Chengalpattu District

SECOND REVISION EXAM – JAN 2025

XII - Physics Answer Key

PART - A

I. Answer all the questions. Choose the correct answers. 15x1=15

1.	(c)	Refraction
2.	(d)	Polarization
3.	(d)	Energy density
4.	(c)	480 W
5.	(b)	45^0
6.	(d)	Am^2
7.	(d)	$V_s > V_p$
8.	(c)	$\frac{Q}{\sqrt{2}}$
9.	(b)	Line absorption
10.	(d)	$\lambda_p \alpha \lambda_e^2$
11.	(b)	3750 A^0
12.	(d)	Steel and Aluminium
13.	(a)	Current gain CE configuration
14.	(b)	OR gate
15.	(c)	1

PART - B

II. Answer any six questions. Question No. 24 is compulsory. 6x2=12

16 During lightning accompanied by a thunderstorm, it is always safer to sit inside a bus than in open ground or under a tree.

17 Temperature coefficient of resistivity is defined as the ratio of increase in resistivity per degree rise in temperature to its resistivity at T_0.

18 One ampere is defined as that constant current which when passed through each of the two infinitely long parallel straight conductors kept side by side parallelly at a distance of one metre apart in air or vacuum causes each conductor to experience a force of 2×10^{-7} newton per metre length of conductor.

19 Induced emf can be produced by changing magnetic flux in any of the following ways.

i. By changing the magnetic field *B*
ii. By changing the area *A* of the coil and
iii. By changing the relative orientation θ of the coil with magnetic field

20 Infrared radiation is used to produce dehydrated fruits, in green houses to keep the plants warm, heat therapy for muscular pain or sprain, TV remote as a signal carrier, to look through haze fog or mist and used in night vision or infrared photography.

21 The *principle of reversibility* states that light will follow exactly the same path if its direction of travel is reversed.

22

Interference	Diffraction
Equally spaced bright and dark fringes	Central bright is double the size of other fringes
Equal intensity for all bright fringes	Intensity falls rapidly for higher order fringes
Large number of fringes are obtained	Less number of fringes are obtained

.

23 The zone (in between A and B) where there is no reception of electromagnetic waves neither ground nor sky is known as skip zone or skip area

24 $N_0 = 100\%$

Decayed = 60% of N_0

Un decayed = 40% of N_0

$N = N_0 e^{-\lambda t}$

T ½ =3.5 days

$$\left(\frac{40}{100}\right) N_0 = N_0 \, e^{\lambda t}$$

$$\left(\frac{40}{100}\right) = e^{\lambda t}$$

$$\left(\frac{100}{40}\right) = 2.5 = e^{\lambda t}$$

$\log_e = 2.5 = \lambda t$

$t = \frac{\log_e 2.5}{\lambda} = \frac{2.3026 \, x \, \log_{10} 2.5}{\lambda}$

t= 5.022 days

PART - C

III Answer any six questions. Question No. 33 is compulsory. 6x3=18

25 Capacitor not only stores the charge but also it stores energy. When a battery is connected to the capacitor, electrons of total charge $-Q$ are transferred from one plate to the other plate. To transfer the charge, work is done by the battery. This work done is stored as electrostatic potential energy in the capacitor.

To transfer an infinitesimal charge *dQ* for a potential difference *V*, the work done is given by

$$dW = V \, dQ \qquad (1.85)$$

$$\text{where } V = \frac{Q}{C}$$

The total work done to charge a capacitor is

$$W = \int_0^Q \frac{Q}{C} dQ = \frac{Q^2}{2C} \qquad (1.86)$$

This work done is stored as electrostatic potential energy (U_E) in the capacitor.

$$U_E = \frac{Q^2}{2C} = \frac{1}{2}CV^2 \quad (\because Q = CV) \qquad (1.87)$$

26

1. $\vec{F}_m$ is directly proportional to the magnetic field $\vec{B}$
2. $\vec{F}_m$ is directly proportional to the velocity $\vec{v}$ of the moving charge
3. $\vec{F}_m$ is directly proportional to sine of the angle between the velocity and magnetic field
4. $\vec{F}_m$ is directly proportional to the magnitude of the charge q
5. The direction of $\vec{F}_m$ is always perpendicular to $\vec{v}$ and $\vec{B}$ as $\vec{F}_m$ is the cross product of $\vec{v}$ and $\vec{B}$
6. The direction of $\vec{F}_m$ on negative charge is opposite to the direction of $\vec{F}_m$ on positive charge provided other factors are identical as shown Figure 3.44 (b)
7. If velocity $\vec{v}$ of the charge q is along magnetic field $\vec{B}$ then, $\vec{F}_m$ is zero

27

Transformers do not have any moving parts so that its efficiency is much higher than that of rotating machines like generators and motors. But there are many factors which lead to energy loss in a transformer.

i) Core loss or Iron loss: This loss takes place in transformer core. Hysteresis loss (Refer section 3.6) and eddy current loss are known as core loss or Iron loss. When transformer core is magnetized and demagnetized repeatedly by the alternating voltage applied across primary coil, hysteresis takes place due to which some energy is lost in the form of heat. Hysteresis loss is minimized by using steel of high silicon content in making transformer core.

ii) Copper loss: Transformer windings have electrical resistance. When an electric current flows through them, some amount of energy is dissipated due to Joule heating. This energy loss is called copper loss which is minimized by using wires of larger diameter.

iii) Flux leakage: Flux leakage happens when the magnetic lines of primary coil are not completely linked with secondary coil. Energy

loss due to this flux leakage is minimized by winding coils one over the other.

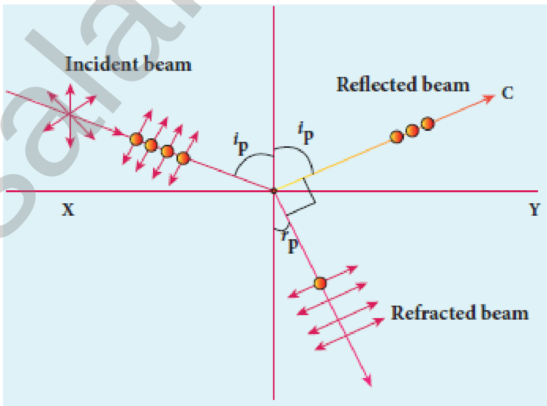
28

Absorption spectra: When light is allowed to pass through a medium or an absorbing substance then the spectrum obtained is known as absorption spectrum. It is the characteristic of absorbing substance. Absorption spectrum is classified into three types:

(i) Continuous absorption spectrum
(ii) Line absorption spectrum
(iii) Band absorption spectrum

29

The British Physicist, Sir. David Brewster found that at the polarising angle, the reflected and the refracted rays are perpendicular to each other. Suppose i_p is the polarising angle and r_p is the angle of refraction, from the geometry as shown in Figure 7.31, we can write,



$$r_p = 90^0 - i_p \qquad (7.56)$$

From Snell's law, the refractive index n of the medium with respect to air is,

$$\frac{\sin i_p}{\sin r_p} = n \qquad (7.57)$$

Substituting equation (7.56) in (7.57), we get,

$$\frac{\sin i_p}{\sin(90^\circ - i_p)} = \frac{\sin i_p}{\cos i_p} = n$$

$$\tan i_p = n \qquad (7.58)$$

30

De Morgan's First Theorem

Statement: The first theorem states that the complement of the sum of two logical inputs is equal to the product of its complements.

Proof

The Boolean equation for NOR gate is $Y = \overline{A+B}$.

The Boolean equation for a bubbled AND gate is $Y = \bar{A}.\bar{B}$.

Both cases generate same outputs for same inputs. It can be verified using the following truth table.

A	B	$A+B$	$\overline{A+B}$	$\bar{A}$	$\bar{B}$	$\bar{A}.\bar{B}$
0	0	0	1	1	1	1
0	1	1	0	1	0	0
1	0	1	0	0	1	0
1	1	1	0	0	0	0

De Morgan's Second Theorem

Statement: The second theorem states that the complement of the product of two inputs is equal to the sum of its complements.

Proof

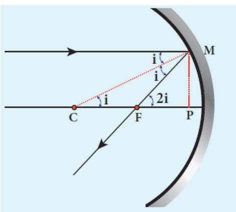
The Boolean equation for NAND gate is $Y = \overline{A.B}$.

The Boolean equation for bubbled OR gate is $Y = \bar{A} + \bar{B}$.

A and *B* are the inputs and *Y* is the output. The above two equations produces the same output for the same inputs. It can be verified by using the truth table

A	B	$A.B$	$\overline{A.B}$	$\bar{A}$	$\bar{B}$	$\bar{A}+\bar{B}$
0	0	0	1	1	1	1
0	1	0	1	1	0	1
1	0	0	1	0	1	1
1	1	1	0	0	0	0

31 **Relation between *f* and *R***: Let *C* be the centre of curvature of the mirror. Consider a ray of light parallel to the principal axis is incident on the mirror at *M*. It passes through the principal focus *F* after reflection. The line *CM* is the normal to the mirror at *M*. Let *i* be the angle of incidence and the same will be the angle of reflection.



(a) Concave mirror

If *MP* is the perpendicular from *M* to the principal axis, then

The angles $\angle MCP = i$ and $\angle MFP = 2i$

From right angle triangles ΔMCP and ΔMFP, we can write,

$$\tan i = \frac{PM}{PC} \text{ and } \tan 2i = \frac{PM}{PF}$$

As the angles are small, $\tan i \simeq i$ and $\tan 2i \simeq 2i$,

$$i = \frac{PM}{PC} \text{ and } 2i = \frac{PM}{PF}$$

Simplifying further,

$$2\frac{PM}{PC} = \frac{PM}{PF};\ 2PF = PC$$

PF is focal length *f* and *PC* is the radius of curvature *R*.

$$2f = R \quad \text{(or)} \quad f = \frac{R}{2} \qquad (6.4)$$

32 **Photo emissive cell**

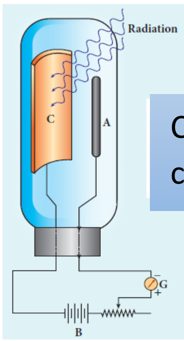
Construction: It consists of an evacuated glass or quartz bulb in which two metallic electrodes – that is, a cathode and an anode are fixed.

The cathode *C* is semi-cylindrical in shape and is coated with a photo sensitive material. The anode *A* is a thin rod or wire kept along the axis of the semi-cylindrical cathode. A potential difference is applied between the anode and the cathode through a galvanometer *G*.

Working: When cathode is irradiated with suitable radiation, electrons are emitted from it. These electrons are attracted by anode and hence a current is produced which is measured by the galvanometer. For a given cathode, the magnitude of the current depends on

i) the intensity of incident radiation and

ii) the potential difference between anode and cathode.



Construction of photo cell

Applications of photo cells: Photo cells have many applications, especially as switches and sensors. Automatic lights that turn on when it gets dark use photocells, and street lights that switch on and switch off according to whether it is night or day use photocells. Photo cells are used for reproduction of sound in motion pictures and are used as timers to measure the speeds of athletes during a race. Photo cells of exposure meters in photography are used to measure the intensity of the given light and to calculate the exact time of exposure.

33

(33) Current density $J = \frac{I}{A} = \frac{2}{10^{-6}}$

$J = 2\times10^{6}\ A m^{-2}$

drift velocity $v_d = \frac{J}{ne} = \frac{2\times10^{6}}{8\times10^{28}\times1.6\times10^{-19}}$

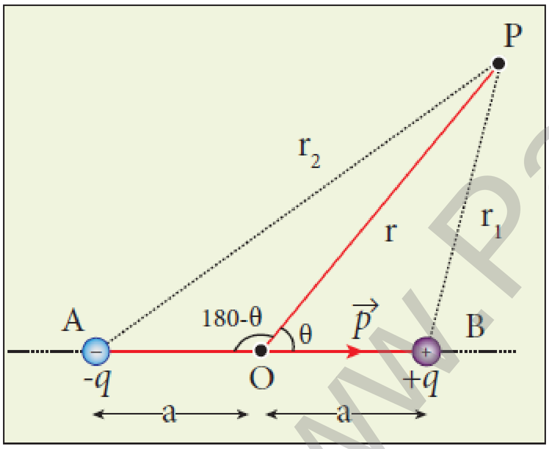
$= \frac{1\times10^{-3}}{6.4} = 0.15625\times10^{-3}$

$v_d = 15.6\times10^{-5}\ m s^{-1}$

IV PART - D

Answer in detail. 5x5=25

34 a **Electrostatic potential at a point due to an electric dipole:** Consider two equal and opposite charges separated by a small distance 2*a*. The point P is located at a distance *r* from the midpoint of the dipole. Let ϑ be the angle between the line OP and dipole axis AB.



Let r_1 be the distance of point P from $+q$ and r_2 be the distance of point P from $-q$.

Potential at P due to charge $+q = \frac{1}{4\pi\epsilon_o}\frac{q}{r_1}$

Potential at P due to charge $-q = -\frac{1}{4\pi\epsilon_o}\frac{q}{r_2}$

Total potential at the point P

$$V = \frac{1}{4\pi\epsilon_o}q\left(\frac{1}{r_1}-\frac{1}{r_2}\right) \qquad (1.35)$$

$$r_1^2 = r^2 + a^2 - 2ra\cos\theta$$

$$r_1^2 = r^2\left(1+\frac{a^2}{r^2}-\frac{2a}{r}\cos\theta\right)$$

$$r_1^2 = r^2\left(1-2a\frac{\cos\theta}{r}\right)$$

$$\text{(or) } r_1 = r\left(1-\frac{2a}{r}\cos\theta\right)^{\frac{1}{2}}$$

$$\frac{1}{r_1} = \frac{1}{r}\left(1-\frac{2a}{r}\cos\theta\right)^{-\frac{1}{2}}$$

$$\frac{1}{r_1} = \frac{1}{r}\left(1+\frac{a}{r}\cos\theta\right) \qquad (1.36)$$

$$r_2^2 = r^2 + a^2 - 2ra\cos(180-\theta)$$

since $\cos(180-\theta) = -\cos\theta$ we get

$$r_2^2 = r^2 + a^2 + 2ra\cos\theta$$

$$r_2^2 = r^2\left(1+\frac{2a\cos\theta}{r}\right)$$

$$r_2 = r\left(1+\frac{2a\cos\theta}{r}\right)^{\frac{1}{2}}$$

Using Binomial theorem, we get

$$\frac{1}{r_2} = \frac{1}{r}\left(1-a\frac{\cos\theta}{r}\right) \qquad (1.37)$$

$$V = \frac{1}{4\pi\epsilon_o}q\left(\frac{1}{r}\left(1+a\frac{\cos\theta}{r}\right)-\frac{1}{r}\left(1-a\frac{\cos\theta}{r}\right)\right)$$

$$V = \frac{q}{4\pi\epsilon_o}\left(\frac{1}{r}\left(1+a\frac{\cos\theta}{r}-1+a\frac{\cos\theta}{r}\right)\right)$$

$$V = \frac{1}{4\pi\epsilon_o}\frac{2aq}{r^2}\cos\theta$$

$$V = \frac{1}{4\pi\epsilon_0}\left(\frac{p\cos\theta}{r^2}\right)$$

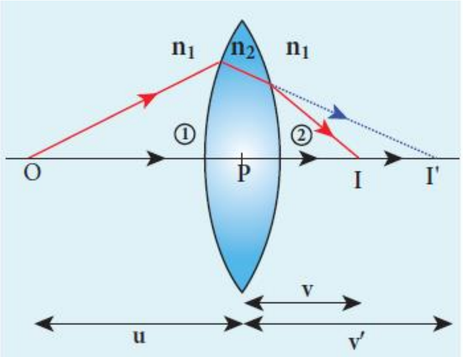
$$V = \frac{1}{4\pi\epsilon_o}\frac{p}{r^2} \qquad (1.39)$$

$$V = -\frac{1}{4\pi\epsilon_o}\frac{p}{r^2} \qquad (1.40)$$

$$V = 0 \qquad (1.41)$$

34 b

Lens maker's formula and lens equation:



$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{(n_2 - n_1)}{R}$$

For the refracting surface ①, the light goes from n_1 to n_2.

$$\frac{n_2}{v'} - \frac{n_1}{u} = \frac{(n_2 - n_1)}{R_1} \qquad (6.58)$$

For the refracting surface ②, the light goes from medium n_2 to n_1.

$$\frac{n_1}{v} - \frac{n_2}{v'} = \frac{(n_1 - n_2)}{R_2} \qquad (6.59)$$

$$\frac{n_1}{v} - \frac{n_1}{u} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

On further simplifying and rearranging,

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2 - n_1}{n_1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad (6.60)$$

$$\frac{1}{f} - \frac{1}{\infty} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad (6.61)$$

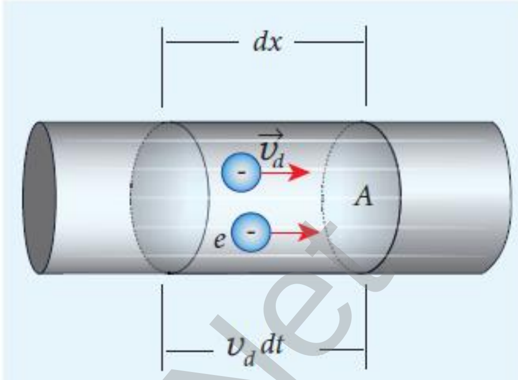
$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad (6.62)$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \qquad (6.63)$$

35 a

Microscopic model of current:

Consider a conductor with area of cross section A and let an electric field $\vec{E}$ be applied to it from right to left. Suppose there are n electrons per unit volume in the conductor and assume that all the electrons move with the same drift velocity $\vec{v}_d$ as shown in Figure 2.5.



$$v_d = \frac{dx}{dt}\ ; \quad dx = v_d\, dt \qquad (2.7)$$

$$= A\,dx \times n \qquad (2.8)$$

$$dQ = (e)(A v_d dt)n$$

Hence the current $I = \dfrac{dQ}{dt}$

$$I = neAv_d \qquad (2.9)$$

$$J = nev_d \qquad (2.10)$$

$$\vec{J} = -\frac{n \cdot e^2 \tau}{m}\vec{E} \qquad (2.11)$$

$$\vec{J} = -\sigma\vec{E}$$

$$\vec{J} = \sigma\vec{E} \qquad (2.12)$$

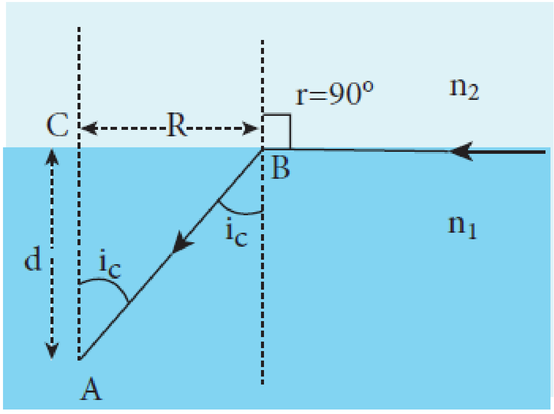
$$\rho = \frac{1}{\sigma} = \frac{m}{ne^2\tau} \qquad (2.13)$$

35 B

Radius of illumination **(Snell's window)**

When a source of light like electric bulb is kept inside a water tank, the light from the source travels in all direction inside the water. The light that is incident on the water surface at an angle less than the critical angle will undergo refraction and emerge out from the water. The light incident at an angle greater than critical angle will undergo total internal reflection.The light falling particularly at critical angle graces the surface. Thus, the entire surface of water appears illuminated when seen from outside.

On the other hand, when the light entering the water from outside is seen from inside the water, the view is restricted to a particular angle equal to the critical angle i_c. The restricted illuminated circular area is called *Snell's window.* The angle of view for water animals is restricted to twice the critical angle $2i_c$. The critical angle for water is 48.6°. Thus the angle of view is 97.2°. The radius *R* of the circular area depends on the depth *d* from which it is seen and also the refractive index *n* of the medium. The radius *R* of Snell's window can be deduced with the illustration.



$$n_1 \sin i_c = n_2 \sin 90^0 \qquad (6.32)$$

$$n_1 \sin i_c = n_2 \qquad \because \sin 90^0 = 1$$

$$\sin i_c = \frac{n_2}{n_1} \qquad (6.33)$$

From the right angle triangle ΔABC,

$$\sin i_c = \frac{CB}{AB} = \frac{R}{\sqrt{d^2 + R^2}} \qquad (6.34)$$

Equating the above two equations (6.33) and (6.34), $\frac{R}{\sqrt{d^2+R^2}} = \frac{n_2}{n_1}$

Squaring on both sides, $\frac{R^2}{R^2+d^2} = \left(\frac{n_2}{n_1}\right)^2$

Further simplifying,

$$1 + \frac{d^2}{R^2} = \left(\frac{n_1}{n_2}\right)^2; \qquad \frac{d^2}{R^2} = \left(\frac{n_1}{n_2}\right)^2 - 1;$$

$$\frac{d^2}{R^2} = \frac{n_1^2}{n_2^2} - 1 = \frac{n_1^2 - n_2^2}{n_2^2}$$

Again taking reciprocal and rearranging,

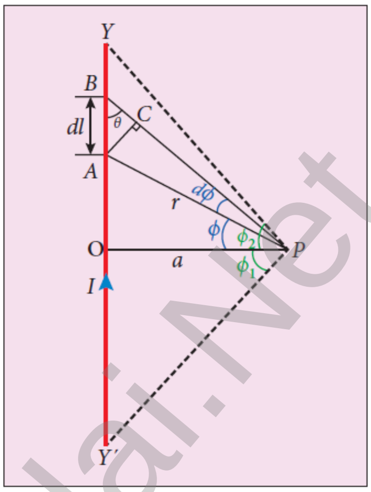
$$\frac{R^2}{d^2} = \frac{n_2^2}{n_1^2 - n_2^2}; \qquad R^2 = d^2\left(\frac{n_2^2}{n_1^2 - n_2^2}\right)$$

After taking the squre root, the radius of illuminated

$$R = d\sqrt{\frac{n_2^2}{(n_1^2 - n_2^2)}} \qquad (6.35)$$

$$R = d\left(\frac{1}{\sqrt{n^2 - 1}}\right) \text{ (or) } R = \frac{d}{\sqrt{n^2 - 1}} \qquad (6.36)$$

36 A **Magnetic field due to long straight conductor carrying current:**



$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{Idl \sin\theta}{r^2} \hat{n}$$

$$\Rightarrow AC = AB \sin\theta$$

But AB = $dl \Rightarrow AC = dl \sin\theta$

Let $d\phi$ be the angle subtended between AP and BP

i.e., $\angle APB = \angle APC = d\phi$

$$\therefore AC = dl \sin\theta = r d\phi$$

$$\therefore d\vec{B} = \frac{\mu_0}{4\pi} \frac{I}{r^2}(r d\phi)\hat{n} = \frac{\mu_0}{4\pi} \frac{I d\phi}{r} \hat{n}$$

$$\Rightarrow r = \frac{a}{\cos\phi}$$

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I}{a/\cos\phi} d\phi \hat{n}$$

$$\Rightarrow d\vec{B} = \frac{\mu_0 I}{4\pi a} \cos\phi \, d\phi \, \hat{n}$$

$$\vec{B} = \int_{-\phi_1}^{\phi_2} d\vec{B} = \int_{-\phi_1}^{\phi_2} \frac{\mu_0 I}{4\pi a} \cos\phi \, d\phi \, \hat{n}$$

$$= \frac{\mu_0 I}{4\pi a} [\sin\phi]_{-\phi_1}^{\phi_2} \hat{n}$$

$$= \vec{B} = \frac{\mu_0 I}{4\pi a}\left(\sin\phi_1 + \sin\phi_2\right)\hat{n}$$

For infinitely long conductor,

$\phi_1 = \phi_2 = 90°$

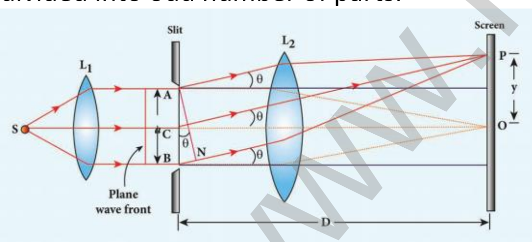
$$\therefore \vec{B} = \frac{\mu_0 I}{4\pi a} \times 2\hat{n} \Rightarrow \vec{B} = \frac{\mu_0 I}{2\pi a}\hat{n} \qquad (3.36)$$

36 B

Diffraction in single slit: Let a parallel beam of light (plane wavefront) fall normally on a single slit AB of width *a*. The diffracted beam falls on a screen kept at a distance *D* from the slit. The center of the slit is *C*. A straight line through *C* perpendicular to the plane of slit meets the center of the screen at *O*. Consider any point *P* on the screen. All the light reaching the point *P* from different points on the slit make an angle ϑ with the normal *CO*.

All the light waves coming from different points on the slit interfere at point *P* (and other points) on the screen to give the resultant intensities. The point *P* is in the geometrically shadowed region, up to which the central maximum is spread due to diffraction. We need to give the condition for the point *P* to be of various minima.

The basic idea is to divide the slit into even number of smaller parts. Then, add their contributions at *P* with the proper path difference to show that destructive interference takes place at that point to make it minimum. To explain maximum, the slit is divided into odd number of parts.



Condition for P to be nth minimum

Dividing the slit into 2*n* number of (even number of) equal parts makes the light produced by one of the corresponding points to be cancelled by its counterpart. Thus, the condition for n^{th} minimum is,

$$\frac{a}{2n}\sin\theta = \frac{\lambda}{2}$$

$$a \sin\theta = n\lambda \qquad (7.40)$$

	Where, $n = 1, 2, 3 \ldots$ is the order of diffraction minimum.
37 A	