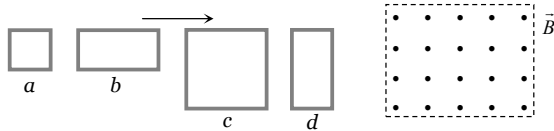
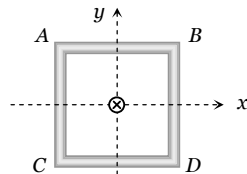


Electromagnetic Induction SET Self Evaluation Test - 23

1. The figure shows four wire loops, with edge lengths of either L or $2L$. All four loops will move through a region of uniform magnetic field \vec{B} (directed out of the page) at the same constant velocity. Rank the four loops according to the maximum magnitude of the e.m.f. induced as they move through the field, greatest first



- (a) $(e_c = e_d) < (e_a = e_b)$ (b) $(e_c = e_d) > (e_a = e_b)$
 (c) $e_c > e_d > e_b > e_a$ (d) $e_c < e_d < e_b < e_a$
2. A circular coil and a bar magnet placed near by are made to move in the same direction. The coil covers a distance of 1 m in 0.5 sec and the magnet a distance of 2 m in 1 sec . The induced emf produced in the coil
3. A square coil $ABCD$ lying in x - y plane with its centre at origin. A long straight wire passing through origin carries a current $i = 2t$ in negative z -direction. The induced current in the coil is



- (a) Zero
 (b) 1 V
 (c) 0.5 V
 (d) Cannot be determined from the given information
- (a) Clockwise
 (b) Anticlockwise
 (c) Alternating
 (d) Zero
4. A short magnet is allowed to fall along the axis of a horizontal metallic ring. Starting from rest, the distance fallen by the magnet in one second may be

- (a) 4 m (b) 5 m
 (c) 6 m (d) 7 m

5. The horizontal component of the earth's magnetic field at a place is $3 \times 10^{-4}\text{ T}$ and the dip is $\tan^{-1}\left(\frac{4}{3}\right)$. A metal rod of length 0.25 m placed in the north-south position and is moved at a constant speed of 10 cm/s towards the east. The emf induced in the rod will be

- (a) Zero (b) $1\text{ }\mu\text{V}$
 (c) $5\text{ }\mu\text{V}$ (d) $10\text{ }\mu\text{V}$

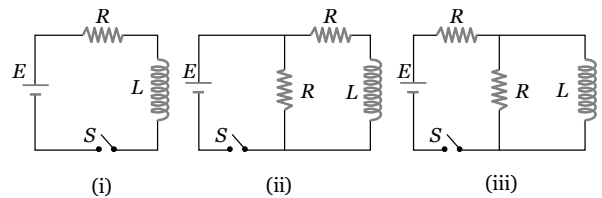
6. A copper disc of radius 0.1 m rotates about its centre with 10 revolutions per second in a uniform magnetic field of 0.1 Tesla . The emf induced across the radius of the disc is

- (a) $\frac{\pi}{10}\text{ V}$ (b) $\frac{2\pi}{10}\text{ V}$
 (c) $10\pi\text{ mV}$ (d) $20\pi\text{ mV}$

7. A coil of Cu wire (radius- r , self inductance- L) is bent in two concentric turns each having radius $\frac{r}{2}$. The self inductance now

- (a) $2L$ (b) L
 (c) $4L$ (d) $L/2$

8. In which of the following circuit is the current maximum just after the switch S is closed

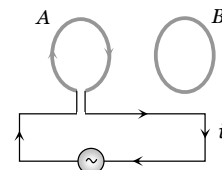


- (a) (i) (b) (ii)
 (c) (iii) (d) Both (ii) and (iii)

9. A small coil is introduced between the poles of an electromagnet so that its axis coincides with the magnetic field direction. The number of turns is n and the cross sectional area of the coil is A . When the coil turns through 180° about its diameter, the charge flowing through the coil is Q . The total resistance of the circuit is R . What is the magnitude of the magnetic induction

- (a) $\frac{QR}{nA}$ (b) $\frac{2QR}{nA}$
 (c) $\frac{Qn}{2RA}$ (d) $\frac{QR}{2nA}$

10. Two circular coils A and B are facing each other as shown in figure. The current i through A can be altered

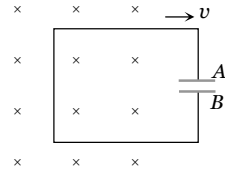


- (a) There will be repulsion between A and B if i is increased
 (b) There will be attraction between A and B if i is increased
 (c) There will be neither attraction nor repulsion when i is changed
 (d) Attraction or repulsion between A and B depends on the direction of current. It does not depend whether the current is increased or decreased

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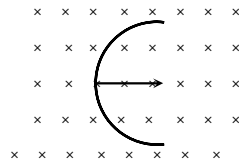
11. A conducting loop having a capacitor is moving outward from the magnetic field then which plate of the capacitor will be positive

- (a) Plate – A
 (b) Plate – B
 (c) Plate – A and Plate – B both
 (d) None



12. A straight wire of length L is bent into a semicircle. It is moved in a uniform magnetic field with speed v with diameter perpendicular to the field. The induced emf between the ends of the wire is

- (a) BLv
 (b) $2BLv$
 (c) $2\pi BLv$
 (d) $\frac{2BvL}{\pi}$



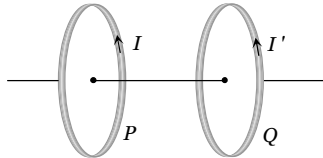
13. If in a coil rate of change of area is $\frac{5 \text{ metre}^2}{\text{millisecond}}$ and current become 1 amp from 2 amp in $2 \times 10^{-3} \text{ sec}$. If magnetic field is 1 Tesla then self inductance of the coil is

- (a) 2 H
 (b) 5 H
 (c) 20 H
 (d) 10 H

14. In series with 20 ohm resistor a 5 henry inductor is placed. To the combination an e.m.f. of 5 volt is applied. What will be the rate of increase of current at $t = 0.25 \text{ sec}$

- (a) e
 (b) e^{-2}
 (c) e^{-1}
 (d) None of these

15. Two coils P and Q are placed co-axially and carry current I and I' respectively



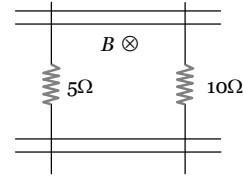
- (a) If $I' = 0$ and P moves towards Q, a current in the same direction as I is induced in Q
 (b) If $I = 0$ and Q moves towards P, a current opposite in direction to that of I' is induced in P
 (c) When $I \neq 0$ and $I' \neq 0$ are in the same direction, then two coil tend to move apart
 (d) None of these

16. The phase difference between the flux linkage and the induced e.m.f. in a rotating coil in a uniform magnetic field

- (a) π
 (b) $\pi/2$
 (c) $\pi/4$
 (d) $\pi/6$

17. A pair of parallel conducting rails lie at right angle to a uniform magnetic field of 2.0 T as shown in the fig. Two resistors 10 Ω and 5 Ω are to slide without friction along the rail. The distance between the conducting rails is 0.1 m. Then

- (a) Induced current = $\frac{1}{150} A$ directed clockwise if 10 Ω resistor is pulled to the right with speed 0.5 ms^{-1} and 5 Ω resistor is held fixed

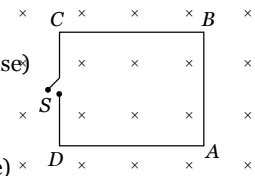


- (b) Induced current = $\frac{1}{300} A$ directed anti-clockwise if 10 Ω resistor is pulled to the right with speed 0.5 ms^{-1} and 5 Ω resistor is held fixed

- (c) Induced current = $\frac{1}{300} A$ directed clockwise if 5 Ω resistor is pulled to the left at 0.5 ms^{-1} and 10 Ω resistor is held at rest

- (d) Induced current = $\frac{1}{150} A$ directed anti-clockwise if 5 Ω resistor is pulled to the left at 0.5 ms^{-1} and 10 Ω resistor is held at rest

18. The magnetic field in the cylindrical region shown in figure increases at a constant rate of 20 mT/sec. Each side of the square loop ABCD has a length of 1 cm and resistance of 4 Ω . Find the current in the wire AB if the switch S is closed



- (a) $1.25 \times 10^{-7} A$, (anti-clockwise)
 (b) $1.25 \times 10^{-7} A$ (clockwise)
 (c) $2.5 \times 10^{-7} A$ (anti clockwise)
 (d) $2.5 \times 10^{-7} A$ (clockwise)

19. An aircraft with a wing-span of 40 m flies with a speed of 1080 km h⁻¹ in the eastward direction at a constant altitude in the northern hemisphere, where the vertical component of earth's magnetic field is $1.75 \times 10^{-5} T$. Then the emf that develops between the tips of the wings is

- (a) 0.5 V
 (b) 0.35 V
 (c) 0.21 V
 (d) 2.1 V

20. A hundred turns of insulated copper wire are wrapped around an iron cylinder of area $1 \times 10^{-3} \text{ m}^2$ and are connected to a resistor. The total resistance in the circuit is 10 ohms. If the longitudinal magnetic induction in the iron changes from 1 weber m⁻², in one direction to 1 Weber m⁻² in the opposite direction, how much charge flows through the circuit

- (a) $2 \times 10^{-2} C$
 (b) $2 \times 10^{-3} C$
 (c) $2 \times 10^{-4} C$
 (d) $2 \times 10^{-5} C$

Answers and Solutions

(SET -23)

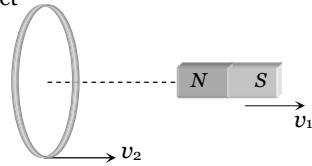
1. (b) Emf induces across the length of the wire which cuts the magnetic field. (Length of c = Length d) > (Length of a = b). So $(e_c = e_d) > (e_a = e_b)$

2. (a) Speed of the magnet

$$v_1 = \frac{2}{1} = 2 \text{ m/s}$$

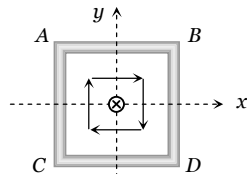
Speed of the coil

$$v_2 = \frac{1}{0.5} = 2 \text{ m/s}$$



Relative speed between coil and magnet is zero, so there is no induced emf in the coil.

3. (d) Magnetic lines are tangential to the coil as shown in figure. Thus net magnetic flux passing through the coil is always zero or the induced current will be zero.



4. (a) We know that in this case acceleration of falling magnet will be lesser than g . If ' g ' would have been acceleration, then distance covered = $\frac{1}{2}gt^2 = 5 \text{ m}$.

Now the distance covered will be less than 5 m . hence only option (a) is correct.

5. (d) Rod is moving towards east, so induced emf across its end will be $e = Bvl = (B_H \tan \phi)vl$

$$\therefore e = 3 \times 10^{-4} \times \frac{4}{3} \times (10 \times 10^{-2}) \times 0.25 = 10^{-5} \text{ V} = 10 \mu\text{V}$$

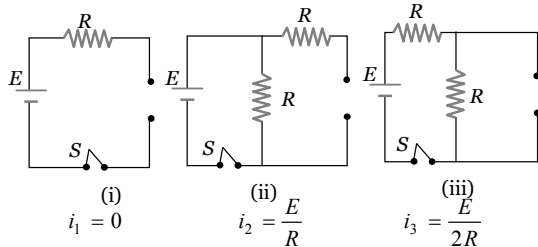
6. (c) The induced emf between centre and rim of the rotating disc is

$$E = \frac{1}{2} B \omega R^2 = \frac{1}{2} \times 0.1 \times 2\pi \times 10 \times (0.1)^2 = 10\pi \times 10^{-3} \text{ volt}$$

7. (a) $\therefore L \propto N^2 r$; $\frac{L_1}{L_2} = \left(\frac{N_1}{N_2}\right)^2 \times \frac{r_1}{r_2}$

$$\Rightarrow \frac{L}{L_2} = \left(\frac{1}{2}\right)^2 \times \left(\frac{r}{r/2}\right) = \frac{1}{2}; L_2 = 2L$$

8. (b) At $t = 0$ current through L is zero so it acts as open circuit. The given figures can be redrawn as follow.



Hence $i_2 > i_3 > i_1$.

9. (d) Induced charge $Q = -\frac{NBA}{R}(\cos \theta_2 - \cos \theta_1)$
 $= -\frac{NBA}{R}(\cos 180^\circ - \cos 0^\circ) \Rightarrow B = \frac{QR}{2NA}$

10. (a) With rise in current in coil A flux through B increases. According to Lenz's law repulsion occurs between A and B.

11. (a) Crosses (\times) linked with the loop are decreasing, so induced current in it is clockwise i.e. from B \rightarrow A. Hence electrons flow from plate A to B so plate A becomes positively charged.

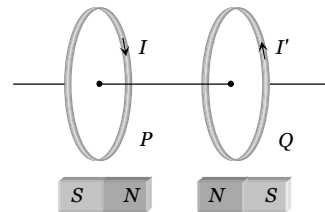
12. (d) Induced emf $e = Bvl \Rightarrow e = Bv(2R) = \frac{2BvL}{\pi}$

13. (d) $e = B \cdot \frac{dA}{dt} = L \frac{di}{dt} \Rightarrow 1 \times \frac{5}{10^{-3}} = L \times \frac{(2-1)}{2 \times 10^{-3}} \Rightarrow L = 10 \text{ H}$

14. (c) $i = i_0(1 - e^{-Rt/L}) \Rightarrow \frac{di}{dt} = i_0 \left(\frac{R}{L}\right) e^{-Rt/L} = \frac{E}{L} e^{-Rt/L}$

On putting values $\frac{di}{dt} = \frac{1}{e} = e^{-1}$.

15. (b)



16. (b) $\phi = BA \cos \theta$ where θ is the angle between area and field

$$e = \frac{-d\phi}{dt} = -BA \sin \theta \cdot \frac{d\theta}{dt} = BA \left(\frac{d\theta}{dt}\right) \cos(90 + \theta)$$

Here phase difference = 90° .

17. (d) When 5Ω resistor is pulled left at 0.5 m/sec induced emf, in the said resistor = $e = vBl = 0.5 \times 2 \times 0.1 = 0.1 \text{ V}$

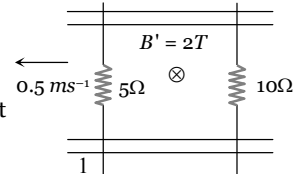
Resistor 10Ω is at rest so induced emf in it ($e = vBl$) be zero.

Now net emf, in the circuit = 0.1 V and equivalent resistance of the circuit

$$R = 15 \Omega$$

$$\text{Hence current } i = \frac{0.1}{15} \text{ amp} = \frac{1}{150} \text{ amp}$$

And its direction will be anti-clockwise (according to Lenz's law)



18. (a) $i = \frac{e}{R} = \frac{A}{R} \cdot \frac{dB}{dt} = \frac{(1 \times 10^{-2})^2}{16} \times 20 \times 10^{-3} = 1.25 \times 10^{-7} \text{ A}$ (Anti-clockwise).

19. (c) $L = 40 \text{ m}$, $v = 1080 \text{ km h}^{-1} = 300 \text{ m sec}^{-1}$ and $B = 1.75 \times 10^{-5} \text{ T} \Rightarrow e = Blv = 1.75 \times 10^{-5} \times 40 \times 300 = 0.21 \text{ V}$

- 20.

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21. (a) $dQ = \frac{d\phi}{R} = \frac{nA dB}{R} = \frac{100 \times 1 \times 10^{-3} \times 2}{10} = 2 \times 10^{-2} C$
