Saitechinfo NEET JEE Academy

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ELECTROMAGNETIC INDUCTION

Class 12 - Physics

Time Allowed: 1 hour and 30 minutes   **Maximum Marks: 45**

1. The polarity of induced emf is defined by **[1]**

    a) Biot-Savart's law

    b) Fleming's right hand rule

    c) Lenz's law

    d) Ampere's circuital law

2. Two inductors of inductance L each are connected in series with opposite magnetic fluxes. What is the resultant inductance? **[1]**

    a) L

    b) Zero

    c) 2 L

    d) 3 L
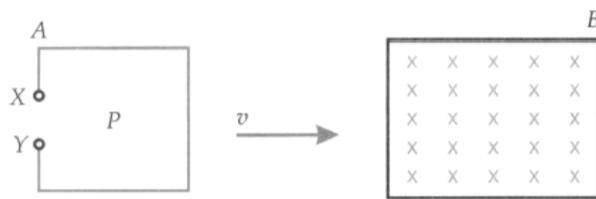
3. A loop, made of straight edges has six corners at A(0, 0, 0), B(L, 0, 0) C(L, L, 0), D(0, L, 0) E(0, L, L) and F(0, 0, L). A magnetic field $\mathbf{B} = B_o(\hat{\mathbf{i}} + \hat{\mathbf{k}})\text{T}$ is present in the region. The flux passing through the loop ABCDEFA (in that order) is **[1]**

    a) $4\ B_o L^2 \text{Wb}$

    b) $\sqrt{2}B_o L^2 \text{Wb}$

    c) $B_o L^2 \text{Wb}$

    d) $2\ B_o L^2 \text{Wb}$

4. If an inductor having inductance L is joined to another identical inductor with its one end joined, the resultant inductance would become **[1]**

    a) 2 L

    b) $\frac{L}{2}$

    c) zero

    d) $\frac{L}{4}$

5. The working of a dynamo is based on the principle of **[1]**

    a) Electromagnetic induction

    b) Heating effect of current

    c) Magnetic effect of current

    d) Chemical effect of current

6. A conducting circular loop is placed in a uniform magnetic field, B = 0.025 T with its plane perpendicular to the loop. The radius of the loop is made to shrink at a constant rate of 1 mm s^{-1}. The induced emf when the radius is 2 cm, is **[1]**

    a) $\frac{\pi}{2}\mu\text{V}$

    b) $2\pi\mu V$

    c) $\pi\mu\text{V}$

    d) $2\mu\text{V}$

7. Whenever a magnet is moved either towards or away from a conducting coil, an e.m.f is induced, the magnitude of which is independent of **[1]**

    a) the resistance of the coil

    b) the speed with which, the magnet is moved

    c) the number of turns in the coil

    d) the strength of the magnetic field

8. The SI unit of magnetic flux is: **[1]**

   a) Gauss   b) Weber

   c) Oersted   d) Tesla

9. A thin circular ring of area A is held perpendicular to a uniform magnetic field of induction B. A small cut is made in the ring and a galvanometer is connected across its ends in such a way that the total resistance of the circuit is R. When the ring is suddenly squeezed to zero area, the charge flowing through the galvanometer is **[1]**

   a) $\frac{B^2 A}{R^2}$ b) $\frac{BR}{A}$

   c) ABR   d) $\frac{AB}{R}$

10. A horizontal ring of radius r spins about it's axis with an angular velocity ω in a uniform magnetic field of magnitude B. Emf induced in the ring is **[1]**

    a) $\pi r^3 \omega B$ b) Zero

    c) $r^2 \omega B$ d) $\pi r^2 \omega B$

11. Write Faraday's law of electromagnetic induction. Express it mathematically. A conducting rod of length l, with one end pivoted, is rotated with a uniform angular speed of ω in a vertical plane, normal to a uniform magnetic field B. Deduce an expression for the emf induced in this rod. **[3]**

12. What is electromagnetic induction? Give an experiment that demonstrates this phenomenon. **[3]**

13. 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. **[3]**

14. A conducting rod XY slides freely on two parallel rails, A and B, with a uniform velocity 'v'. A galvanometer 'G' is connected, as shown in the figure and the closed circuit has a total resistance 'R'. A uniform magnetic field, perpendicular to the plane defined by the rails A and B and the rod XY (which are mutually perpendicular), is present over the region, as shown. **[3]**

   i. With key K open:

      a. Find the nature of charges developed at the ends of the rod XY.

      b. Why do the electrons, in rod XY, (finally) experience no net force even though the magnetic force is acting on them due to the motion of the rod?

   ii. How much power needs to be delivered, (by an external agency), to keep the rod moving at its uniform speed when key K is (a) closed (b) open?

   iii. With key K closed, how much power gets dissipated as heat in circuit 1 State the source of this power

15. A rectangular coil P is moved from a point A to another point B with uniform velocity 'v' through a region of a uniform magnetic field acting normally inwards as shown in the figure. Show graphically (i) the variation of magnetic flux associated with the coil with time, (ii) the variation of induced emf across points X and Y of the coil with time. **[3]**

Explain the nature of variation in magnetic flux as represented by the graph in the first case.

16. i. 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. **[5]**

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

    a. magnetic flux versus the current.

    b. induced emf versus $\frac{dI}{dt}$

    c. magnetic potential energy stored versus the current.

17. 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. **[5]**

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 $\pi^2 = 10$)

18. Define the self-inductance of a coil. Obtain an expression for self-inductance of a long solenoid of cross-sectional area A, length L having n turns for unit length. Prove that self-inductance is the analog of mass in mechanics. **[5]**

19. I. i. What is meant by current sensitivity of a galvanometer ? Mention the factors on which it depends. **[5]**

ii. A galvanometer of resistance G is converted into a voltmeter of range $(0 - V)$ by using a resistance R. Find the resistance, in terms of R and G , required to convert it into a voltmeter of range $\left(0 - \frac{V}{2}\right)$.

II. The magnetic flux through a coil of resistance 5Ω increases with time as:

$\phi = \left(2.0t^3 + 5.0t^2 + 6.0t\right) mWb$

Find the magnitude of induced current through the coil at $t = 2\ s$.