of a magnet. What is the cause of this damping ?

View Text Solution

15. The motion of copper plates is damped when it is allowed to oscillate between the two poles of a magnet. If slots are cut in the plate, how will damping be affected ?

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16. Name any two applications where eddy currents are used to advantage.

View Text Solution

17. The coils, in certain galvanometers, have a fixed core made of a non-magnetic metallic material. Why does the oscillatory coil come to rest so quickly in such a core ?

View Text Solution

18. A light metal disc on the top of an electromagnet is thrown up as the current is switched on. Why? Give reason.

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19. Two spherical bobs, one metallic and the other of glass, of the same size are allowed to fall freely from the same height above the ground. Which of the two would reach earlier and why?

View Text Solution

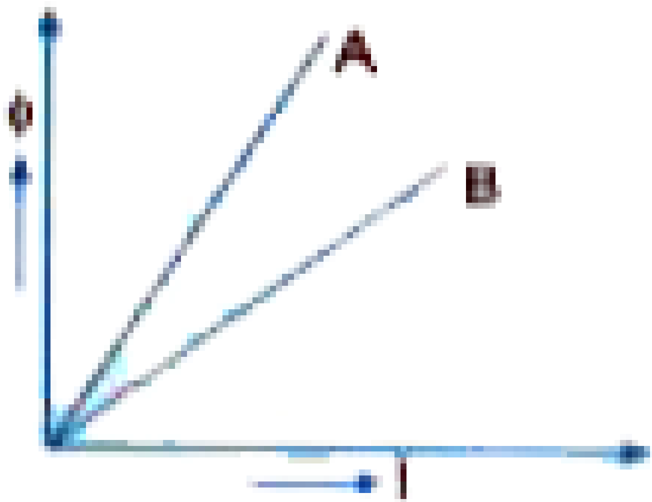
20. Define the term 'self-inductance of a coil. Write its SI unit.

View Text Solution

21. On which factors does the self-inductance of a coil depend?

View Text Solution

22. A plot of magnetic flux (ϕ) versus current (I) is shown in the Fig. 6.20 for two inductors A and B. Which of the two has larger value of self-inductance ?



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23. If the number of turns of a solenoid is doubled, keeping the other factors constant, how does the self-inductance of the solenoid change?

View Text Solution

24. A solenoid with an iron core and a bulb are connected to a d.e. source. How does the brightness of the bulb change, when the iron core is removed from the solenoid ?

View Text Solution

25. Why does a metallic piece become very hot when it is surrounded by a coil carrying high frequency alternating current ?

View Text Solution

26. Define mutual inductance of a pair of coils and write its SI unit.

View Text Solution

27. Name two factors on which mutual inductance of a pair of coils depends.

View Text Solution

28. How does the mutual inductance of a pair of coils change when

(i) distance between the coils is decreased and

(ii) number of turns in the coils is decreased ?

View Text Solution

29. Two coils 1 and 2 are placed close to each other. On changing current flowing through coil 1 an induced emf is set up in coil 2 and vice-versa. What is the relation between mutual inductance of coil 1 due to change in current in coil 2 and the mutual inductance of coil 2 due to change in current in coil 1?

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30. An iron core solenoid has self-inductance 2.8 H. When the core is removed, the self-inductance becomes 2 mH. What is the relative permeability of the core used ?

View Text Solution

Short Answer Questions

1. State Lenz's law. Explain by giving examples that Lenz's law is a consequence of conservation law of energy.

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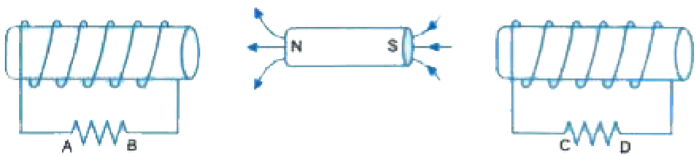
2. State Lenz's Law.

A metallic rod held horizontally along east-west direction, is allowed to fall under gravity. Will there be an emf induced at its ends ? Justify your answer.

View Text Solution

3. A solenoid is connected to a battery so that a steady current flows through it. If an iron core is inserted into the solenoid, will the current increase or decrease ? Explain.

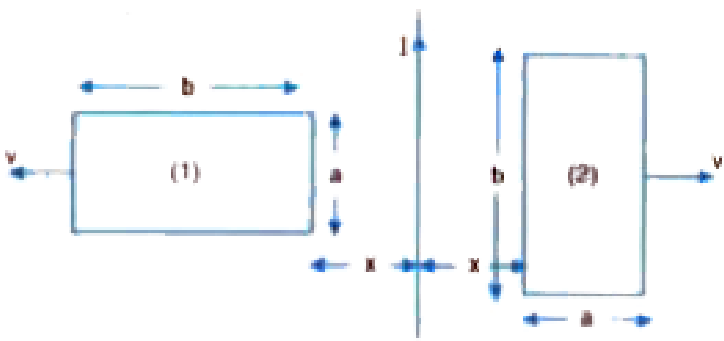
4. In the Fig. 6.22 given below, a bar magnet moving towards the right or left induces an emf in the coils (i) and (ii). Find, giving reason, the directions of the induced currents through the resistors AB and CD when the magnet is moving (a) towards the right and (b) towards the left.



5. The Fig. 6.23 shows two identical rectangular loops (1) and (2), placed on a table along with a straight long current carrying conductor between them.

What will be the directions of the induced currents in the loops when they are pulled away from the conductor with same velocity v ?

(ii) Will the emf induced in the two loops be equal ? Justify your answer.



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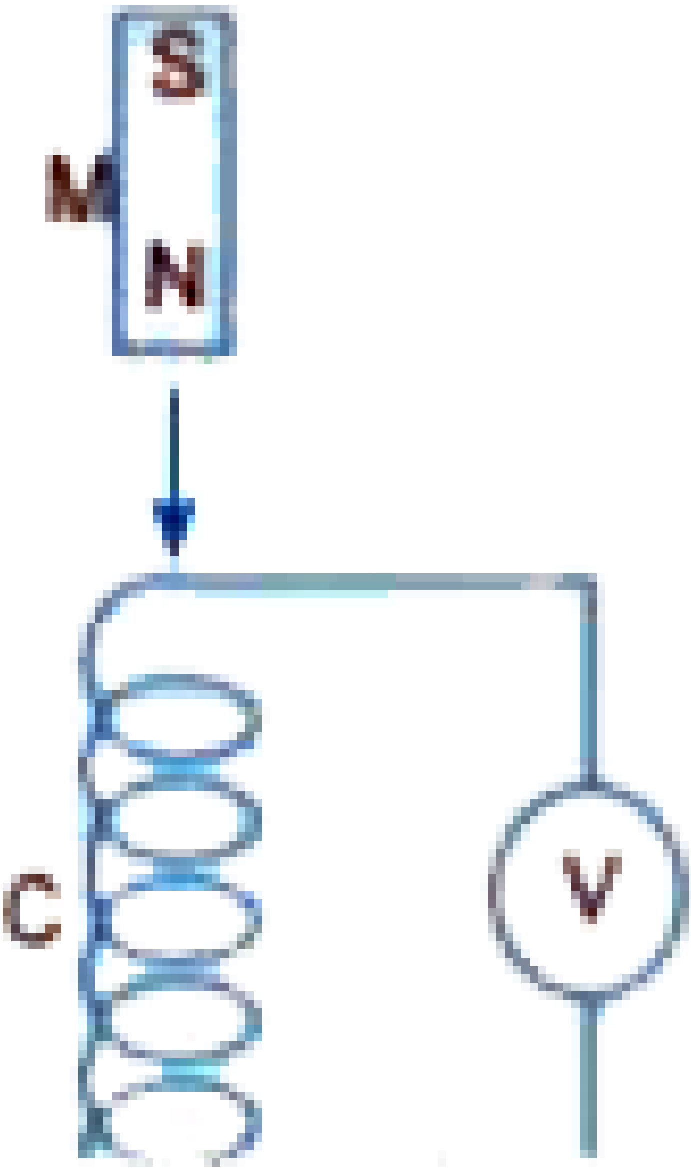
6. Fig. 6.24 shows a bar magnet M falling under gravity through an air cored coil C. Plot a graph Induced showing variation of induced emf (E) with time (t). What does the area enclosed by the E-t curve depict ?



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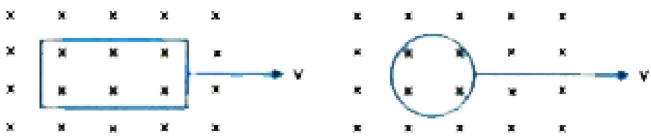
7. As shown in Fig. 6.26, a rectangular loop and a circular loop are moving out of a uniform magnetic field region to a field free region with a constant velocity v. In which loop do you expect the induced emf to be constant during the passage out of the field region ? The field is normal to the loops.



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8. Predict the polarity of the capacitor in the situation described by adjoining Fig. 6.27. Explain the reason too.

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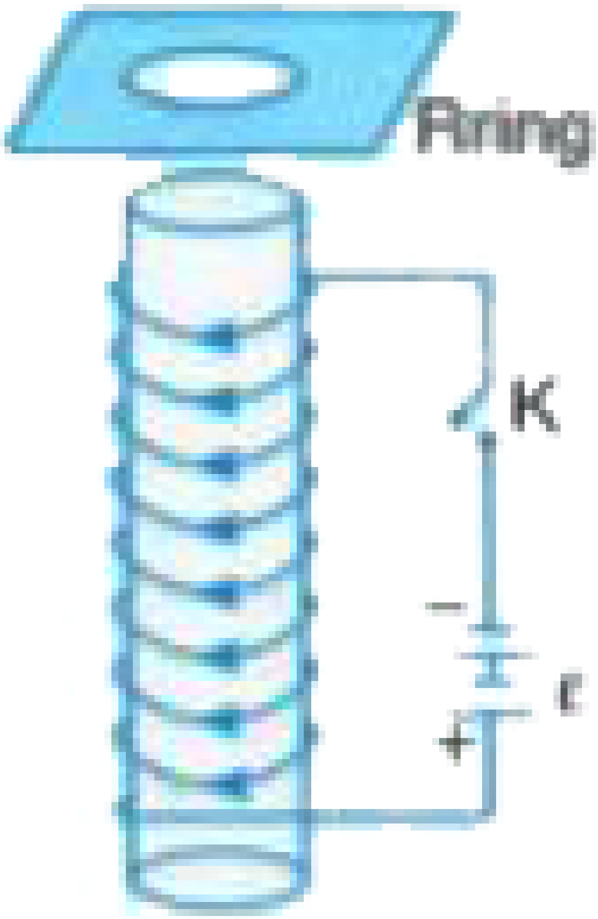
9. Consider a metal ring kept on top of a fixed solenoid (say on a cardboard) as shown in Fig. 6.28. The centre of the ring coincides with the axis of the solenoid. If the current is suddenly switched on, the metal ring jumps up. Explain.



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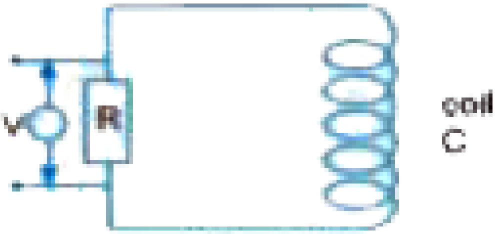
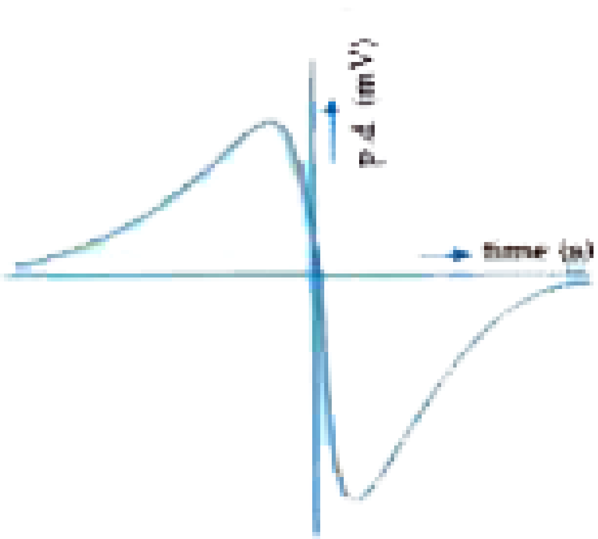
10. A bar magnet M is dropped so that it falls vertically through the coil C [Fig. 6.29). The graph obtained for voltage produced across the coil vs time is shown in Fig. 6.30.

(a) Explain the shape of the graph.

(b) Why is the negative peak longer than the positive peak?





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11. A metallic rod of length 'l' is rotated with angular frequency of $'\omega'$ with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius 'l', about an axis passing through its centre and perpendicular to the plane of ring. A constant and uniform magnetic field B parallel to the axis is present everywhere. Deduce the expression for the emf between the centre and the metallic ring.

View Text Solution

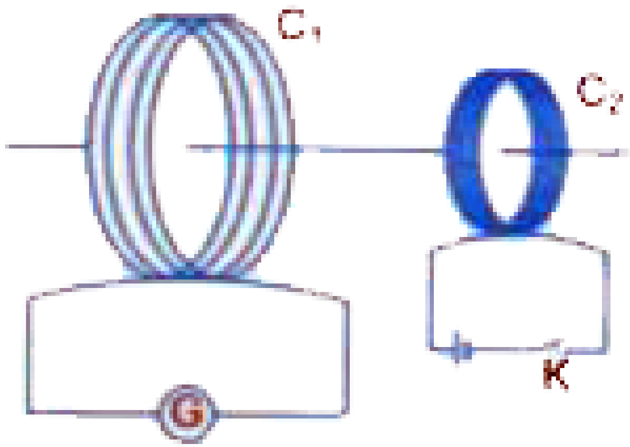
12. A wheel with 8 metallic spokes each 50 cm long is rotated with a speed of 120 rev/min in a plane normal to the horizontal component of the Earth's magnetic field. The Earth's magnetic field at the place is 0.4 G and the angle of dip is 60°. Calculate the emf induced between the axle and the rim of the wheel. How will the value of emf be affected if the number of spokes were increased ?

View Text Solution

13. A current is induced in coil C_1 due to the motion of current carring coil C_2 as shown in Fig. 6.32.

(a) Write any two ways by which a large deflection can be obtained in the galvanometer G.

(b) Suggest an alternative device to demonstrate the induced current in place of a galvanometer.



View Text Solution

14. A rectangular coil of N-turns, area A is held in a uniform magnetic field B. If the coil is rotated at a steady angular velocity ω, deduce an

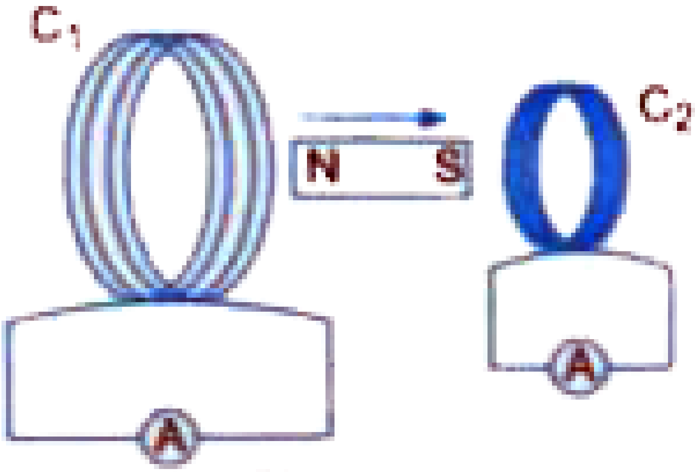
expression for the induced emf in the coil at any instant of time.

View Text Solution

15. A rectangular coil of area 'A', having number of turns N, is rotated at 'f' revolutions per second in a uniform magnetic field B, the field being perpendicular to the coil. Prove that the maximum emf induced in the coil is $2\pi fNBA$.

View Text Solution

16. A magnet is quickly moved in the direction indicated by an arrow between two coils C_1 and C_2 as shown in the Fig. 6.34. What will be the direction of induced current in each coil as seen from the magnet ? Justify you answer.



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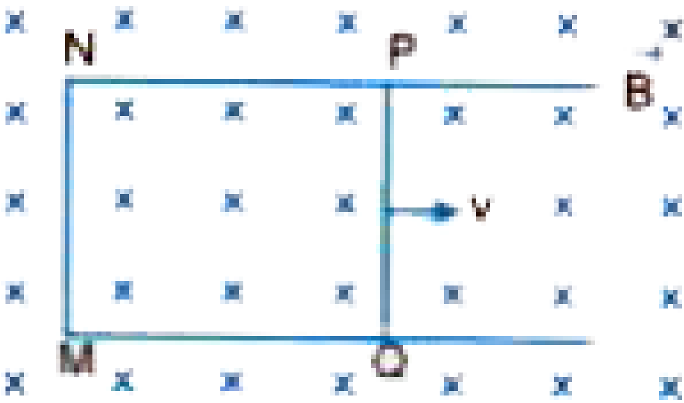
17. Derive an expression for the induced emf and induced current produced by changing the area of a rectangular coil placed perpendicular to a uniform magnetic field.

View Text Solution

18. A rectangular conductor LMNO is placed in a uniform magnetic field of 0.5 T. The field is directed perpendicular to the plane of the conductor. When the arm MN of length of 20 cm is moved towards left with a velocity of $10ms^{-1}$, calculate the emf induced in the arm. Given the resistance of the arm to be 5Ω (assuming that other arms are of negligible resistance) find the value of the current in the arm.

View Text Solution

19. A rectangular loop PQMN with movable arm PQ of length 10 cm and resistance 2Ω is placed in a uniform magnetic field of 0.1 T acting perpendicular to the plane of the loop as shown in Fig. 6.37. The resistance of the arm MN, NP and MQ are negligible. Calculate (i) the emf induced in the arm PQ, and (ii) current induced in the loop when arm PQ is moved with velocity $20 m s^{-1}$.



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20. A 0.5 m long solenoid of 10 turns/cm has area of cross-section $1 cm^2$. Calculate the voltage induced across its ends if the current in the solenoid is changed from 1 A to 2 A in 0.1 s.

View Text Solution

21. A small flat search coil of area $5cm^2$ with 140 closely wound turns is placed between the poles of a powerful magnet producing magnetic field 0.09 T and then quickly removed out of the field region. Calculate

(a) change of magnetic flux through the coil, and

(b) emf induced in the coil.

View Text Solution

22. A metallic rod of length l is moved perpendicular to its length with velocity v in a magnetic field $\vec{B}$ acting perpendicular to the plane in which rod moves. Derive the expression for the induced emf. Or Starting from the expression for the Lorentz force acting on the free charge carriers of a conductor moving in a perpef Zicular magnetic field, obtain the expression for the motional emf induced.

View Text Solution

23. What are eddy currents ? Write any two applications of eddy currents.

View Text Solution

24. How can eddy currents be reduced in a metallic conductor ?

View Text Solution

25. Define self-inductance and give its unit. Write down the expression for the self-inductance of a long solenoid of length l having N-turns.

View Text Solution

26. The given Fig. 6.39, shows an inductor L and resistor R connected in parallel to a battery B through a switch S. The resistance of R is same as that of the coil that makes L. Two identical bulbs Pand Q are put in each arm of the circuit as shown.

(a) When S is closed, which of the two bulbs will light up earlier ?

(b) Will the bulbs be equally bright after some time? Justify your answer.

View Text Solution

27. A source of emf ε is used to establish a current I through a coil of self-inductance L. Show that the work done by the source to build up the current $I_0 is \frac{1}{2}LI_0^2$.

Or

Obtain the expression for the magnetic energy stored in an ideal inductor of self-inductance L when a current I_0 passes through it.

View Text Solution

28. Deduce an expression for the mutual inductance of two long coaxial solenoids but having different radii and different number of turns.

Or

Obtain the expression for the mutual inductance of two long coaxial solenoids S_1 and S_2 wound one over the other, each of length l and radii r_1 and r_2, and number of turns per unit length n_1 and n_2 respeetively, when a current I is set up in the outer solenoid S_2.

View Text Solution

29. The circuit arrangement given shows that when an a.c. passes through the coil, the current starts flowing in the coil B.

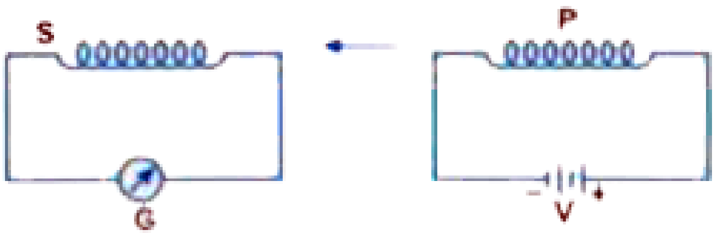
(i) State the underlying principle involved.

(ii) Mention two factors on which the current produced in the coil depends.

View Text Solution

30. (i) When primary coil P is moved towards secondary coil S (as shown in the Fig.) the galvanometer shows momentary deflection. What can be done to have larger deflection in the galvanometer with the same battery?

(ii) State the related law.



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31. Two concentric circular coils, one of small radius r and the other of large radius R, such that R >> T, are placed coaxially with centres coinciding. Obtain the mutual inductance of the arrangement.

View Text Solution

32. A rectangular frame of wire is placed in a uniform magnetic field directed outwards normal to the paper. AB is connected to a spring which is stretched to A'B' and then released at time t = 0. Explain qualitatively how induced emf in the coil would vary with time. Neglect damping of oscillations of spring.

View Text Solution

33. The flux linked with a large circular coil, of radius R, is 0.5×10^{-3} Wb when a current of 0.5 A flows through a small neighbouring coil of radius'r'. Calculate the mutual inductance for

the given pair of coils. If the current through the small coil suddenly falls to zero, what would be its effect in the larger coil ?

View Text Solution

34. A circular copper disc 10 cm in radius rotates at 20π rad/s about an axis through its centre and perpendicular to the disc. A uniform magnetic field of 0.2 T acts perpendicular to the disc.

(i) Calculate the potential difference developed between the axis of the disc and the rim.

(ii) What is the induced current if the resistance of the disc is `2Omega?

View Text Solution

35. A coil Q is connected to low voltage bulb B and placed near another coil P as shown in the Fig. 6.46. Give reasons to explain the following observations:

(a) The bulb 'B' lights.

(b) Bulb gets dimmer if the coil Q is moved towards left.

View Text Solution

36. A circular coil of radius 8 cm and 20 turns rotates about its vertical diameter with an angular speed of $50s^{-1}$ in a uniform horizontal magnetic field of magnitude $3 \times 10^{-2}T$. Find the maximum and average value of the emf induced in the coil.

View Text Solution

37. There are two coils A and B separated by some distance. If a current of 2 A flows through A, a magnetic flux of 10^{-2} Wb passes through B (no current through B). If no current passes through A and a current of 1 A passes through B, what is the flux through A ?

View Text Solution

38. A wheel with 15 metallic spokes, each 60 cm long, is rotated at 360 revolutions per minute in a plane normal to the horizontal component of earth's magnetic field. The angle of dip at that place is 60°. If the emf induced between rim of the wheel and the axle 400 mV, calculate the horizontal component of earth's magnetic field at the place.

How will the induced emf change if the number of spokes is increased ?

View Text Solution

Long Answer Questions I

1. State and explain Faraday's law of electromagnetic induction.

View Text Solution

2. State Lenz's law.

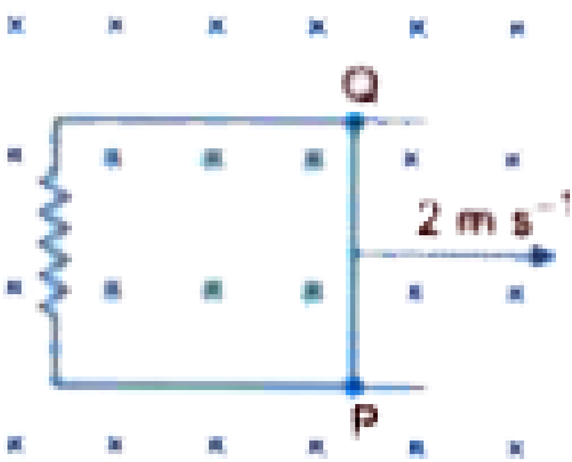
Two identical loops, one of copper and the other of aluminium, are rotated with the same speed in a uniform magnetic field acting normal to the plane of the loops. State with reason, for which of the coils (i) induced emf, (ii) induced current will be more.

View Text Solution

3. What are eddy currents ? How are these produced ? In what sense are eddy currents considered undesirable in a transformer and how are these reduced in such a device?

View Text Solution

4. A 0.5 m long metal rod PQ completes the circuit as shown in the Fig. 6.47. The area of the circuit is perpendicular to the magnetic field of flux density 0.15 T. If the resistance of the total circuit is 3Ω, calculate the force needed to move the rod in the direction as indicated with a constant speed of $2ms^{-1}$.



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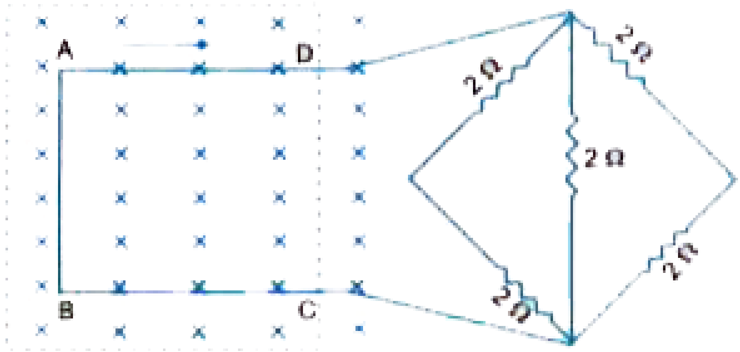
5. A metallic square loop ABCD of size 15 cm and resistance 1.0Ω is moved at a uniform velocity of v m/s in a uniform magnetic field of 2 T, the field lines being normal to the plane of paper. The loop is connected to an electrical network of resistors, each of resistance 2Ω. Calculate the speed of the loop, for which 2 mA current flows in the loop.



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6. A metallic rod of length 'l' is rotated with a frequency v with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius r, about an axis passing through the centre and perpendicular

to the plane of the ring. A constant uniform magnetic field B parallel to the axis is present every where. Using Lorentz force, explain how emf is induced between the centre and the metallic ring and hence obtain the expression for it.

View Text Solution

7. Fig. 6.50 shows a rectangular conducting loop PQRS in which the arm PQ is free to move. A uniform magnetic field acts in the direction perpendicular to the plane of the loop. Arm PQ is moved with a velocity v towards the arm RS. Assuming that the arms QR, RS and SP have negligible resistances and the moving arm PQ has the resistance r, obtain the expression for the current in the loop (ii) the force and (iii) the power required move the arm PQ.

View Text Solution

8. A circular coil of N-turns and of radius R is kept normal to a magnetic field given by $B = B_0$ cos omegat`. Deduce an expression for emf induced in this coil. State the rule which helps to detect the direction of induced current.

View Text Solution

9. A coil of number of turns N, area A, is rotated at a constant angular speed ω, in a uniform magnetic field B, and connected to a resistor R. Deduce expressions for :

(i) maximum emf induced in the coil, (ii) power dissipated in the coil.

View Text Solution

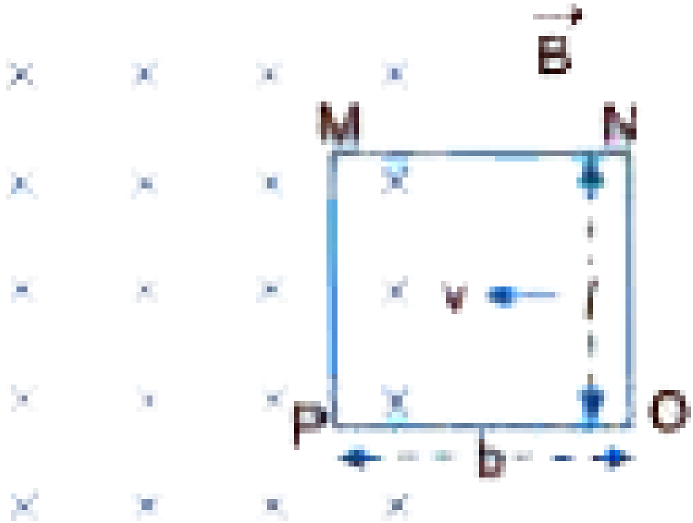
10. The figure shows a rectangular conducting frame MNOP of resistance R placed partly in a perpendicular magnetic field $\overrightarrow{B}$ and moved with velocity $\overrightarrow{v}$ as shown in the fig. 6.52.

Obtain the expressions for the

(a) force acting on the arm 'ON' and its direction, and

(b) power required to move the frame to get a steady emf induced between the arms MN and

PO.



View Text Solution

11. Define self-inductance. Write its SI unit. Derive an expression for self-inductance of a long, aircored solenoid of length l, cross-sectional area A (radius r), and having N number of turns.

View Text Solution

12. (a) Obtain the expression for the magnetic energy stored in a solenoid, due to the current I flowing in it, in terms of magnetic field B, area of cross-section A and length l of the solenoid.

(b) How is this magnetic energy per unit volume compared with the electrostatic energy per unit volume stored in a parallel plate capacitor ?

View Text Solution

13. Define the term 'mutual inductance between the two coils. Obtain the expression for mutual inductance of a pair of long coaxial solenoids each of length l and radii r_1 and $r_2 (r_2 > r_1)$. Total number of turns in two solenoids are N_1 and N_2 respectively.

View Text Solution

14. (i) Define mutual inductance.

(ii) A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20 A in 0.5 s, what is the change of flux linkage with the other coil ?

View Text Solution

15. (a) The current through two inductors, of self-inductance 12 mH and 30 mH respectively, is increasing with time at the same rate. Draw graphs showing the variation of the

(i) emf induced with the rate of change of current in each inductance,

(ii) energy stored in each inductor with the current flowing through it.

(b) Compare the energy stored in the coils if the power dissipated in the coils is the same.

View Text Solution

16. Draw a labelled schematic diagram of an a.c. generator. Explain briefly its principle and working.

View Text Solution

Long Answer Questions Ii

1. (a) Describe a simple experiment (or activity) to show that the polarity of emf induced in a coil is always such that it tends to produce a current which opposes the change of magnetic flux that produces it.

(b) The current flowing through an inductor of self-inductance L is continuously increasing. Plot a graph showing the variation of

(i) Magnetic flux versus the current

(ii) Induced emf versus dI/dt

(iii) Magnetic potential energy stored versus the current.

View Text Solution

2. Derive an expression for the induced emf developed when a coil of N turns, and area of cross-section A, is rotated at a constant angular speed ω in a uniform magnetic field B.

(b) A wheel with 100 metallic spokes each 0.5 m long is rotated with a speed of 120 rev/min in a plane normal to the horizontal component of the Earth's magnetic field. If the resultant magnetic field at that place is 4×10^{-4} T and the angle of dip at the place is 30°, find the emf induced between the axle and the rim of the wheel.

View Text Solution

3. Describe briefly, with the help of a labelled diagram, the basic elements of an a.c generator. State its underlying principle. Show diagrammatically how an alternating emf is generated by a loop of wire rotating in a magnetic field. Write the expression for the instantaneous value of the emf induced in the rotating loop.

View Text Solution

4. State the working of a.c. generator with the help of a labelled diagram.

The coil of an a.c. generator having N turns, each of area A, is rotated with a constant angular velocity ω. Deduce the expression for the alternating emf generated in the coil.

What is the source of energy generation in this device?

View Text Solution

5. (a) Draw a labelled diagram of a.c. generator. Derive the expression for the instantaneous value of the emf induced in the coil.

(b) A circular coil of cross-sectional area $200 cm^2$ and 20 turns is rotated about the vertical diameter with angular speed of 50 rad s^{-1} in a uniform magnetic field of magnitude $3.0 \times 10^{-2} T$.

Calculate the maximum value of the current in the coil.

View Text Solution

6. (a) Draw a labelled diagram of an a.c.generator. Obtain the expression for the emf induced in the rotating coil of N turns each of cross-sectional area A, in the presence of a magnetic field $\vec{B}$.

(b) A horizontal conducting rod 10 m long extending from east to west is falling with a speed $5.0ms^{-1}$ at right angles to the horizontal component of the Earth's magnetic field, $0.3 \times 10^{-4} Wbm^{-2}$. Find the instantaneous value of the emf induced in the rod.

View Text Solution

7. (a) State the principle of an a.c. generator and explain its working with the help of a labelled diagram. Obtain the expression for the emf induced in a coil having N turns each of cross-sectional area A, rotating with a constant angular speed $'\omega'$ in a magnetic field $\vec{B}$, directed perpendicular to the axis of rotation.

(b) An aeroplane is flying horizontally from west to east with a velocity of 900 km/hour. Calculate the potential difference developed between the ends of its wings having a span of 20 m. The horizontal component of Earth's magnetic field is 5×10^{-4}T and the angle of dip is 30°.

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8. (a) Define mutual inductance and write its SI units.

(b) Derive an expression for the mutual inductance of two long co-axial solenoids of same length wound one over the other.

(c) In an experiment, two coils C_1 and C_2 are placed close to each other. Find out the expression for the emf induced in the coil C_1

due to a change in the current through the coil C_2.

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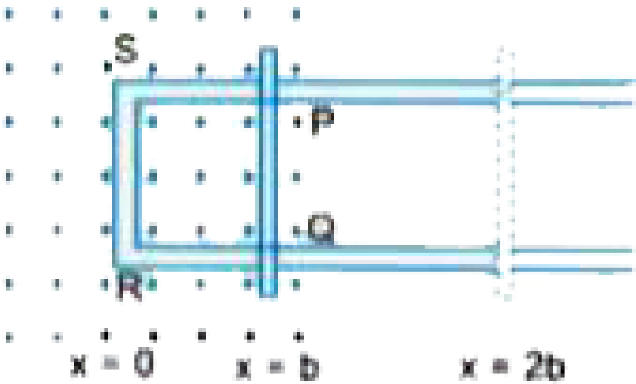
9. (a) State Faraday's law of electromagnetic induction.

(b) Figure 6.60 shows a rectangular conductor PQRS in which the conductor PQ is free to move in a uniform magnetic field B perpendicular to the plane of the paper. The field extends from x = 0 to x =b and is zero for $> b$. Assume that only the arm PQ possesses resistance r. When the arm PQ is pulled outward from x =0 to x = 2b and is then moved backward to x = 0 with constant speed v, obtain the expressions for the flux and the induced emf. Sketch the variations of these quantities with distance $0 \leq x \leq 2b$.



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Self Assessment Test Section A

1. A metallic ring is attached with the wall of a room. When the north pole of a magnet is brought near it, the induced current in the ring will be

A. first clockwise then anticlockwise.

B. inclockwise direction.

C. first anticlockwise then clockwise.

D. in anticlockwise direction.

Answer: D

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2. A coil of area $0.1m^2$ has 500 turns. After placing the coil in a magnetic field of strength $4 \times 10^{-4}T$, it is rotated through 90° in 0.1 s. The average emf induced in the coil is

A. 0.012 V

B. 0.05 V

C. 0.1 V

D. 0.2 V

Answer: D

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3. A copper disc of radius 0.1 m is rotated about its centre with 10 revolutions per second in a uniform magnetic field of 0.1 Twith its plane perpendicular to the field. The emf induced across the radius of the dics is

A. $\frac{\pi}{10}V$

B. $\frac{2\pi}{10}V$

C. $\pi \times 10^{-2}V$

D. $2\pi \times 10^{-2}V$

Answer: C

View Text Solution

4. The average emf induced in a coil in which the current changes from 2 A to 6 A in 0.05 s is 8 V. Self-inductance of the coil is

A. 0.1 H

B. 0.2 H

C. 0.4 H

D. 0.8 H

Answer: A

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5. A coil of resistance 20Ω and inductance 5 H is connected with 100 V battery. Energy stored in the coil will be

A. 41.5 J

B. 62.50 J

C. 125 J

D. 250J

Answer: B

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Self Assessment Test Fill In The Blanks Section B

1. Self-inductance of a long solenoid of length l, area A and total number of turns N with a core material of relative magnetic permeability, μ_0 is_____.

View Text Solution

2. Magnitude of induced emf in a circuit is given by ______ law and the direction of induced current can be obtained by applying _____ law.

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Self Assessment Test Very Short Answer Questions Section A

1. The mutual inductance for a pair of 2 coils is 6 mH. Calculate the induced emf developed in one coil when a steady current of 5 A flows through the other coil.

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Self Assessment Test Section B

1. Find the emf induced in a coil of 200 turns and cross-sectional area $0.2m^2$, when a magnetic field perpendicular to the plane of the coil changes from $0.1Wbm^{-2} \rightarrow 0.5Wbm^{-2}$ at a uniform rate over a period of 0.05 s.

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2. A metal conductor of length 1 m rotates vertically about one of its ends at an angular velocity of $5 rad s^{-1}$. If the horizontal component of earth's magnetic field be 0.2 G, find the value of potential difference developed between the two ends of the conductor.

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Self Assessment Test Section C

1. An ac. generator consists of a coil of 50 turns and area $2.5m^2$ rotating at an angular speed of $60rad\sin^{-1}$ in a uniform magnetic field B = 0.2 T between the two fixed pole pieces. The resistance of the circuit including that of the coil is 500Ω.

(i) Calculate the maximum current drawn from the generator.

(ii) What is the flux when the current is zero?

(iii) Would the generator work if the coil were stationary and instead the pole pieces rotated together with the same speed as above? Give reason.

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Self Assessment Test Section D

1. (a) Derive the expression for the magnetic energy stored in an inductor when a current I develops in it. Hence, obtain the expression for the magnetic energy density.

(b) A square loop of sides 5 cm carrying a current of 0.2 A in the clockwise direction is placed at a distance of 10 cm from an infinitely long wire carrying a current of 1 A as shown in

Fig. 6.66. Calculate (i) the resultant magnetic force, and (ii) the torque, if any, acting on the loop.

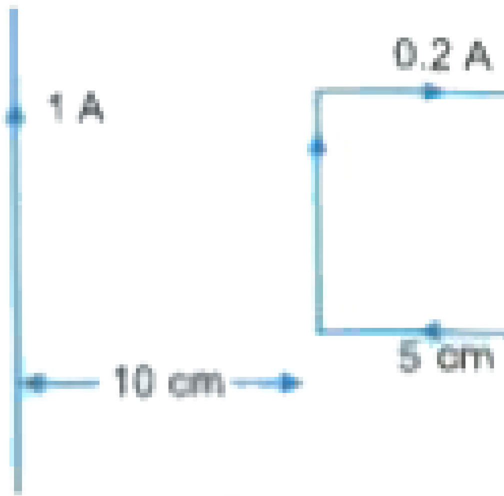

Fig. 6.66

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