INDIAN SCHOOL MUSCAT

CLASS : XII

SUBJECT: PHYSICS

WORKSHEET-6

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CHAPTER 6. ELECTROMAGNETIC INDUCTION

SECTION A CONCEPTUAL AND APPLICATION TYPE QUESTIONS

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

2 A conducting coil is moved relative to a magnetic field .Will there be induced emf and induced current always? Justify

3 Two identical bar magnets are dropped from the same height simultaneously, one falls through a copper tube and the other falls through air, will they reach ground at the same time? Justify.

4 The south pole of a magnet is brought near a conducting loop. What is the direction of induced current as observed by a person on the other side of the loop?

5 How does the self inductance of an air core coil change, when i) the number of turns in the coil is decreased? ii) an iron rod is introduced in the coil?

6 A bismuth rod is introduced in a solenoid carrying current, how do i) its self inductance ii) emf induced in the solenoid change?

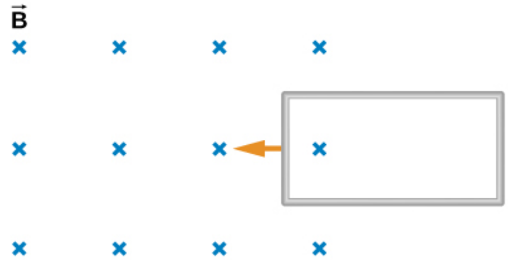
7 A copper coil L wound on a soft iron core and a lamp B is connected to a battery E through a tap key K. When the key is closed, the lamp glows dimly .But when the key is suddenly opened , the lamp flashes for an instant to much greater brightness . Explain.

8 In any ac circuit is the applied instantaneous voltage equal to the algebraic sum of the instantaneous voltages across the series elements of the circuit?

9 A conducting loop of area A and resistance R is placed perpendicular to the magnetic field B. The loop is withdrawn completely from the field. Derive an expression for induced charge that flows through any cross section of the wire

10 The south pole of a magnet is brought near a conducting loop. What is the direction of induced current as observed by a person on the other side of the loop?

11 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.



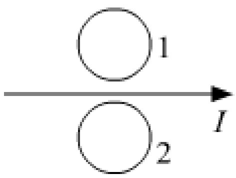
Obtain the expressions for the

(i) Force acting on the arm ON and its direction, and

(ii) Power required to move the frame to get a steady emf induced between the arms MN and PO.

12 A coil of number of turns N, area A, is rotated at a constant angular speed w, in a uniform magnetic field B, and connected to a resistor R. Deduce expressions for: (i) Maximum emf induced in the coil (ii) Power dissipation in the coil.

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



14 (i) Define mutual inductance and write its SI unit.

(ii) A square loop pf side ‘a’ carrying current I_2 is kept at distance ‘x’ from an infinitely long straight wire carrying a current I_1 as shown in the figure. Obtain the expression for the resultant force acting on the loop.

15 (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

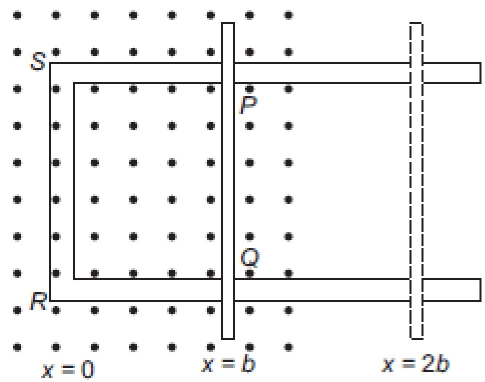
(i) Magnetic flux versus the current

(ii) Induced emf versus dI/dt

(iii)Magnetic potential energy stored versus the current.

16 State Faraday’s law of electromagnetic induction.
Figure shows a rectangular conductor PORS 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 with constant speed v, as in the expressions for the flux and the induced emf. Sketch the variations of these quantities with distance $0 \le x \le 2b$.



17 (a) State Lenz's law. Give one example to illustrate this law. The Lenz's is a consequence of the principle of conservation of energy. 'Justify this statement.
(b) Deduce an expression for the inductance of two long coaxial solenoids but having different radii and different number of turns.

SECTION B NUMERICAL PROBLEMS

1 A jet plane is travelling west at 450 ms^{-1}. If the horizontal component of earth's magnetic field at that place is 4 X 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.

2 A train is running due north on metre gauge at a speed of 36km/h. What will be the emf generated between the rails, if the vertical component of the earth's magnetic field at that place is 4 x 10^{-5} T?

3 A coil having an area of cross section 0.05 m2 and number of turns 100 is placed at right angles to a magnetic field of strength 0.08 T. How much emf will be induced in it, if the field is reduced to 0.04 T in 0.01s?

4 Magnetic flux in closed circuit varies with time t according to the equation $\varphi = (6t^2+5t+1)$ Wb. If the resistance of the circuit is 10Ω, what is the magnitude of induced current at t= 5s ?

5 A circular coil of radius 10 cm, 500 turns and resistance 2Ω is placed with its plane perpendicular to the horizontal component of the earth's magnetic field. It is rotated about its vertical diameter through 180° in 0.25 s. Estimate the magnitudes of the emf and current induced in the coil. Horizontal component of the earth's magnetic field at the place is 3.0×10^{-5} T.

6 A wheel with 10 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 earth's magnetic field H_E at a place. If H_E = 0.4 G at the place, what is the induced emf between the axle and the rim of the wheel? Note that 1 G = 10^{-4} T.

7 A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5.0 m s^{-1}, at right angles to the horizontal component of the earth's magnetic field, 0.30×10^{-4} Wb m^{-2}.
(a) What is the instantaneous value of the emf induced in the wire?
(b) What is the direction of the emf?

(c) Which end of the wire is at the higher electrical potential?

8 Draw a schematic diagram of an ac generator. Explain its working and obtain the expression for the instantaneous value of the emf in terms of the magnetic field B, number of turns N of the coil of area A rotating with angular frequency ω. Show how an alternating emf is generated by a loop of wire rotating in a magnetic field.

A circular coil of radius 10cm and 20 turns is rotated about its vertical diameter with angular speed of 50rad/s in a uniform horizontal magnetic field of 3.0×10^{-2}T.

(i) Calculate the maximum and average emf induced in the coil.

(ii) If the coil forms a closed loop of resistance 10Ω, calculate the maximum current in the coil and the average power loss due to Joule heating.