SHORT QUESTIONS.

Q 15.1: Does the induced emf in a circuit depend on the resistance of the circuit? Does the induced current depend on the resistance of the circuit?

Ans. The emf induced in a coil depends upon the rate of change of magnetic flux through the coil $\left(\mathcal{E} = -N\frac{\Delta\phi}{\Delta t}\right)$. Hence its value does not depend upon the resistance of the coil. But the induced current flowing through a coil is equal to $I = \frac{\mathcal{E}}{R}$ and its value depends upon the resistance "R" of the coil. If resistance increases, current will decrease because the product of "I" and "R" is always constant i.e; $I \times R$ = constant.

Q15.2: A square loop of wire is moving through a uniform magnetic field. The normal to the loop is oriented parallel to the magnetic field. Is a emf induced in the loop? Give a reason for your answer.

Ans. Induced emf will not be produced because there is no change in magnetic flux linking the loop i.e; $\frac{\Delta\phi}{\Delta t} = 0$. So according to the relation

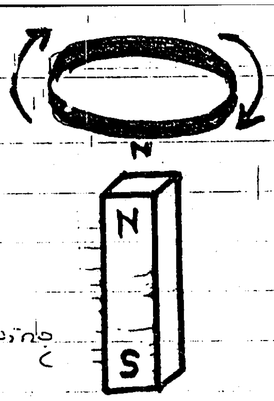
$$\mathcal{E} = -N \times \frac{\Delta\phi}{\Delta t} = -N \times 0 = 0$$

If the square loop is being rotated in the magnetic field in such a way that the loop is cutting the magnetic field lines due to its motion, then an emf will produced in the coil.

Q 15.3. A light metallic ring is released from above into a vertical bar magnet. Viewed from above, does the current flow clockwise or anticlockwise in the ring?

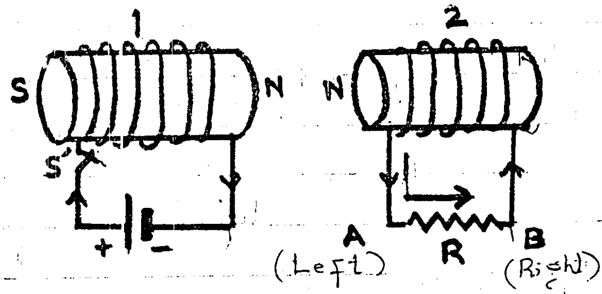
Ans. According to Faraday Law, an induced emf and hence an induced current will be produced

(P.T.O)



in the metallic ring. Lenz's law shows that the induced current in ring should flow in the ring in such a way so as to oppose the cause producing it. The induced current flowing through the ring should produce a magnetic field that will oppose the motion to the loop toward the bar. So, the side of ring facing magnet must be north pole of the induced magnetic field. Right hand rule shows that this magnetic field will be produced only if induced current flows through the ring is clockwise direction

Q 15.4: What is the direction of the current through resistor 'R' as shown? As switch 'S' is (a) closed (b) opened.



Ans (a) When switch is closed, the current in the circuit increases from zero to max. steady value; during this interval magnetic flux in the second coil increases from zero to max. and an induced current is produced in it. The side of current carrying coil facing the other coil becomes north pole, so to oppose N-pole, the current in the other coil must flow anticlockwise. Hence current in 'R' flows from left to right as shown.

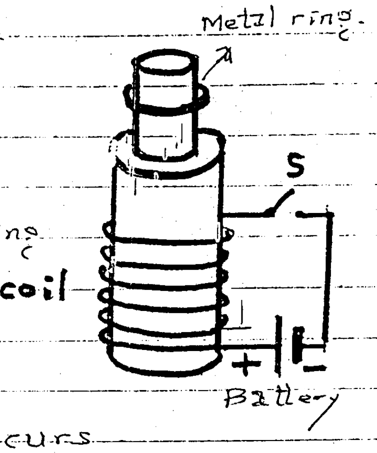
(b) However, when switch is opened, the current in circuit decrease from max. to zero and flux linked with other coil decreases and induced current is produced in reverse direction. So current in 'R' flows from right to left (clockwise) as shown.

Q 15.5: Does the induced emf always act to decrease the magnetic flux through a circuit?

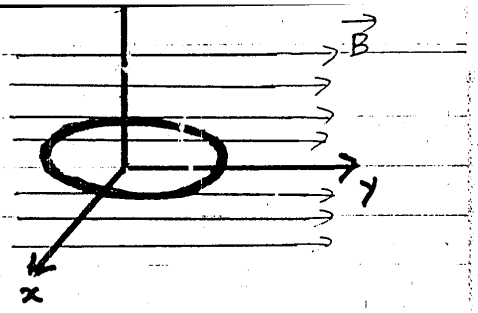
Ans. No, the induced emf does not act so as to decrease the magnetic flux through a circuit. According to Lenz's law the induced emf always acts so as to oppose the cause producing it. If an induced emf appears in a circuit due to decreasing magnetic flux linking that circuit, the induced current which flows through the circuit produces its own magnetic field that opposes the decrease of magnetic field. In other words it is reinforcing or increasing the magnetic flux passing through the circuit.

Q15.6: When the switch in the circuit is closed, a current is established in the coil and the metal ring jumps upward. Why? Describe what would happen to the ring if the battery polarity were reversed.

Ans. When switch in the circuit is closed, the current is set up in the coil. Magnetic flux changes through the metallic ring and an induced emf is produced in it. The face of the ring opposite to coil (according to Lenz's law) develops similar pole of magnet and experiences repulsion from the side of coil and jumps up. The same event occurs even if the polarity of the battery is reversed.



Q15.7: The figure shows a coil of wire in the XY plane with a magnetic field directed along the y-axis. Around which of the three coordinate axes should the coil be rotated in order to generate an emf and a current in the coil?



Ans. The coil must be rotated about **x – axis** to get change of magnetic flux and an induced current through it.

Q 15.8: How would you position a flat loop of wire in a changing magnetic field so that there is no emf induced in the loop?

Ans. If the flat loop of wire is placed parallel to changing magnetic field, no flux changes through it and hence no induced emf is produced.

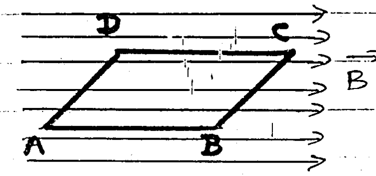
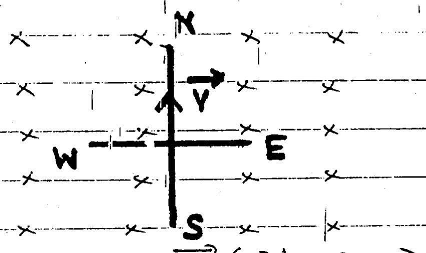


fig (flat loop in a changing magnetic flux)

Q 15.9: In a certain region the earth's magnetic field points vertically down. When a plane flies due North, which wing tip is positively charged?

Ans. In the vertically downward directed magnetic field, when an aeroplane flies in the direction of north, then the positive charge in the wing will experience a force $\vec{F} = q(\vec{V} \times \vec{B})$. Right hand rule shows that this force is in the direction of $\vec{V} \times \vec{B}$ i.e; along the direction of **West**. Hence the left wing tip pointing towards west is charged positively.



$\vec{B}$ (into Paper)

Q 15.10. Show that $\mathcal{E}$ and $\frac{\Delta\phi}{\Delta t}$ have the same units.

Ans. As $\mathcal{E} = \frac{W}{q}$, $\mathcal{E}$ has the unit **volt** (or JC^{-1}) —— (1)

Moreover, $\frac{\Delta\phi}{\Delta t}$ has unit $Wb\,s^{-1}$

$\because Wb\,s^{-1} = \frac{N \times m}{A \times s} = \frac{J}{C} =$ **Volt** —— (2)

Hence both $\mathcal{E}$ and $\frac{\Delta\phi}{\Delta t}$ carry the same unit.

(P.T.O)

Q 15.11: When an electric motor, such as an electric drill, is being used, does it also act as generator? If so what is the consequence of this?

Ans- When an electric motor is running, its armature is rotating in a magnetic field. A torque acts on the armature and at the same time magnetic flux is changing through the armature which produces an induced emf. The induced emf opposes the rotation of armature. This means that <u>motor also acts as generator when it is running</u>.

Q 15.12: Can a D.C motor be turned into a D.C generator? What changes are required to be done?

Ans. A D.C motor can be converted into a D.C generator. For this the armature coil of the motor is to be coupled with some rotating body. The rotational motion of the body is transferred to the armature coil of the motor. Due to its rotation, the magnetic flux through the coil changes and so an emf will be induced at the output. The motor therefore becomes a generator.

Q 15.13: Is it possible to change both the area of the loop and the magnetic field passing through the loop and still not have an induced emf in the loop?

Ans. Yes, if the plane of the loop is kept parallel to the direction of the magnetic field, no emf remains will be induced in the loop either by changing its area or by changing the magnetic field.

Q 15.14: Can an electric motor be used to drive an electric generator with the output from the generator being used to operate the motor?

Ans. No, it is not possible. Because if it is possible it will be a self-operating system without getting energy from some external source and this is against the law of conservation of energy.

(P.T.O)

Q 15.15: A suspended magnet is oscillating freely in a horizontal plane. The oscillations are strongly damped when a metal plate is placed under the magnet. Explain why this occurs?

Ans. Due to the oscillations of the magnet, the magnetic flux passing through the metallic plate changes. This produces an induced emf in the plate and hence an induced current. The induced current produces its own magnetic field which always opposes the motion of the bar magnet. Thus oscillatory motion of the bar magnet is therefore damped.

Q 15.16: Four unmarked wires emerge from a transformer. What steps would you take to determine the turns ratio?

Ans. With the help of an ohm metre first separate the wires into two pairs forming primary and secondary of the transformer. The with one pair connect small a.c voltage of known value treating this pair as the primary. With the help of voltmeter, measure the voltage obtained at the other pair. so

$$V_p/V_s = \frac{N_p}{N_s}$$

Q 15.17: (a) Can a step-up transformer increase the power level? **(b)** In a transformer, there is not transfer of charge from the primary to the secondary. How is, then the power transferred?

Ans. (a) No, a step-up transformer can only increase the voltage level obtained at its secondary. It cannot increase the power level in the light of law of conservation of energy.

(b) Energy or power from primary coil is transfered to the secondary coil through the magnetic flux which is also linking the secondary coil.

(P.T.O)

Q15/8: When the primary of a transformer is connected to a.c mains the current in it:

(a) is very small if the secondary circuit is open, but

(b) increases when the secondary circuit is closed.

Explain these facts.

Ans.(a) If the secondary circuit is open, the output power ($=V_s I_s$) will be zero. Since output power of a transformer is always slightly smaller than the input power, so a very small current is drawn by the transformer from the a.c mains i.e; the input current (I_p) in primary coil is very small.

(b) When the secondary circuit is closed the output power increases. To produce this power, transformer will draw large current from the a.c mains, to increase its primary power ($=V_p I_p$).