ANSWERS

SECTION A

1. Option (D) is correct.

Explanation: Circuit current

$$I = \frac{E}{r+R} \Rightarrow E = I(r + R)$$

For 2 Ω, $E = 0.9(r + 2)$ ...(i)

For 7 Ω, $E = 0.3(r + 7)$ ...(ii)

From equations (i) & (ii),

$$0.9(r + 2) = 0.3(r + 7)$$

$$r = 0.5\,\Omega$$

2. Option (D) is correct.

Explanation: Since,

Magnetic force = centripetal force

$$qvB = \frac{mv^2}{R}$$

$$qB = \frac{mv}{R} \Rightarrow R = \frac{mv}{qB}$$

For $m = 2m$ and $q' = \frac{q}{2}$

$$\frac{q}{2}B = \frac{2mv}{R'}$$

$$R' = \frac{4mv}{qB} = 4R$$

3. Option (B) is correct.

Explanation: Paramagnetic are the materials that are feebly attracted to an external magnetic field. If a magnet is brought near these materials, these materials will get feebly magnetise towards it. Sodium and Calcium are paramagnetic materials.

4. Option (C) is correct.

Explanation: $V = I_g(G + R)$

I-Case: $2 = I_g(50 + 1000)$

$$I_g = \frac{2}{1050}\text{A}$$

II-Case: $10 = I_g(50 + R)$

$$10 = \frac{2}{1050}(50 + R)$$

$$R = \frac{10(1050)}{2} - 50$$

$$R = 5.2\text{ k}\Omega$$

5. Option (A) is correct.

Explanation: By Mutual Inductance

$$\varepsilon_2 = -M\frac{dI}{dt}$$

$$2 \times 10^{-3} = -M(5)$$

$$M = -0.4\text{ mH}$$

Negative sign shows that the mutual inductance is opposite to the induced emf.

6. Option (B) is correct.

Explanation: Ultraviolet rays are used to purify water and eye surgery.

7. Option (D) is correct.

Explanation: For the eyepiece:

$$\frac{1}{f_e} = \frac{1}{v_e} - \frac{1}{u_e}$$

$$\Rightarrow \quad \frac{1}{2} = \frac{1}{(-25)} - \frac{1}{u_e}$$

$$\Rightarrow \quad u_e = -1.85\text{ cm}$$

Since, the length of pipe is 10 cm.

So, $|v_o| + |u_e| = 10$ cm

$\Rightarrow \quad |v_o| = 10 - 1.85 = 8.15$ cm

For the objective lens:

$$\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$$

$$\Rightarrow \quad \frac{1}{1} = \frac{1}{8.15} - \frac{1}{u_o}$$

$$\Rightarrow \quad u_o = -0.877\text{ cm}$$

Now, magnification,

$$m = \frac{v_o}{|u_o|}\left(1 + \frac{D}{f_e}\right)$$

$$m = \frac{8.15}{0.877}\left(1 + \frac{25}{2}\right)$$

$$m = 125.46 \simeq 125$$

8. Option (A) is correct.

Explanation: Since, the threshold frequency is lesser for metal A. Hence, for the same frequency of incident radiation producing photoelectrons in the metals, the kinetic energy ($KE = hv - hv_0$) will be maximum for metal A.

9. Option (C) is correct.

Explanation: For first excited state, $n = 2$

$$E_1 = \frac{-13.6}{n^2} = \frac{-13.6}{(2)^2} = \frac{-13.6}{4}$$

$$E_1 = -3.4\text{ eV}$$

Now, $K = -E = -(-3.4) = 3.4$ eV

$U = 2E = 2(-3.4) = -6.8$ eV

10. Option (C) is correct.

Explanation: Position of n^{th} bright fringe,

$$x_n = \frac{n\lambda D}{\mu d}$$

For 6^{th} maximum in air, ($\mu = 1$)

$$x_6 = \frac{6\lambda D}{d}$$

For n^{th} maximum in medium, $\left(\mu = \frac{4}{3}\right)$

$$x_n' = \frac{3n\lambda D}{4d}$$

Now, $x_n' = x_6$

$$\frac{3n\lambda D}{4d} = \frac{6\lambda D}{d}$$

$\Rightarrow$ $n = 8$

11. Option (A) is correct.

Explanation: the potential energy between two nucleons inside a nucleus is minimum at a distance of about 0.8 fm. If the distance reduces, the force becomes repulsive.

12. Option (B) is correct.

Explanation: 1 atom of Si doped out of 10^6 atom (1 ppm)

$\Rightarrow$ In 5×10^{28} atoms, net doped $= \frac{5 \times 10^{28}}{10^6}$

$= 5 \times 10^{22}$ atoms

1 Antimony creates 1 excess electron

$\Rightarrow$ Number of excess electrons $= n_e = 5 \times 10^{22}$

Also, $n_i^2 = n_e n_h$

$n_i^2 = (5 \times 10^{22})(4.5 \times 10^9)$

$\Rightarrow$ $n_i = 1.5 \times 10^{16}$

13. Option(C) is correct.

Explanation: Electric field is from positive charge to negative charge, hence the direction of electric field will be along OC. Also, the net potential at O is zero. Hence, assertion is true and reason is false.

14. Option (A) is correct.

Explanation: As the velocity and applied magnetic field are perpendicular to each other, hence, the work done by a magnetic force on a charge moving in a magnetic field is zero. This also means that the energy of the particle will not change. So, both the assertion and reason are true and reason correctly explains the assertion.

15. Option (C) is correct.

Explanation: As the fringe width is inversely proportional to the separation between two sources, so, there will be no pattern when the two sources are infinitely close to each other. So, the assertion is true but the reason is false.

16. Option (D) is correct.

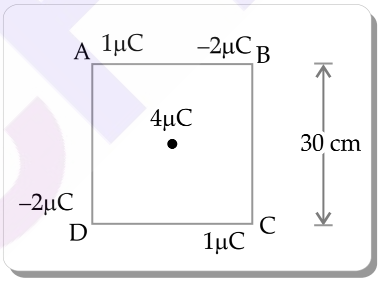
Explanation: Impact parameter, $b = \frac{Ze^2 \cot\left(\frac{\theta}{2}\right)}{4\pi\varepsilon_0 E}$

So, it depends upon the atomic number of target nucleus and its value is 0 when scattering angle is 180°. Therefore, both assertion and reason are false.

SECTION B

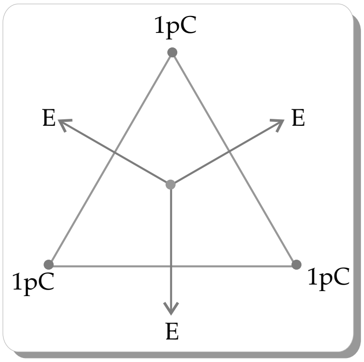
17. (a) The force of repulsion on charge 4μC due to charge 1μC at A and C are equal and opposite. Hence, they cancel each other.

Similarly, the force of attraction on charge 4μC due to charge –2μC at B and D are equal and opposite. Hence, they also cancel each other. So, the net force acting on the charge at the centre is zero.



OR

(b) The electric field at the centre of triangle due to all the three charges is zero as it is balanced from all the sides.



18. Since, the force on an individual charge moving at the drift velocity v_d,

$$F = qv_d B \sin\theta$$

For N charge carriers

$$F = (qv_d B \sin\theta)(N)$$

where, $N = nV = nAL$

$$\Rightarrow \quad F = qv_d B \sin\theta\, nAL$$
$$F = nq Av_d B \sin\theta L$$
$$F = ILB \sin\theta \qquad [\because I = nq Av_d]$$
$$\vec{F} = I(\vec{L} \times \vec{B})$$

Yes, it is valid even when the conductor is in zig-zag form as then also the length of the wire will remain at the same angle with the magnetic field as before.

19. Given, $f_o = 150$ cm

$f_e = 5$ cm

In normal adjustment,

$$m = -\frac{f_o}{f_e} = -\frac{150}{5} = -30$$

For objective lens,

$$\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$$

$$\frac{1}{150} = \frac{1}{v_o} - \frac{1}{\infty}$$

$[\because u_o = \infty$, as object is at infinity$]$

$v_0 = 150$ cm

20. (a) Given, $E = 2.55$ eV $= 2.55 \times 1.6 \times 10^{-19}$ J

$E = 4.08 \times 10^{-19}$ J

Since, $$E = \frac{hc}{\lambda}$$

$$\Rightarrow \quad 4.08 \times 10^{-19} = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{\lambda}$$

$$\Rightarrow \quad \lambda = 4872 \text{ Å}$$

(b) This line falls in Balmer series of hydrogen spectrum.

21. Given, $r = 1.5 \times 10^{11}$ m

$v = 3 \times 10^4$ m/s

$m = 6.0 \times 10^{24}$ kg

According to Bohr's model, angular momentum is given as,

$$mvr = \frac{nh}{2\pi}$$

$$\Rightarrow \quad n = \frac{mvr2\pi}{h}$$

$$= \frac{6 \times 10^{24} \times 3 \times 10^{4} \times 1.5 \times 10^{11} \times 2 \times 3.14}{6.626 \times 10^{-34}}$$

$$\Rightarrow \quad n \simeq 3.0 \times 10^{74}$$

SECTION C

22. (a) Einstein's photoelectric equation is,

$$hv - hv_0 = KE$$

Through a series of experiments, Millikan determined the slope $\frac{h}{e}$, of the $V_0 \to v$ graph. He calculated the known value of Planck's constant, $h = 6.626 \times 10^{-34}$ J-s, using the slope and electron charge values. Millikan conducted an experiment using a variety of alkali metals for a wide range of incident radiation, and he accurately verified the photoelectric equation.

(b) The threshold frequency is the frequency of incident radiation below which the photoelectric effect does not occur. At the threshold frequency, the electron is just ejected but does not have any kinetic energy to it. And when the energy with frequency more than the threshold frequency is incident on the surface, the electron gets ejected with a kinetic energy.

23. (a) The total number of electric field lines passing through an area per unit time is defined as electric flux. It is represented by ϕ.

$$\phi = \vec{E}.\vec{A}$$

Its dimensions are,

$$\phi = [MLT^{-3}I^{-1}].[L^2]$$
$$\phi = [ML^3T^{-3}I^{-1}]$$

(b) $$\vec{E} = 100\frac{\text{N}}{\text{C}}\hat{i}$$

side $= 1$ cm $= 0.01$ m

Surface area, $A = (0.01)^2 = 1 \times 10^{-4}$ m^2

Normal unit vector, $\hat{n} = 0.8\hat{i} + 0.6\hat{k}$

Angle, $$\theta = \tan^{-1}\left(\frac{0.6}{0.8}\right) = 36.87°$$

Now, $$\phi = EA\cos\theta$$
$$\phi = 100(1 \times 10^{-4}) \cos 36.87$$
$$\phi = 10^{-2} \times 0.8$$
$$\phi = 8 \times 10^{-3} \text{ Nm}^2/\text{C}$$

24. (a) (i) Lenz's law states that the direction of the induced current is such that the magnetic flux produced will oppose the change in flux which induced in the EMF in the first place.

Lenz's law is based upon the law of conservation of energy. Lenz law states that the induced current always tends to oppose the cause which produce it. So, in order to do work against opposing force we have to put extra effort. This extra work leads to periodic change in magnetic flux hence more current is induced. Thus, the extra effort is just transformed into electrical energy which is law of conservation of energy.

(ii) Given, $l = 2$ m

$\omega = 60$ rev/s

$B = 2T$

We know, $\varepsilon = \frac{1}{2}Bl^2w$

$\varepsilon = \frac{1}{2}(2)(2)^2(60)$

$\varepsilon = 4 \times 60$

$\varepsilon = 240$ V

OR

24. (b) (i) Ampere's circuit law state that the line integral of the magnetic field r around a closed path is equal to the product of magnetic permeability of that space and the current through the area bounded by the path.

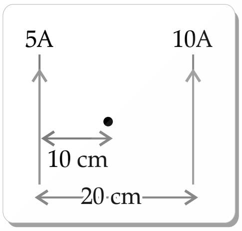
That is $\oint \vec{B}.\vec{dl} = \mu_0 I$

Where B is the magnetic field , μ_0 the magnetic permeability and I is the current through the area bounded by the path .

For its explanation, we can say that, Ampere's circuit law is the generalization of Biot-Savart's law. It is used to determine the magnetic field at any point due to distribution of current.

(ii) Given, $I_1 = 5A$

$I_2 = 10A$



We know, $B = \frac{\mu_0}{4\pi}\frac{2I}{d}$

So, $B_1 = \frac{\mu_0}{4\pi}\frac{10}{(0.01)} \otimes$

$B_2 = \frac{\mu_0}{4\pi}\frac{20}{(0.01)} \odot$

Thus, $B = B_2 - B_1$

$B = \frac{\mu_0}{4\pi(0.01)}(20-10)$

$B = \frac{10^{-7}\times 10}{0.01}$

$B = 10^{-4}$ T(outward direction)

25. Given, $\vec{v} = (1.0\times10^7 \text{ m/s})\hat{i} + (0.5\times10^7 \text{ m/s})\hat{j}$

$\vec{B} = (0.5 \text{ mT})\hat{j}$

Since, $\frac{mv^2}{r} = qvB$

$\Rightarrow \quad r = \frac{mv_x}{qB} = \frac{(9.10\times10^{-31}\times1.0\times10^7)}{(1.6\times10^{-19}\times0.5\times10^{-3})}$

$r = 11.3875 \times 10^{-2}$ m

$r = 11.39$ cm

Now, $T = \frac{2\pi r}{v} = \frac{2\pi m}{qB}$

$T = \frac{2\times3.14\times9.11\times10^{-31}}{1.6\times10^{-19}\times0.5\times10^{-3}}$

$T = 71.51 \times 10^{-9}$ s

$T = 71.51$ ns

The electron traces a linear path too. For one revolution pitch,

$T \times v_y = 71.51 \times 10^{-9} \times 0.5 \times 10^7$

$= 35.75 \times 10^{-2}$ m

$= 35.75$ cm

26. (a) (i) Infrared

(ii) Ultraviolet

(b) Production:

(1) Heated bodies radiate infrared rays.

(2) Ultraviolet rays are produced when electric current passed through gaseous medium known as gas discharge.

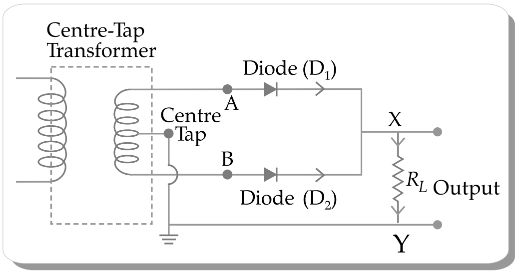
Detection:

(1) Infrared rays are detected using the point contact diodes.

(2) Ultraviolet light is detected using the specialised UV detectors.

27. (a) If an alternating voltage is applied across a junction diode, then the current will only in the part where it is forward biased. This property of junction diode can be used to rectify alternating current. The circuit used for this purpose is a rectifier.

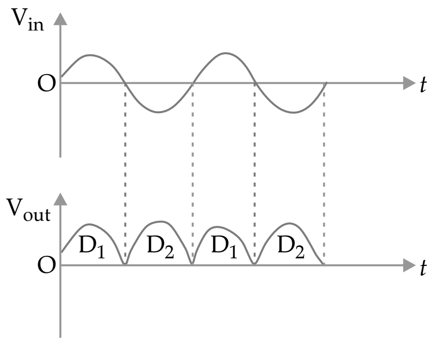
(b)



A full wave rectifier consists of two diodes connected in parallel across the ends of secondary winding of a centre tapped step down transformer. The load resistance R_L is connected across secondary winding and the diodes between A and B as shown in the circuit.

During positive half cycle of input a.c., end A of the secondary winding becomes positive and end B negative. Thus, diode D_1 becomes forward biased, whereas diode D_2 reverse biased. So, diode D_1 allows the current to flow through it, while diode D_2 does not, and current in the circuit flows from D_1 and through load R_L from X to Y.

During negative half cycle of input a.c., end A of the secondary winding becomes negative and end B positive, thus diode D_1 becomes reverse biased, whereas diode D_2 forward biased. So, diode D_1 does not allow the current to flow through it but diode D_2 does, and current in the circuit flows from D_2 and through load R_L from X to Y.



Input-Output waveforms

Since, in both the half cycles of input a.c., electric current through load R_L flows in the same direction, so d.c. is obtained across R_L. Although the direction of electric current through R_L remains same, but its magnitude changes with time, so it is called pulsating d.c.

28. **(a)** An intrinsic semiconductor has no fixed charges; instead, every electron comes from a broken bond that also leaves a hole in it. There are no fixed charges in this instance, and the number of positive and negative mobile charges is equal. As a result, an electrically neutral semiconductor is always uniformly doped.

(b) At equilibrium, the *p-n* junction has the same number of majority and minority carriers moving in opposite directions. The net current is the sum of drift current and diffusion current. So, the net current will be zero as diffusion and drift currents are equal and opposite.

(c) Since the current in a reverse-biased diode is caused by the minority charge carriers drifting from one area to another through the junction, the reverse current is essentially independent of the critical voltage. Therefore, a modest voltage is sufficient to continue sweeping the minority charge carriers.

SECTION D

29 **(i) Option (D) is correct.**

Explanation: HCl is a polar molecule because Chlorine atom in HCl is electronegative while Hydrogen is electropositive and they do not share the bonding electrons equally.

(ii) Option (B) is correct.

Explanation: The dipole moment is from negative charge to positive charge. So, when an external electric field is applied, the net dipole moments of induced dipoles is along the direction of the applied electric field.

(iii) Option (B) is correct.

Explanation: When a dielectric slab is inserted between the plates of an isolated charged capacitor, the capacitance increases. We know, $Q = CV$, so, for an isolated capacitor, the potential difference decreases which also concludes that the electric field decreases. Also the energy stored will decrease as the capacitance increases.

(iv) (a) Option (C) is correct.

Explanation: Since,

$$C_o = \frac{A\varepsilon_o}{d}$$

Now,
$$C = \frac{A\varepsilon_o}{d - t + \frac{t}{K}}$$

$$C = \frac{A\varepsilon_o}{d - \frac{d}{5} + \frac{d}{5K}} \qquad [\because t = \frac{q}{2}]$$

$$C = \frac{A\varepsilon_o}{d}\left[\frac{1}{1 - \frac{1}{5} + \frac{1}{5K}}\right]$$

$$C = \left[\frac{5K}{1+4K}\right]C_o$$

OR

(iv) (b) Option (D) is correct.

Explanation: For series combination,

$$\frac{1}{C_S} = \frac{1}{2C_o} + \frac{1}{6C_0}$$

$$\frac{1}{C_S} = \frac{3+1}{6C_o}$$

$$\Rightarrow \qquad C_S = \frac{3C_o}{2}$$

Energy stored,
$$U_S = \frac{1}{2}C_S V^2$$

$$U_S = \frac{1}{2}\left(\frac{3C_o}{2}\right)V^2$$

For parallel combination,

$$C_P = 2C_o + 6C_o$$

$$C_P = 8C_o$$

Energy stored, $U_P = \frac{1}{2}C_P V^2$

$$U_P = \frac{1}{2}(8C_o)V^2$$

Now, $\frac{U_S}{U_P} = \frac{\frac{3}{2}C_o}{8C_o}$

$$\frac{U_S}{U_P} = \frac{3}{16}$$

30. (i) Option (C) is correct.

Explanation: $\sin\theta_1 = \frac{1}{\mu_g}$; $\sin\theta_2 = \frac{1}{\mu_w}$

since, $\mu_g > \mu_w$, $\theta_1 < \theta_2$

Critical angle θ between glass and water will be given by, $\sin\theta = \frac{\mu_w}{\mu_g} \Rightarrow \theta > \theta_2$

(ii) Option (C) is correct.

Explanation: When a ray of light is refracted into a denser medium, the frequency remains same but the wavelength decreases.

We know, $\mu = \frac{v_{rarer}}{v_{denser}} > 1$

$\Rightarrow \quad v_{rarer} > v_{denser}$

$\Rightarrow \quad \lambda_1 \nu_1 > \lambda_2 v_2 \quad$ [as $\nu_1 = \nu_2$]

$\Rightarrow \quad \lambda_1 > \lambda_2$

(iii) (a) Option (D) is correct.

Explanation: The critical angle is least for violet colour because its refractive index is the highest.

OR

(b) Option (D) is correct.

Explanation: In the case of minimum deviation, the refraction from the second surface for all the three rays are equal. For minimum deviation, the ray should be parallel to the base of the prism.

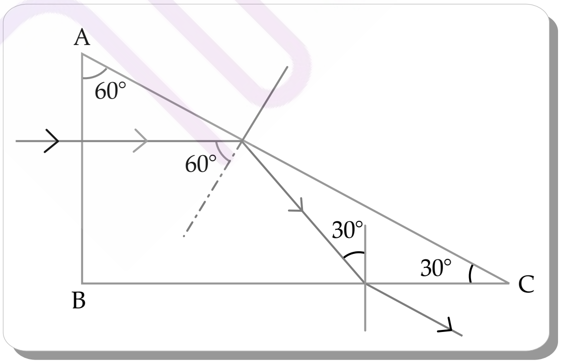
(iv) Option (D) is correct.

Explanation: $\mu = \sqrt{2}$

$\Rightarrow \quad \sin i_c = \frac{1}{\mu} = \frac{1}{\sqrt{2}}$

$$i_c = 45°$$

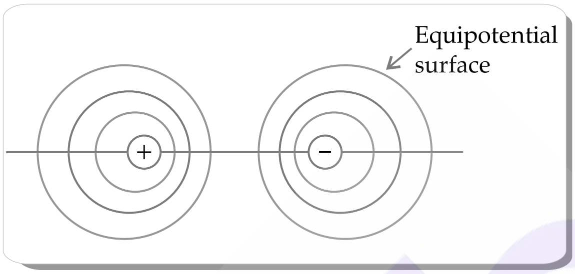
Now,



As the incident angle is greater than the critical angle, the ray will undergo total internal reflection.

SECTION E

31. (a) (i)



(ii) Work done is bringing the charge q_1 from infinity to the position r_1,

$$W_1 = q_1 V(r_1)$$

Work done in bringing the charge q_2 to the position r_2

$$W_2 = q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_o r_2}$$

Hence, total potential energy of system,

$$U = W_1 + W_2$$

$$U = q_2 V(r_1) + q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_o r_2}$$

(iii) Given, $P = 10^{-30}$ cm

$$E = 10^5 \text{ V/m}$$

$$\Delta U = -PE(\cos\theta_2 - \cos\theta_1)$$

$$\Delta U = -10^{-30} \times 10^5(\cos 60° - \cos 0°)$$

$$\Delta U = -10^{-30} \times 10^5\left(-\frac{1}{2}\right)$$

$$\Delta U = 10^{-25} \text{ J}$$

OR

(b) (i) (i) Outside the shell:

Let $\vec{E}$ be the electric field at P. The electric field through an elemental surface $\vec{dS}$ is, $d\phi = \vec{E}.\vec{dS}$

Total electric flux through the gaussian surface is

$$\phi = \oint_S EdS = E\oint_S dS = E(4\pi r^2)$$

Also, $\phi = \frac{q}{\varepsilon_o}$

$\Rightarrow \quad E(4\pi r^2) = \frac{q}{\varepsilon_o}$

$\Rightarrow \quad E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2} \quad$ (for $r > R$)

(ii) Inside the shell:

$\Rightarrow \quad E(4\pi r^2) = 0$

$$E = 0$$

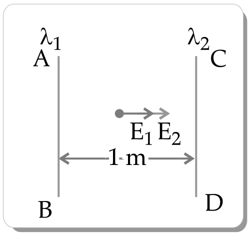
(ii) Given, $\lambda_1 = 10\mu$ C/m

$$\lambda_2 = -20\mu \text{ C/m}$$

$$d = 1 \text{ m}$$

For a point at a distance from linear charge,

$$E = \frac{\lambda}{2\pi\varepsilon_o r}$$



Total electric field,

$$E = E_1 + E_2$$

$$E = \frac{\lambda_1}{2\pi\varepsilon_o r} + \frac{\lambda_2}{2\pi\varepsilon_o r}$$

$$E = \frac{2}{4\pi\varepsilon_o r}(\lambda_1 + \lambda_2)$$

$$E = \frac{2\times 10^9 \times 9}{0.5}(10\times 10^{-6} - 20\times 10^{-6})$$

$$E = -36 \times 10^9 \times 10^{-5}$$

$$E = -3.6 \times 10^5 \text{ N/C}$$

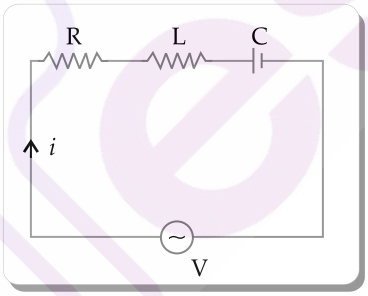
The direction of electric field is towards wire CD.

32. (a) (i) Since, the phase difference between V and I is zero, hence, the element X is a resistor.

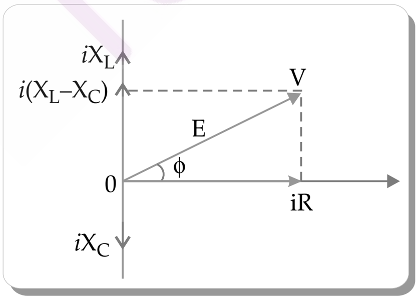
Since, the voltage leads the current by $\frac{\pi}{4}$, hence, the element Y is an inductor.

And, since, the current leads the voltage by $\frac{\pi}{4}$, hence, the element Z is a capacitor.

(ii)



Circuit diagram



Phasor diagram

Now,

$$V_R = i_o R$$

$$V_L = i_o X_L$$

$$V_C = i_o X_C$$

$\Rightarrow$

$$V^2 = VR^2 + (V_L - V_C)^2$$

$$V^2 = i^2(R^2 + (X_L - X_C)^2)$$

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

$\Rightarrow$

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

When $X_L = X_C$

$$\omega_r L = \frac{1}{\omega_r C}$$

$\Rightarrow$

$$\omega_r = \frac{1}{\sqrt{LC}}$$

$$2\pi\nu_r = \frac{1}{\sqrt{LC}}$$

$$\nu_r = \frac{1}{2\pi\sqrt{LC}}$$

At this frequency ν_r, as $X_L = X_C$

$\Rightarrow$ $Z = R \rightarrow$ minimum

From the above relation, for frequencies greater than or less than ω_r, the values of current are less than the maximum value (I_0).

(iii) (i) When, $X_L = X_C$

$\therefore$ $Z = R$

So, the impedance is minimum when $X_L = X_C$.

(ii) $P = VI \cos\phi$

When $\phi = \frac{\pi}{2}$

$$P = 0$$

Therefore, wattless current flows when the impedance of the circuit is purely inductive or purely capacitive, i.e., $R = 0$.

OR

(b) (i) Transformer: A transformer is a device that can be used to increase or decrease an alternating voltage to any desired level. Step down transformers are the first kind of transformers that produce an output voltage that is lower than the input voltage. Step up transformers are the second kind of transformers that provide an output voltage that is higher than the input voltage.

Principle: When the current in a nearby coil varies, an e.m.f. is induced in the secondary coil.

Construction: The figure depicts a basic transformer. It is composed of two coils with varying turns wound around a closed, laminated soft iron core. Insulated wire is used to create the coils. The primary coil is the one to which the AC input voltage is applied, and the secondary coil is the one across which the AC output voltage is measured.

Working: When the primary is subjected to an alternating voltage, the resulting current creates an alternating magnetic flux that connects the secondary and causes an electromagnetic field (emf) in it. The number of turns determines this emf's value.

Let ϕ be flux in each turn in the core at time t due to current in primary when a voltage V_P is applied to it.

So, $$\varepsilon_S = -N_S \frac{d\phi}{dt}$$

Also, $$\varepsilon_P = -N_P \frac{d\phi}{dt}$$

But $\varepsilon_P = V_P$ and for small current $\varepsilon_S = V_S$

$$\Rightarrow \quad \frac{V_S}{V_P} = \frac{N_S}{N_P}$$

(ii) 1. Copper loss

(1) Heat energy lost as a result of the resistance of the copper coils used in a transformer's windings is known as copper loss.

(2) Using wire with a large cross-sectional area in the coils can reduce copper loss.

2. Hysteresis loss

(1) Hysteresis loss is the term for energy lost as a result of the transformer's constant magnetization and demagnetization.

(2) Soft magnetic core materials, such as silicon iron or permalloy, can reduce hysteresis loss in transformers.

3. Flux loss

(1) Poor coupling between the primary and secondary coils results in flux loss.

(2) Winding a transformer's primary and secondary coils one over the other will lower flux loss.

4. Eddy current loss

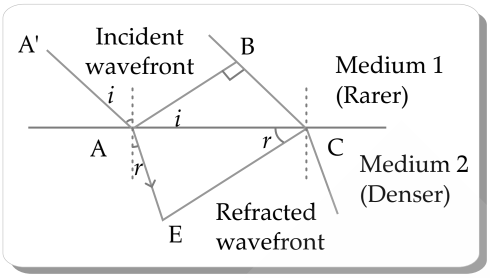
(1) Eddy current loss results from energy loss in a metallic plate kept in a time-varying magnetic field.

(2) It can be reduced by using a transformer with a laminated iron core.

33. (a) (i) Here, v_1 and v_2 are speeds of light in medium 1 and 2 as shown $BC = vt$ to get the shape of wave front draw an arc of radius v_2t form A towards medium 2.

If CE is tangent plane then $AE = v_2t$,

CE represents refracted wave front



In ΔABC, $$\sin i = \frac{BC}{AC} = \frac{v_1 t}{AC}$$

In ΔAEC, $$\sin r = \frac{AE}{AC} = \frac{v_2 t}{AC}$$

$$\Rightarrow \quad \frac{\sin i}{\sin r} = \frac{v_1}{v_2} \quad \text{...(i)}$$

Also, $\mu_1 = \dfrac{C}{v_1}$; $\mu_2 = \dfrac{C}{v_2}$

$$\Rightarrow \quad \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} \quad \text{...(ii)}$$

From (i) & (ii)

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$$

This is snell's is law of refraction.

(ii) Given, $d = 0.30 \text{ mm} = 0.30 \times 10^{-3}$ m

$D = 1.5$ m

$\lambda = 600 \text{ nm} = 600 \times 10^{-9}$ m

For dark fringe,

$$x_n = \frac{(2n-1)}{2} \frac{\lambda D}{d}$$

When $n = 4$

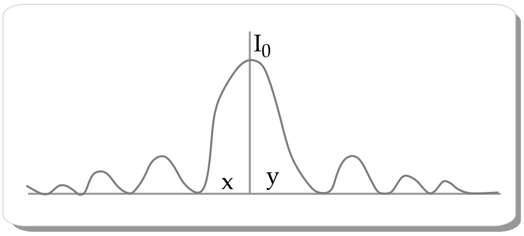
$$x_4 = \frac{(8-1)}{2} \frac{600 \times 10^{-9} \times 1.5}{0.30 \times 10^{-3}}$$

$$x_4 = \frac{7}{2} \frac{600 \times 10^{-9} \times 1.5}{0.30 \times 10^{-9}}$$

$$x_4 = 1.05 \text{ cm}$$

OR

(b) (i) Diffraction of light from a single slit: When monochromatic light is incident on a single slit, it diffracts light at that location. Behind the slit, on a screen, is the diffraction pattern. There are both dark and bright bands in the diffraction pattern. The central band reaches its peak intensity and then continues to decrease on either side.



(ii) Apply mirror's focal length formula.

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

for concave mirror, $f < 0$ & $u < 0$

$\Rightarrow \quad \frac{1}{v} = \frac{1}{f} - \frac{1}{u}$; since $u < f < 0$

$\Rightarrow \quad \frac{1}{f} - \frac{1}{u} > 0$

or $\quad \frac{1}{v} > 0$

$\Rightarrow \quad v > 0$

This shows that image is an right side of concave mirror.

Now, $\quad m = \frac{-v}{u}$

$\because \quad v > 0$ & $u < 0$

$\Rightarrow \quad m > 0$

Therefore, virtual and enlarged image is obtained.