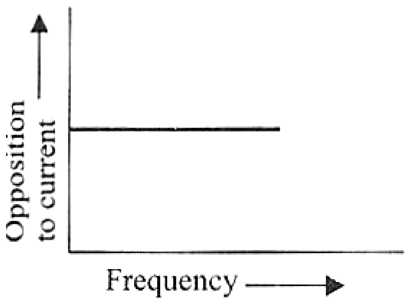
THE EDUCARE (SIROHI CLASSES)

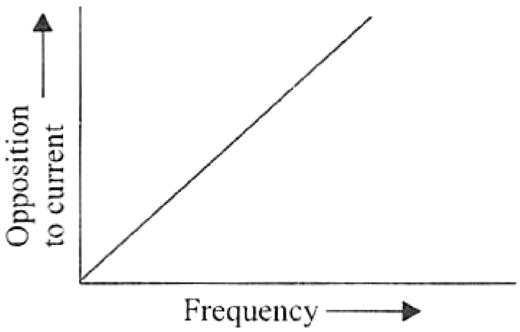
XII PHYSICS TEST

MAGNETIC , MAGNETISM , E.M.I. AND A.C.

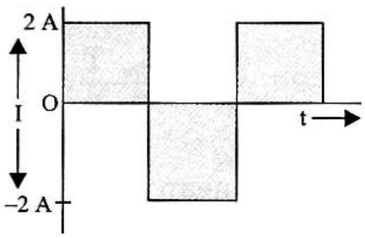
NAME-……………………….............… DATE-………….. MM- 25 TIME-1 HR

1) State the principle of cyclotron. (1)
2) What happens if a bar magnet is cut into two pieces (i) transverse to its length (ii) along its length? (1)
3) Why permanent magnets are made of steel or alnico ? (1)
4) Is it possible to convert a galvanometer into an ammeter of range $I < I_g$. I_g is the maximum current that can be passed through the galvanometer. (1)
5) A proton and an alpha particle having the same kinetic energy are allowed to pass through a uniform magnetic field perpendicular to their direction of motion . Compare the radii of the paths of proton and alpha particle . (2)
6) The given graphs (a) and (b) of Fig. represent the variation of the opposition offered by the circuit element to the flow of alternating current with frequency of the applied emf. Identify the circuit element corresponding to each graph. (2)





7) Determine the rms value of alternating current shown in Fig. (2)



8) Can the voltage drop across the inductor or the capacitor in a series LCR circuit be greater than the applied voltage of the ac source ? Justify your answer . (2)

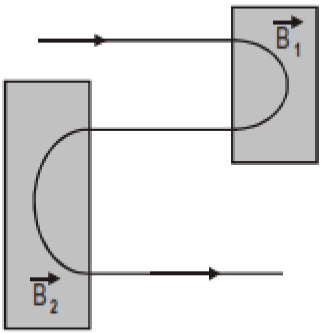
9) The vertical component of the earth's magnetic field at a given place is $\sqrt{3}$ times its horizontal component. If total intensity of earth's magnetic field at the place is 0.4 G, find the value of :

i) angle of dip

ii) the horizontal component of earth's magnetic field. (2)

10) What are eddy currents. How are these produced? In what sense are eddy currents considered undesirable in a transformer and how are these reduced in such a device ? (3)

11) Figure shows the path of an electron that passes through two regions containing uniform magnetic fields of magnitude B1 and B_2. Its path in each region is a half circle. (a) Which field is stronger? (b) What are the directions of two fields? (c) Is the time spend by the electron in the $\vec{B_1}$, region greater than, less than, or the same as the time spent in $\vec{B_2}$ region? (3)



12) A circuit is set up by connecting L = 100 mH, C = 5μF and R = 100 Ω in series. An alternating emf of (150 $\sqrt{2}$) volt, $\frac{500}{\pi}$ Hz is applied across this series combination. Calculate the impedance of the circuit. What is the average power dissipated in (a) the resistor (b) the capacitor (c) the inductor and (d) the complete circuit ? (5)

OR

State the principle of an ac generator. Find an expression for the maximum emf produced in it.

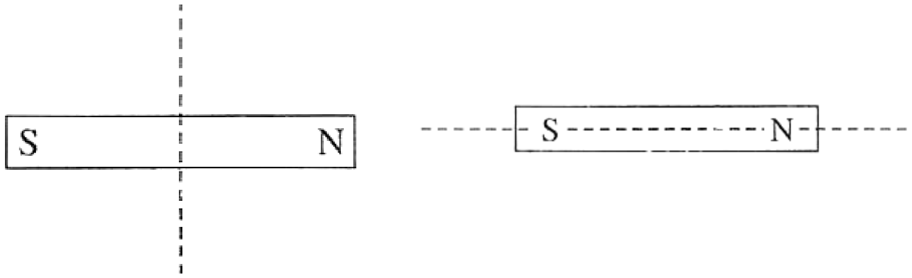
SOLUTION

1) State the principle of cyclotron. (1)

SOL: A positive ion can acquire sufficiently large energy with a small alternating potential difference by making the ion cross the same electric field time and again by making use of a strong magnetic field.

2) What happens if a bar magnet is cut into two pieces (i) transverse to its length (ii) along its length? (1)

SOL: In both the cases, we get two magnets having north and south poles.



When the bar magnet is cut transverse to its length, the pole strength of each piece is the same as that of the bar magnet. But the length is halved. So, magnetic moment is halved.

When the bar magnet is cut along its length (Fig.), the pole strength of each piece is halved. But the length is unchanged. So, magnetic moment is halved.

3) Why permanent magnets are made of steel or alnico ? (1)

Ans: Inspite of low retentivity, steel or alnico is preferred for making permanent magnets because of large coercivity.

4) Is it possible to convert a galvanometer into an ammeter of range $I < I_g$. I_g is the maximum current that can be passed through the galvanometer. (1)

SOL:

Shunt resistance, $$S = \frac{GI_g}{I - I_g}$$

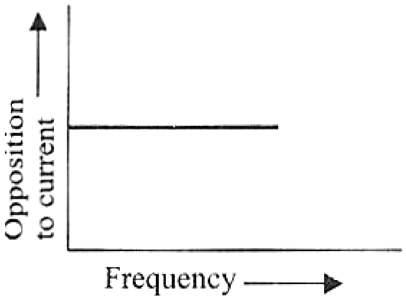
If $I < I_g$, then S is negative. This is not possible. Thus, we cannot convert a galvanometer into an ammeter of range $I < I_g$.

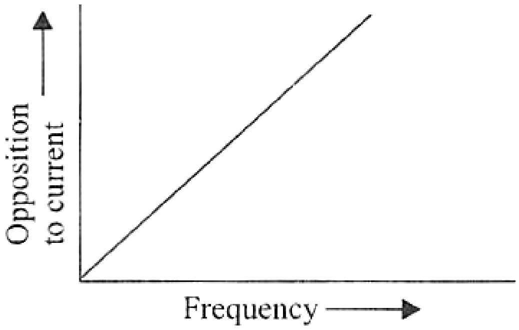
5) **A proton and an alpha particle having the same kinetic energy are allowed to pass through a uniform magnetic field perpendicular to their direction of motion . Compare the radii of the paths of proton and alpha particle .** **(2)**

SOL: $r = \frac{\sqrt{2mE_k}}{Bq}$

$$\frac{r_p}{r_\alpha} = \frac{\sqrt{2mE_k}}{Bq} \times \frac{B(2q)}{\sqrt{2(4m)E_k}} = \frac{1}{1}.$$

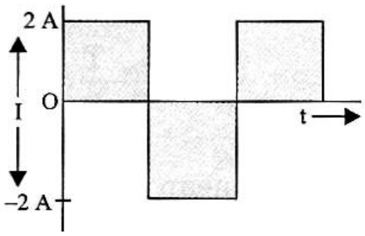
6) **The given graphs (a) and (b) of Fig. represent the variation of the opposition offered by the circuit element to the flow of alternating current with frequency of the applied emf. Identify the circuit element corresponding to each graph.** **(2)**





Ans:(a) Resistor *(b)* inductor.

7) **Determine the rms value of alternating current shown in Fig.** **(2)**



SOL:

$$I_v = \sqrt{\frac{2^2 + 2^2 + 2^2}{3}} \text{ A}$$
$$= \mathbf{2\ A}$$

8) **Can the voltage drop across the inductor or the capacitor in a series LCR circuit be greater than the applied voltage of the ac source ? Justify your answer .**

SOL: . Yes. The voltage drop across the inductor or capacitor in a series circuit can be greater than the applied volt age. Since these voltages are not in the same phase therefore they cannot be added like ordinary numbers.

9) The vertical component of the earth's magnetic field at a given place is $\sqrt{3}$ times its horizontal component. If total intensity of earth's magnetic field at the place is 0.4 G, find the value of :

i) angle of dip

ii) the horizontal component of earth's magnetic field. (2)

SOL:

$$(i)\ \tan\delta = \frac{B_V}{B_H} = \frac{\sqrt{3}\,B_H}{B_H} = \sqrt{3}$$

$$\delta = 60^\circ$$

$$(ii)\ B_H = B\cos\delta = 0.4\cos 60^\circ \text{ gauss} = 0.2 \text{ gauss.}$$

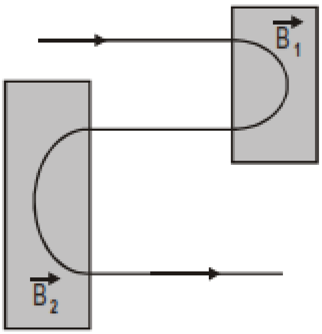
10) What are eddy currents. How are these produced? In what sense are eddy currents considered undesirable in a transformer and how are these reduced in such a device ? (3)

SOL: Eddy currents are the currents induced in solid metallic masses when changing magnetic flux passes through them. Changing magnetic fields set up current loops in the metallic masses. These loops are irregularly shaped and are called eddy currents.

Eddy current are considered undesirable in a transformer because they dissipate energy in the form of heat. To reduce the loss, the core is made of a large number of thin layers separated by insulating material. This increases the resistance of the possible paths and hence reduces the eddy currents.

11) Figure shows the path of an electron that passes through two regions containing uniform magnetic fields of magnitude B1 and B_2. Its path in each region is a half circle. (a) Which field is stronger? (b) What are the directions of two fields? (c) Is the time spend by the electron in the

$\vec{B_1}$, region greater than, less than, or the same as the time spent in $\vec{B_2}$ region? (3)



SOL: (a) $B_1 > B_2$; (b) B_1 inward; B_2 outward. (c) Time spent in $B_1 <$ Time spent in B_2**.**

12) A circuit is set up by connecting L = 100 mH, C = 5μF and R = 100 Ω in series. An alternating emf of (150 $\sqrt{2}$) volt, $\frac{500}{\pi}$ Hz is applied across this series combination. Calculate the impedance of the circuit. What is the average power dissipated in (a) the resistor (b) the capacitor (c) the inductor and (d) the complete circuit ? (5)

SOL:

$$Z = \sqrt{R^2 + (X_L - X_C)^2}\ ,$$

$$R = 100\ \Omega,\ X_L = \omega L = 2\pi\nu L$$

$$= 2\pi \times \frac{500}{\pi} \times 100 \times 10^{-3}\ \Omega = 100\ \Omega$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi\nu C} = \frac{1}{2\pi\left(\frac{500}{\pi}\right)5 \times 10^{-6}}\ \Omega = 200\ \Omega$$

$$Z = \sqrt{100^2 + (100 - 200)^2}\ \Omega = 141.4\ \Omega$$

$$I = \frac{V}{Z} \quad \text{or} \quad I = \frac{150\sqrt{2}}{100\sqrt{2}} = \mathbf{1.5\ A}$$

(a) Power consumed in resistor is $I^2R = 1.5 \times 1.5 \times 100$

W = 225 W

(b) in capacitor is zero.

(c) in inductor is zero.

(d) in circuits same as power consumed in resistor *i.e.*, 225 W

OR

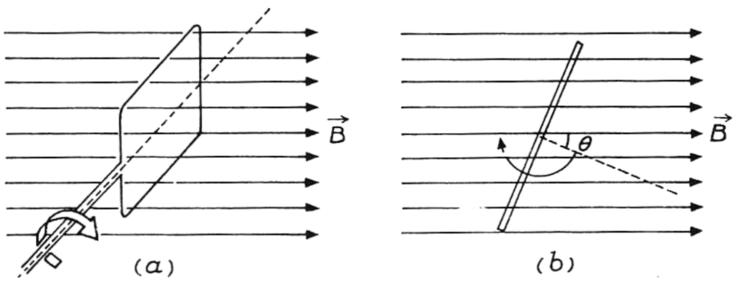
State the principle of an ac generator. Find an expression for the maximum emf produced in it.

(5)

SOL: It is based upon the principle of electromagnetic induction.

Expression for the Induced emf : In Fig. (a) is shown a coil rotating clockwise about a horizontal axis perpendicular to a magnetic field $\vec{B}$**.** Suppose we start timing from the instant when the plane of the coil is perpendicular to the field $\vec{B}$**.** In this position the magnetic flux linked with the coil is maximum.

As the coil rotates, the magnetic flux linked with it changes. Suppose, in *t* second, the coil rotates through an angle θ. At this instant, the normal to the plane of the coil makes an angle θ with the direction of the field $\vec{B}$ (Fig. b) and the component of $\vec{B}$ perpendicular to the plane of the coil is $\vec{B}$ cos θ. If ***A*** be the area of the plane of the coil, then the instantaneous magnetic flux linked with each turn of the coil is



$$\Phi_B = (B\cos\theta)\,A\,.$$

If ω be the angular velocity of the coil, then $\theta = \omega t$.

$$\therefore \quad \Phi_B = B\,A\cos\omega t\,.$$

The rate of change of magnetic flux is

$$\frac{d\Phi_B}{dt} = -B\,A\,\omega\sin\omega t\,.$$

By Faraday's law of electromagnetic induction, the emf induced in each turn of the coil is $-d\Phi_B/dt$. If the coil has N turns, then the emf induced in the coil is given by

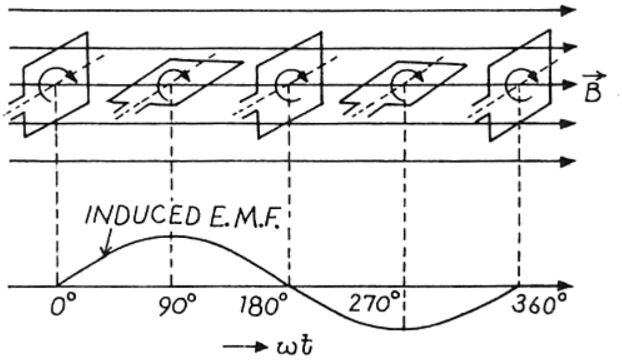
$$e = -N\frac{d\Phi_B}{dt} = N\,B\,A\,\omega\,\sin\omega t\,.$$

This shows that ***the magnitude of the emf induced in a coil rotating in a magnetic field changes continuously with time.*** The maximum value of sin ωt is 1 and so the maximum value of e is $NBA\omega$. Let it be e_0. That is

$$e_0 = NBA\omega.$$

Thus, $e = e_0 \sin \omega t$.

In the upper part of Fig are shown the positions of the coil at different times and in the lower part is shown the time-variation of the emf induced in the coil rotating with a constant angular velocity ω in a uniform magnetic field $\vec{B}$.



The emf is zero when the coil is perpendicular to the field ($\theta = \omega t = 0, 180^0, 360^0$) and maximum being alternately positive , when the coil is parallel to the field ($\theta = \omega t = 90^0, 270^0$)

When a load of resistance R is connected across the terminals, a current I flows in the external circuit.

$$I = \frac{e}{R} = \frac{e_0 \sin \omega t}{R} = I_0 \sin \omega t$$

$$where\ I_0 = \frac{e_0}{R}$$

Both current and voltage vary sinusoidally with time. The power dissipated in the load is supplied by the agent in rotating the coil in the magnetic field.