Class 12 Physics Chapterwise PYQs

2026 – 2003 | All CBSE Board Papers

Chapter-wise previous year questions, sorted by marks and year

Chapter 6: Electromagnetic Induction

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1-Mark Questions (73 questions · Section A · MCQ)

Q1. A magnet held vertically, with its north pole down, is dropped along the axis of a closed solenoid placed vertically on a table. If the observer looks down from the top, then:

(A) the induced current will flow in the anticlockwise direction.
(B) the induced current will flow in the clockwise direction.
(C) no induced current will flow in the solenoid.
(D) the magnet will fall with a constant velocity.

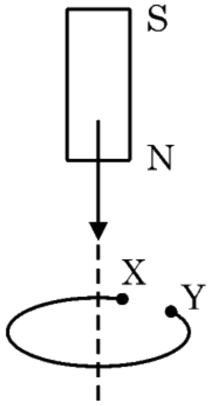
[2026 • Set 55-2-1]

Q2. The magnetic flux ϕ (in Wb) linked with a coil is related to time t (in s) as $\phi = 5At^2 + Bt - 2C$. The SI units of A and B are respectively:

(A) Wb s^2, Wb s
(B) Wb s^{-1}, Wb
(C) Wb s^{-2}, Wb s^{-1}
(D) Wb s^{-1}, Wb s^{-2}

[2026 • Set 55-2-1]

Q3. Figure shows a magnet dropped through a small loop with a small cut. Which of the following statements is correct?



(A) The speed of the falling magnet increases as it approaches the loop and starts decreasing as it crosses the loop.
(B) Acceleration of magnet increases as it approaches the loop and starts decreasing as it crosses the loop.
(C) Speed of magnet remains uniform as it moves through the loop.
(D) Acceleration of the magnet remains uniform as it moves through the loop.

[2026 • Set 55-2-2]

Q4. Two identical circular loops A and B of metal wire are arranged on a table close to each other. Loop A is connected to a battery and the current in it increases with time. In response, the loop B:
(A) remains stationary
(B) is attracted by loop A
(C) is repelled by loop A
(D) rotates about its centre of mass which is fixed

[2026 • Set 55-2-3]

Q5. A square loop of side 50 cm is placed in a uniform magnetic field of $3{\cdot}0$ T acting perpendicular to the plane of the loop. If the loop is rotated through an angle of $90°$ in $0{\cdot}3$ s, the value of emf induced in the loop would be:
(A) $0{\cdot}25$ V
(B) $0{\cdot}50$ V
(C) $0{\cdot}75$ V
(D) $1{\cdot}0$ V

[2026 • Set 55-3-1]

Q6. A metallic rod of 1 m length is rotated with a frequency of 40 rev/s, with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius 1 m, about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field of $0{\cdot}5$ T parallel to the axis is present in the region. The value of emf induced between the centre and the metallic ring is close to:
(A) 20 V

(B) 32 V
(C) 40 V
(D) 63 V

[2026 • Set 55-3-2]

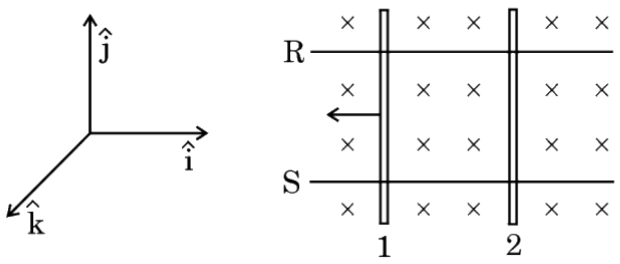
Q7. A square loop of side L lies in the x-y plane in a magnetic field $\vec{B} = B_0(2\hat{i} + 3\hat{j} + 4\hat{k})$, where B_0 is a constant. The magnetic flux through the loop is:
(A) $2B_0L^2$
(B) $4B_0L^2$
(C) $3B_0L^2$
(D) $\sqrt{29}\,B_0L^2$

[2026 • Set 55-3-3]

Q8. The dimensions of the rate of change of magnetic flux are:
(A) $[MLT^{-3}A^{-1}]$
(B) $[ML^2T^{-3}A^{-1}]$
(C) $[ML^2T^{-2}A^{-1}]$
(D) $[ML^2T^{-3}A^{-2}]$

[2026 • Set 55-4-1]

Q9. Two identical conductors 1 and 2 are placed on two frictionless conducting rails R and S in a uniform magnetic field directed vertically downward into the plane of the page. If conductor 1 is moved with a constant velocity in the direction as shown in figure, the force on conductor 2 will be along:



(A) $-\hat{i}$
(B) $-\hat{j}$
(C) $\hat{k}$
(D) $\hat{j}$

[2026 • Set 55-4-1]

Q10. A closely wound long solenoid of self-inductance L is cut into two identical solenoids. The value of self-inductance of each small solenoid will be:
(A) $\frac{L}{4}$

(B) $\frac{L}{2}$
(C) $2L$
(D) $4L$

[2026 • Set 55-4-2]

Q11. Two coils are placed closed to each other. The mutual inductance of the pair of coils depends upon the:

(A) rate at which currents change in the two coils.
(B) relative position and orientation of the coils.
(C) currents in the two coils.
(D) value of voltage induced in one coil due to change in value of current in the other coil.

[2026 • Set 55-4-3]

Q12. Assertion (A): Induced emf produced in a coil will be more when the magnetic flux linked with the coil is more. Reason (R): Induced emf produced is directly proportional to the magnetic flux. Select the correct answer from the codes given below:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Both Assertion (A) and Reason (R) are false.

[2026 • Set 55-5-1]

Q13. The magnetic flux through a loop placed in a magnetic field can be changed by changing:

(A) area of the loop only
(B) the value of magnetic field only
(C) orientation of the loop in the magnetic field only
(D) any one or more of the factors given in (A), (B) and (C)

[2026 • Set 55-5-1]

Q14. A rectangular loop of size $5\,\text{cm} \times 8\,\text{cm}$ is lying in x-y plane in a uniform magnetic field $\vec{B} = (2.0\,\text{T})\,\hat{k}$. The total magnetic flux linked with the loop is:

(A) $80\,\text{Wb}$
(B) $16\,\text{Wb}$
(C) $8 \times 10^{-2}\,\text{Wb}$
(D) $8 \times 10^{-3}\,\text{Wb}$

[2026 • Set 55-5-2]

Q15. A square loop of side 0.50 m is placed in a uniform magnetic field of 0.4 T perpendicular to the plane of the loop. The loop is rotated through an angle of $60°$ in 0.2 s. The value of emf induced in the loop will be:

(A) 5 V
(B) 3.5 V
(C) 2.5 V
(D) Zero V

[2026 • Set 55-5-3]

Q16. Assertion (A): It is difficult to move a magnet into a coil of large number of turns when the circuit of the coil is closed. Reason (R): The direction of induced current in a coil with its circuit closed, due to motion of a magnet, is such that it opposes the cause.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false and Reason (R) is also false.

[2025 • Set 55-1-1]

Q17. A coil has 100 turns, each of area $0.05\,m^2$ and total resistance $1.5\,\Omega$. It is inserted at an instant in a magnetic field of 90 mT, with its axis parallel to the field. The charge induced in the coil at that instant is:

(A) 3.0 mC
(B) 0.30 C
(C) 0.45 C
(D) 1.5 C

[2025 • Set 55-1-1]

Q18. You are required to design an air-filled solenoid of inductance 0.016 H having a length 0.81 m and radius 0.02 m. The number of turns in the solenoid should be:

(A) 2592
(B) 2866
(C) 2976
(D) 3140

[2025 • Set 55-1-1]

Q19. A circular coil of diameter 15 mm having 300 turns is placed in a magnetic field of 30 mT such that the plane of the coil is perpendicular to the direction of magnetic field. The magnetic field is reduced uniformly to zero in 20 ms and again increased uniformly to 30 mT in 40 ms. If the emfs induced in the two time intervals are e_1 and e_2 respectively, then the value of e_1/e_2 is:

(A) $\frac{1}{2}$

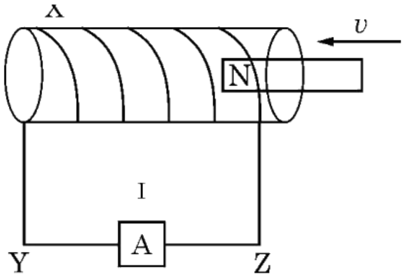
(B) 1

(C) 2

(D) 4

[2025 • Set 55-1-2]

Q20. In the figure X is a coil wound over a hollow wooden pipe. A permanent magnet is pushed at a constant speed v from the right into the pipe and it comes out at the left end of the pipe. During the entry and the exit of the magnet, the current in the wire YZ will be from



(A) Y to Z and then Y to Z

(B) Z to Y and then Y to Z

(C) Y to Z and then Z to Y

(D) Z to Y and then Z to Y

[2025 • Set 55-2-1]

Q21. Two long solenoids of radii r_1 and r_2 $(r_2 > r_1)$ and number of turns per unit length n_1 and n_2, respectively are co-axially wrapped one over the other. The ratio of self-inductance of inner solenoid to their mutual inductance is

(A) $\frac{n_1}{n_2}$

(B) $\frac{n_2}{n_1}$

(C) $\frac{n_1 r_1^2}{n_2 r_2^2}$

(D) $\frac{n_2 r_1^2}{n_1 r_2^2}$

[2025 • Set 55-2-2]

Q22. A coil of an ac generator, having 100 turns and area 0.1 m^2 each, rotates at half a rotation per second in a magnetic field of 0.02 T. The maximum emf generated in the coil is

(A) 0.31 V

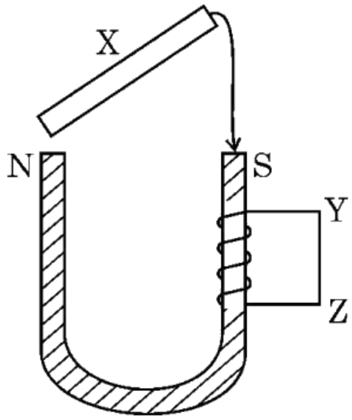
(B) 0.20 V

(C) 0.63 V

(D) 0.10 V

[2025 • Set 55-2-2]

Q23. A soft iron rod X is allowed to fall on the two poles of a U shaped permanent magnet as shown in figure. A coil is wrapped over one arm of the U shaped magnet. During fall of the rod, the current in the coil will be



(A) clockwise current
(B) anticlockwise current
(C) alternating current
(D) zero

[2025 • Set 55-2-3]

Q24. When current in a coil changes at a steady rate from $8\,\text{A}$ to $6\,\text{A}$ in $4\,\text{ms}$, an emf of $1.5\,\text{V}$ is induced in it. The value of self-inductance of the coil is :

(A) $6\,\text{mH}$
(B) $12\,\text{mH}$
(C) $3\,\text{mH}$
(D) $9\,\text{mH}$

[2025 • Set 55-4-2]

Q25. The magnetic flux linked with a closed coil (in Wb) varies with time t (in s) as $\phi = 5t^2 + 4t - 2$. If the resistance of the circuit is $14\,\Omega$, the magnitude of induced current in the coil at $t = 1\,\text{s}$ will be :

(A) $0.5\,\text{A}$
(B) $1.0\,\text{A}$
(C) $1.5\,\text{A}$
(D) $2.0\,\text{A}$

[2025 • Set 55-4-3]

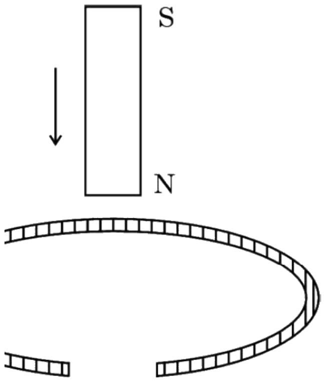
Q26. The magnetic flux linked with a coil changes with time t as $\phi = (8t^2 + 5t + 7)$, where t is in seconds and ϕ is in Wb. The value of emf induced in the coil at $t = 4$ s is:

(A) 32 V
(B) 37 V
(C) 64 V

(D) 69 V

[2025 • Set 55-5-1]

Q27. A vertically held bar magnet is dropped along the axis of a copper ring having a cut as shown in the diagram. The acceleration of the falling magnet is:



(A) zero
(B) less than g
(C) g
(D) greater than g

[2025 • Set 55-6-1]

Q28. A rectangular coil of area A is kept in a uniform magnetic field $\vec{B}$ such that the plane of the coil makes an angle α with $\vec{B}$. The magnetic flux linked with the coil is:
(A) $BA \sin\alpha$
(B) $BA \cos\alpha$
(C) BA
(D) zero

[2025 • Set 55-7-1]

Q29. A metal rod of length 50 cm is held vertically and moved with a velocity of 10 m/s towards east. The horizontal component of the Earth's magnetic field at the place is 0.4 G. The emf induced across the ends of the rod is:
(A) 0.1 mV
(B) 0.2 mV
(C) 0.8 mV
(D) 1.6 mV

[2025 • Set 55-7-1]

Q30. The dimensions of 'self-inductance' are:
(A) $[MLT^{-2}A^{-2}]$
(B) $[ML^2T^{-1}A^{-1}]$

(C) $[ML^{-1}T^{-2}A^{-2}]$
(D) $[ML^{2}T^{-2}A^{-2}]$

[2025 • Set 55-7-1]

Q31. Assertion (A): The mutual inductance between two coils is maximum when the coils are wound on each other. Reason (R): The flux linkage between two coils is maximum when they are wound on each other.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false and Reason (R) is also false.

[2024 • Set 55-1-1]

Q32. A conducting circular loop is placed in a uniform magnetic field $B = 50\,\text{mT}$ with its plane perpendicular to the magnetic field. The radius of the loop is made to shrink at a constant rate of $1\,\text{mm s}^{-1}$. At the instant the radius of the loop is $4\,\text{cm}$, the induced emf in the loop is:

(A) $\pi\,\mu\text{V}$
(B) $2\pi\,\mu\text{V}$
(C) $4\pi\,\mu\text{V}$
(D) $8\pi\,\mu\text{V}$

[2024 • Set 55-1-2]

Q33. Assertion (A): Lenz's law is a consequence of the law of conservation of energy. Reason (R): There is no power loss in an ideal inductor.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false and Reason (R) is also false.

[2024 • Set 55-2-1]

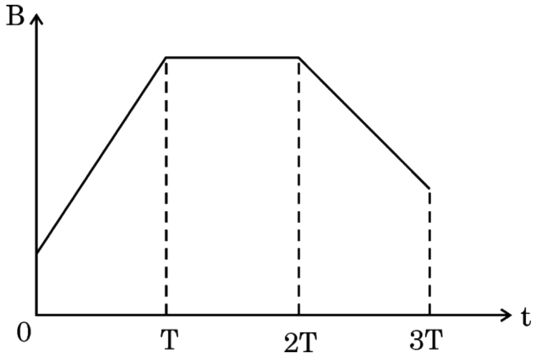
Q34. A circular coil of radius 10 cm is placed in a magnetic field $\vec{B} = (1.0\,\hat{i} + 0.5\,\hat{j})\ mT$ such that the outward unit vector normal to the surface of the coil is $(0.6\,\hat{i} + 0.8\,\hat{j})$. The magnetic flux linked with the coil is:

(A) $0.314\ \mu Wb$
(B) $3.14\ \mu Wb$
(C) $31.4\ \mu Wb$

(D) $1.256\ \mu Wb$

[2024 • Set 55-2-1]

Q35. A conducting loop is placed in a magnetic field, normal to its plane. The magnitude of the magnetic field varies with time as shown in the figure. If $\varepsilon_1, \varepsilon_2$ and ε_3 are magnitudes of induced emfs during periods $0 < t < T$, $T < t < 2T$ and $2T < t < 3T$, then:



(A) $\varepsilon_1 > \varepsilon_2 > \varepsilon_3$
(B) $\varepsilon_1 > \varepsilon_3 > \varepsilon_2$
(C) $\varepsilon_3 > \varepsilon_1 > \varepsilon_2$
(D) $\varepsilon_1 > \varepsilon_2 > \varepsilon_3$

[2024 • Set 55-2-2]

Q36. The emf induced in a coil rotating in a magnetic field does not depend upon the following:

(A) Area of the coil
(B) Resistance of the coil
(C) Number of turns in the coil
(D) Angular speed of rotation of the coil

[2024 • Set 55-2-3]

Q37. The current in a coil of 15 mH increases uniformly from zero to 4 A in 0.004 s. The emf induced in the coil will be:

(A) 22.5 V
(B) 17.5 V
(C) 15.0 V
(D) 12.5 V

[2024 • Set 55-3-1]

Q38. Consider a solenoid of length l and area of cross-section A with fixed number of turns. The self-inductance of the solenoid will increase if:

(A) both l and A are increased
(B) l is decreased and A is increased

(C) l is increased and A is decreased

(D) both l and A are decreased

[2024 • Set 55-3-1]

Q39. The mutual inductance of two coils C_1 and C_2 is 20 mH. In coil C_1, the current changes from 4 A to zero in 0.2 s. If the resistance of coil C_2 is $4\ \Omega$, then the charge that flows through it per second will be:

(A) 4.0 C

(B) 1.5 C

(C) 0.05 C

(D) 0.1 C

[2024 • Set 55-3-2]

Q40. A coil of N turns is placed in a magnetic field $\vec{B}$ such that $\vec{B}$ is perpendicular to the plane of the coil. $\vec{B}$ changes with time as $B = B_0 \cos\left(\frac{2\pi t}{T}\right)$, where T is time period. The magnitude of emf induced in the coil will be maximum at

(A) $t = \frac{nT}{2}$

(B) $t = \frac{nT}{4}$

(C) $t = \frac{nT}{8}$

(D) $t = nT$

[2024 • Set 55-4-1]

Q41. Two coils are placed near each other. When the current in one coil is changed at the rate of 5 A/s, an emf of 2 mV is induced in the other. The mutual inductance of the two coils is:

(A) 0.4 mH

(B) 2.5 mH

(C) 10 mH

(D) 25 H

[2024 • Set 55-5-1]

Q42. A coil of area of cross-section $0.5\,\text{m}^2$ is placed in a magnetic field acting normally to its plane. The field varies as $B = 0.5t^2 + 2t$, where B is in tesla and t in seconds. The emf induced in the coil at $t = 1$ s is:

(A) 0.5 V

(B) 1.0 V

(C) 1.5 V

(D) 3.0 V

[2024 • Set 55-5-2]

Q43. The mutual inductance of two coils, in a given orientation is $50\,\text{mH}$. If the current in one of the coils changes as $i = 1.0\,\sin\left(100\pi t + \frac{\pi}{6}\right)$ A, the peak value of emf (in volt) induced in the other coil will be:

(A) 5

(B) 5π

(C) 0.5π

(D) 0.05π

[2024 • Set 55-5-3]

Q44. A circular coil of radius 8.0 cm and 40 turns is rotated about its vertical diameter with an angular speed of 25 rad s^{-1} in a uniform horizontal magnetic field of magnitude 3.0×10^{-2} T. The maximum emf induced in the coil is:

(A) 0.12 V

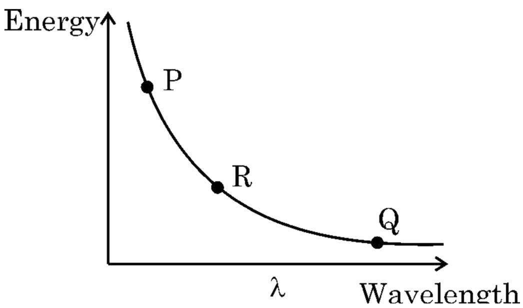
(B) 0.15 V

(C) 0.19 V

(D) 0.22 V

[2023 • Set 55-1-1]

Q45. Figure shows a rectangular conductor $PSRQ$ in which movable arm PQ has a resistance 'r' and resistance of $PSRQ$ is negligible. The magnitude of emf induced when PQ is moved with a velocity $\vec{V}$ does not depend on:



(A) magnetic field ($\vec{B}$)

(B) velocity ($\vec{v}$)

(C) resistance (r)

(D) length of PQ

[2023 • Set 55-1-1]

Q46. Two identical circular coaxial coils A and B, arranged in vertical planes parallel to each other, carry currents in the same direction. If the distance between the coils is decreased at a constant rate, the current:

(A) increases in A and decreases in B.

(B) decreases in both A and B.

(C) increases in both A and B.

(D) remains same in both A and B.

[2023 • Set 55-1-2]

Q47. A bar magnet is dropped in a hollow metallic cylinder along its vertical axis. The acceleration of the falling magnet will be:

(A) zero

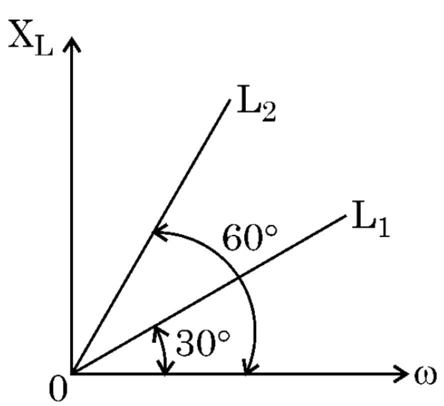
(B) equal to g

(C) less than g

(D) greater than g

[2023 • Set 55-1-3]

Q48. The direction of induced current in the loop abc is:



(A) along abc if I decreases

(B) along acb if I increases

(C) along abc if I is constant

(D) along abc if I increases

[2023 • Set 55-4-1]

Q49. A square shaped coil of side 10 cm, having 100 turns is placed perpendicular to a magnetic field which is increasing at 1 T/s. The induced emf in the coil is

(A) 0.1 V

(B) 0.5 V

(C) 0.75 V

(D) 1.0 V

[2023 • Set 55-5-1]

Q50. Laminated iron sheets are used to minimize ______ currents in the core of a transformer.

[2020 • Set 55-1-1]

Q51. The number of turns of a solenoid are doubled without changing its length and area of cross-section. The self-inductance of the solenoid will become ______ times.

[2020 • Set 55-1-1]

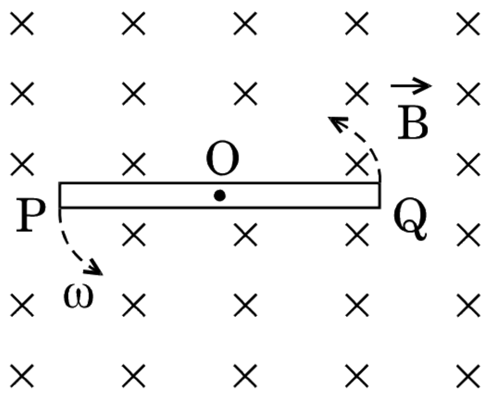
Q52. A conducting rod of length l is kept parallel to a uniform magnetic field $\vec{B}$. It is moved along the magnetic field with a velocity $\vec{v}$. What is the value of emf induced in the conductor?

[2020 • Set 55-2-1]

Q53. Draw the graph showing variation of the value of the induced emf as a function of rate of change of current flowing through an ideal inductor.

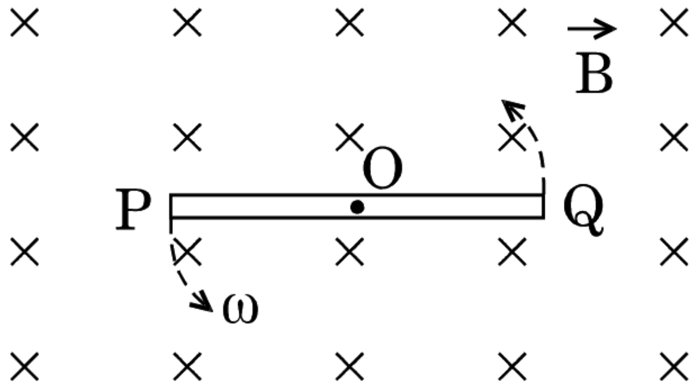
[2020 • Set 55-2-1]

Q54. A metallic rod PQ of length l is rotated with an angular velocity ω about an axis passing through its mid-point (O) and perpendicular to the plane of the paper, in uniform magnetic field $\vec{B}$, as shown in the figure. What is the potential difference developed between the two ends of the rod, P and Q?



[2020 • Set 55-2-2]

Q55. A metallic rod PQ of length l is rotated with an angular velocity ω in a magnetic field $\vec{B}$ about an axis passing through the mid-point O of the rod and perpendicular to the plane of paper as shown in the figure. What is the potential difference developed between the points O and Q of the rod?



[2020 • Set 55-2-3]

Q56. Two identical coils, one of copper and the other of aluminium are rotated with the same angular speed in an external magnetic field. In which of the two coils will the induced current be more?

[2020 • Set 55-3-1]

Q57. In which orientation of the armature coil of an ac generator relative to the magnetic field, will the induced emf be maximum?

[2020 • Set 55-3-3]

Q58. Plot a graph showing variation of induced e.m.f. with the rate of change of current flowing through a coil.

OR

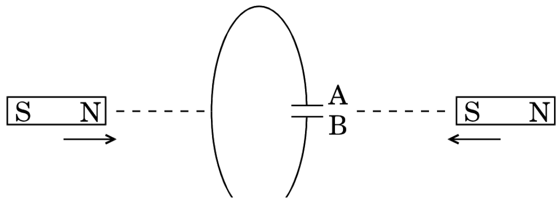
A series combination of an inductor (L), capacitor (C) and a resistor (R) is connected across an ac source of emf of peak value E_0 and angular frequency (ω). Plot a graph to show variation of impedance of the circuit with angular frequency (ω).

[2020 • Set 55-5-1]

Q59. 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.

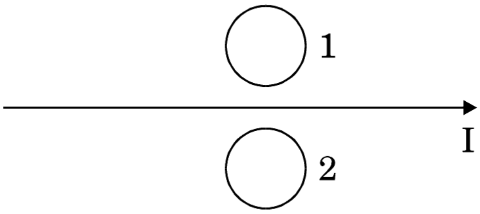
[2017]

Q60. Predict the polarity of the capacitor in the situation described below:



[2017]

Q61. What is the direction of induced currents in metal rings 1 and 2 when current I in the wire is increasing steadily?

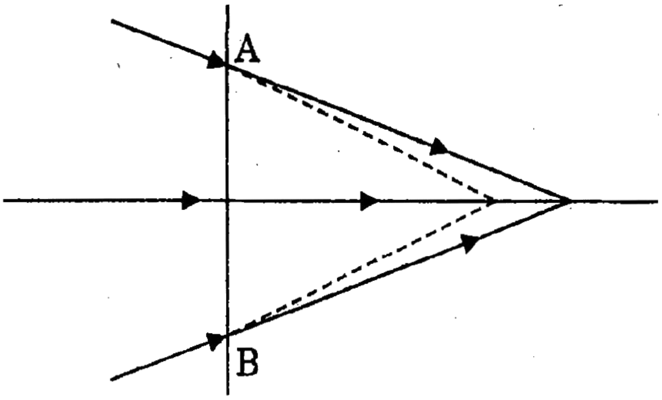


[2017]

Q62. 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 ?

[2014]

Q63. A conducting loop is held below a current carrying wire PQ as shown. Predict the direction of the induced current in the loop when the current in the wire is constantly increasing.



[2014]

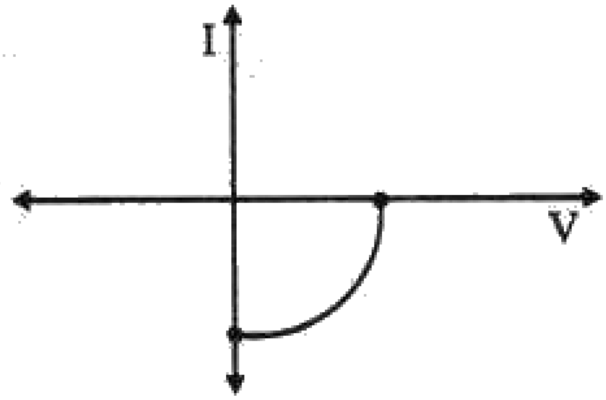
Q64. Give the direction in which the induced current flows in the coil mounted on an insulating stand when a bar magnet is quickly moved along the axis of the coil from one side to the other as shown in the figure.

[2013]

Q65. Define self-inductance of a coil. Write its S.I. units.

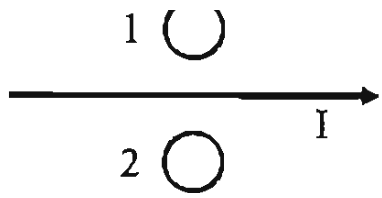
[2012]

Q66. 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.



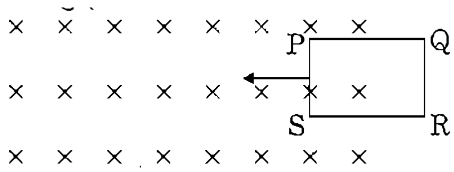
[2012]

Q67. 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.



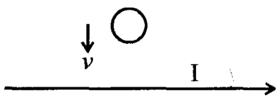
[2012]

Q68. A closed loop (PQRS) of wire is moved into a uniform magnetic field at right angles to the plane of the paper as shown in the figure. Predict the direction of the induced current in the loop.



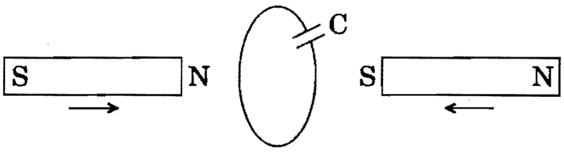
[2012]

Q69. 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 the figure.



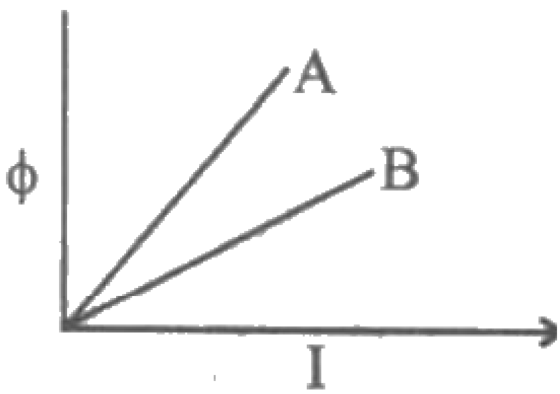
[2012]

Q70. Two bar magnets are quickly moved towards a metallic loop connected across a capacitor C as shown in the figure. Predict the polarity of the capacitor.



[2011]

Q71. A plot of magnetic flux (ϕ) versus current (I) is shown in the figure for two inductors A and B. Which of the two has larger value of self inductance?



[2010]

Q72. When current in a coil changes with time, how is the back emf induced in the coil related to it?

[2008]

Q73. Write S.I. unit of magnetic flux. Is it a scalar or a vector quantity?

[2003]

2-Mark Questions (21 questions · Section B · VSA)

Q1. A plane circular coil is rotated about its vertical diameter with a constant angular speed ω in a uniform horizontal magnetic field. Initially the plane of the coil is parallel to the magnetic field. Draw plots showing the variation of the following physical quantities as the function of ωt, where t represents time elapsed:

(a) Magnetic flux ϕ linked with the coil, and

(b) emf induced in the coil.

[2026 • Set 55-5-1]

Q2. A square loop of side $10\,\text{cm}$, free to rotate about a vertical axis coinciding with its one arm, is initially held perpendicular to a uniform horizontal magnetic field of $0.2\,\text{T}$. If it is rotated at the uniform speed of $60\,\text{rpm}$, find the emf induced in the loop.

[2026 • Set 55-5-2]

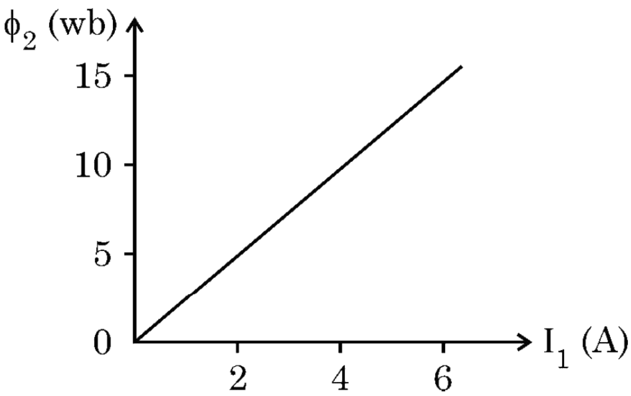
Q3. A light copper ring is freely suspended by a light string. A bar magnet is held horizontally with its length along the axis of the ring. The magnet is moved towards the ring with its N pole facing the loop. What will happen to the ring and its position? Explain.

[2026 • Set 55-5-3]

Q4. Two coils C_1 and C_2 are placed close to each other. The magnetic flux ϕ_2 linked with the coil C_2 varies with the current I_1 flowing in coil C_1, as shown in the figure. Find

(i) the mutual inductance of the arrangement, and

(ii) the rate of change of current $\left(\frac{dI_1}{dt}\right)$ that will induce an emf of 100 V in coil C_2.



[2023 • Set 55-5-1]

Q5. Two identical circular discs, one of copper and another of aluminium, are rotated about their geometrical axes with same angular speed in the same magnetic field acting perpendicular to their planes. Compare the (i) induced emf, and (ii) induced current produced in discs between its centre and edge. Justify your answers.

[2021]

Q6. Two coplanar and concentric coils 1 and 2 have respectively the number of turns N_1 and N_2 and radii r_1 and r_2 $(r_2 \gg r_1)$. Deduce the expression for mutual inductance of this system.

[2020 • Set 55-3-1]

Q7. The energy stored in a solenoid of inductance L is U. The number of turns per unit length of the solenoid is doubled. Keeping the current and all other factors same, find (a) change in inductance of the solenoid, and (b) the final energy stored in the inductor.

[2020 • Set 55-3-2]

Q8. (a) Define the SI unit of self-inductance.

(b) The self-inductance of a solenoid is L. If the number of turns per unit length in it is doubled and the area of cross-section is halved, find the new inductance of the solenoid.

[2020 • Set 55-3-3]

Q9. A 0.5 m long solenoid of 10 turns/cm has area of cross-section $1\,\text{cm}^2$. 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.

OR

A small flat search coil of area $5\,\text{cm}^2$ 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

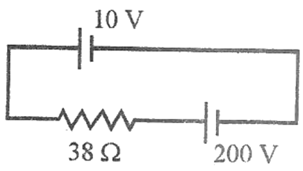
(b) emf induced in the coil.

[2019 • Set 55-3-1]

Q10. 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.

[2013]

Q11. Figure shows a bar magnet M falling under gravity through an air cored coil C. Plot a graph showing variation of induced e.m.f. (E) with time (t). What does the area enclosed by the E–t curve depict?



[2013]

Q12. Two identical loops, one of copper and the other of aluminium, are rotated with the same angular speed in the same magnetic field. Compare (i) the induced emf and (ii) the current produced in the two coils. Justify your answer.

[2012]

Q13. Define self-inductance of a coil. Show that magnetic energy required to build up the current I in a coil of self-inductance L is given by $\frac{1}{2}LI^2$.

[2012]

Q14. A metallic rod of 'L' length is rotated with angular frequency of 'ω' 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 the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field $\vec{B}$ parallel to the axis is present everywhere. Deduce the expression for the emf between the centre and the metallic ring.

[2012]

Q15. Derive the expression for the self inductance of a long solenoid of cross sectional area A and length l, having n turns per unit length.

[2012]

Q16. What are eddy currents? Write any two applications of eddy currents.

[2011]

Q17. A current is induced in coil C_1 due to the motion of current carrying coil C_2.

(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.

[2011 • Set 55-1-1]

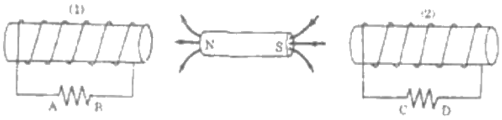
Q18. Current in a circuit falls steadily from 5.0 A to 0.0 A in 100 ms. If an average e.m.f. of 200 V is induced, calculate the self-inductance of the circuit.

[2011 • Set 55-2-1]

Q19. A jet plane is traveling west at $450\ ms^{-1}$. If the horizontal component of earth's magnetic field at that place is $4 \times 10^{-4}\ Tesla$ and the angle of dip is $30°$, find the emf induced between the ends of wings having a span of $30\ m$.

[2008]

Q20. In the figure given below, a bar magnet moving towards the right or left induces an e.m.f. in the coils (1) and (2). 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.



[2005]

Q21. Two circular coils, one of radius r and the other of radius R are placed coaxially with their centres coinciding. For $R \gg r$, obtain an expression for the mutual inductance of the arrangement.

[2004]

3-Mark Questions (51 questions · Section C · SA)

Q1. (i) Define mutual inductance of a pair of coils. Write its SI unit.

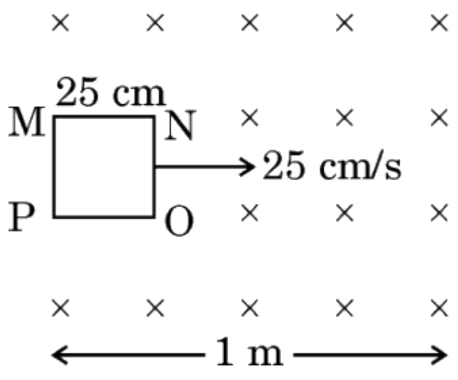
(ii) A long solenoid of radius R and length L has n turns per unit length. A circular loop of radius r $(< R)$ is placed inside at the centre of the solenoid such that its axis coincides with the axis of the solenoid. Obtain the mutual inductance of the solenoid and the loop.

[2026 • Set 55-2-1]

Q2. State Faraday's law of electromagnetic induction. Briefly describe two methods for producing induced emf.

[2026 • Set 55-3-3]

Q3. The figure given below shows a square-shaped loop MNOP of side 25 cm placed horizontally in a uniform magnetic field $\vec{B}$ directed vertically downward. The position of the loop at $t = 0$ s is as shown in figure. The loop is pulled with a constant velocity of 25 cm/s till it goes out of the field.

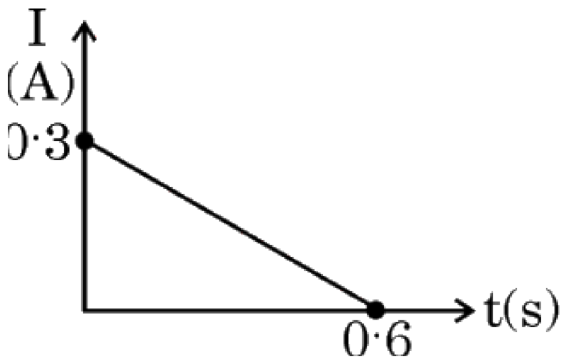


(a) What will be the direction of the induced current in the loop as it goes out of the field? For how long would the current in the loop persist?

(b) Plot graphs showing the variation of magnetic flux and magnitude of induced emf as a function of time.

[2026 • Set 55-4-1]

Q4. A conducting rectangular loop of area 5 cm^2 and resistance 4 Ω is removed from a region of uniform magnetic field, acting normal to the plane of the loop. The value of induced current I in the loop varies with time t, as shown in the figure.



Find:

(a) total charge that passed through the loop

(b) change in magnetic flux through the loop

(c) magnitude of magnetic field in the region

[2026 • Set 55-4-2]

Q5. Two coils, one of radius 0·5 cm having 10 turns and the other of radius 5 cm having 50 turns are placed coaxially in air such that their centres are coincident. Calculate:

(a) the magnetic flux through the smaller coil if the larger coil carries a current of 3 A, and

(b) the mutual inductance of the two coils.

[2026 • Set 55-4-3]

Q6. A long solenoid of length L and radius r_1, having N_1 turns is surrounded symmetrically by a coil of radius r_2 ($> r_1$) having N_2 turns ($N_2 \ll N_1$) around its mid-point. Derive an expression for the mutual inductance of solenoid and coil. Is $M_{12} = M_{21}$ valid in this case?

[2026 • Set 55-5-1]

Q7. (a) Show that the energy required to build up the current I in a coil of inductance L is $\frac{1}{2}LI^2$.

(b) Considering the case of magnetic field produced by air-filled current carrying solenoid, show that the magnetic energy density of a magnetic field B is $\frac{B^2}{2\mu_0}$.

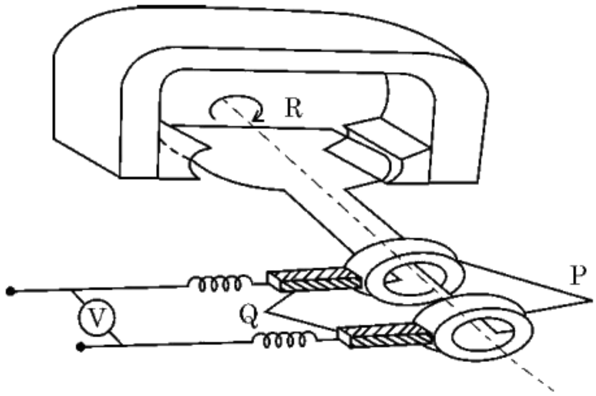
[2025 • Set 55-1-1]

Q8. Consider two long co-axial solenoids S_1 and S_2, each of length $l\,(\gg r_2)$ and of radius r_1 and $r_2\,(r_2 > r_1)$. The number of turns per unit length are n_1 and n_2 respectively. Derive an expression for mutual inductance M_{12} of solenoid S_1 with respect to solenoid S_2. Show that $M_{12} = M_{21}$.

[2025 • Set 55-1-2]

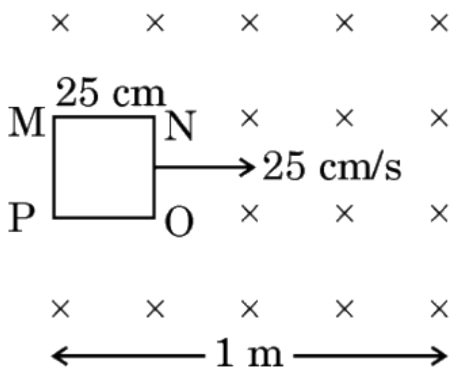
Q9. (a) State Lenz's law.

(b) In the given figure: (i) Identify the machine. (ii) Name the parts P and Q and R of the machine. (iii) Give the polarities of the magnetic poles. (iv) Write the two ways of increasing the output voltage.



[2025 • Set 55-2-1]

Q10. Two coils '1' and '2' are placed close to each other as shown in the figure. Find the direction of induced current in coil '1' in each of the following situations, justifying your answers :



(a) Coil '2' is moving towards coil '1'.

(b) Coil '2' is moving away from coil '1'.

(c) The resistance connected with coil '2' is increased keeping both the coils stationary.

[2025 • Set 55-4-1]

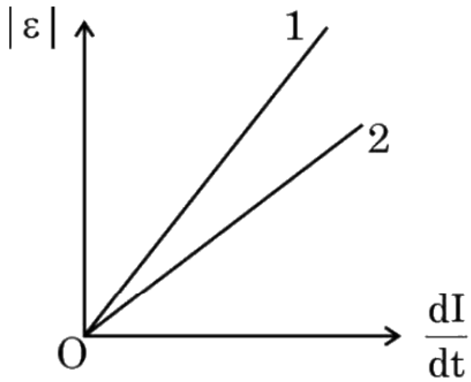
Q11. (a) Differentiate between magnetic flux through an area and magnetic field at a point.

(b) A bar magnet is held with its length along the axis of a closed coil. Initially the south pole of the magnet faces the coil. If the magnet is moved towards the coil, explain how a current is induced in the coil and in what direction.

[2025 • Set 55-4-2]

Q12. (a) Obtain an expression for the self-inductance of a long solenoid of length 'l', cross-sectional area 'A' and having 'N' turns.

(b) The figure shows the plot of magnitude of induced emf ($|\varepsilon|$) versus the rate of change of current in two coils '1' and '2'. Which coil has greater value of self-inductance and why ?



[2025 • Set 55-4-3]

Q13. (a) State Lenz's law. A rod MN of length L is rotated about an axis passing through its end M perpendicular to its length, with a constant angular velocity $\vec{\omega}$ in a uniform magnetic field $\vec{B}$ parallel to the axis. Obtain an expression for emf induced between its ends.

OR

(b) Define 'self-inductance' of a coil. Derive an expression for self-inductance of a long solenoid of cross-sectional area A and length l, having n turns per unit length.

[2025 • Set 55-6-1]

Q14. (a) State Faraday's law of electromagnetic induction and explain the role of negative sign in its expression.

(b) Explain, with an example, that Lenz's law is consistent with the law of conservation of energy.

[2025 • Set 55-7-1]

Q15. (a) Two concentric circular coils of radii r_1 and r_2 ($r_2 \gg r_1$) are placed coaxially with their centres coinciding. If a current I is passed through the outer coil, obtain the expression for mutual inductance of the arrangement.

(b) The current in a solenoid decreases steadily from 6 mA to 2 mA in 50 ms. If an average emf of 0.4 V is induced, find the self-inductance of the solenoid.

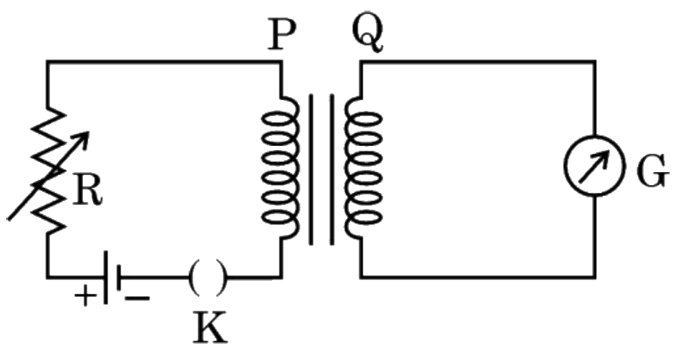
[2025 • Set 55-7-2]

Q16. Consider the arrangement of two coils P and Q shown in the figure. When current in coil P is switched on or switched off, a current flows in coil Q.

(a) Explain the phenomenon involved in it.

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

(c) Give the direction of current in coil Q when there is a current in the coil P and (i) R is increased, and (ii) R is decreased.



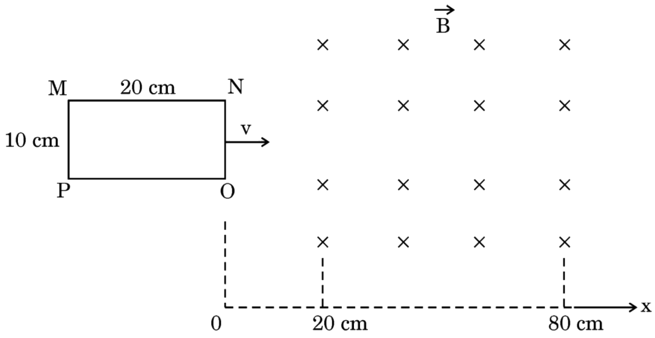
[2024 • Set 55-1-2]

Q17. A 100-turn coil of radius 1.6 cm and resistance $5.0\ \Omega$ is co-axial with a solenoid of 250 turns/cm and radius 1.8 cm. The solenoid current drops from 1.5 A to zero in 25 ms.

Calculate the current induced in the coil in this duration. (Take $\pi^2 = 10$)

[2024 • Set 55-2-1]

Q18. A rectangular loop of sides 10 cm × 20 cm is kept outside a region of uniform magnetic field $|\vec{B}| = 5\ mT$ as shown in the figure. The loop is moved with the velocity of 5 cm/s till it goes completely out of the magnetic field.



(a) Plot a graph showing variation of the magnetic flux ϕ with x $(0 < x < 100\ cm)$.

(b) Find the maximum value of magnetic flux linked with the loop.

(c) Will an external work be required to be done to move the loop through the magnetic field?

[2024 • Set 55-2-2]

Q19. Prove that induced charge depends on the net change in the magnetic flux and not on the time interval of the flux change.

[2024 • Set 55-3-3]

Q20. **(i)** Define mutual inductance. Write its SI unit.

(ii) Derive an expression for the mutual inductance of a system of two long coaxial solenoids of same length l, having turns N_1 and N_2 and of radii r_1, r_2 $(r_2 > r_1)$.

[2024 • Set 55-4-1]

Q21. **(i)** State Lenz's Law. In a closed circuit, the induced current opposes the change in magnetic flux that produced it as per the law of conservation of energy. Justify.

(ii) A metal rod of length 2 m is rotated with a frequency 60 rev/s about an axis passing through its centre and perpendicular to its length. A uniform magnetic field of 2 T perpendicular to its plane of rotation is switched-on in the region. Calculate the e.m.f. induced between the centre and the end of the rod.

[2024 • Set 55-5-1]

Q22. A long solenoid of radius r consists of n turns per unit length. A current $I = I_0 \sin \omega t$ flows in the solenoid. A coil of N turns is wound tightly around it near its centre. What is:

(a) the induced emf in the coil?

(b) the mutual inductance between the solenoid and the coil?

[2023 • Set 55-1-1]

Q23. What is meant by the term 'mutual inductance' of a pair of coils? Obtain an expression for the mutual inductance of two long coaxial solenoids, each of length l but having different number of turns N_1 and N_2 and radii r_1 and r_2 $(r_2 > r_1)$.

[2023 • Set 55-3-1]

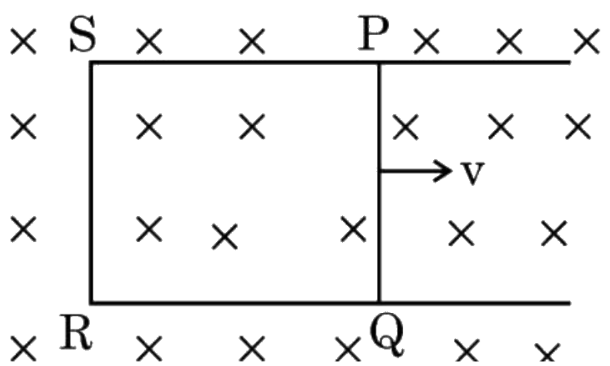
Q24. A rectangular loop of sides $25\,\text{cm}$ and $20\,\text{cm}$ is lying in x-y plane. It is subjected to a magnetic field $\vec{B} = (5t^2 + 2t + 10)\,\hat{k}$, where B is in tesla and t is in seconds. If the resistance of the loop is $4\,\Omega$, find the emf induced and the induced current in the loop at $t = 5\,\text{s}$.

[2023 • Set 55-3-2]

Q25. The figure shows a rectangular conductor $PQRS$ in which the arm PQ of length $10\,\text{cm}$ and resistance $0.4\,\Omega$ is free to move. It is kept in a uniform magnetic field $B = 0.2\,\text{T}$ acting perpendicular into the plane of $PQRS$. If arm PQ is moved with a velocity v of $5\,\text{cm/s}$ as shown, find:

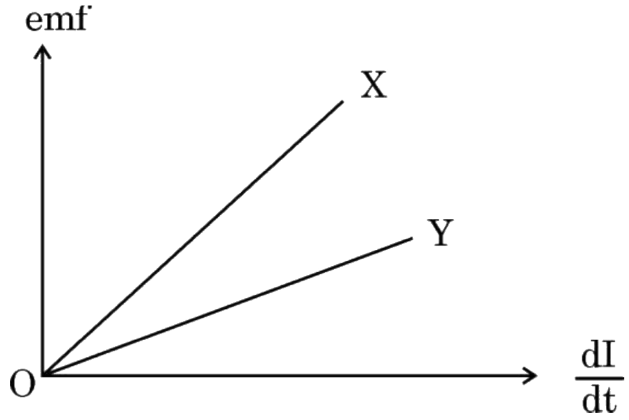
(a) the current induced in the loop, and

(b) the power required to move the arm. (Resistances of arms PS, SR and RQ are negligible.)



[2023 • Set 55-3-3]

Q26. (a) The figure shows the variation of induced emf as a function of rate of change of current for two identical solenoids X and Y. One is air cored and the other is iron cored. Which one of them is iron cored? Why?



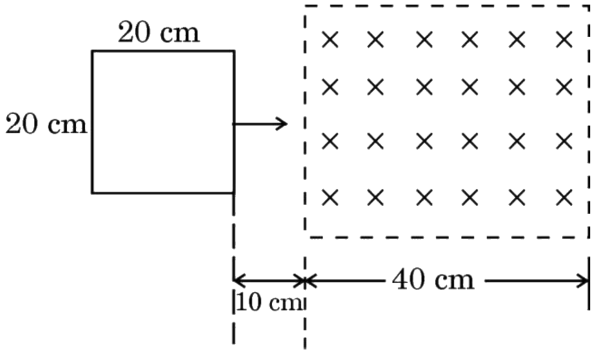
(b) Obtain an expression for self-inductance of a long solenoid of length L and cross-sectional area A having N turns.

[2023 • Set 55-4-1]

Q27. (a) Two coplanar concentric circular loops of radii R and r ($r \ll R$) are arranged coaxially. Obtain the expression for their mutual inductance.

OR

(b) A square loop of side 20 cm starts moving at $t = 0$ with a velocity of 5 cm/s towards a region of uniform magnetic field as shown in the figure. Specify the time interval(s) during which induced emf is produced in the loop.

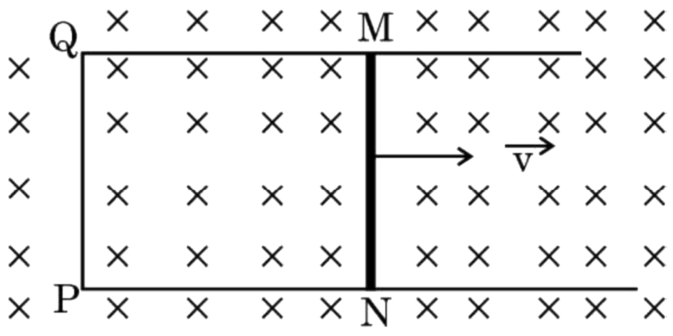


[2023 • Set 55-4-2]

Q28. A rectangular conductor MNPQ with a movable arm MN (resistance r) is kept in a uniform magnetic field as shown in the figure. Resistance of arms MQ, QP and PN are negligible. Obtain the expression for the:

(a) current induced in the loop specifying its direction, and

(b) power required to move the arm.



[2023 • Set 55-4-3]

Q29. State the basic principle behind the working of an ac generator. Briefly describe its working and obtain the expression for the instantaneous value of emf induced.

[2023 • Set 55-5-1]

Q30. Two concentric circular coils X and Y of radii r_1 and r_2 $(r_1 > r_2)$ having N_1 and N_2 turns respectively are placed coaxially with centres coinciding. Obtain an expression for (i) the mutual inductance for the arrangement, and (ii) the magnetic flux linked with coil Y when current I flows through coil X.

[2021]

Q31. What are eddy currents? Why does the pendulum plate with holes or slots reduce electromagnetic damping? How are the eddy currents minimised in the core of a transformer? Why is the electromagnetic braking effect smooth in a train?

[2021]

Q32. (a) Differentiate between self inductance and mutual inductance.

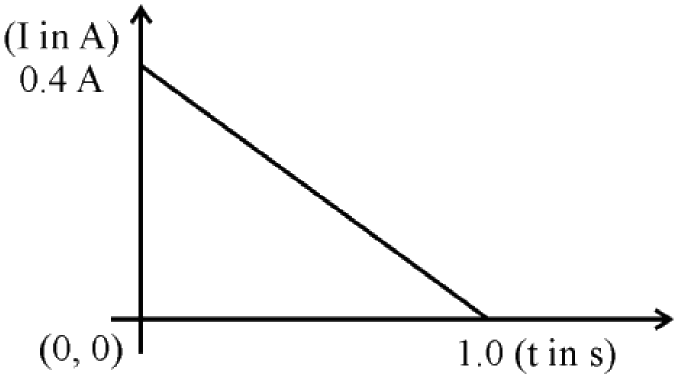
(b) The mutual inductance of two coaxial coils is 2 H. The current in one coil is changed uniformly from zero to 0.5 A in 100 ms. Find the: (i) change in magnetic flux through the other coil. (ii) emf induced in the other coil during the change.

[2020 • Set 55-4-1]

Q33. Draw the labelled diagram of an AC generator. Briefly explain its working and obtain the expression for the emf produced in the coil.

[2020 • Set 55-4-3]

Q34. When a conducting loop of resistance $10\,\Omega$ and area 10 cm^2 is removed from an external magnetic field acting normally, the variation of induced current in the loop with time is shown in the figure.



Find the

(i) total charge passed through the loop.

(ii) change in magnetic flux through the loop.

(iii) magnitude of the magnetic field applied.

[2020 • Set 55-5-1]

Q35. Define mutual inductance and write its S.I. unit.

[2019 • Set 55-1-1]

Q36. (a) How are eddy currents generated in a conductor which is subjected to a magnetic field?

(b) Write two examples of their useful applications.

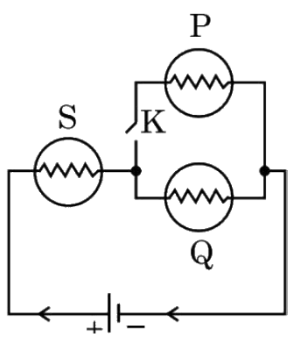
(c) How can the disadvantages of eddy currents be minimized?

[2019 • Set 55-3-1]

Q37. The figure shows a rectangular conducting frame MNOP of resistance R placed partly in a perpendicular magnetic field $\vec{B}$ and moved with velocity $\vec{v}$ as shown in the figure. 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.



[2019 • Set 55-4-1]

Q38. Define mutual inductance between a pair of coils. Derive an expression for the mutual inductance of two long coaxial solenoids of same length wound one over the other.

[2017]

Q39. Define self-inductance of a coil. Obtain the expression for the energy stored in an inductor L connected across a source of emf.

[2017]

Q40. Define mutual inductance between a pair of coils. Derive an expression for the mutual inductance of two long coaxial solenoids of same length wound one over the other.

OR

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

[2017]

Q41. State Lenz's law. Illustrate, by giving an example, how this law helps in predicting the direction of the current in a loop in the presence of a changing magnetic flux. In a given coil of self-inductance of 5 mH, current changes from 4 A to 1 A in 30 ms. Calculate the emf induced in the coil.

[2015]

Q42. (a) 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 the expression for the emf induced across the ends of the rod.

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

[2014]

Q43. A metallic rod of length 'l' is rotated with a frequency ν 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.

[2013]

Q44. (a) Define self inductance. Write its S.I. units.

(b) Derive an expression for self inductance of a long solenoid of length l, cross-sectional area A having N number of turns.

[2009]

Q45. (i) State Faraday's law of electromagnetic induction.

(ii) 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 $5 \times 10^{-4}\ T$ and the dip angle is $30°$?

[2009]

Q46. A metallic rod of length l is rotated at a constant angular speed ω, normal to a uniform magnetic field B. Derive an expression for the current induced in the rod, if the resistance of the rod is R.

[2008]

Q47. Explain with the help of a labelled diagram the underlying principle and working of a step-up transformer. Why cannot such a device be used to step up d.c. voltage?

[2007]

Q48. Draw a labelled diagram of an a.c. generator. Explain briefly its principle and working.

[2007]

Q49. How is the mutual inductance of a pair of coils affected when:

(i) separation between the coils is increased?

(ii) the number of turns of each coil is increased?

(iii) a thin iron sheet is placed between the two coils, other factors remaining the same? Explain your answer in each case.

[2006]

Q50. Explain, with the help of a diagram, the principle and working of an a.c. generator. Write the expression for the e.m.f. generated in the coil in terms of its speed of rotation.

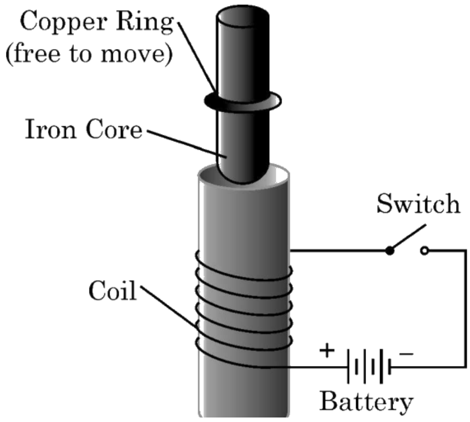
[2005]

Q51. A circular coil of N turns and radius R, is kept normal to a magnetic field, given by $B = B_0 \cos \omega t$. Deduce an expression for e.m.f. induced in this coil. State the rule which helps to detect the direction of induced current.

[2004]

4-Mark Questions (3 questions · Section D · Case Study)

Q1. Read the following paragraph and answer the questions. Consider the experimental set up shown in the figure. This jumping ring experiment is an outstanding demonstration of some simple laws of Physics. A conducting non-magnetic ring is placed over the vertical core of a solenoid. When current is passed through the solenoid, the ring is thrown off.



Answer the following questions:

(i) Explain the reason of jumping of the ring when the switch is closed in the circuit.

(ii) What will happen if the terminals of the battery are reversed and the switch is closed? Explain.

(iii) Explain the two laws that help us understand this phenomenon.

[2023 • Set 55-2-1]

Q2. Ram is a student of class X in a village school. His uncle gifted him a bicycle with a dynamo fitted in it. He was very excited to get it. While cycling during night, he could light the bulb and see the objects on the road. He, however, did not know how this device works. He asked this question to his teacher. The teacher considered it an opportunity to explain the working to the whole class. Answer the following questions:

(a) State the principle and working of a dynamo.

(b) Write two values each displayed by Ram and his school teacher.

[2016]

Q3. A group of students while coming from the school noticed a box marked "Danger H.T. 2200 V" at a substation in the main street. They did not understand the utility of such a high voltage, while they argued, the supply was only 220 V. They asked their teacher this question the next day. The teacher thought it to be an important question and therefore explained to the whole class. Answer the following questions:

(i) What device is used to bring the high voltage down to low voltage of a.c. current and what is the principle of its working?

(ii) Is it possible to use this device for bringing down the high dc voltage to the low voltage? Explain.

(iii) Write the values displayed by the students and the teacher.

[2015]

5-Mark Questions (29 questions · Section E · Long Answer)

Q1. (a) State Faraday's law of electromagnetic induction.

(b) Derive an expression for the self-inductance of an air-filled long solenoid of length l and cross-sectional area A having N turns.

(c) A conducting rod of length 50 cm, with one end pivoted, is rotated with angular speed of 60 rpm in a uniform magnetic field of 4.0 mT directed perpendicular to the plane of rotation of rod. Find the emf induced in the rod.

OR

(a) Draw a labelled diagram of a step-up transformer. State the principle on which it works and obtain the ratio of secondary voltage to primary voltage in terms of number of turns and currents in the two coils.

(b) The ratio of the number of turns in the primary to the secondary of an ideal transformer is $1 : 5$. If 5 kW power at 200 V is supplied to the primary, find (i) current in the primary, and (ii) output voltage.

[2026 • Set 55-1-1]

Q2. (a) (i) With the help of a labelled diagram, explain the principle, construction and working of an a.c. generator. (ii) Deduce an expression for the induced emf in the coil of the generator.

[2026 • Set 55-2-1]

Q3. (b) If T is the time period of the rotation of the coil, at what values of T in a cycle, the emf generated is maximum?

[2026 • Set 55-2-1]

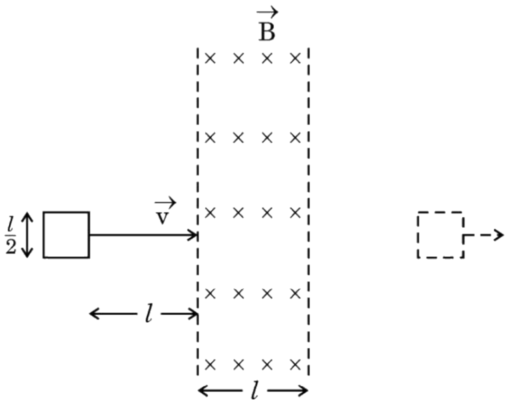
Q4. (i) State Lenz's law and explain that it follows the law of conservation of energy.

[2026 • Set 55-3-1]

Q5. (ii) Write the dimensional formula for self-inductance. The current in a coil changes from $8{\cdot}0$ A to $2{\cdot}0$ A in $0{\cdot}6$ s. If an average emf induced in the coil is 50 V, calculate the self-inductance of the coil.

[2026 • Set 55-3-1]

Q6. (a) (i) State Lenz's law and explain how this law is a consequence of conservation of energy principle. (ii) A square shaped loop of side ℓ is initially lying outside a region of uniform magnetic field $\vec{B}$ as shown in the figure. The loop is moved towards right with a constant velocity v till it goes out of the region of magnetic field.



(I) What will be the directions of induced current when the loop enters the field and when it leaves the field ? (II) Draw the plots showing the variation of magnetic flux ϕ linked with the loop with time t and variation of induced emf E with time t. Mark the relevant values of E, ϕ and t on the graphs.

OR

(b) (i) Differentiate between peak and rms values of alternating current. How are they related ? (ii) A current element X is connected across an ac source of emf $V = V_0 \sin 2\pi\nu t$. It is found that the voltage leads the current in phase by $\frac{\pi}{2}$ radian. If element X was replaced by element Y, the voltage lags behind the current in phase by $\frac{\pi}{2}$ radian. (I) Identify elements X and Y by drawing phasor diagrams. (II) Obtain the condition of resonance when both elements X and Y are connected in series to the source and obtain expression for resonant frequency. What is the impedance value in this case ?

[2025 • Set 55-4-1]

Q7. (a) (i) Define self-inductance of a coil. Derive the expression for the energy required to build up a current I in a coil of self-inductance L. (ii) The currents passing through two inductors of self-inductances 10 mH and 20 mH increase with time at the same rate. Draw graphs showing the variation of: (I) the magnitude of emf induced with the rate of change of current in each inductor. (II) the energy stored in each inductor with the current flowing through it.

OR

(b) (i) Define the term mutual inductance. Deduce the expression for the mutual inductance of two long coaxial solenoids of the same length having different radii and different number of turns. (ii) The current through an inductor is uniformly increased from zero to 2 A in 40 s. An emf of 5 mV is induced during this period. Find the flux linked with the inductor at $t = 10$ s.

[2025 • Set 55-5-1]

Q8. **(i)** A rectangular coil of N turns and area of cross-section A is rotated at a steady angular speed ω in a uniform magnetic field. Obtain an expression for the emf induced in the coil at any instant of time.

(ii) Two coplanar and concentric circular loops L_1 and L_2 are placed coaxially with their centres coinciding. The radii of L_1 and L_2 are 1 cm and 100 cm respectively. Calculate the mutual inductance of the loops. (Take $\pi^2 = 10$)

[2024 • Set 55-3-1]

Q9. **(i)** With the help of a diagram, briefly explain the construction and working of ac generator.

(ii) An electron is revolving around a proton in an orbit of radius r with a speed v. Obtain expression for magnetic moment associated with the electron.

[2024 • Set 55-4-1]

Q10. **(i)** Define coefficient of self-induction. Obtain an expression for self-inductance of a long solenoid of length l, area of cross-section A having N turns.

(ii) Calculate the self-inductance of a coil using the following data obtained when an AC source of frequency $\left(\frac{200}{\pi}\right)$ Hz and a DC source is applied across the coil. AC Source: V (V), I (A) = (3.0, 0.5), (6.0, 1.0), (9.0, 1.5). DC Source: V (V), I (A) = (4.0, 1.0), (6.0, 1.5), (8.0, 2.0).

[2023 • Set 55-2-1]

Q11. **(i)** With the help of a labelled diagram, describe the principle and working of an ac generator. Hence, obtain an expression for the instantaneous value of the emf generated.

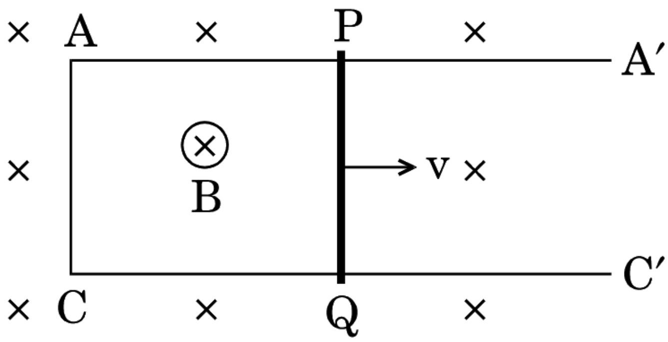
(ii) The coil of an ac generator consists of 100 turns of wire, each of area 0.5 m^2. The resistance of the wire is $100\ \Omega$. The coil is rotating in a magnetic field of 0.8 T perpendicular to its axis of rotation, at a constant angular speed of 60 radian per second. Calculate the maximum emf generated and power dissipated in the coil.

[2023 • Set 55-2-1]

Q12. A conducting rod PQ of length 20 cm and resistance $0{\cdot}1\,\Omega$ rests on two smooth parallel rails of negligible resistance AA' and CC'. It can slide on the rails and the arrangement is positioned between the poles of a permanent magnet producing uniform magnetic field $B = 0{\cdot}4$ T. The rails, the rod and the magnetic field are in three mutually perpendicular directions as shown in the figure. If the ends A and C of the rails are short circuited, find the

(i) external force required to move the rod with uniform velocity $v = 10$ cm/s, and

(ii) power required to do so.



[2020 • Set 55-1-1]

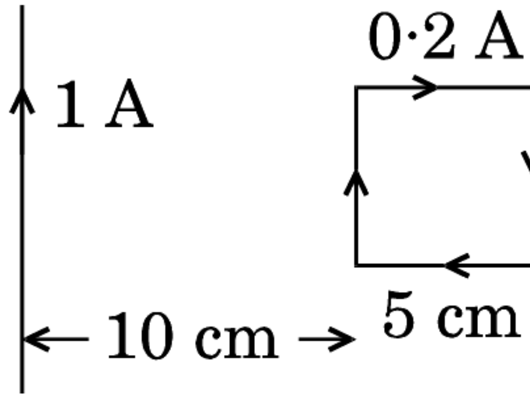
Q13. (a) Derive an expression for the induced emf developed when a coil of N turns, and area of cross-section A, is rotated at a constant angular speed ω in a uniform magnetic field B.

(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.

OR

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



[2019 • Set 55-2-1]

Q14. (a) A metallic rod of length 'l' and resistance 'R' is rotated with a frequency 'ν' 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 the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field 'B' parallel to the axis is present everywhere. (i) Derive the expression for the induced emf and the current in the rod. (ii) Due to the presence of current in the rod and of the magnetic field, find the expression for the magnitude and direction of the force acting on this rod. (iii) Hence, obtain an expression for the power required to rotate the rod.

(b) A copper coil is taken out of a magnetic field with a fixed velocity. Will it be easy to remove it from the same field if its ohmic resistance is increased?

OR

(a) A rectangular coil rotates in a uniform magnetic field. Obtain an expression for induced emf and current at any instant. Also find their peak values. Show the variation of induced emf versus angle of rotation (ωt) on a graph.

(b) An iron bar falling through the hollow region of a thick cylindrical shell made of copper experiences a retarding force. What can you conclude about the nature of the iron bar? Explain.

[2019 • Set 55-5-1]

Q15. (a) State the principle of an ac 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 'ω' 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 the Earth's magnetic field is 5×10^{-4} T and the angle of dip is $30°$.

[2018]

Q16. (a) Draw a labelled diagram of AC 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 3.0×10^{-2} T. Calculate the maximum value of the current in the coil.

OR

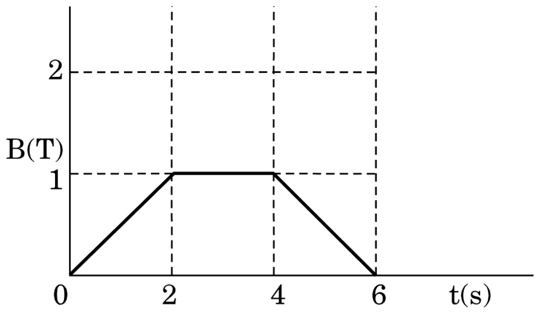
(a) Draw a labelled diagram of a step-up transformer. Obtain the ratio of secondary to primary voltage in terms of number of turns and currents in the two coils.

(b) A power transmission line feeds input power at 2200 V to a step-down transformer with its primary windings having 3000 turns. Find the number of turns in the secondary to get the power output at 220 V.

[2017]

Q17. (a) State Faraday's law of electromagnetic induction.

(b) The magnetic field through a circular loop of wire 12 cm in radius and $8{\cdot}5\ \Omega$ resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Calculate the induced current in the loop and plot it as a function of time.



(c) Show that Lenz's law is a consequence of conservation of energy.

OR

(a) Describe, with the help of a suitable diagram, the working principle of a step-up transformer. Obtain the relation between input and output voltages in terms of the number of turns of primary and secondary windings and the currents in the input and output circuits.

(b) Given the input current 15 A and the input voltage of 100 V for a step-up transformer having 90% efficiency, find the output power and the voltage in the secondary if the output current is 3 A.

[2017]

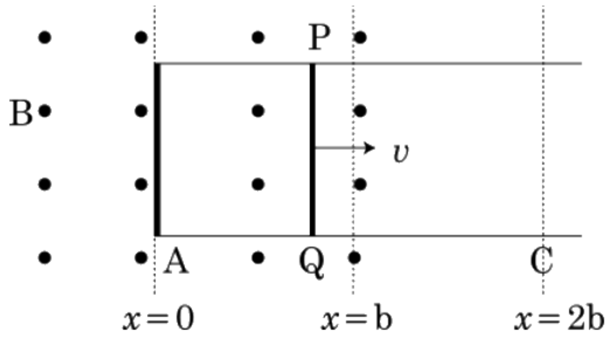
Q18. (a) Draw a labelled diagram of an ac generator. Obtain the expression for the emf induced in the rotating coil of N turns each of cross-sectional area A, in the presence of a magnetic field $\vec{B}$.

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

[2017]

Q19. (a) When a bar magnet is pushed towards (or away) from the coil connected to a galvanometer, the pointer in the galvanometer deflects. Identify the phenomenon causing this deflection and write the factors on which the amount and direction of the deflection depends. State the laws describing this phenomenon.

(b) 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 with speed v on a rectangular conductor placed in uniform magnetic field as shown in the figure.



[2016]

Q20. Draw a necessary arrangement for winding of primary and secondary coils in a step-up transformer. State its underlying principle and derive the relation between the primary and secondary voltages in terms of number of primary and secondary turns. Mention the two basic assumptions used in obtaining the above relation. State any two causes of energy loss in actual transformers.

[2015]

Q21. (a) Define mutual inductance and write its S.I. 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.

[2015]

Q22. (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.

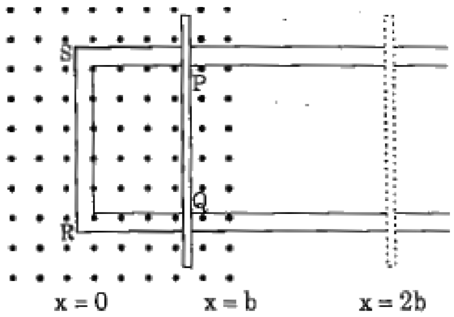
OR

(a) Draw a schematic sketch of an ac generator describing its basic elements. State briefly its working principle. Show a plot of variation of (i) Magnetic flux and (ii) Alternating emf versus time generated by a loop of wire rotating in a magnetic field.

(b) Why is choke coil needed in the use of fluorescent tubes with ac mains ?

[2014]

Q23. State Faraday's law of electromagnetic induction. Figure 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 $x > b$. 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 $0 \leq x \leq 2b$.



OR

Draw a schematic diagram of a step-up transformer. Explain its working principle. Deduce the expression for the secondary to primary voltage in terms of the number of turns in the two coils. In an ideal transformer, how is this ratio related to the currents in the two coils? How is the transformer used in large scale transmission and distribution of electrical energy over long distances?

[2012]

Q24. (a) State the principle on which AC generator works. Draw a labelled diagram and explain its working.

(b) A conducting rod held horizontally along East-West direction is dropped from rest from a certain height near the Earth's surface. Why should there be an induced emf across the ends of the rod? Draw a plot showing the instantaneous variation of emf as a function of time from the instant it begins to fall.

OR

(a) State the principle of a step-up transformer. Explain, with the help of a labelled diagram, its working.

(b) Describe briefly any two energy losses, giving the reasons for their occurrence in actual transformers.

[2012]

Q25. 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 e.m.f. generated in the coil. What is the source of energy generation in this device?

[2011]

Q26. (a) Derive the expression for the mutual inductance of two long coaxial solenoids of same length l having radii r_1 and r_2 ($r_2 > r_1$ and $l \gg r_2$).

(b) Show that mutual inductance of solenoid 1 due to solenoid 2, M_{12}, is the same as that of 2 due to 1 i.e. M_{21}.

(c) A power transmission line feeds power at 2200 V with a current of 5 A to a step down transformer with its primary winding having 4000 turns. Calculate the number of turns and the current in the secondary in order to get output power at 220 V.

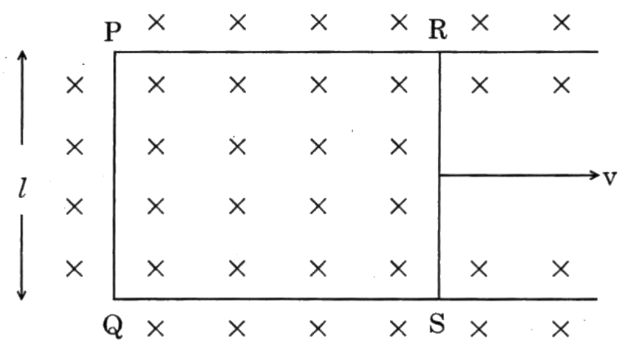
[2011 • Set 55-2-1]

Q27. 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.

[2010]

Q28. (a) What are eddy currents? Write their two applications.

(b) Figure shows a rectangular conducting loop $PQSR$ in which arm RS of length l is movable. The loop is kept in a uniform magnetic field B directed downward perpendicular to the plane of the loop. The arm RS is moved with a uniform speed v.



Deduce an expression for (i) the emf induced across the arm RS, (ii) the external force required to move the arm, and (iii) the power dissipated as heat.

[2009]

Q29. (a) State Lenz's law. Give one example to illustrate this law. "The Lenz's law is a consequence of the principle of conservation of energy." Justify this statement.

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

[2009]