BK BIRLA CENTRE FOR EDUCATION

SARALA BIRLA GROUP OF SCHOOLS
SENIOR SECONDARY | CO-ED DAY CUM BOYS' RESIDENTIAL SCHOOL

PRE BOARD- 1 EXAMINATION 2024-25

Class : XII | Duration: 3 Hrs
Date : 18/11/2024 | Max. Marks: 70

ANSWER KEY

Section A

1. (a) Electric field intensity	1
2. (d) Zero	1
3. (c) q/8ε0	1
4. (b) +0.4%	1
5. (d) 6 A in the clockwise direction	1
6. (b) 10√2 V	1
7. (a) 1.8 × 10^8 ms-¹	1
8. (d) Both electric and magnetic field vectors are parallel to each other	1
9. (b) -20 cm	1
10. (d) 0.85	1
11. (d) All of the above	1
12. (c) the valence band is completely filled and the conduction band is partially filled	1
13. (c)	1
14. (b)	1
15. (a)	1
16. (b)	1

Section B

17.

$$\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)}$$
$$= \frac{2.7 - 2.1}{2.1(100 - 27.5)} = 0.0039\ ^{\circ}C^{-1}$$

2

18. A **moving coil galvanometer** is an instrument used to measure small electric currents. It works based on the principle that a current-carrying coil, placed in a magnetic field, experiences a torque. Here's how it operates: 1

Working: When an electric current passes through the coil, the coil experiences a magnetic force due to the interaction between the current and the magnetic field. The force generates a torque (rotational force), which causes the coil to rotate. The amount of rotation is proportional to the current passing through the coil. The suspension wire or spring provides a restoring torque that opposes the rotation. The coil comes to rest when the restoring torque equals the magnetic torque. As the coil rotates, the pointer attached to the coil moves over a calibrated scale. The deflection of the pointer is proportional to the current flowing through the coil. 1

19. Using Lens Formula

$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ 1

$\frac{1}{20}=\frac{1}{v}+\frac{1}{12}$

$\frac{1}{v}=\frac{3}{60}-\frac{5}{60}=-\frac{1}{30}$

V=-30 cm 1

Or

$m=\frac{\text{fo}}{\text{fe}}$

$=\frac{144}{6.0}$ 1

= 24

Separation= $f_o + f_e$= 144+6= 150 cm 1

20. Let λα be the wavelength of the alpha-particle and λp be the wavelength of the proton.
Mass of the proton m_p=1 u, Charge of the proton q_p=e
Mass of the alpha-particle m_α=4 u, Charge of the alpha-particle q_α=2e
Now, substitute these values into the expression:

$\frac{\lambda\alpha}{\lambda p}=\frac{\frac{h}{\sqrt{2m\alpha q\alpha V}}}{\frac{h}{\sqrt{2mpqpV}}}=\frac{\sqrt{mpqp}}{\sqrt{m\alpha q\alpha}}=\frac{1}{2\sqrt{2}}$ 2

Thus, the ratio of the de Broglie wavelengths of the α\alphaα-particle to the proton is: $\frac{1}{2\sqrt{2}}$

21. Steps of calculations:

To find the wavelength of the spectral line when an electron jumps from the third orbit (n=3) to the first orbit (n=1) in a hydrogen atom, we can use the Rydberg formula for the wavelengths of spectral linesWe know that

1. Calculate $\frac{1}{1^2} - \frac{1}{3^2}$:

$$\frac{1}{1} - \frac{1}{9} = 1 - \frac{1}{9} = \frac{9}{9} - \frac{1}{9} =$$

2. Now substitute back into the Rydberg formula:

$$\frac{1}{\lambda} = R_H \left(\frac{8}{9}\right)$$

$$\frac{1}{\lambda} = 1.097 \times 10^7 \times \frac{8}{9}$$

1

Calculating the right side:

$$\frac{1}{\lambda} \approx 1.097 \times 10^7 \times 0.8889 \approx 9.75 \times 10^6 \, \mathrm{m}^{-1}$$

3. Now take the reciprocal to find λ:

$$\lambda \approx \frac{1}{9.75 \times 10^6} \approx 1.0256 \times 10^{-7} \, \mathrm{m} = 102.56 \, \mathrm{nm}$$

1

22. 3

$$W = \int_0^Q V dq = \int_0^Q \frac{q}{C} dq$$

$$= \frac{1}{C}\left[\frac{q^2}{2}\right]_0^Q = \frac{1}{C}\left[\frac{Q^2 - 0}{2}\right] = \frac{Q^2}{2C}$$

If V is the final difference between capacitor plates, then Q = CV

$$W = \frac{(CV)^2}{2C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$$

This work is stored as electrostatic potential energy of capacitor i.e.,

Electrostatic potential energy, $U = \frac{Q^2}{2C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$

Energy Density: Consider a parallel plate capacitor consisiting of plates, each of area A, separated by a distance d. If space between the plates is filled with a medium of dielectric constant K, then

Capacitance of capacitor, $C = \frac{K\varepsilon_0 A}{d}$

If σ is the surface charge density of plates, then electric field strength between the plates

$$E = \frac{\sigma}{K\varepsilon_0} \Rightarrow \sigma = K\varepsilon_0 E$$

Charge on each plate of capacitor $Q = \sigma A = K\varepsilon_0 EA$

$\therefore$ Energy stored by capacitor, $U = \frac{Q^2}{2C} = \frac{(K\varepsilon_0 EA)^2}{2(K\varepsilon_0 A/d)} = \frac{1}{2}K\varepsilon_0 E^2 Ad$

23.

Consider a uniformly charged spherical shell of radius R and total charge Q. To find the electric field at a point outside the shell (at distance $r > R$), we use a Gaussian surface that is a sphere of radius r centered at the center of the shell.

Apply Gauss's Law:

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = E \cdot (4\pi r^2)$$

$$E \cdot (4\pi r^2) = \frac{Q}{\varepsilon_0}$$

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}$$ 1

(ii) Electric Field at the Surface of the Shell

At the surface of the shell, $r = R$:

$$E = \frac{Q}{4\pi\varepsilon_0 R^2}$$ 1

(iii) Electric Field Inside the Shell

$$\Phi_E = E \cdot (4\pi r^2) = 0$$

E=0 1

24.

Substituting B_1:

$$F = I_2 \cdot L \cdot \left(\frac{\mu_0 I_1}{2\pi r}\right)$$

Force Per Unit Length

To find the force per unit length f:

$$f = \frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi r}$$ 1

Magnetic Field Due to Conductor 1

Conductor 1 generates a magnetic field B_1 at the location of conductor 2:

$$B_1 = \frac{\mu_0 I_1}{2\pi r}$$

Force on Conductor 2

Now, using the magnetic field from conductor 1, the force F on conductor 2 (with current I_2) can be expressed as:

$$F = I_2 \cdot L \cdot B_1$$ 1

One ampere is defined as the current that, when flowing in two straight parallel conductors of infinite length and placed 1 meter apart in a vacuum, produces a force of 2×10^{-7} *newtons per meter of length between them.*

This can be mathematically expressed as:

If $I_1 = I_2 = 1\,\mathrm{A}$ and $r = 1\,\mathrm{m}$:

$$f = \frac{\mu_0 \cdot 1 \cdot 1}{2\pi \cdot 1} = \frac{4\pi \times 10^{-7}}{2\pi} = 2 \times 10^{-7}\,\mathrm{N/m}$$

1

25. a. Microwaves are suitable for radar systems that are used in aircraft navigation.
These rays are produced by special vacuum tubes, namely Klystrons, magnetrons and Gunn diodes. 1
b. Infrared waves are used to treat muscular strain.
These rays are produced by hot bodies and molecules. 1
c. X rays are used as a diagnostic tool in medicine.
These rays are produced when high energy electrons are stopped suddenly on a metal of high atomic number. 1

26. Angle of minimum deviation δm and angle of prism A are related as

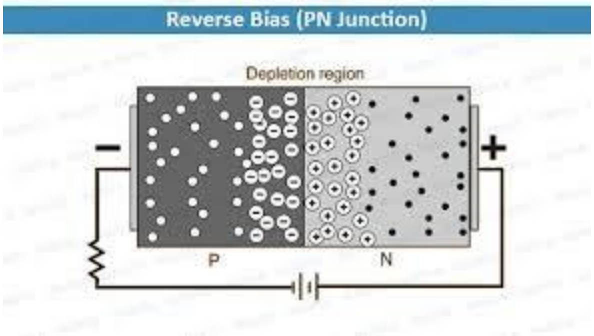
$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

1

Glass prism of refractive index 1.5 is immersed in a liquid of refractive index 1.3 so the relative refractive index of the prism decreases μ' = 1.5/1.3 = 1.115 1

So as per above equation as A is constant for a prism, as μ decreases, δm also decreases.1

27. (a) When the p-type is connected to the battery's negative terminal and the n-type is connected to the positive side, the P-N junction is reverse biased. 1
(b)



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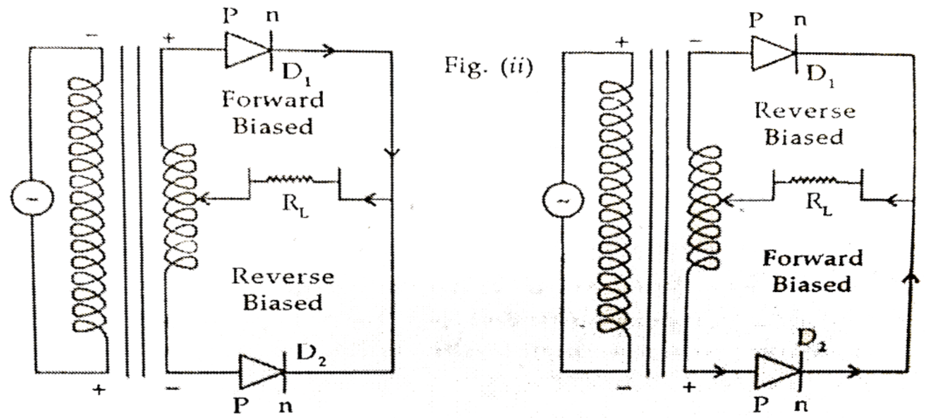
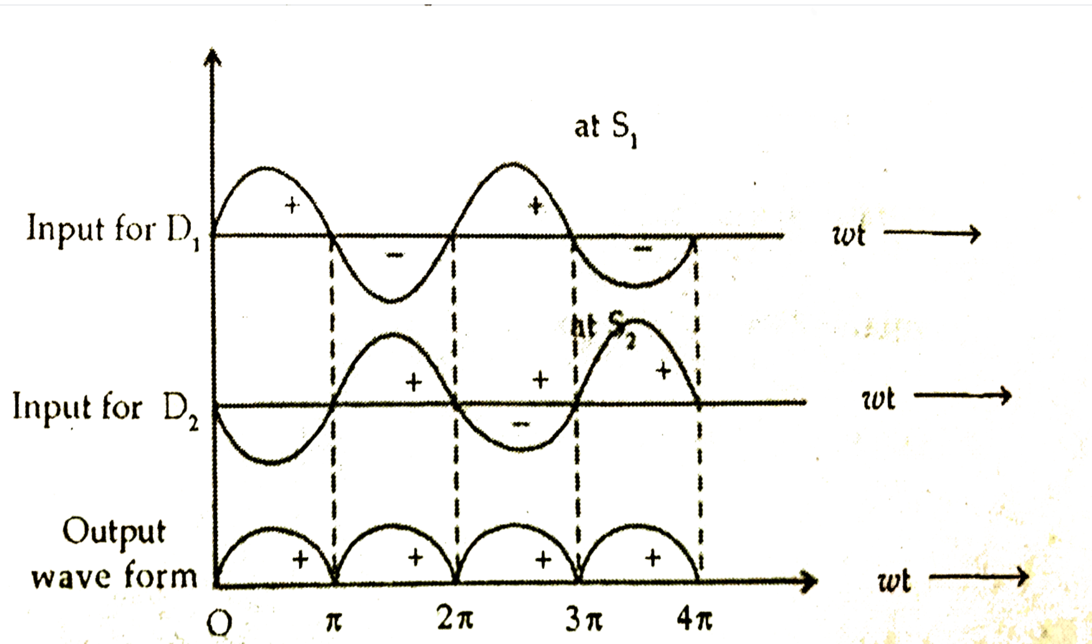
28.

Full wave rectifier:



1

Working: When positive half cycle of AC input signal flows through the primary coil, induced emf is set up in the secondary coil due to mutual induction. Let the direction of the induced e.m.f. be such that the upper end of the secondary coil become + ve while the lower end lower end become - ve this makes D1 forward biased and D2 reverse biased current due to diode D1 flows through the circuit as shown in fig (i) and when D1 is reverse biased D2 will become forward biased and current in diode D2 flows through the circuit as shown in fig (ii) hence unidirectional current will always flow in Load Resistance RL. 1



1

29. (i) (c) Both electric and magnetic field perpendicular to each other

(ii) (c) If v is parallel to B

(iii) (c) - Y axis

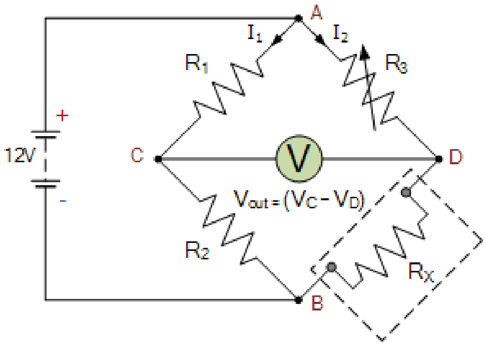
(iv) (c) **v** and **B**

Or

(c) A helix with uniform pitch

30. (i) (b) Frequency of visible light is less than that for ultraviolet light I 1
(ii) (a)For non-metals the work function is high 1
(iii) (a)Photoelectric current increases 1
(iv) (b) Frequency 1
Or
(b) It decreases as the work function increases 1

31. (a) The figure given below shows a variation of Wheatstone bridge, where the resistance R4 has been replaced by an unknown resistance Rx. Rx is attached to the sensing arm between the points BD, and R3 has been adjusted to give the Wheatstone Bridge its balanced condition. Now, the circuit is expected to bring zero output on the galvanometer as per the Wheatstone bridge principle.



1

Thus, when the bridge is balanced, the resistances on the circuit can be indicated as:

$$\frac{R1}{R2} = \frac{R3}{Rx}$$

Now, let's explore the Wheatstone bridge balance equation for unknown resistance

$$V_{OUT} = (V_C - V_D) = (V_{R2} - V_{R4}) = 0$$

$$R_C = \frac{R_2}{R_1 + R_2} \quad \text{and} \quad R_D = \frac{R_4}{R_3 + R_4}$$

$$\text{At Balance}: R_C = R_D \quad \text{So,} \quad \frac{R_2}{R_1 + R_2} = \frac{R_4}{R_3 + R_4}$$

$$\therefore R_2(R_3 + R_4) = R_4(R_1 + R_2)$$
$$R_2R_3 + \cancel{R_2R_4} = R_1R_4 + \cancel{R_2R_4}$$

$$\therefore R_4 = \frac{R_2R_3}{R_1} = R_X$$

1

(b) Let I_1 be the current flowing through the outer circuit.
Let I_2 be the current flowing through AB branch.
Let I_3 be the current flowing through AD branch.
Let $I_2 - I_4$ be the current flowing through branch BC.
Let $I_3 + I_4$ be the current flowing through branch DC.
Let us take closed-circuit ABDA into consideration, we know that potential is zero.

i.e , $10\, I_2 + 5\, I_4 - 5\, I_3 = 0$ 1

$2\, I_2 + I_4 - I_3 = 0$

$I_3 = 2\, I_2 + I_4$ . . . . (1)

Let us take closed circuit BCDB into consideration, we know that potential is zero.

$5\,(I_2 - I_4) - 10\,(I_3 + I_4) - 5\, I_4 = 0$

$5\, I_2 - 5\, I_4 - 10\, I_3 - 10\, I_4 - 5\, I_4 = 0$

$5\, I_2 - 10\, I_3 - 20\, I_4 = 0$

$I_2 = 2\, I_3 - 4\, I_4$ . . . . (2)

Let us take closed-circuit ABCFEA into consideration, we know that potential is zero.

i.e , $-10 + 10\,(I_1) + 10\,(I_2) + 5\,(I_2 - I_4) = 0$

$10 = 15\, I_2 + 10\, I_1 - 5\, I_4$

$3\, I_2 + 2\, I_2 - I_4 = 2$ . . . . (3)

From equation (1) and (2), we have :

$I_3 = 2(2\, I_3 + 4\, I_4) + I_4$

$I_3 = 4\, I_3 + 8\, I_4 + I_4$

$-3\, I_3 = 9\, I_4$

$-3\, I_4 = +\, I_3$ . . . . (4)

Putting equation (4) in equation (1) , we have :

$I_3 = 2\, I_2 + I_4$

$-4\, I_4 = 2\, I_2$

$I_2 = -2\, I_4$ . . . . (5)

From the above equation , we infer that :

$I_1 = I_3 + I_2$ . . . .(6)

Putting equation (4) in equation (1), we obtain

$3\, I_2 + 2\,(I_3 + I_2) - I_4 = 2$

$5\, I_2 + 2\, I_3 - I_4 = 2$ . . . . (7)

Putting equations (4) and (5) in equation (7), we obtain

$5\,(-2\, I_4) + 2\,(-3\, I_4) - I_4 = 2$

$-10\, I_4 - 6\, I_4 - I_4 = 2$

$17\, I_4 = -2$

$I_4 = -2/17\text{A}$

$I_3 = -3\,(I_4) = 6/17\text{ A}$

$I_2 = 4/17\text{A}$

$I_1 = 10/17\text{ A}$

In branch AB 4/17A

In branch BC 6/17 A,

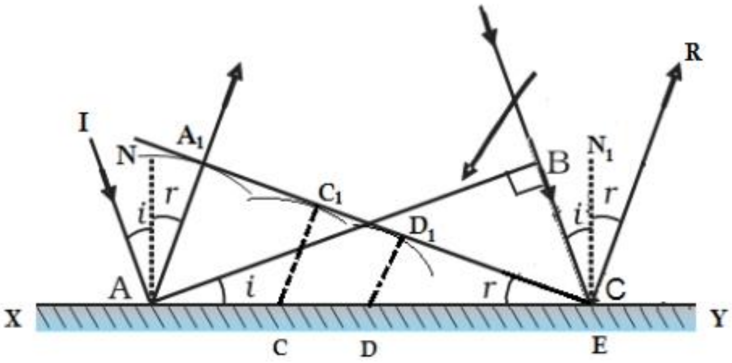
In branch CD -4/17A,

In branch AD 6/17A,

In branch BD -2/17 A

Total Current 10/17 A 2

32. (a)



1

In the given figure, AB is the wavefront incident on a reflecting surface XY with an angle of incidence i as shown in figure. According to Huygen's principle, every point on AB acts as a source of secondary wavelets. At first, wave incidents at point A and then to points C, D and E. They form a sphere of radii AA1, CC1 and DD1 as shown in figure.

A1E represents the tangential envelope of the secondary wavelet in forward direction.

In ΔABE and ΔAA1E, ∠ABE = ∠AA1E = 90°

Side AE = Side AE, AA1 = BE = distance travelled by wave in same time

So, these triangles are congruent.

So, ∠BAE = i and ∠BEA =r 2

Thus, i = r

(b) The wavelength of the light is $\lambda 1$=650nm. The wavelength of second light,λ_2=520nm. Distance between the slit and the screen is 1.2m.

Distance between the slits is 2 mm.

(i) The relation between the nth bright fringe and the width of fringe is:

$x=n\lambda_1 D/d$

For third bright fringe, n=3

$x=3\times 650\ X10^{-9}\ X\ 1.2/\ (2\times 10^{-3}) = 1950\times 6\times 10^{3}$nm

$x=11.7\times 10^{-3}$m =11.7mm 1

(ii) We can consider that nth bright fringe of $\lambda 2$ and the (n−1) th bright fringe of wavelength $\lambda 1$ coincide with each other.

$n\lambda_2 = (n-1)\lambda_1$

520n=650n−650 Or 650=130n Or n=5

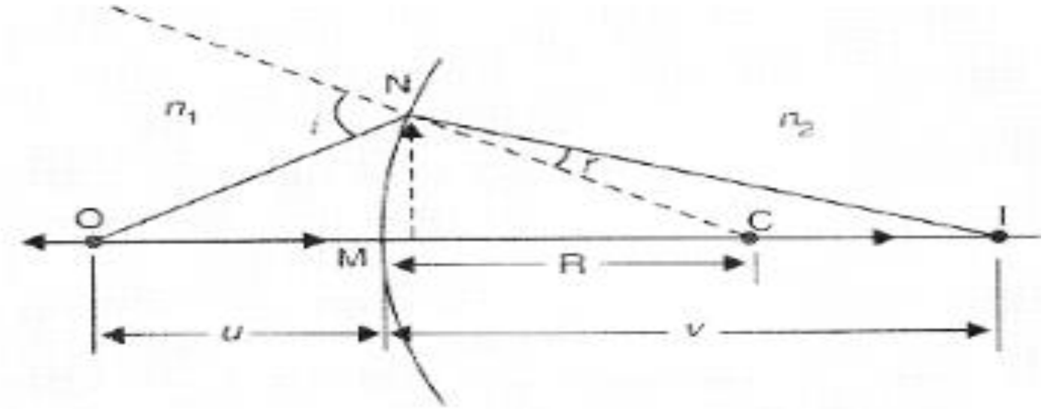
Therefore, the least distance from the central maximum can be obtained as:

$x'=n\lambda_2 D/d$ Or $x'=5\times 520D/d=2600\ X\ 1.2\ /\ 2\times 10^{-3}$ nm

$x'=1.56\times 10^{-3}$m=1.56 mm 1

OR

(a)



From the given diagram, for small angles :

$$\tan \angle NOM = \frac{MN}{OM} = \angle NOM$$

$$\tan \angle NCM = \frac{MN}{MC} = \angle NCM$$

$$\tan \angle NIM = \frac{MN}{MI} = \angle NIM$$

For Δ NOC, $\angle i$ is the exterior angle.

$$\Rightarrow \quad \angle i = \angle NOM + \angle NCM$$

$$= \frac{MN}{OM} + \frac{MN}{MC}$$

Similarly,

$$\Rightarrow \quad \angle r = \angle NCM + \angle NIM$$

$$r = \frac{MN}{MC} + \frac{MN}{MI}$$ 2

$$n_1 \sin i = n_2 \sin r$$

$$n_1 i = n_2 r$$

$$\Rightarrow n_1 \left(\frac{MN}{OM} + \frac{MN}{MC} \right) = n_2 \left(\frac{MN}{MC} - \frac{MN}{MI} \right)$$ 1

(n_2/v)- $(n_1/v) = (n_2$-$n_1)/R$

(b) Lens maker's formula,

$1f=(\mu-1)(1/R1-1/R2)$ 1

Here, f = 20 cm, μ = 1.55, R1 = R, R2 = -R

$120=(1.55-1)(1/R-1/(-R))$ or $120 = 0.55\times 2R$

$\Rightarrow R=1.1\times 20=22cm$ 1

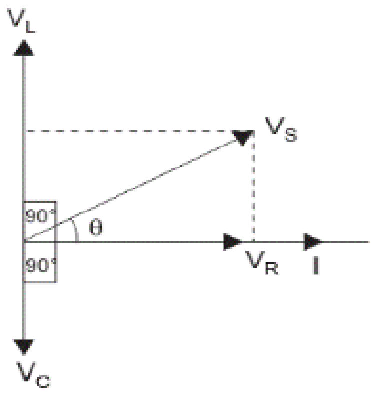
33.

(a) Impedance of the RLC circuit as seen in the phasor diagram, can be found as

$Z=VI=\sqrt{(IR)^2+I^2(XL-XC)^2}I$

$=\sqrt{R^2+(X_L-X_{C})^2}$ 1

$=\sqrt{R^2+(\omega L-1/\omega C)^2}$



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(b) Inductance of the inductor, L = 0.50 H Resistance of the resistor, R = 100 Ω Potential of the supply voltage, V = 240 V Frequency of the supply, ν = 50 Hz

(i) Peak voltage is given as:

$$V_0=\sqrt{2}V$$
$$=\sqrt{2}\times 240=339.41\text{ V}$$

Angular frequency of the supply, ω = 2 πν = 2π × 50 = 100 π rad/s, Maximum current in the circuit is given as:

$$I_0=\frac{V_0}{\sqrt{R^2+\omega^2L^2}}$$
$$=\frac{339.41}{\sqrt{(100)^2+(100\pi)^2(0.50)^2}}=1.82\text{ A}$$

1

Hence, the time lag between maximum voltage and maximum current is

$$\tan\phi=\frac{\omega L}{R}$$
$$=\frac{2\pi\times 50\times 0.5}{100}=1.57$$
$$\phi=57.5^\circ=\frac{57.5\pi}{180}\text{ rad}$$
$$\omega t=\frac{57.5\pi}{180}$$
$$t=\frac{57.5}{180\times 2\pi\times 50}$$
$$=3.19\times 10^{-3}\text{s}$$
$$=3.2\text{ ms}$$

1

Now, phase angle Φ is given by the relation, Hence, the time lag between maximum voltage and maximum current is 3.2 ms.

Or

(a)

$$\epsilon = \int_0^l B\,x\omega dx$$
$$= B\omega \int_0^l x.dx$$
$$= B\omega\left[\frac{x^2}{2}\right]_0^l$$
$$= B\omega\left[\frac{l^2}{2} - 0\right]$$
$$= \frac{1}{2}B\omega l^2$$

Current induced in rod, $I = \frac{\epsilon}{R} = \frac{1}{2}\frac{B\omega l^2}{R}$ 2

(b) Principle: It is based on the principle of mutual inductance and transforms the alternating low voltage to alternating high voltage and in this the number of turns in secondary coil is more than that in primary coil. (i. e. $N_S > Np$).

Working: When alternating current source is connected to the ends of primary coil, the current changes continuously in the primary coil; due to which the magnetic flux linked with the secondary coil changes continuously, therefore the alternating emf of same frequency is developed across the secondary. 1

Let Np be the number of turns in primary coil, N_S the number of turns in secondary coil and f the magnetic flux linked with each turn. We assume that there is no leakage of flux so that the flux linked with each turn of primary coil and secondary coil is the same. According to Faraday's laws the emf induced in the primary coil

$$\varepsilon_p = -N_p \frac{\Delta\phi}{\Delta t} \quad ...(i)$$

and emf induced in the secondary coil

$$\varepsilon_S = -N_S \frac{\Delta\phi}{\Delta t} \quad ...(ii)$$

From (*i*) and (*ii*)

$$\frac{\varepsilon_S}{\varepsilon_p} = \frac{N_S}{N_p} \quad ...(iii)$$

1

If the resistance of primary coil is negligible, the emf (εp) induced in the primary coil, will be equal to the applied potential difference (Vp) across its ends. Similarly if the secondary circuit is open, then the potential difference VS across its ends will be equal to the emf (ε_S) induced in it; therefore

$$\frac{V_S}{V_p} = \frac{\varepsilon_S}{\varepsilon_p} = \frac{N_S}{N_p} = r \text{ (say)} \quad ...(iv)$$

Where r = N_S/Np is called the transformation ratio. If ip and i_S are the instantaneous currents in primary and secondary coils and there is no loss of energy; then for about 100% efficiency, Power in primary = Power in secondary

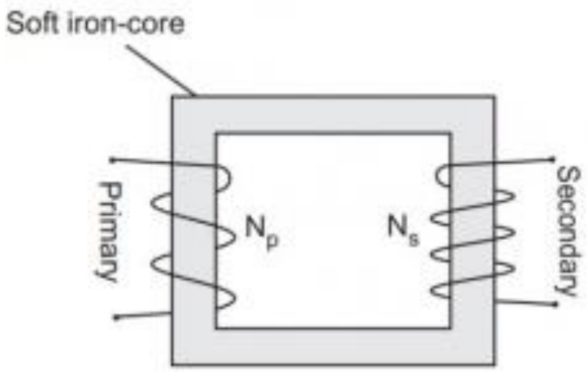
$$V_p i_p = V_S i_S$$

$$\therefore \quad \frac{i_S}{i_p} = \frac{V_p}{V_S} = \frac{N_p}{N_S} = \frac{1}{r} \quad ...(v)$$

In step up transformer, $N_s > N_p \;\rightarrow\; r > 1$;

So $V_S > V_p$ and $i_S < i_p$

i.e., step up transformer increases the voltage.



Two coils on separate limbs of the core 1

---------------------------ALL THE BEST------------------------------