PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

ELECTROMAGNETIC INDUCTION & ALTERNATING CURRENT

Example

1. A coil of resistance 100 Ω having 100 turns is placed in a magnetic field. A galvanometer of resistance 400Ω is connected in series with it. If the coil is brought from the present magnetic field to another magnetic field in $\frac{1}{10}s$, determine the average emf and the current. Given, the initial and final magnetic flux linked with each turn of the coil are 1 mWb and 0.2 mWb respectively.

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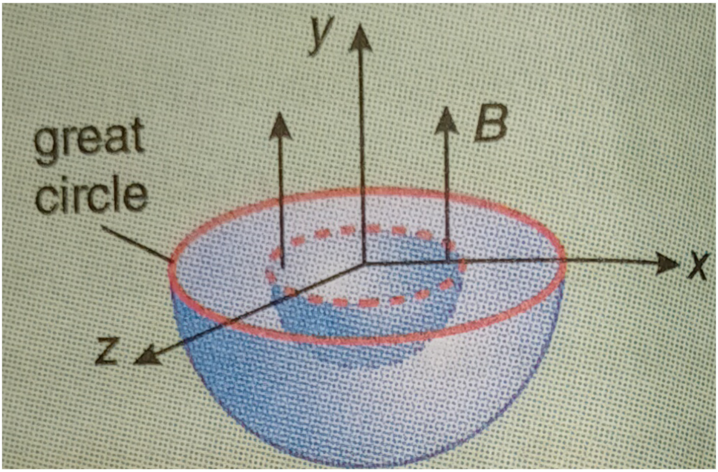
2. A conducting wire is wound around the great circle of a spherical balloon. This circular loop can contract with the balloon. A hemispherical cross section of the balloon is shown in figure. The initial radius of the balloon is 0.60 m. A uniform magnetic field B = 0.25 T exists along the perpendicular to the plane of the circular loop, i.e., in $+y-$ direction. After 5.0×10^{-2}s the balloon is defiated to a radius of 0.30 m. What will be the average emf induced in the loop during this time?



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3. A copper wire of diameter 0.04 in. and length 50 cm is bent in the form of a circular loop. The plane of the loop is normal to a uniform magnetic field which is increasing with time at a constant rate of 100 G s^{-1}.

What is the rate of joule heating in the loop?

[Resistivity of copper

$= 1.7 \times 10^{-8} \Omega. m, 1 \text{ in.} = 2.54 cm$]

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4. The distance between the two end-points of the wings of an aeroplane is 5 m and the aeroplane is flying parallel to earth's surface with a velocity of 360 km h^{-1}. If the geomagnetic intensity is $4 \times 10^{-4} Wb. m^{-2}$

and the angle of dip at that place is 30°, determine the emf induced between the two end-points of the wings.

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5. A copper disc of diameter 20 cm is rotating uniformly about its horizontal axis passing through the centre with angular frequency 600 rpm. A uniform magnetic field of strength $10^{-2}T$ acts perpendicular to the plane of the disc. Calculate the induced emf between its centre and a point on the rim of the disc.

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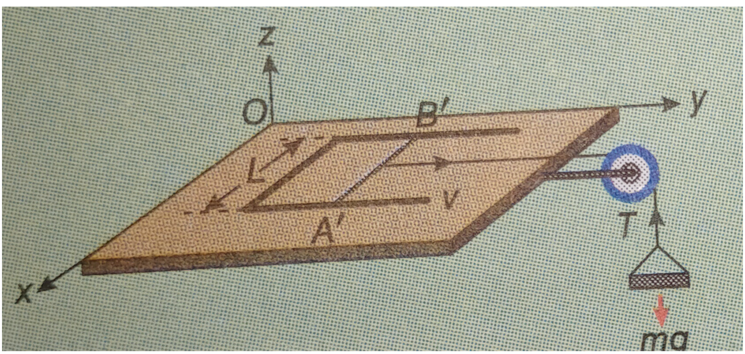
6. A pair of parallel horizontal conducting ralls of negligible resistance shorted at one end is fixed on a smooth table. The distance between the ralls is L. A massless conducting rod of resistance R can slide on the rails frictionlessly. The rod is tied to a massless string which passes over a pulley fixed to another edge of the table. A mass m, tied to the other end of the string, hangs vertically. A constant magnetic field B exists along the perpendicular to the plane of the table in upward direction. If the system is released from rest, calculate [i] the terminal velocity of the rod, [ii] the acceleration of the mass at the instant, when the velocity of the rod is half the terminal velocity.



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7. The mutual inductance between two adjacent coils is 1.5 H. If the current in the primary coil changes from 0 to 20 A in 0.05 s, determine the average emf induced in the secondary coil. If the number of turns in the secondary coil is 800, what change in flux will be observed in it?

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8. When current in a coil changes from $+2A$ to $-2A$ in 0.05 s, an emf of 8 V is induced in the coil. Determine the self-inductance of the coil.

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9. Mutual inductance of two coils is 0.005H, ac in primary coil, $I = I_0 \sin \omega t$, where $I_0 = 10A$ and $\omega = 100\pi$ rad/s. What is the maximum emf in the secondary coil?

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10. If a rate of change of current of $2A.\ s^{-1}$ induces an emf of 10 mV in a solenoid, what is the self-inductance of the solenoid?

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11. Resistance of a coil is 10Ω and its self inductance is 5H. Find the energy stored when it is connected with a 100V battery.

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12. Self-inductance of an air core solenoid increases from 0.01 mH to 10 mH when an iron core is introduced in it. What is the relative magnetic permeability of iron?

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13. A small square loop of wire of side y is placed inside a large square loop of side $x(x > > y)$. The loops are coplanar and their centres coincide. Find the mutual inductance of the system.

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14. Cross sectional area of a solenoid is $10 cm^2$. Half of its cross section is filled with iron $(\mu_r = 450)$ and the remaining half with air $(\mu_r = 1)$. Calculate the self-inductance of the solenoid if its length is 2 m and number of turns is 3000.

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Section Related Questions

1. What do you mean by electromagnetic induction?

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2. What is induced electromotive force?

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3. What do you mean by induced current?

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4. Define flux in a magnetic field.

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5. What do you mean by magnetic flux density?

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6. State and explain Faraday's laws of electromagnetic induction.

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7. State and explain the three laws of electromagnetic induction.

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8. State and explain Lenz's law related with the electromagnetic induction.

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9. How would you obtain the expression for induced emf from the laws of electromagnetic induction?

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10. How would you demonstrate the phenomenon of electromagnetic induction with the help of two circular conducting coils?

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11. What do you mean by magnetic flux and magnetic flux density?

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12. Justify Lenz's law from the point of view of the law of conservation of energy.

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13. State Fleming's right hand rule. Mention one of its uses in an electrical appliance.

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14. State, Fleming's right hand rule related with the direction of induced emf.

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15. If a straight conductor moves in a magnetic field, what will be the expression for emf induced in that conductor? On what factors does this emf depend?

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16. When an aeroplane flies horizontally, a potential difference is developed across the two ends of its wings. Why? On what factors does this potential difference depend?

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17. What is eddy current?

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18. What do you mean by energy loss due to eddy currents?

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19. How can the loss of energy due to eddy current be minimised?

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20. State an application of eddy current.

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21. What do you mean by non-inductive resistance coil?

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22. What is a choke?

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23. Define Henry.

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24. Self-inductance of a coil is 1 H'. What do you mean by this statement?

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25. Mutual inductance between a pair of coils is 1 H'. What do you mean by this statement?

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26. Find out the energy stored in a coil of self inductance L due to a current I through it.

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27. Establish an expression for self inductance of a solenoid

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28. find out the mutual inductance of two inseparable solenoids.

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29. Establish the equation for energy density at any point in the magnetic field of a solenoid.

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Hots

1. A cylindrical bar magnet is placed along the axis of a circular coil. If the magnet is rotated about that axis, will any current be induced in the coil?

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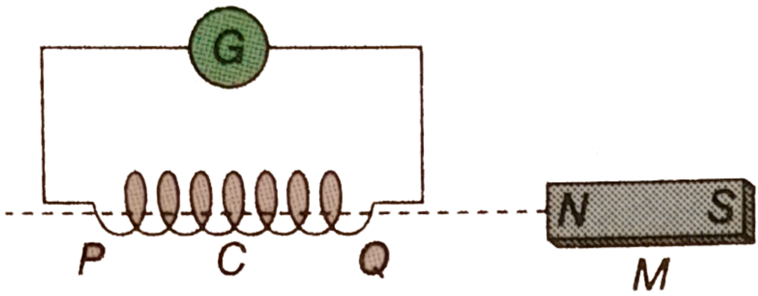
2. With reference to where a small bar magnet M approaches a coil C (with ends connected to a galvanometer), show that, Lenz's law is consistent with the principle of conservation of energy. What will be the magnetic polarity of the coil according to the diagram, as the magnet moves through it and comes out from the left?



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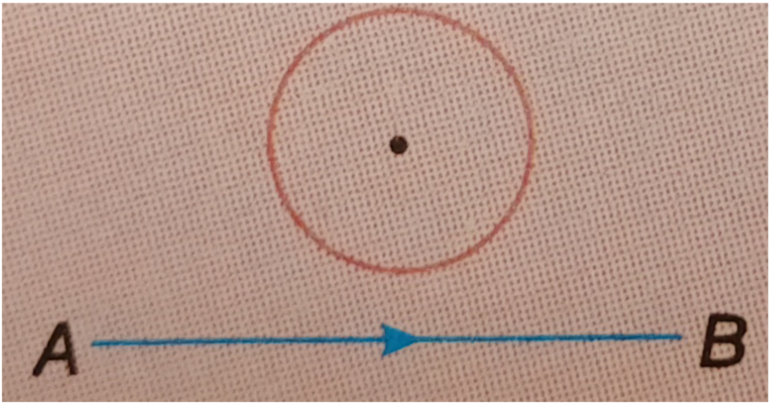
3. A conducting wire is bent in the form of a circle of a circle and a straight conductor AB is kept outside but near the conducting circle. The wires are in the plane of the paper. If the current flowing from A to B gradually increases in magnitude, will there be any current in the circular conductor? If so, in what direction?



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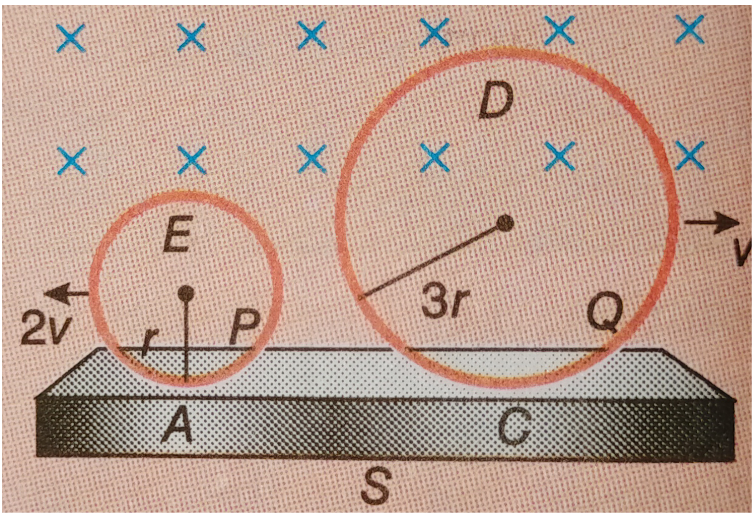
4. The conducting rings P and Q of radius r and 3r move in opposite directions with velocity 2v and v respectively on a conducting surface S. There is a uniform magnetic field of magnitude B perpendicular to the plane of the rings. What is the potential difference between the highest points of the two rings?



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5. Two identical circular coils A and B are placed parallel to each other with their centres on the same axis. The coil B carries current in the clockwise direction as seen from A. What would be the directions of the induced current in A as seen from B when the current in B is increased

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6. Two identical circular coils A and B are placed parallel to each other with their centres on the same axis. The coil B carries current in the clockwise direction as seen from A. What would be the directions of the induced current in A as seen from B when the coil B is moved towards A, keeping the current in B constant?

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7. Show that the units of RC and $\frac{L}{R}$ are of time. R, L and C carry their usual significances.

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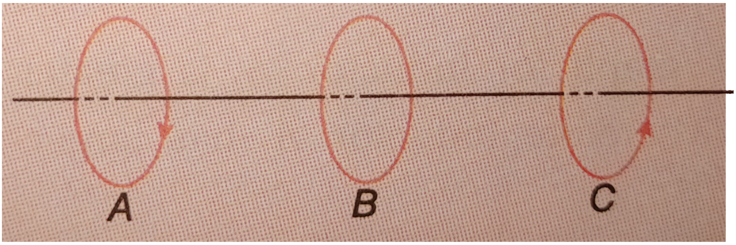
8. Three identical closed coils A, B and C are placed parallely. Coils A and C carry equal currents as shown in Fig. Coils B and C are fixed and coil A is moved towards B with uniform speed. Will there be any induced current in B? If no, give reason. If yes, mark the direction of the induced current in fig.



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9. A coil of resistance R having n turns is connected with a galvanometer of resistance 4R. If the magnetic flux changes from ϕ_1 to ϕ_2 in time t in the circuit, what will be the value of induced current?

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10. Self-inductance of a coil is 2mH, current through this coil is, $I = t^2 e^{-t}$ (t = time). After how much time will the induced emf be zero?

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11. North pole of a bar magnet faces a closed ciruclar coil. It is oscillated rapidly along the common axis of the magnet and the coil.

Determine the direction of induced current in the coil from Lenz's law.

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12. A bar magnet is pulled through a conducting loop along its axis with its south pole entering the loop first. Draw the graphs of

the induced current

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13. A bar magnet is pulled through a conducting loop along its axis with its south pole entering the loop first. Draw the graphs of

joule heating as a function of time. Take the induced current to be positive, if it is clockwise when viewed along the path of the magnet.

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14. A semicircular wire of radius r is rotating with angular velocity ω in a uniform magnetic field B with its radius as axis. If the resistance of the circuit be R and if the axis of rotation remains perpendicular to B, what will be the average power produced in each period?

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15. Write down the dimensional formula for induced emf?

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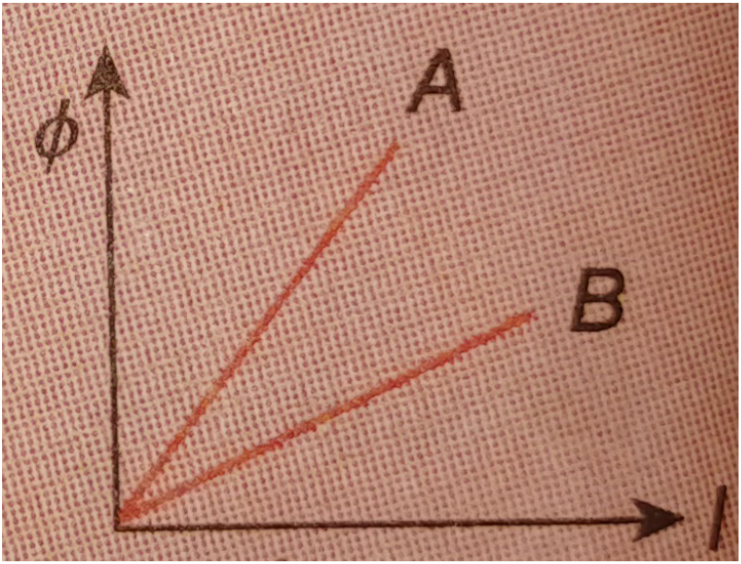
16. A plot of magnetic flux (ϕ) versus current (I) is shown in figure for two inductors A and B. Which of the two has larger value of selfinductance?



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17. A circular conducting coil of radius a and resistance R is placed with its plane perpendicular to a magnetic field. The magnetic field varies with time according to the equation $B = B_0 \sin \omega t$. Obtain the expression for the induced current in the coil.

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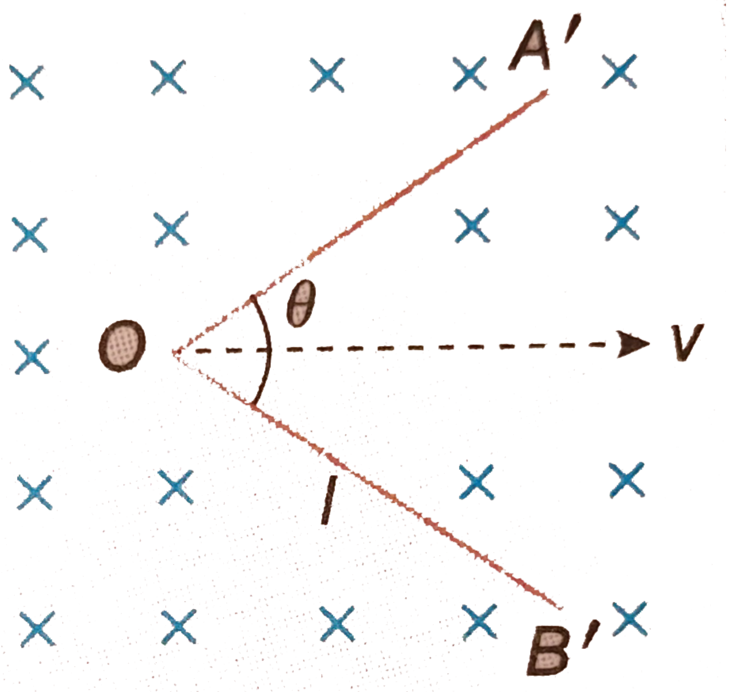
18. A conducting wire is bent in the form of an angle θ. The wire moves with velocity v along the bisector of $\angle A'OB'$ as shown in figure.

Find the emf induced between the two ends of the wire if a magnetic field is acting perpendicular to the plane of the paper and directed into it.



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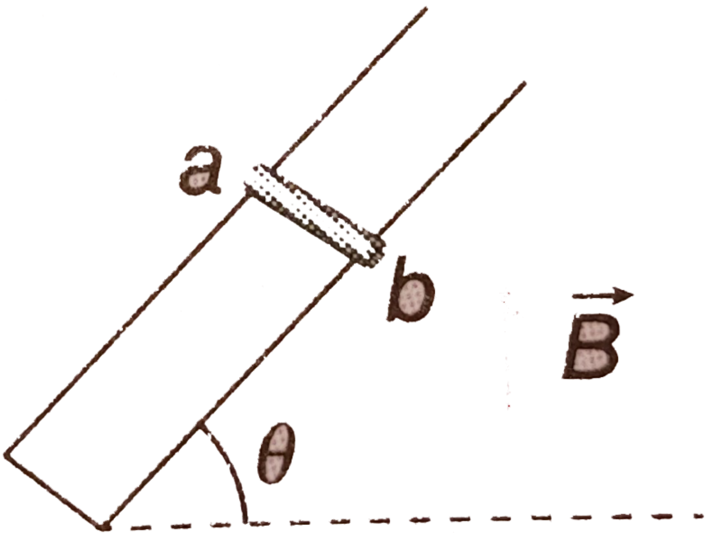
19. A conducting rod ab of length l, mass m and resistance R slides on a smooth, thick pair of metallic rails. The plane of the rails makes an angles θ with the horizontal. A magnetic field B acts along the perpendicular to the horizontal plane in upward direction. If the rod slides down on the rails at a constant speed v, then show that $B = \sqrt{\frac{mgR \sin\theta}{l^2 v \cos^2\theta}}$.



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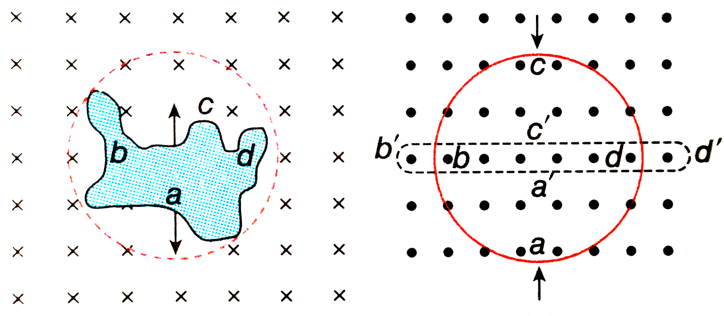
Ncerts Textbook Questions With Answer Hint

1. Use Lenz's law to determine the direction of induced current in the situations described in the figure :



(a) (b)

A wire of irregular shape turning into a circular shape.

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

A circular loop being deformed into a narrow straight wire.

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3. 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 m. s^{-1} in a direction normal to the longer side

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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 mef developed across the cut if the velocity of the loop is 1 m. s^{-1} in a direction normal to the shorter side of the loop? For how long does the induced voltage last in each case?

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5. 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 mef developed across the cut if the velocity of the loop is 1 m. s^{-1} in a direction normal to the Suppose in this case the loop is stationary but the current feeding the electromagnet 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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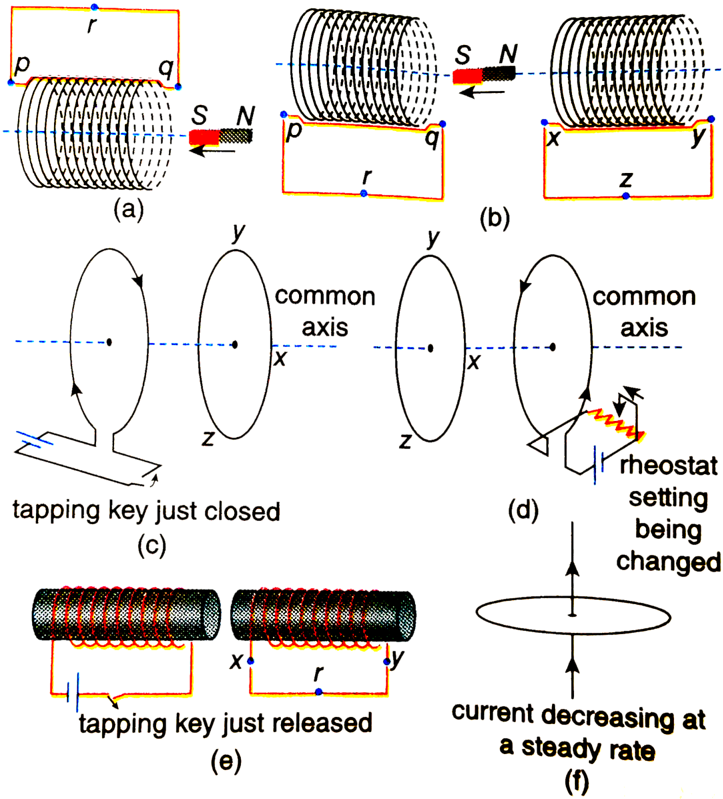
6. Indicates the direction of induced current in each case of the fig.



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7. A 1.0 m long metallic rod is rotated with an angular velocity 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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8. A circular coil of radius 8.0 cm and 20 turns rotates 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 10Ω, 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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9. A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5 m . s^{-1}, at right angles to the horizontal component of earth's magnetic field, $0.30 \times 10^{-4} Wb. m^{-2}$.

What is the instantaneous value of the emf induced in the wire?

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10. A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5 m . s^{-1}, at right angles to the horizontal component of earth's magnetic field, $0.30 \times 10^{-4} Wb. m^{-2}$.

What is the direction of the emf?

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11. A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5 m . s^{-1}, at right angles to the horizontal component of earth's magnetic field, $0.30 \times 10^{-4} Wb. m^{-2}$. what is the emf induced in the wire.

Which end of the wire is at higher electrical potential?

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12. 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 $10^{-3} T. cm^{-1}$ along the negative x-direction and is decreasing in time at the rate of $10^{-3} T. s^{-1}$. Determine the direction and magnitude of induced current in the loop if its resistance is 4.50 m Ω.

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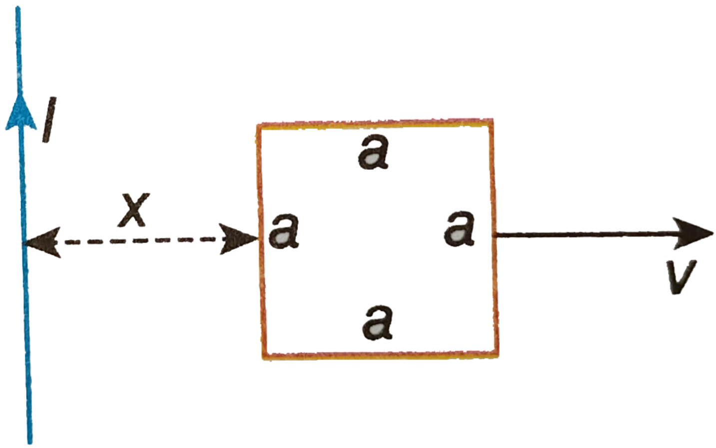
13. Obtain an expression for the mutual inductance between a long straight wire and a square loop of side a as shown in fig.



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14. Now assume that the straight wire carries a current of 50 A and the loop is moved to the right with a constant velocity $v = 10m. s^{-1}$.

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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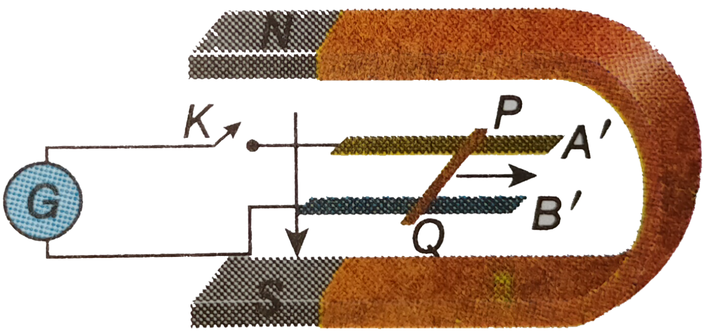
15. A metal rod PQ is resting on the rails A'B' and positioned between the poles of a permanent magnet. The rails, the rod and the magnetic field are in three mutually perpendicular directions. A galvanometer G connects the rails through a switch K. Length of the rod = 15 cm, B = 0.50 T, resistance of the closed loop containing the rod = $9.0 m\Omega$. Assume the field to be uniform.



Suppose K is open and the rod is moved with a speed of 12 cm. s^{-1} in the direction shown.

Give the polarity and magnitude of the induced emf.

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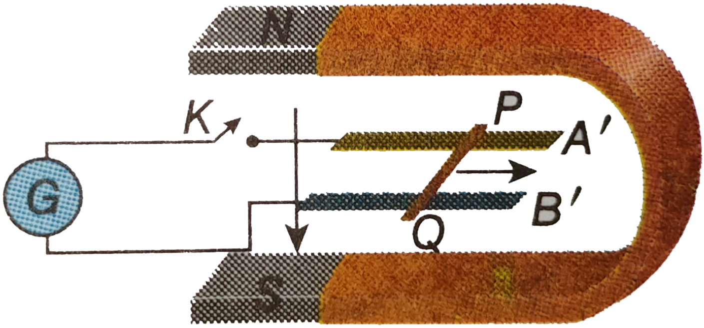
16. A metal rod PQ is resting on the rails A'B' and positioned between the poles of a permanent magnet. The rails, the rod and the magnetic field are in three mutually perpendicular directions. A galvanometer G connects the rails through a switch K. Length of the rod = 15 cm, B = 0.50 T, resistance of the

closed loop containing the rod = $9.0 m\Omega$.

Assume the field to be uniform.



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

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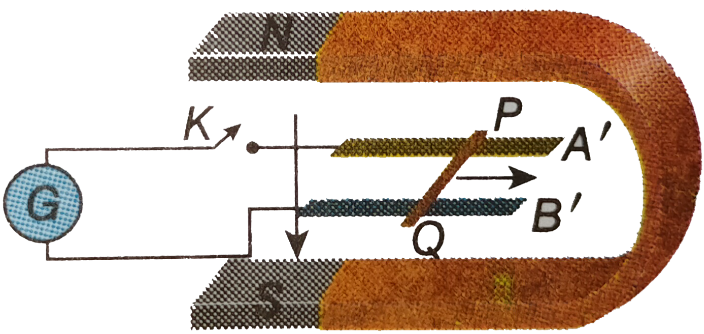
17. A metal rod PQ is resting on the rails A'B' and positioned between the poles of a permanent magnet. The rails, the rod and the magnetic field are in three mutually perpendicular directions. A galvanometer G connects the rails through a switch K. Length of the rod = 15 cm, B = 0.50 T, resistance of the closed loop containing the rod = $9.0 m\Omega$. Assume the field to be uniform.



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

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18. Explain why are there gaps between the rails? Explain what will happen if there is no gap

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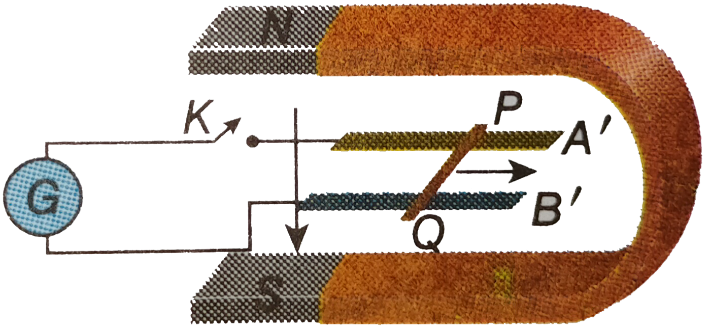
19. A metal rod PQ is resting on the rails A'B' and positioned between the poles of a permanent magnet. The rails, the rod and the magnetic field are in three mutually perpendicular directions. A galvanometer G connects the rails through a switch K. Length of the rod = 15 cm, B = 0.50 T, resistance of the closed loop containing the rod = $9.0 m\Omega$. Assume the field to be uniform.



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

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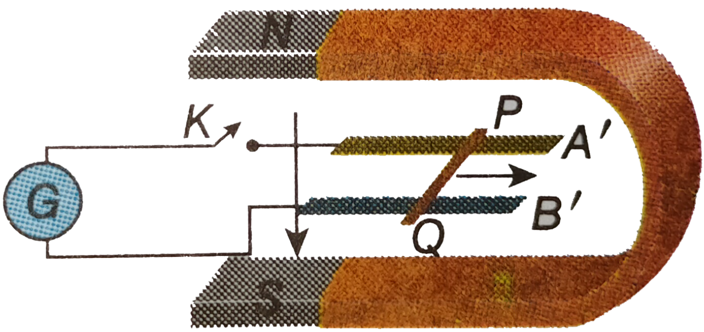
20. A metal rod PQ is resting on the rails A'B' and positioned between the poles of a permanent magnet. The rails, the rod and the magnetic field are in three mutually perpendicular directions. A galvanometer G connects the rails through a switch K. Length of the rod = 15 cm, B = 0.50 T, resistance of the closed loop containing the rod = $9.0 m\Omega$. Assume the field to be uniform.



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

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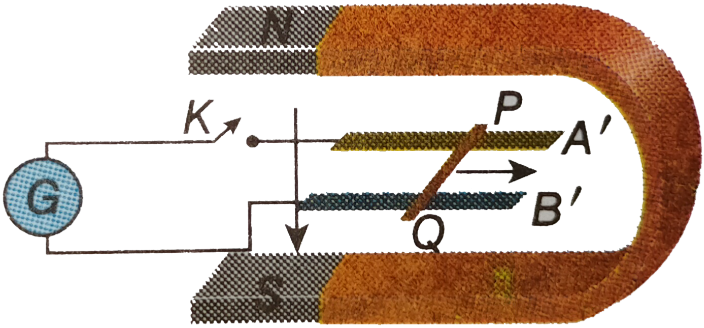
21. A metal rod PQ is resting on the rails A'B' and positioned between the poles of a permanent magnet. The rails, the rod and the magnetic field are in three mutually perpendicular directions. A galvanometer G connects the rails through a switch K. Length of the rod = 15 cm, B = 0.50 T, resistance of the closed loop containing the rod = $9.0 m\Omega$.

Assume the field to be uniform.



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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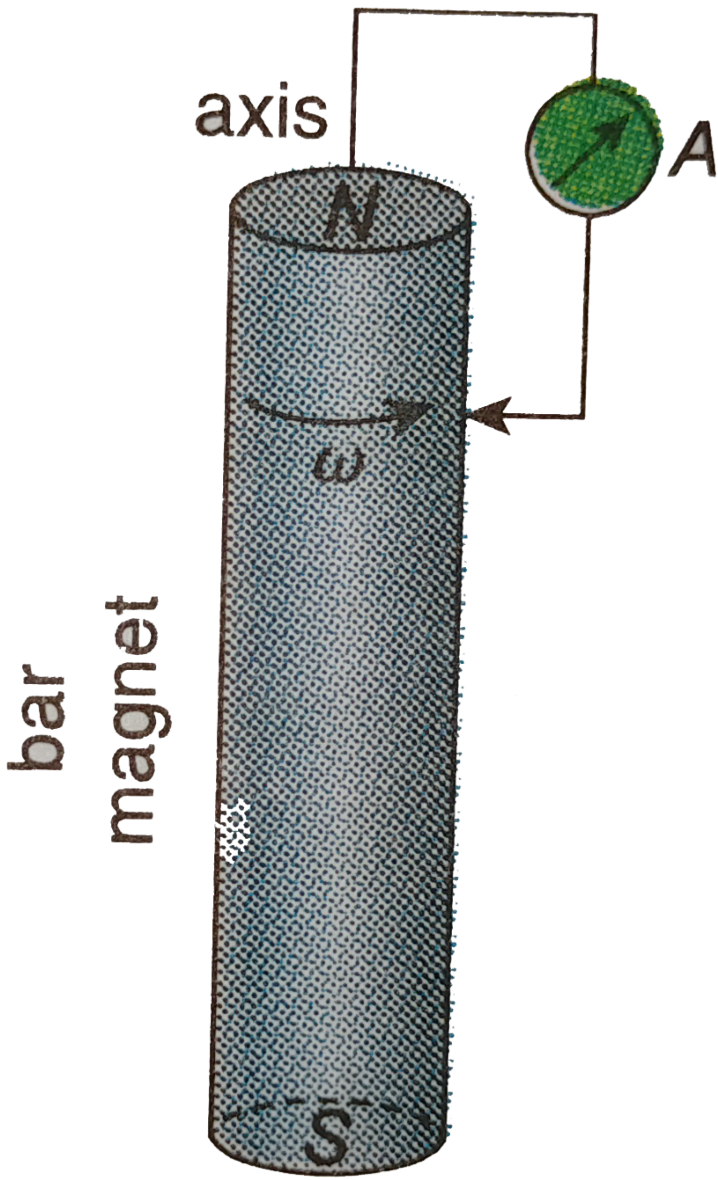
Ncert Exemplar Questions With Answer Hint Mcq 1

1. A cylinder bar magnet is rotated about its axis. A wire is connected from the axis and is made to touch the cylindrical surface through a contact. Then



A. a direct current flows in the ammeter A

B. no current flows through A

C. an alternating sinusoidal current flows through the ammeter A with time period, $T = \frac{2\pi}{\omega}$

D. a time-varying non-sinusoidal current flows through ammeter A

Answer: B

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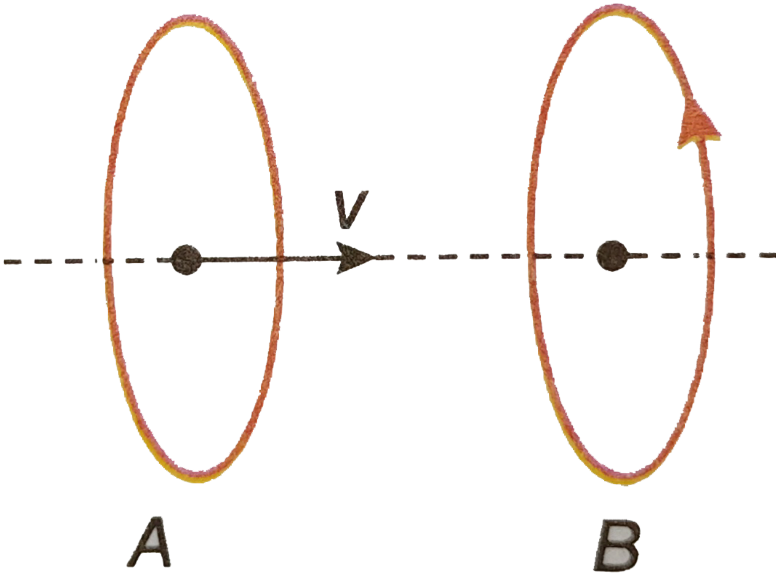
2. There are two coils A and B. When A is brought towards B, a current flows through B which stops when A



stops moving. The current in B is counterclockwise. B is stationary when A moves. We can infer that

A. a constant current flows through A in the clockwise direction

B. a varying current is passing through A

C. there is no current through A

D. a constant counter clockwise current is passing through A

Answer: D

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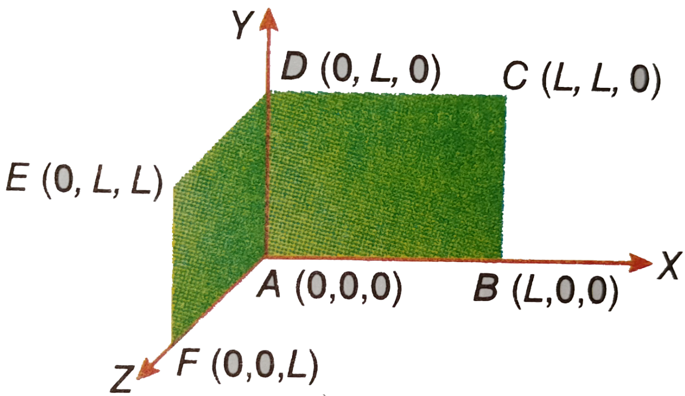
3. A loop, made of straight edges has six corners at A(0,0,0), B(L,0,0), C(L,L,0), D(0,L,0), E(0,L,L) and F(0,0,L). A magnetic field $\vec{B} = B_0\left(\hat{i} + \hat{k}\right)T$ is present in the region. The flux passing through the loop ABCDEFA (in that order) is:



A. B_0L^2Wb

B. $2B_0L^2Wb$

C. $\sqrt{2}B_0L^2Wb$

D. $4B_0L^2Wb$

Answer: B

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

A. l and A increase

B. l decreases and A increases

C. l increases and A decreases

D. both l and A decrease

Answer: B

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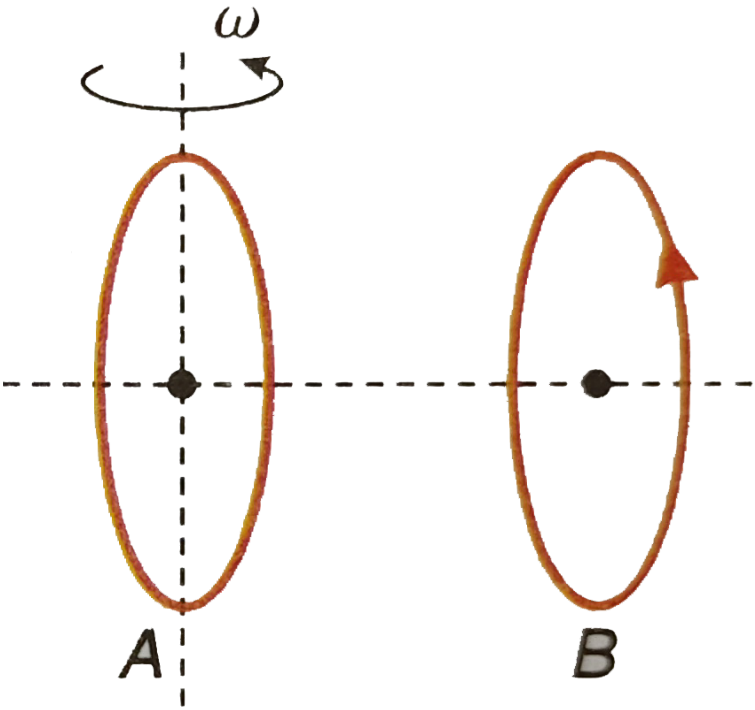
5. The two coils A and B are same as in the picture given below . The coil A is made to rotate about a vertical axis. No current flows in

B if A is at rest. The current in coil A, when the current in B (at t = 0) is counterclockwise and the coil A is as shown at this instant t = 0, is



A. constant current clockwise

B. varying current clockwise

C. varying current counterclockwise

D. constant current counterclockwise

Answer: A

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Ncert Exemplar Questions With Answer Hint Mcq 2

1. A metal plate is getting heated. It can be because

A. a direct current is passing through it

B. it is placed in a time-varying magnetic field

C. it is placed in a magnetic field which varies with space but not with time

D. a current (either direct or alternating) is passing through it

Answer: A::B::D

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2. An emf is produced in a coil, which is not connected to an external voltage source. This can be due to

A. the coil being in a time-varying magnetic field

B. the coil moving in a time-varying magnetic field

C. the coil moving in a constant magnetic field

D. the coil is stationary in external spatially varying magnetic field, which does not change with time

Answer: A::B::C

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3. A circular coil expands radially in a region of magnetic field but no electromotive force is produced in the coil. It can be because

A. the magnetic field is constant

B. the magnetic field is in the same plane as the circular coil and it may or may not vary

C. the magnetic field may have a perpendicular (to the plane of the coil) component with suitably decreasing magnitude

D. there is a constant magnetic field perpendicular (to the plane of the coil) direction

Answer: B::C

Watch Video Solution

4. The mutual inductance M_{12} of coil 1 with respect to coil 2

A. increases when they are brought nearer

B. depends on the current passing through the coils

C. increases when one of them is rotated about an axis

D. is the same as M_{21} of coil 2 with respect to coil 1

Answer: A::D

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Exercise

1. If the emf induced in an electrical circuit be e and the current induced be I then,

A. both e and I depend on the resistance of the circuit

B. none of e and I depends on the resistance of the circuit

C. e depends on the resistance of the circuit but not i

D. I depends on the resistance of the circuit but not e

Answer: D

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2. The magnetic flux across a coil, of 50 turns and of diameter 0.1 m, changes from $3 \times 10^{-4} Wb$ to $10^{-4} Wb$ in 0.02 s. The emf induced in the coil is

A. 3.9 mV

B. 10 mV

C. 15 mV

D. 196 mV

Answer: B

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3. A coil with a small area of $10^{-5}m^2$ is lying on the xy -plane around a point P. If the magnetic field at P is $\left(\hat{i}+\hat{j}+\hat{k}\right)Wb.\,m^{-2}$, the magnetic flux passing through the coil would be

A. $10^{-5}Wb$

B. $\sqrt{2}\times10^{-5}Wb$

C. $\sqrt{3}\times10^{-5}Wb$

D. $3\times10^{-5}Wb$

Answer: A

Watch Video Solution

4. The magnetic flux linked with a coil varies with time t as $\phi = at^2 + bt + c$, where a, b and c are constants. The emf induced in the coil will be zero at a time of

A. $\frac{b}{a}$

B. $-\frac{b}{a}$

C. $\frac{b}{2a}$

D. $-\frac{b}{2a}$

Answer: D

Watch Video Solution

5. Induced current in a coil due to electromagnetic induction does not depend upon

A. rate of change of flux

B. shape of the coil

C. resistance of coil

D. non of these

Answer: D

Watch Video Solution

6. A metal ring is held horizontally with the ground and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet is

A. equal to g

B. less than g

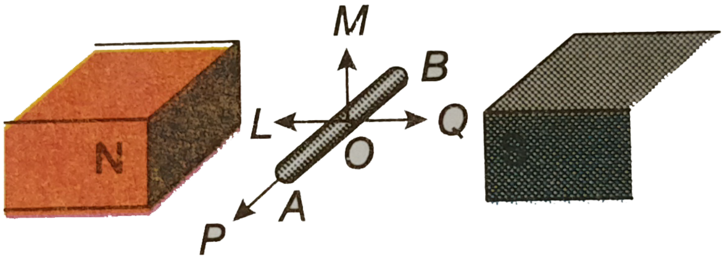
C. more than g

D. zero

Answer: B

Watch Video Solution

7. An electric potential difference will be induced between the ends of the conductor (AB) shown in the figure when the conductor moves along



A. OP

B. OQ

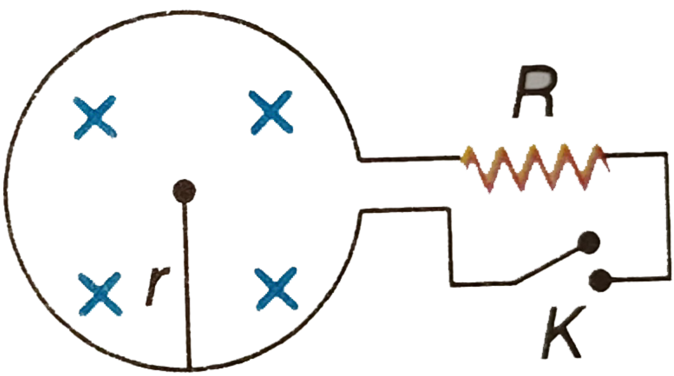
C. OL

D. OM

Answer: D

Watch Video Solution

8. In the figure a circular loop of radius r and resistance R is shown. A variable magnetic field of induction $B = e^{-t}$ exists inside the loop. If the key (K) is closed at t = 0, the electrical power developed in the circuit at that instant is equal to



A. $\frac{\pi r^2}{R}$

B. $\frac{10r^3}{R}$

C. $\frac{\pi^2 r^4}{R}$

D. $\frac{10r^4}{R}$

Answer: D

Watch Video Solution

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

A. remains stationary

B. is attracted by the loop A

C. is repelled by the loop A

D. rotates about its centre of mass with centre of mass fixed

Answer: C

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10. A circular disc of radius 0.2 m is placed in a uniform magnetic field of induction $\frac{1}{\pi} Wb/m^2$ in such a way that its axis makes an angle 60° with the field. The magnetic flux linked with the disc is

A. 0.01 Wb

B. 0.02 Wb

C. 0.06 Wb

D. 0.08 Wb

Answer: B

Watch Video Solution

11. A square wire loop of side 10 cm is placed at an angle of 45° with a magnetic field that changes uniformly from 0.1 T to zero in 0.7 s. If resistance of the loop is 1Ω, then the induced current in it is

A. 1 mA

B. 2.5 mA

C. 3.5 mA

D. 4 mA

Answer: A

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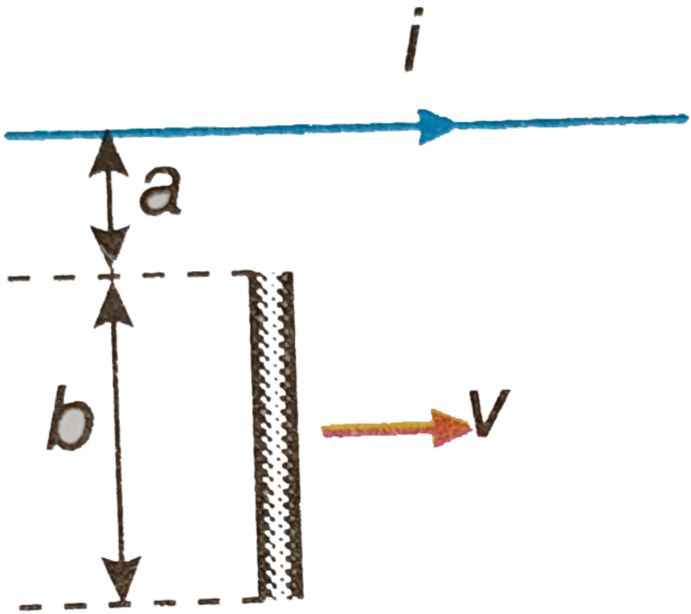
12. A rod of length b moves with a constant velocity v in the magnetic field of a infinitely long straight conducting wire that carries a current I as shown in the figure. The induced emf in the rod is



A. $\frac{\mu_0 i v}{2\pi} \tan^{-1}\left(\frac{a}{b}\right)$

B. $\frac{\mu_0 i v}{2\pi} \ln\left(1 + \frac{b}{a}\right)$

C. $\frac{\mu_0 i v \sqrt{ab}}{4\pi(a+b)}$

D. $\frac{\mu_0 i v (a+b)}{4\pi a b}$

Answer: B

Watch Video Solution

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

A. 0.75 mV

B. 0.50 mV

C. 0.15 mV

D. 1 mV

Answer: C

Watch Video Solution

14. SI unit henry (H) of inductance can be written as

A. $Wb.\ A^{-2}$

B. $J.\ A^{-1}$

C. $V.\ s.\ A^{-2}$

D. $\Omega.\ s$

Answer: D

Watch Video Solution

15. The self-inductance of a long straight solenoid is L. Each of the length, the diameter and the number of turns of another solenoid is double that of the first. The self-inductance of the second solenoid is

A. 2L

B. 4L

C. 8L

D. 16L

Answer: C

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16. The self inductances of two coils are 16 mH and 25 mH, and they have a mutual inductances of 10 mH. Their coupling constant is

A. 0.025

B. 0.05

C. 0.25

D. 0.5

Answer: D

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Watch Video Solution

17. If current I passes through a pure inductor of self-inductance L, the energy stored is

A. LI^2

B. $\frac{LI^2}{2}$

C. $\frac{LI^2}{4}$

D. zero

Answer: B

Watch Video Solution

18. Two solenoids of equal number of turns have their lengths and the radii in the same ratio $1:2$. The ratio of their self-inductances will be

A. $1:2$

B. $2:1$

C. $1:1$

D. $1:4$

Answer: A

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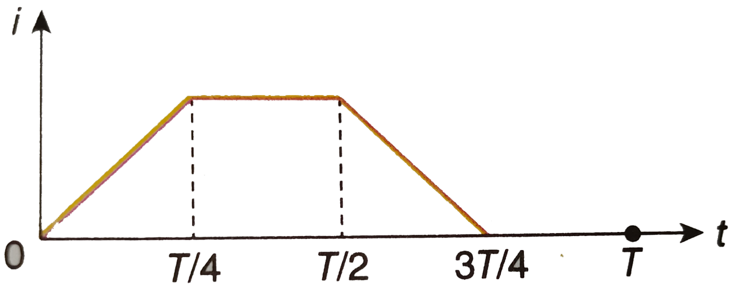
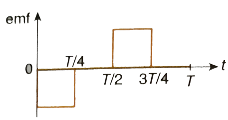
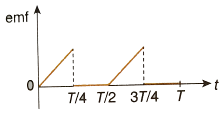
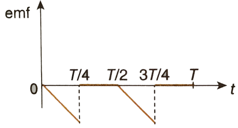
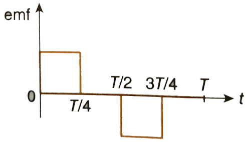
19. The current I in a coil varies with time as shown in the fig. The variation of induced emf with time would be



A. 

B. 

C. 

D. 

Answer: A

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Very Short Answer Type Questions

1. What is the unit of magnetic induction or magnetic flux density in SI?

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2. What is the relation of the magnetic field vector $\vec{B}$ with magnetic induction and magnetic flux density?

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3. Induced emf is directly proportional to the rate of change with time of magnetic______linked with a coil.

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4. In case of electromagnetic induction, the_______always opposes the cause of its own generation.

Watch Video Solution

5. With the help of Fleming's_______rule, the direction of induced current in a straight conductor in motion can be determined.

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6. What is the relation between the units: tesla and weber?

Watch Video Solution

7. What is the relation between the unit: weber and volt?

Watch Video Solution

8. Which of the conservation laws would not hold if Lenz's law was incorrect?

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9. Self-inductance of a coil is 1H. If 1A current passes through it, what will be the magnetic flux linked with the coil?

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10. What is the relation between the units: weber and ampere?

Watch Video Solution

11. What is the relation between the units of self-inductance and mutual inductance?

Watch Video Solution

12. Self-inductance of an air core inductor increases from 0.01 mH to 10 mH on introducing an iron core into it. What is the relative permeability of the core used?

Watch Video Solution

Short Answer Type Questions I

1. A cylindrical bar magnet is kept along the axis of a circular coil. If the magnet is rotated about the axis, will there be any current induced in that coil?

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2. A metallic coil is kept at rest in a non-uniform static magnetic field. Will there be any emf induced in that coil?

Watch Video Solution

3. Two circular coils are kept co-axially one alongside the other. If a current suddenly starts flowing in one coil, what will be the direction of current induced at that moment in the other coil?

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4. A conducting rod AB is moving parallel to the positive x-axis. A magnetic field is acting along positive z-axis. The end A of the rod will get a higher potential with respect to the end B-state whether it is true or false?

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5. What measures are to be taken to minimise energy loss due to flow of eddy current in an electromagnetic arrangement?

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6. The use of a laminated core in a conducting coil reduces eddy currents. Explain why it is so.

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7. How can the energy stored in an inductor be utilised?

Watch Video Solution

8. The self-inductance of a solenoid is L. If it is cut into two equal halves, what will be the self-inductance of each half?

Watch Video Solution

9. The self-inductance of a solenoid is L. If it is compressed to half its length by pressing it from both ends, what will be the new self-inductance?

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10. If a wire is stretched to double its length, find the new resistance if the original resistance be R.

Watch Video Solution

11. A steady current from a source of emf is passing through a straight conductor from left to right. If the source in switched off, what will be the direction of induced current in the wire?

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12. A solenoid carrying a current supplied by a DC source with a constant emf contains an iron core inside it. How will the current change when the core is pulled out of the solenoid: will it increase, decrease, or remain the same?

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13. The emf E of a source varies with time. It sends a current I through a coil of self-inductance L connected to it. What is the instantaneous effective emf of the circuit?

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14. Why the coil of a dead beat galvanometer is wound on a metal frame?

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

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Short Answer Type Questions Ii

1. The current passing through a choke coil of 5H is decreasing at the rate of 2A/s. The e.m.f.

developed across the coil is?

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2. The current I through a closed coil of self-inductance 0.25 H is related with time t as $I = 4t - t^2$. Then the emf e induced in the coil will vary with time in the manner shown in the justify.

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Problem Set I

1. At an instant t, the magnetic flux linked with a coil is, $\phi = 5t^3 - 100t + 300Wb$. What will be the induced emf in the coil at time t = 2s?

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2. A rectangular coil of area $0.2m^2$ is held in a magnetic field of strength 2T in such a way that the normal to the plane of the coil makes an angle 30° with the field. What is the flux linked with the coil?

Watch Video Solution

3. A magnet is being brought near a circular coil, of radius 10 cm, having 10 turns and of resistance 10Ω, along its axis. Due to this, if the magnetic flux density linked with the coil increases from 0.1 Wb. m^{-2} to $0.5 Wb. m^{-2}$ in $\frac{1}{10}s$, find out the current induced in the coil.

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4. A conducting wire of length 30 cm revolves 1000 times per minute about one of its ends and perpendicular to the direction of a magnetic field of 0.5 T. Determine the emf induced across the ends of the wire.

Watch Video Solution

5. A 10m long horizontal wire, lying along the magnetic east-west direction, begins to fall with a velocity of 5.0 m. s^{-1}. What will be the emf induced in the wire? [Given, $H = 0.3 \times 10^{-4} Wb. m^{-2}$]

Watch Video Solution

6. The distance between the extremities of the two wings of an aeroplane is 30m. It is flying horizontally with a velocity of $1080 km. h^{-1}$. The vertical component of earth's magnetic field in that region is $4.5 \times 10^{-5} T$. Find the emf induced across the extremities of the two wings.

Watch Video Solution

7. A coil of 100 turns and of diameter 0.2 m is placed at right angles to a uniform magnetic field. If the field increases uniformly from 0.1Wb . m^{-2} to $0.3Wb. m^{-2}$ in 0.05s, find out the emf induced in the coil.

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8. A wire xy has a semicircular part of radius a. Obtain the expression for induced emf across xy when the wire rotates in a uniform magnetic field B with a frequency f. The direction of B and rotation of xy are shown in the fig.

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9. A closed circular coil having a diameter of 50 cm and of 200 turns, with a total resistance of

10Ω is placed with its plane at right angles to a magnetic field of strength $10^{-2}T$. Calculate the quantity of electric charge that flows through it when the coil is turned through 180° about its diameter.

View Text Solution

10. The current in a primary coil increases by 20 A in 0.1 s. If the average emf induced in the secondary coil be 100 V, determine the mutual inductance between the coils and the change in magnetic flux in the secondary coil.

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11. The inductance of a coil of 400 turns is 8 mH. If a current of 5 mA flows through the coil, calculate the magnetic flux linked with it.

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12. Find the amount of stored energy within a coil of inductance 10mH due to a current of 50mA through it.

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13. The ratio of the inductances of two coils is 1 : 2 and that of the currents through them is 2 : 1. Find the ratio of energy stored in the coils.

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14. Self-inductance and resistance of a coil are 30mH and 20Ω respectively. It is connected to a 30Ω resistance and a 2V battery in series. How much energy will be stored in the coil?

Watch Video Solution

15. The current in a coil increases by 10 A in 0.01s. If the average emf induced in the coil is 100 V, find out the self-inductance of the coil and the flux linked with it.

Watch Video Solution

16. An emf of 100V is induced in a coil when the current through it changes at the rate of $50A. s^{-1}$. Determine the self-inductance of the coil.

Watch Video Solution

17. The self-inductance of a circular coil of 600 turns is 36 mH. What will be the self-inductance of another circular coil of identical shape, but of 500 turns?

Watch Video Solution

18. A straight solenoid of length 50 cm and across sectional area $1cm^2$ has a self-inductance of $10^{-5}H$. If a current of 100 mA passes through it, what will be the magnetic field along its axis?

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19. A solenoidal coil has 50 turns per centimeter along its length and a cross sectional area of $4 \times 10^{-4} m^2$. 200 turns of another wire is wound round the first solenoid co-axially. The two coils are electrically insulated from each other. Calculate the mutual inductance between the two coils.

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Problem Set Ii

1. A square loop of wire of side 10 cm is placed at angle of 45° with a magnetic field that changes uniformly from 0.2 T to zero in 1 second. Find the current induced in the loop of resistance 1Ω.

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2. The rails of a railway track are 1.80 m apart and assumed to be insulated from one another. Calculate the emf induced between the rails if a train is passing at 120 km. h^{-1}.

Assume that the horizontal component of earth's magnetic field, $H = 0.36 \times 10^{-4} T$ and angle of dip. $\theta = \tan^{-1}(1.026)$.

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3. A wheel with 10 metallic spokes each 0.5 m long, is rotated with a speed of 120 rpm. Please of the wheel is normal to earth's magnetic field at that place. If the magnitude of the field is 0.40 G, what is the induced emf between the axle and rim of the wheel?

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4. A square metallic wire loop of side 10 cm and resistance 1Ω is moved with a constant velocity $\overrightarrow{v}$ in a uniform magnetic field of induction 2T as shown in figure. The loop is connected to a network of resistances, each of value 3Ω. The resistance of wires QD and PB are negligible. What should be the speed of the loop to have a steady current of 1 mA in the loop? What is the direction of flow of current?

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5. Magnetic flux through a stationary loop with a resistance R varies during the time interval τ as $\phi = \alpha t(\tau - t)$ where α is a constant. Calculate the amount of heat generated in the loop during the time interval τ.

Watch Video Solution

6. Two differenct coils have self-inductances $L_1 = 16mH$ and $L_2 = 12mH$. At a certain instant, the current in the two coils is increasing at the same rate and power supplied to the two coils is the same. Find the ratio of

induced voltage

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induced current

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8. Two differenct coils have self-inductances $L_1 = 16mH$ and $L_2 = 12mH$. At a certain instant, the current in the two coils is increasing at the same rate and power supplied to the two coils is the same. Find the ratio of

energy stored in the two coils at that instant.

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9. What will be the self-inductance of a solendoid of length 1m, diameter 12cm and number of turns 4000? How much energy will be stored in its magnetic field due to a current of 2A through it? $\left(\mu_0 = 4\pi \times 10^{-7} H.m^{-1}\right)$.

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10. A long solenoid having 450 turns per m carries a current of 1.6 A. At the centre of the solenoid a coil of 180 turns with cross sectional area $3.5cm^2$ is placed having its axis parallel to the field produced by the solenoid. What will be the amount of induced emf when the direction of current in the solenoid is reversed within 0.03 s?

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Entrance Corner

1. Statement I: Induced emf in a conductor is proportional to the time rate of change of associated magnetic flux.

Statement II: In case of electromagnetic induction transfer of energy takes place in a manner so that total energy is conserved.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I

B. Statement I true, statement II is true, statement II is not a correct explanation for statement I

C. Statement I is true, statement II is false

D. Statement I is false, statement II is true

Answer: B

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2. Statement I: The north pole of a bar magnet is moving towards a closed circular coil along its axis. As a result the direction of induced current in the front face of the coil will be clockwise.

Statement II: Any incident connected with electromagnetic induction obeys Lenz's law.

View Text Solution

3. Statement I: The charge passing through a coil in time Δt is $\frac{\Delta \phi}{R}$, where R is the resistance of the coil and $\Delta \phi$ is the change in flux linked with the coil in time Δt.

Statement II: The induced emf in a conductor $e \propto \frac{d\phi}{dt}$, where $\frac{d\phi}{dt}$ is the time rate of change of flux linked with the conductor.

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4. Statement I: A closed solenoid is placed in an external magnetic field. Both of the magnetic field and axis of the solenoid are directed along z-axis. No electromotive force will be induced if the solenoid is rotated along its own axis.

Statement II: Electromagnetic induction in a conducting coil takes place only when the magnetic flux linked with the coil changes with time.

Watch Video Solution

5. Statement I: Self-inductance of a solenoid having 1000 turns is 100 mH if the associated magnetic flux linked with each turn is 10^{-3} Wb for a current of 1 A passig through the solenoid.

Statement II: The self-inductance L of a coil is defined as $\phi = LI$ when ϕ is the magnetic flux linked with the coil for a current I through it.

Watch Video Solution

6. Statement I: When two coils are wound on each other, the mutual induction between the coils is maximum.

Statement II: Mutual induction does not depend on the orientation of the coils.

Watch Video Solution

7. Statement I: When the number of turns of a coils is doubled, coefficient of self-inductance of the coil becomes 4 times.

Statement II: Self-inductance $\propto (\text{number of turns})^2$

Watch Video Solution

Mcq

1. In case of electromagnetic induction in a conductor

A. electromotive force is induced whenever the conductor starts moving in a magnetic field

B. induced electromotive force is proportional to the magnetic flux linked with the conductor

C. induced current may be zero even if the induced emf is not zero

D. induced emf does not depend on the resistance of the conductor

Answer: C::D

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2. The induced emf between the two ends of a straight conductor moving perpendicular to its axis in a uniform magnetic field is

A. proportional to the length of the conductor

B. proportional to the velocity of the conductor

C. proportional to the magnetic field

D. inversely proportional to the magnetic field

Answer: A::C::D

Watch Video Solution

3. The length and radius of a solenoid of N turns are l and r respectively. The self-inductance of the solenoid is

A. proportional to N

B. proportional to N^2

C. inversely proportional to r

D. inversely proportional to l

Answer: A::C::D

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4. Which of the following relations are correct?

A. henry = ohm $\times$ second

B. farad = ohm/second

C. weber = volt $\times$ second

D. henry = weber/ampere

Answer: A:C:D

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5. The mutual inductance of two adjacent coils depends on the

A. rate of change of current in any one of them

B. number of turns of the two solenoids

C. length of the solenoids

D. relative position of the solenoids

Answer: B::C::D

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6. A conducting coil of resistance R and radius r has its centre at the origin of the coordinate system in a uniform magnetic field of induction B. When it is rotated about y-axis through 90°, the change of flux in the coil is directly proportional to

A. B

B. R

C. r^2

D. r

Answer: B::C::D

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7. A V-shaped conducting wire is moved with a speed of v in a magnetic field as shown in the fig. Magnetic field is perpendicular to the paper, directed inwards, then

A. $v_a = v_c$

B. $v_a > v_c$

C. $v_a > v_b$

D. $v_c > v_b$

Answer: B::D

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8. The magnetic flux (ϕ) linked with a coil varies with time (t) as $\phi = at^n$, where a and n are constants. The induced emf in the coil is e. Which of the following are correct?

A. if $0 < n < 1, e = 0$

B. if $0 < n < 1, e \neq 0$ and |e| decreases with time

C. if n = 1, e is constant

D. if $n > 1$, $|e|$ increases with time

Answer: A::C

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9. Current (i) passing through a coil varies with time t as $i = 2t^2$. At 1 s total flux passing through the coil is 10 Wb. Then

A. self-inductance of the coil is 10 H

B. self-inductance of the coil is 5 H

C. induced emf across the coil at 1 s is 20 V

D. induced emf across the coil at 1 s is 10 V

Answer: B::C

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Comprehension Type

1. If the current through a solenoid changes with time electromagnetic induction takes place in the solenoid. This is known as self-induction. In general, for a current I, the induced emf in the coil is $e = -L\frac{dI}{dt}$.

L is the self-inductance of the solenoid. On the other hand, such change in the current in a solenoid can produce electromagnetic induction in another adjacent solenoid. The induced emf in the other solenoid

$e = -M\frac{dI}{dt}$, M is called the mutual inductance of the solenoids.

If L_1 and L_2 are the self-inductance of the adjacent coils then their mutual inductance $M = k\sqrt{L_1L_2}$. If the magnetic flux produced by the current in one coil is totally linked with the other coil then k = 1.

Watch Video Solution

2. If the current through a solenoid changes with time electromagnetic induction takes place in the solenoid. This is known as self-induction. In general, for a current I, the induced emf in the coil is $e = -L\frac{dI}{dt}$.

L is the self-inductance of the solenoid. On the other hand, such change in the current in a solenoid can produce electromagnetic induction in another adjacent solenoid. The induced emf in the other solenoid $e = -M\frac{dI}{dt}$, M is called the mutual inductance of the solenoids.

If L_1 and L_2 are the self-inductance of the adjacent coils then their mutual inductance $M = k\sqrt{L_1L_2}$. If the magnetic flux produced by the current in one coil is totally linked with the other coil then k = 1.

The self-inductance (in H) of a coil when the induced emf is $50\mu V$ for a change of 1 mA.s^{-1} in current through it, is

A. 50

B. 5

C. 0.5

D. 0.05

Answer: D

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$e = - M\frac{dI}{dt}$, M is called the mutual inductance of the solenoids.

If L_1 and L_2 are the self-inductance of the adjacent coils then their mutual inductance $M = k\sqrt{L_1 L_2}$. If the magnetic flux produced by the current in one coil is totally linked with the other coil then k = 1.

If the induced emf in a coil totally linked with the coil be $20 \mu V$ for change of 1mA/s, the mutual inductance (in H) of the two coils is

A. 0.002

B. 0.02

C. 0.2

D. 2

Answer: B

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4. If the current through a solenoid changes with time electromagnetic induction takes place in the solenoid. This is known as self-induction. In general, for a current I, the induced emf in the coil is $e = -L\frac{dI}{dt}$.

L is the self-inductance of the solenoid. On the other hand, such change in the current in a solenoid can produce electromagnetic induction in another adjacent solenoid. The induced emf in the other solenoid $e = -M\frac{dI}{dt}$, M is called the mutual inductance of the solenoids.

If L_1 and L_2 are the self-inductance of the adjacent coils then their mutual inductance $M = k\sqrt{L_1L_2}$. If the magnetic flux produced by the current in one coil is totally linked with the other coil then k = 1.

Self-inductance (in H) of the coil in question (III) is

A. 0.1

B. 0.08

C. 0.01

D. 0.008

Answer: D

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5. If the current through a solenoid changes with time electromagnetic induction takes place in the solenoid. This is known as self-induction. In general, for a current I, the induced emf in the coil is $e = -L\frac{dI}{dt}$.

L is the self-inductance of the solenoid. On the other hand, such change in the current in a solenoid can produce electromagnetic induction in another adjacent solenoid. The induced emf in the other solenoid $e = -M\frac{dI}{dt}$, M is called the mutual inductance of the solenoids.

If L_1 and L_2 are the self-inductance of the adjacent coils then their mutual inductance $M = k\sqrt{L_1 L_2}$. If the magnetic flux produced by the current in one coil is totally linked with the other coil then k = 1.

The negative sign in the expression of induced emf is explained by

A. Faraday's first law

B. Faraday's second law

C. Law of conservation of energy

D. Law of conservation of charge

Answer: C

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Integer Answer Type

1. The current through a coil of self-inductance 500 mH is 4 A. What amount of magnetic energy (in J) is stored in its magnetic field?

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2. A straight conductor of length 50 cm is moving with a velocity 5 m. s^{-1} in a magnetic field of strength 2T in a direction perpendicular to the field. What is the emf (in V) induced between the two ends of the conductor?

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3. The magnetic flux (ϕ) (in Wb) linked with a 100Ω coil changes with time t (in s) according to the relation $\phi = 8t^2 - 2t + 1$. What is the value of induced current (in A) in the coil at t = 2 s?

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4. A straight conductor of length 10 cm is rotating in a vertical plane with one of its ends fixed. The angular velocity is 10 rad . s^{-1}. What is the value of emf (in μV) induced between the two ends of the conductor if the horizontal component of earth's magnetic field at the place is $10^{-4}T$?

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5. Find the change in magnetic flux (in Wb) in an inductor of 10H in which the emf induced is 300 V in $10^{-2}s$.

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6. An average induced emf of 0.20 V appears in a coil when the current in it is changed from 5A in one direction to 5A in the opposite

direction in 0.20 s. Find the self-inductance of the coil in mH.

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Examination Archive With Solution

1. Which of the following is the unit of magnetic flux?

A. tesla

B. tesla/m^2

C. tesla $\times m^2$

D. weber/m^2

Answer: C

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2. Write Lenz's law in relation to electromagnetic inuction. Explain the law from the principle of conservation of energy.

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3. A current flowing through a coil changes from +2A to -2A in 0.05 s and an emf of 8 V is induced in the coil. The value of self-inductance of the coil is

A. 0.8 H

B. 0.1 H

C. 0.2 H

D. 0.4 H

Answer: B

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4. State Fleming's right hand rule. Define self-inductance of a coil. Explain non-inductive coil with diagram.

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5. A metallic disc of radius 10 cm is rotating uniformly about a horizontal axis passing through its centre with angular velocity 10 revolution per second. A uniform magnetic field of intensity $10^{-2}T$ acts along the axis of the disc. Find the potential difference induced between the centre and the rim of the disc.

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6. Dimension of magnetic flux is

A. $ML^2T^{-2}A^{-1}$

B. $MLT^{-1}A^{-2}$

C. $ML^{-1}TA^{-1}$

D. $ML^{-1}A$

Answer: A

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7. What do you mean by magnetic flux density?

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8. State Faraday's law of electromagnetic induction.

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9. The magnetic flux through a coil is varying according to the relation $\phi = (4t^2 + 2t - 5)Wb$, t measured in seconds. Calculate the induced current through the coil at t = 2s, if the resistance of the coil is 5Ω.

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10. Show that Lenz's law obeys the law of conservation of energy.

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11. Mutual inductance of two coils can be increased by

A. decreasing the number of turns on the coils

B. increasing the number of turns on the coils

C. winding the coils on the wooden core

D. none of these

Answer: B

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12. If L and R denote inductance and resistance respectively, then the dimension of $\frac{L}{R}$ is

A. $M^0L^0T^0$

B. $M^0L^0T^1$

C. $M^2L^0T^2$

D. $M^1L^1T^2$

Answer: B

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13. A horizontal straight wire 5 m long extending from east to west is falling with a speed of 10 m/s at right angles to the horizontal component of earth's magnetic field $0.40 \times 10^{-4} Wb. m^{-2}$.

find the instantaneous value of emf induced in the wire.

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14. A horizontal straight wire 5 m long extending from east to west is falling with a speed of 10 m/s at right angles to the horizontal component of earth's magnetic field $0.40 \times 10^{-4} Wb. m^{-2}$.

What is the direction of the emf?

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15. A horizontal straight wire 5 m long extending from east to west is falling with a speed of 10 m/s at right angles to the horizontal component of earth's magnetic field $0.40 \times 10^{-4} Wb. m^{-2}$.

Which end of the wire will be at higher potential? (Neglect acceleration due to gravity.)

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16. Derive the expression for energy stored in an inductor of coefficient of self-inductance L carrying current i_0.

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17. A coil of metallic wire is at rest in a non-uniform magnetic field. Would any electromotive force be induced in the coil?

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1. A very small circular loop of radius a is initially (at t = 0) coplaner and concentric with a much larger fixed circular loop of radius b. A constant I flows in the larger loop. The smaller loop is rotated with a constant angular speed ω about the common diameter. The emf induced in the smaller loop as a function of time t is

A. $\frac{\pi a^2 \mu_0 I}{2b} \omega \cos(\omega t)$

B. $\frac{\pi a^2 \mu_0 I}{2b} \omega \sin(\omega^2 t^2)$

C. $\frac{\pi a^2 \mu_0 I}{2b} \omega \sin(\omega t)$

D. $\frac{\pi a^2 \mu_0 I}{2b} \omega \sin^2(\omega t)$

Answer: C

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2. A straight conductor 0.1 m long moves in a uniform magnetic field 0.1 T. The velocity of the conductor is 15 m/s and is directed perpendicular to the field. The emf induced between the two ends of the conductor is

A. 0.10 V

B. 0.15 V

C. 1.50 V

D. 15.00 V

Answer: B

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3. A conducting loop in the form of a circle is placed in a uniform magnetic field with its plane perpendicular to the direction of the field. An emf will be induced in the loop if

A. it is translated parallel to itself

B. it is rotated about one of its diameters

C. it is rotated about its own axis which is parallel to the field

D. the loop is deformed from the original shape

Answer: B::D

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4. Two coils of self-inductances 6mH and 8mH are connected in series and are adjusted for highest coefficient of coupling. Equivalent self-inductance L for the assembly is approximately

A. 50 mH

B. 36 mH

C. 28 mH

D. 18 mH

Answer: C

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5. As shown in the figure, a rectangular loop of a conducting wire is moving away with a constant velocity v in a perpendicular direction from a very long straight conductor carrying a steady current I. When the breadth of the rectangular loop is very small compared to its distance from the straight conductor, how does the emf E induced in the loop vary with time t?

A. $E \propto \frac{1}{t^2}$

B. $E \propto \frac{1}{t}$

C. $E \propto -\ln(t)$

D. $E \propto \frac{1}{t^3}$

Answer: A

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Jee Main

1. 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. 200 Wb

B. 225 Wb

C. 250 Wb

D. 275 Wb

Answer: C

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Aipmt

1. A thin semicircular conducting ring (PQR) of radius r is falling with its plane vertical in a horizontal magnetic field B, as shown in The potential difference developed across the ring when its speed is v, is

A. zero

B. $\frac{Bv\pi r^2}{2}$ and P is at higher potential

C. $\pi r Bv$ and R is at higher potential

D. $2rBv$ and R is at higher potential

Answer: D

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2. A conducting square frame of side a and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity v. The emf induced in the frame will be proportional to

A. $\frac{1}{x^2}$

B. $\frac{1}{(2x-a)^2}$

C. $\frac{1}{(2x+a)^2}$

D. $\frac{1}{(2x-a)(2x+a)}$

Answer: D

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Neet

1. A long solenoid has 1000 turns. When a current of 4A flows through it, the magnetic flux linked with each turn of the solenoid is $4 \times 10^{-3} Wb$. The self-inductance of the solenoid is

A. 3 H

B. 2 H

C. 1 H

D. 4 H

Answer: C

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2. A circular coil of radius 10 cm, 500 turns and resistance 2Ω is placed with its plane, perpendicular to the horizontal component of the earth's magnetic field. It is rotated about its vertical diameter through 180° in 0.25 s. The induced emf in the coil is (take $H_E = 3.0 \times 10^{-5} T$)

A. $6.6 \times 10^{-4} V$

B. $1.4 \times 10^{-2} V$

C. $2.6 \times 10^{-2} V$

D. $3.8 \times 10^{-3} V$

Answer: D

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3. Inside a parallel plate capacitor the electric field E varies with time as t^2. The variation of induced magnetic field with time is given by

A. a) t^2

B. b) no variation

C. c) t^3

D. d) t

Answer: D

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4. 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. 1.389 H

B. 138.88 H

C. 0.138 H

D. 13.89 H

Answer: D

Cbse Scanner

1. A bar magnet is moved in the direction indicated by the arrow between two coils PQ and CD. Predict the directions of induced current in each coil.

2. The motion of copper plate is damped when it is allowed to oscillate between the two plates of a magnet. What is the cause of this damping?

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3. 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 10 m $.s^{-1}$, calculate the emf induced in the arm. Given the resistance of the arm to be 5Ω, (assuming that the other arms are of negligible resistance) find the value of the current in the arm.

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4. A wheel with 8 metallic spokes each 50 cm long is rotated with a speed of 120 rev. $\min^{-1}$ in a plane normal to the horizontal component of the Earth's magnetic field. The Earth's magnetic field at the place in 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.

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

distance between the coils is increased and

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

number of turns in the coils is increased?

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7. 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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8. The motion of copper plate is damped when it is allowed to oscillate between the two plates of a magnet. What is the cause of this damping?

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9. A conducting loop is held above a current carrying wire PQ as shown in the figure. Depict the direction of the current induced in the loop when the current in the wire PQ is constantly increasing.

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10. Define the term self-inductance of a solenoid. Obtain the expression for the magnetic energy stored in an inductor of self-inductance L to build up a current I through it.

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11. A varying current in a coil change from 10A to 0 in 0.5sec. If the average emf induced in the coil is 220V, the self inductance of the coil is :

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12. A rod of length l is moved horizontally with a uniform velocity v in a direction perpendicular to its length through a region in which a uniform magnetic field is acting vertically downward. Derive an expression for the emf induced across the ends of the rod.

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13. How does one understand this motional emf by invoking the Lorentz force acting on the free charge carriers of the conductor? Explain.

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14. Describe, with the help of a suitable diagram, how one can demonstrate that emf can be induced in a coil due to the change of magnetic flux. Hence state Faraday's law of electromagnetic induction.

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15. Two loops, one rectangular of dimensions $10 \text{ cm} \times 2.5 \text{ cm}$ and second of square shape of side 5 cm are moved out of a uniform magnetic field $\vec{B}$ perpendicular to the planes of the loops with equal velocity v as is shown in the figure.

In which case will the emf induced be more?

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16. Two loops, one rectangular of dimensions 10 cm $\times$ 2.5 cm and second of square shape of side 5 cm are moved out of a uniform magnetic field $\vec{B}$ perpendicular to the planes of the loops with equal velocity v as is shown in the figure.

In which case will the current flowing through the two loops be less?

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17. Sketch the change in flux, emf and force when a conducting rod PQ of resistance R and length L moves freely to and fro between A and C will speed v on a rectangular conductor placed in uniform magnetic field as shown in the figure.

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18. Define mutual inductance.

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19. 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?

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20. 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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21. Predict the polarity of the capacitor in the situation described below:

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22. The average self-induced emf in a 25mH solenoid when the current in it falls from 0.2A to 0A in 0.01 second, is

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23. What is the direction of induced currents in metal rings 1 and 2 when current I in the wire is increasing steadily?

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24. A horizontal conducting rod 10 m long extending from east to west is falling with a speed 5.0 m . s^{-1} at right angles to the horizontal component of the Earth's magnetic field, $0.3 \times 10^{-4} Wb. m^{-2}$. Find the

instantaneous value of the emf induced in the rod.

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25. Define the term 'self-inductance' and write its SI unit.

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26. 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 n_1 and n_2 number of turns per unit length, when a current I is set up in the outer solenoid S_2.

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27. Define self-inductance of a coil. Obtain the expression for the energy stored in an inductor L connected across a source of emf.

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

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