SECTION – A
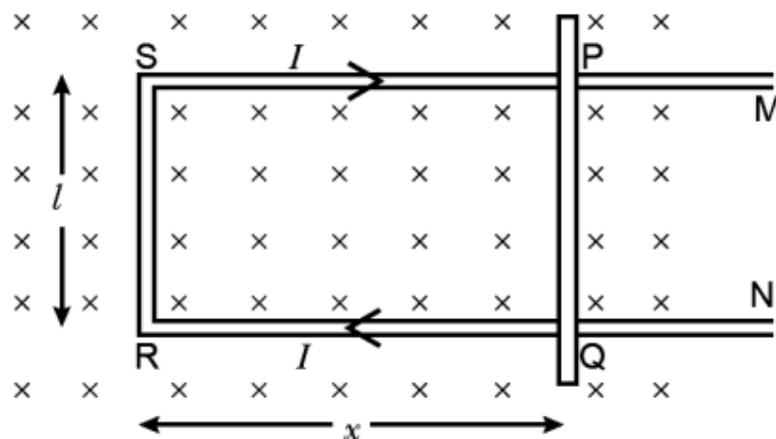### Questions 1 to 10 carry 1 mark each.

1. 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 v does not depend on


(a) magnetic field $\vec{B}$ (b) velocity field $\vec{v}$ (c) resistance (r)   (d) length of PQ

2. A cylindrical bar magnet is rotated about its axis (Figure). A wire is connected from the axis and is made to touch the cylindrical surface through a contact. Then
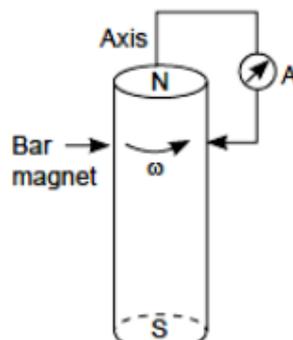
(a) a direct current flows in the ammeter A.

(b) no current flows through the ammeter A.(c) an alternating sinusoidal current flows through the ammeter A with a time period $T = \dfrac{2\pi}{\omega}$.

(d) a time varying non-sinosoidal current flows through the ammeter A.

CD SIR (Chandra Dev Singh)
Founder , Mentor , Subject Expert
& Career Counsellor at CBSE ACADEMY PLUS

SURYADEV SINGH (SURYA BHAIYA)
Data Scientist, IIT Guwahati | M.Sc (IIT Delhi)
Director & Educator at CBSE Academy Plus

3. There are two coils A and B as shown in Figure. A current starts flowing in B as shown, when A is moved towards B and stops when A stops moving. The current in A is counterclockwise. B is kept stationary when A moves. We can infer that
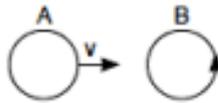
(a) there is a constant current in the clockwise direction in A.
(b) there is a varying current in A.
(c) there is no current in A.
(d) there is a constant current in the counterclockwise direction in A.

4. When current in a coil changes from 5 A to 2 A in 0.1 s, average voltage of 50 V is produced. The selfinductance of the coil is
   (a) 1.67 H   (b) 6 H   (c) 3 H   (d) 0.67 H

5. A coil of 100 turns carries a current of 5 mA and creates a magnetic flux of 10^{-5} weber. The inductance is
   (a) 0.2 mH   (b) 2.0 mH   (c) 0.02 mH   (d) 0.002 H

6. The current flows from A to B is as shown in the figure. The direction of the induced current in the loop is

   (a) clockwise.   (b) anticlockwise.   (c) straight line.   (d) no induced e.m.f. produced.

7. The self-inductance L of a solenoid of length l and area of cross-section A, with a fixed number of turns N increases as
   (a) *l* and A increase.   (b) *l* decreases and A increases.
   (c) *l* increases and A decreases.   (d) both l and A decrease.

8. In a coil of resistance 10 π, the induced current developed by changing magnitude of change in flux through the coil is weber is
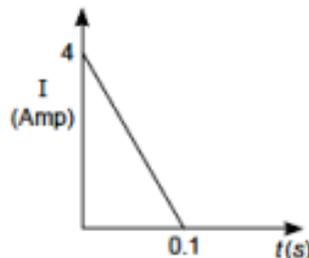
   (a) 8   (b) 2   (c) 6   (d) 4

In the following questions 9 and 10, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:
(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 but reason (R) is true.

9. **Assertion (A):** In the given figure the induced emf across the ends of the rod is zero.
   Reason (R): Motional emf is given by e = Bvl sin θ

10. **Assertion (A):** Mutual induction is the phenomenon in which the emf is induced in the coil due to change in magnetic flux it.
   **Reason (R):** It follows law of conservation of energy.

**CD SIR (Chandra Dev Singh)**
Founder , Mentor , Subject Expert
& Career Counsellor at CBSE ACADEMY PLUS

SURYADEV SINGH (SURYA BHAIYA)
Data Scientist, IIT Guwahati | M.Sc (IIT Delhi)
Director & Educator at CBSE Academy Plus

SECTION – B
### Questions 11 to 14 carry 2 marks each.

11. The given figure shows an inductor L and resistor R connected in parallel to a battery B through a switch S. The resistance of R is the same as that of the coil that makes L. Two identical bulbs, P and Q are put in each arm of the circuit as shown in the figure. When S is closed, which of the two bulbs will light up earlier? Justify your answer.
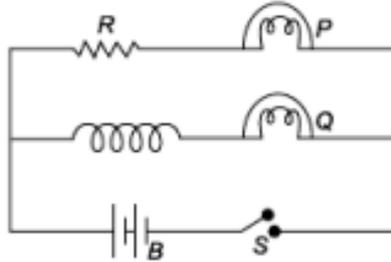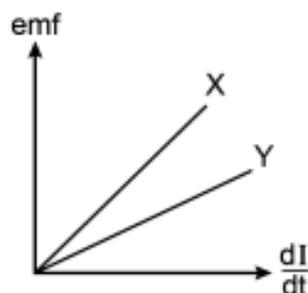

12. A bar magnet M is dropped so that it falls vertically through the coil C. The graph obtained for voltage produced across the coil vs time is shown in figure (b).
(i) Explain the shape of the graph.
(ii) Why is the negative peak longer than the positive peak?
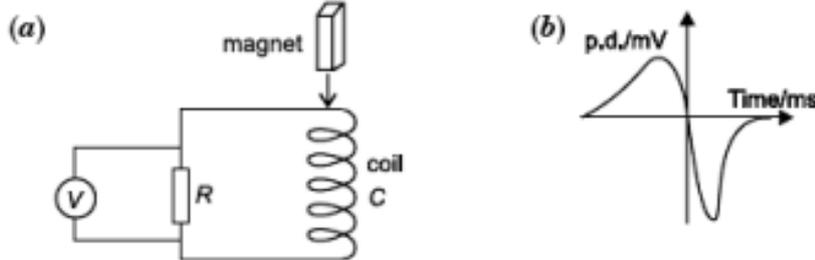
13. A square loop MNOP of side 20 cm is placed horizontally in a uniform magnetic field acting vertically downwards as shown in the figure. The loop is pulled with a constant velocity of 20 cms^{-1} till it goes out of the field.
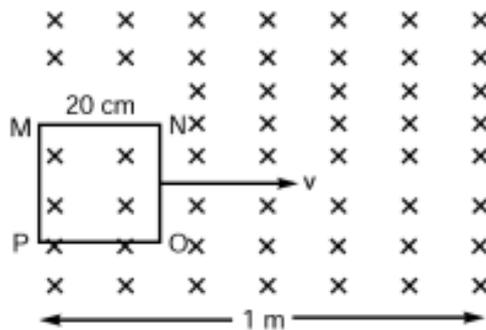
(i) Depict the direction of the induced current in the loop as it goes out of the field. For how long would the current in the loop persist?
(ii) Plot a graph showing the variation of magnetic flux and induced emf as a function of time.

14. 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?


CD SIR (Chandra Dev Singh)
Founder , Mentor , Subject Expert
& Career Counsellor at CBSE ACADEMY PLUS

SURYADEV SINGH (SURYA BHAIYA)
Data Scientist, IIT Guwahati | M.Sc (IIT Delhi)
Director & Educator at CBSE Academy Plus

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## SECTION – C
Questions 15 to 17 carry 3 marks each.

15. State Lenz's Law. Does it violate the principle of conservation of energy. Justify your answer.

16. A conducting rod, PQ, of length l, connected to a resistor R, is moved at a uniform speed, v, normal to a uniform magnetic field, B, as shown in the figure.
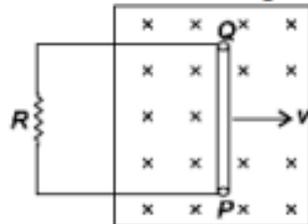

(i) Deduce the expression for the emf induced in the conductor.
(ii) Find the force required to move the rod in the magnetic field.
(iii) Mark the direction of induced current in the conductor.

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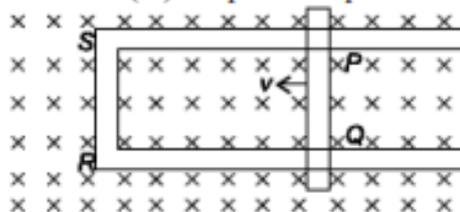
OR

State Faraday's laws for electromagnetic induction. Two concentric magnetic coils P and Q are placed mutually perpendicular as shown in figure. When current is changed in any one coil, will the current induce in another coil, will the current induce in another coil? Justify your answer.
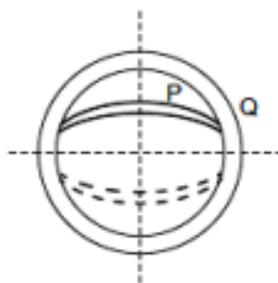
SECTION – D
Questions 18 carry 5 marks.

18. (a) Define mutual inductance and write its SI units.
(b) Derive an expression for the mutual inductance of two long co-axial solenoids of same length wound one over the other.
(c) In an experiment, two coils C_1 and C_2 are placed close to each other. Find out the expression for the emf induced in the coil C_1 due to a change in the current through the coil C_2.

OR

(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.

CD SIR (Chandra Dev Singh)
Founder , Mentor , Subject Expert
& Career Counsellor at CBSE ACADEMY PLUS

SURYADEV SINGH (SURYA BHAIYA)
Data Scientist, IIT Guwahati | M.Sc (IIT Delhi)
Director & Educator at CBSE Academy Plus

(ii) Calculate the self-inductance of a coil using the following data obtained when an AC source of frequency $\left(\dfrac{200}{\pi}\right)$ Hz and a DC source is applied across the coil.

AC Source		
S.No	V (Volts)	I (A)
1	3.0	0.5
2	6.0	1.0
3	9.0	1.5

DC Source		
S.No	V (Volts)	I (A)
1	4.0	1.0
2	6.0	1.5
3	8.0	2.0

SECTION – E (Case Study Based Questions)
Questions 19 to 20 carry 4 marks each.

19. **Electromagnetic Induction:**
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.
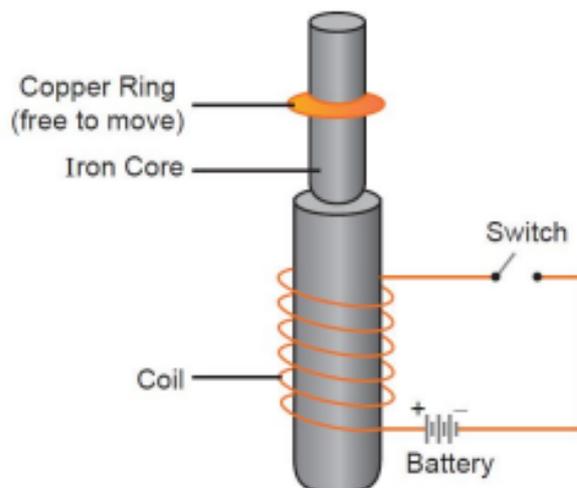
(i) The direction of induced current in the ring in jumping ring experiment is such that the polarity developed in the ring is same as that of the polarity on the face of the coil, then ring will jump up due to
(a) attractive force when the switch is closed in the circuit.
(b) repulsive force when the switch is closed in the circuit.
(c) attractive force when the switch is closed in the circuit.
(d) repulsive force 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?
(a) Ring will not be jump.
(b) Ring will jump again.
(c) Current will not induced in the ring.
(d) none of these

(iii) The jumping ring experiment based on which of the following law?
(a) Lenz's Law
(b) Faraday's law
(c) Snell's Law
(d) both (a) and (b)

(iv) Two identical circular loops A and B 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

CD SIR (Chandra Dev Singh)
Founder , Mentor , Subject Expert
& Career Counsellor at CBSE ACADEMY PLUS

SURYADEV SINGH (SURYA BHAIYA)
Data Scientist, IIT Guwahati | M.Sc (IIT Delhi)
Director & Educator at CBSE Academy Plus

(a) remains stationary.
(b) is attracted by loop A.
(c) is repelled by loop A.
(d) rotates about its centre of mass with centre of mass fixed.

OR

An emf of 200 V is induced in a circuit when current in the circuit falls from 5 A to 0 A in 0.1 second. The self-inductance of the circuit is

(a) 3.5 H   (b) 3.9 H   (c) 4 H   (d) 4.2 H

20. A solenoid is held in a vertical position. The solenoid is connected to a sensitive, centre-zero ammeter.
A vertical bar magnet is held stationary at position X just above the upper end of the solenoid as shown. The magnet is released and it falls through the solenoid. During the initial stage of the fall, the sensitive ammeter shows a small deflection to the left
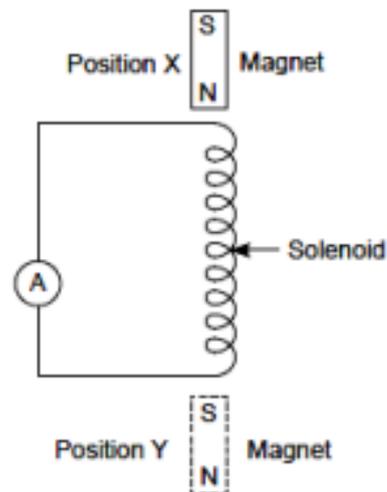
(i) Why does the ammeter show deflection?
(a) Due to induced current starts flowing in the solenoid
(b) Due to magnetic flux linked with the solenoid increases
(c) Due to magnetic flux linked with the solenoid becomes constant.
(d) Both (a) and (b).

(ii) Choose the correct graph for voltage produced across coil vs time
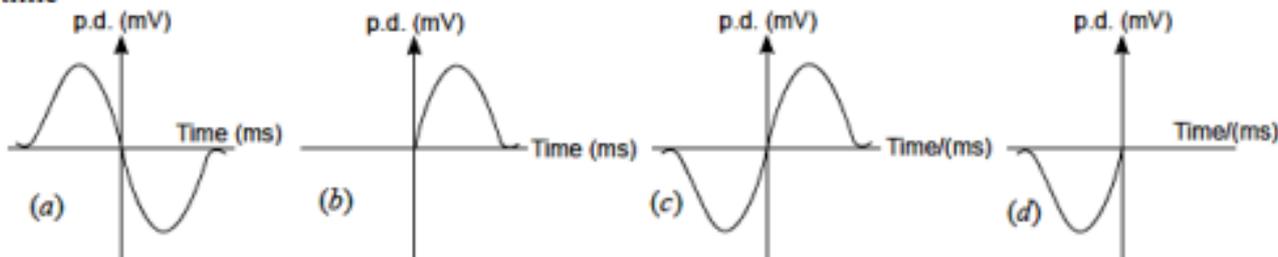
(iii) A magnet passes the middle point of the solenoid and continues to fall, it reaches position Y. What is observed on the ammeter as the magnet falls from middle point of the solenoid to position Y?
(a) Ammeter will show smaller deflection as change in magnetic flux is slower.
(b) Ammeter will show smaller deflection as change in magnetic flux is faster.
(c) Ammeter will show faster deflection as change in magnetic flux is slower.
(d) Ammeter will show faster deflection as the change in magnetic flux is faster.

(iv) Suggest the change in the apparatus that would increase the initial deflection of ammeter.
(a) By using stronger magnet
(b) By using solenoid of same length with more turns.
(c) By using solenoid wire of smaller resistance
(d) All of these

OR

(iv) Inductance plays the role of
(a) inertia   (b) friction   (c) source of emf   (d) force

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CD SIR (Chandra Dev Singh)
Founder , Mentor , Subject Expert
& Career Counsellor at CBSE ACADEMY PLUS

SURYADEV SINGH (SURYA BHAIYA)
Data Scientist, IIT Guwahati | M.Sc (IIT Delhi)
Director & Educator at CBSE Academy Plus