important chapter

Saathi

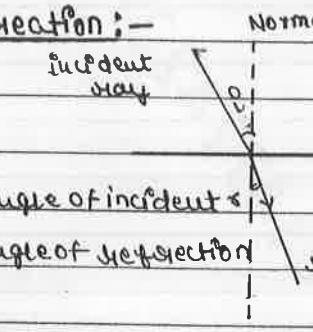
Date __/__/____

Ray optics

topics :-

1. Reflection
2. Refraction
3. Prism
4. lens
5. optical instruments.

Refraction :-



Speed → change

i = angle of incident

r = angle of refraction

All angle measure From Normal

Refractive Index

☆ $\mu = 1$ air ⟷ $\mu = \frac{4}{3}$ 1.33 water

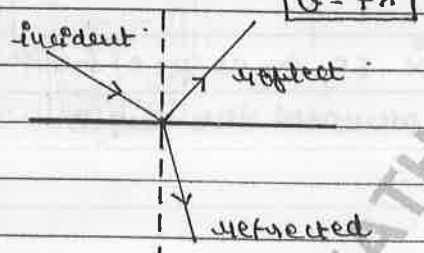
rarer ↑ denser ↑

water ⟷ Glass

1.33 $\mu = 1.5$

☆ Ref Index = $\frac{c}{v}$ = Speed of light in vacuum / Speed of light in Space

$v = f\lambda$



Refraction Hone ke liye (property of source).

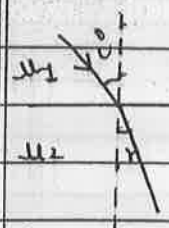
☆ Frequency = constant

Speed → change

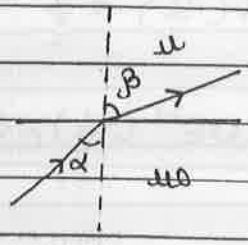
wavelength → change

intensity of light → change (always decreases)

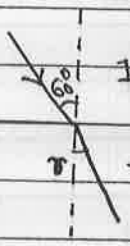
Snell's law :-



$\mu_1 \sin i = \mu_2 \sin r$



$\mu_0 \sin\alpha = \mu \sin\beta$



$1 \sin 60^\circ = \mu \sin r$

☆ incident ray, reflected ray and normal are in a same plane.

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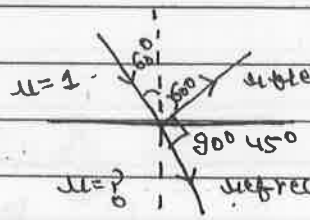
Date ___ / ___ / _____

Q1 In a given situation light enters into air having $\angle i = 60^\circ$. If reflected ray and refracted ray are mutually perpendicular then find out the ref. index of air?



** $\because \angle i = \angle r$

Solve: $60^\circ + 90^\circ + x = 180^\circ$

$150^\circ + x = 180$

$\boxed{x = 30^\circ}$

$1 \times \sin 60^\circ = \mu \times \sin 30^\circ$

$1 \times \frac{\sqrt{3}}{2} = \mu \times \frac{1}{2}$

$\boxed{\mu = \sqrt{3}}$

Q2 Light enters from denser medium μ into air. If the angle of incidence is half of angle of refraction then calculated the angle of refraction?

$\mu \sin\frac{\theta}{2} = 1 \times \sin\theta$

* Important

$\mu \sin\frac{\theta}{2} = \sin\theta$

$\sin 2\theta = 2\sin\theta\cos\theta$

$\sin\theta = 2\sin\frac{\theta}{2}\cos\frac{\theta}{2}$ $\quad \mu\sin\frac{\theta}{2} = 2\sin\frac{\theta}{2}\cos\frac{\theta}{2}$

$\frac{\mu}{2} = \cos\frac{\theta}{2}$

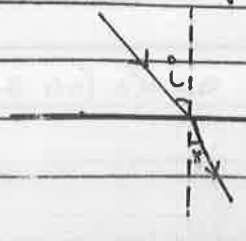
$\cos^{-1}\left(\frac{\mu}{2}\right) = \frac{\theta}{2}$

$\boxed{2\cos^{-1}\left(\frac{\mu}{2}\right) = \theta}$

** Concepts-

Light ray

rarer to denser ray bend toward normal.



** $\mu_1 \sin i = \mu_2 \sin r$

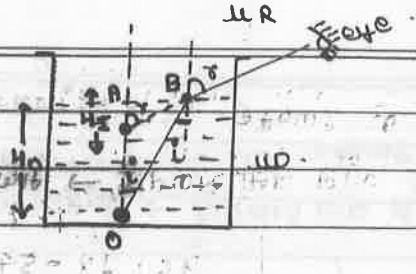
Paraxial rays :- rays having small angles.

optical Illusion :-

Date ___/___/_____

Article - 1.

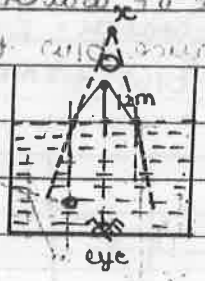
Apparent depth :-



$$\frac{H_I}{H_0} = \frac{\mu_R}{\mu_D}$$

→ μR → Refraction Hone के बाद rays जिस medium में जाती उस medium का Refractive index.

Q1

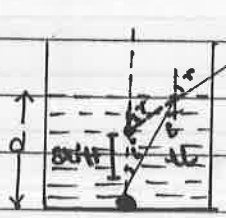


$$\frac{H_I}{H_0} = \frac{\mu_R}{\mu_D}$$

$$\frac{x}{12} = \frac{4}{3}$$

$$x = \frac{4 \times 12}{3} \quad \boxed{x = 16m}$$

AIIMS 2010 → Refraction from plane surface में जिसे दबे object उसकी side image.

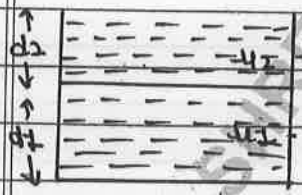


$$\frac{H_I}{H_0} = \frac{\mu_R}{\mu_D}$$

$$\frac{H_I}{d} = \frac{1}{\mu}$$

$$\boxed{H_I = \frac{d}{\mu}}$$ ✱ medium must be air.

$$\boxed{\text{Shift} = \text{dactual} - \text{dapparent}}$$

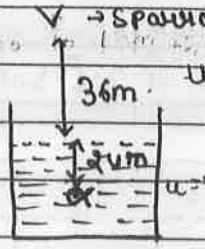


$$d_{actual} = d_1 + d_2$$

$$\boxed{d_{app} = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2}}$$

Fish and Sparrow Questions :-

Q1



$$\frac{x}{24} = \frac{1}{4/3} \quad \text{or} \quad \frac{x}{24} = \frac{3}{4}$$

$$x = \frac{24 \times 3}{4}$$

$$x = 18m.$$

$$H = 36 + 18.$$

$$= 54m.$$

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Date ___ / ___ / _____

पिछा → मछली की image

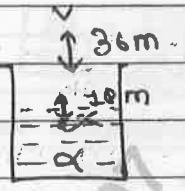
मछली की image कौन बना सकता है → मछली [OBJECT]

$\mu_R = 1$

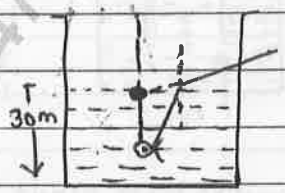
$\mu^\circ = 4/3$

$H_0 = 24m$

$36 + 18 = 54m$



Q A fish at a depth of 30m below the surface of water. If RI of water = 4/3 then find out the distance b/w fish and its image?



$$\frac{H_I}{H_0} = \frac{\mu_R}{\mu^\circ}$$

$$\frac{x}{30} = \frac{1}{4/3}$$

$$\frac{x}{30} = \frac{3}{4} \qquad \frac{30}{4/3}$$

$$\frac{30 \times 3}{4}$$

$$\frac{90}{4}$$

$$30m - \frac{90}{4}m$$

$$\frac{120 - 90}{4} = \frac{30}{4} = 7.5m$$

conceptual point :-

$$\vec{V_{I/S}} = \frac{\mu_R}{\mu^\circ} \vec{V_{O/S}}$$

$\vec{V_{I/S}}$ → velocity of image w.r.t to surface.

$\vec{V_{O/S}}$ → velocity of object w.r.t surface.

μ_R → refraction hone ke Baad rays jis med. me ghusi uska RI.

$$\frac{\vec{V_{I/S}}}{\vec{V_{O/S}}} = \frac{\mu_R}{\mu^\circ}$$

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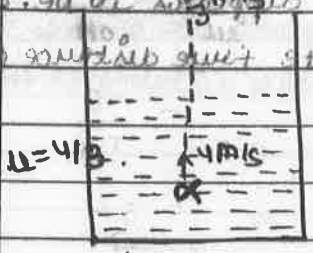
Date ___ / ___ / ___

Q1. Velocity of image of bird as seen by fish.



bird → object

$$\frac{V_{I/S}}{V_{O/S}} = \frac{\mu_R}{\mu_i}$$

$$\frac{x}{3} = \frac{4}{3}$$

$$3x = 4 \times 3$$

$$\boxed{x = 4 \text{ m/s}} \qquad \boxed{x = -4\hat{j} \text{ m/s}}$$

$$\frac{\vec{V_I} - \vec{V_S}}{\vec{V_O} - \vec{V_S}} = \frac{4}{3}$$

$V_S \rightarrow$ zero

$$\frac{x\hat{j} - 0}{-3\hat{j}} = \frac{4}{3}$$

$$\frac{4x - 3\hat{j}}{3}$$

$$\boxed{\vec{V_I} = -4\hat{j} \text{ m/s}}$$

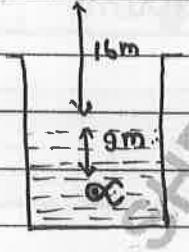
$$V_{I/Fish} = \vec{V_I} - \vec{V_F}$$

$$= -4\hat{j} - 0[+4\hat{j}]$$

$$= -4\hat{j} - 4\hat{j}$$

$$\boxed{V_{I/F} = -8\hat{j} \text{ m/s}}$$

Q2. Bird



માછલી ની સ્થિતિ પર પક્ષી કેવડી દેખાશે?

$$\frac{H_I}{H_O} = \frac{\mu_R}{\mu_i}$$

$$\frac{x}{16} = \frac{4}{3}$$

$$3x = 4 \times 16$$

$$x = \frac{64}{3} \text{ m}$$

$$9 + \frac{64}{3} = \frac{27 + 64}{3} = \frac{91}{3} \text{ m}$$

4:40
Module-6
Ex I = 27, 30, 33, 34, 35
Ex II → 1, 36
Solved eg → 10, 11, 12, 13, 14
Date
Beg 80 x 3 → 2, 3.

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Q4 To a fish in water, A Bird in air appears to be at 30m from the surface. then calculate true distance of the bird from the surface?

solve.

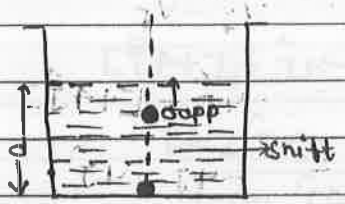
$$\frac{30}{x} = \frac{4}{3}$$

$$4x = 30 \times 3$$

$$x = \frac{90}{4}$$

$$\boxed{x = 22.5\,m}$$

Random Key point :-



actual depth = d

$$\star \quad \boxed{\text{app depth} = \frac{d}{\mu}}$$

$$\star \quad \boxed{\text{shift} = d_{actual} - d_{apparent}}$$

Q1 A microscope focussed on a mark in paper then a glass slab of thickness = 3cm and RI = 1.5 is placed over the mark. How should the microscope is moved to get the mark in focus again?

shift ← 3cm ↓

$$\text{Shift} = d_{actual} - d_{app}$$

$$= 3cm - \frac{3}{1.5}$$

$$= 3cm - 2cm$$

$$= 1cm$$

** Q2 An Air bubble in glass slab with RI = 1.5 is 5cm deep when viewed from 1 surface and 3cm deep when viewed from opp. face. Calculate the

(i) thickness of slab?

$$\frac{H_I}{H_O} = \frac{\mu_R}{\mu_O}$$

$$\frac{5}{x} = \frac{1}{1.5}$$

$$\boxed{x = 7.5\,m}$$

Date ___/___/_____

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$$\frac{H_I}{H_O} = \frac{\mu_R}{\mu_O}$$

$$\frac{3}{x-1} = \frac{1}{1.5}$$

$$4.5 = x - 7.5$$

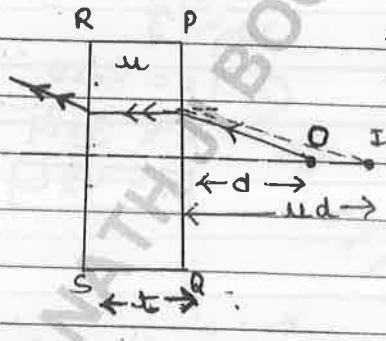
$$\boxed{x = 12\,cm}$$

Concept :-

$$\text{Actual depth} = d_1 + d_2 + d_3$$

$$\boxed{\text{apparent depth} = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} + \frac{d_3}{\mu_2}}$$

Normal shift :-



$t \rightarrow$ thickness of slab

$\mu \rightarrow$ refractive index.

PQ की ऊपर से देखने पर

$$\frac{H_I}{H_O} = \frac{\mu_R}{\mu_O}$$

$$\frac{H_I}{d} = \frac{\mu}{1}$$

$$\boxed{H_I = \mu d}$$

ऊपर से RS की object की image I_1

$$\frac{H_I}{H_O} = \frac{\mu_R}{\mu_O}$$

$$\frac{H_I}{\mu d + t} = \frac{1}{\mu}$$

$$\boxed{H_I = d + \frac{t}{\mu}}$$

$$\text{Shift} = (d+t) - \left(d + \frac{t}{\mu}\right)$$

$$= t - \frac{t}{\mu}$$

$$\boxed{\text{shift} = t\left(1 - \frac{1}{\mu}\right)}$$

O.T.4

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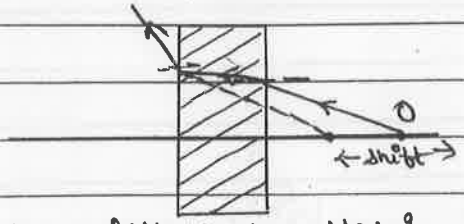
Date ___ / ___ / ____

$$\text{Shift} = \pm t\left(1 - \frac{1}{\mu}\right)$$



shift = ⊕ve .

always in the direction of light.

Q1. The width of the slab is 6cm and RI = 3/2. If the Rear surface is silvered and the object is placed at a distance of 20cm from the front face then calculate the final position of image from the silvered surface.

$$\frac{HI}{HO} = \frac{\mu_1}{\mu_2}$$

$$\frac{x}{20} = \frac{3}{2}$$

$$2x = 3 \times 20$$

$$x = 3 \times 14$$

$$\boxed{x = 42\text{cm}}$$

$$\frac{HI}{HO} = \frac{\mu_1}{\mu_2}$$

$$\frac{x}{42} = \frac{1}{3}$$

$$3x = 2 \times 14 \qquad \frac{2 \times 14}{3} \qquad 34 - 2 = 32\text{cm}$$

$$3x = 20\text{cm} + 6 = 34\text{cm}$$

P.T.O

Date ___ / ___ / _____

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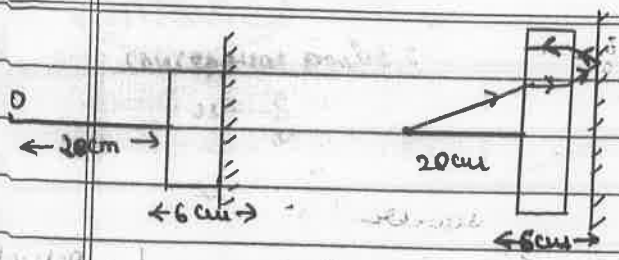


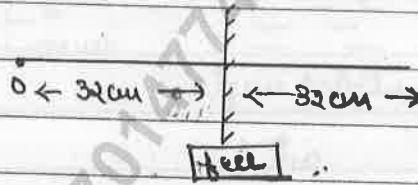
slab-shift $= t\left(1-\frac{1}{\mu}\right)$

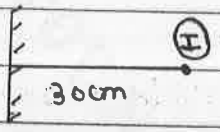
$6\left(1-\frac{1}{3/2}\right)$

$6\times\frac{1}{3} = 2\text{cm}$.

object की mirror से कितनी दूरी $= 28+6$
$= 34\text{cm}$.

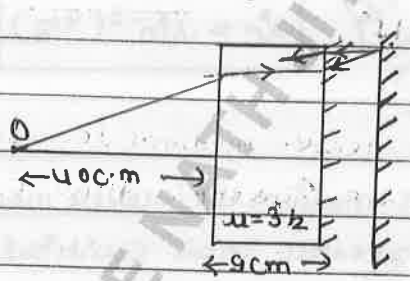
mirror की object $= 34-2 = 32\text{cm}$.





shift = ②
$34-4\text{ cm} = 30\text{cm}$.

Q3 In the given situation calculate the position of final image from the silvered surface?



$40+9 = 49\text{ cm}$.

$40-3 =$

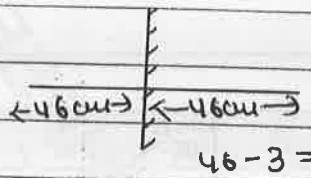
appear $= 49-3 = 46\text{cm}$.

shift $= d-\frac{d}{\mu}$.

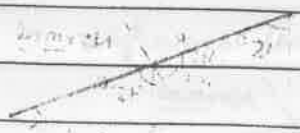
$9\left(1-\frac{1}{3/2}\right)$

$9\left(1-\frac{2}{3}\right)$

$9\times\frac{1}{3} = 3\text{cm}$.



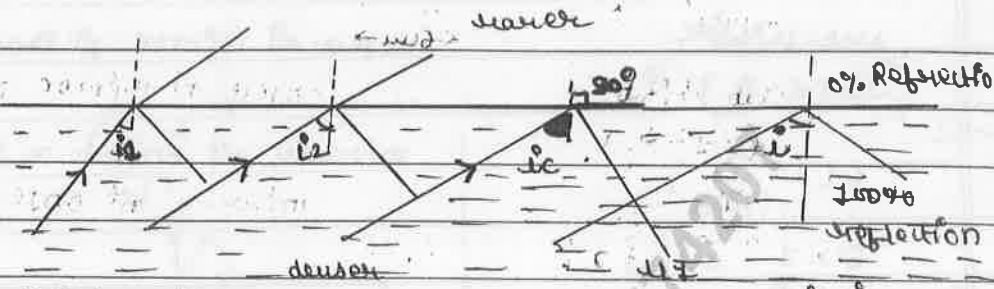
$46-3 = 43\text{cm}$



Saathi

Date __ / __ / ____

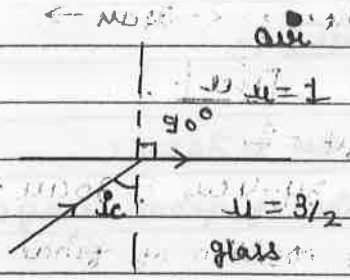
Total Internal Reflection (TIR) :-



i_c = critical angle.

$i > i_c$

TIR.



$\frac{3}{2} \sin i_c = 1 \times \sin 90°$

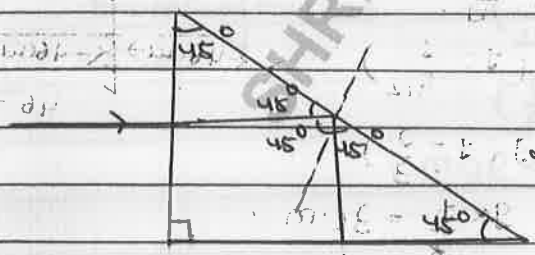
$\sin i_c = 2/3$

$\boxed{i_c = \sin^{-1}(2/3)}$

NCERT. $\boxed{i_c = 41°}$

Conditions For TIR :-

1. The ray must travel from denser medium to rarer medium.
2. The angle of incidence must be greater than critical angle.



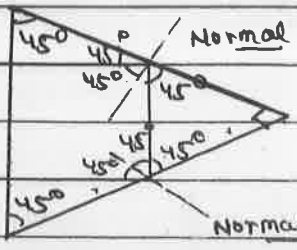
$i > i_c$

$45° > 41°$

Hence TIR.

Angle of incidence $= 45°$

If ray comes at 90° then it goes straight.



$45° > 41°$

TIR.

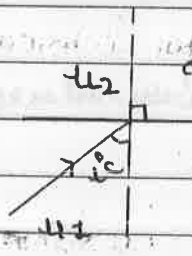
Date ___ / ___ / _____

Saathi

Conceptual point :-

$\mu = \frac{c}{v}$ → $\mu = \frac{K}{\rho d}$	$v = f\lambda$
$\mu \propto \frac{1}{\lambda}$	$\mu = \lambda/v$
$\frac{\mu_1}{\mu_2} = \frac{d_2}{d_1}$	$\mu \propto 1/v$
	$\frac{\mu_1}{\mu_2} = \frac{v_2}{v_1}$

Ex ①



$d_2 = 6000 A^0$

$d_1 = 4000 A^0$

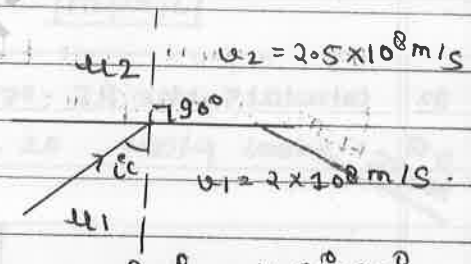
$\mu_1 \sin i_c = \mu_2 \sin 90^0$

$i_c = \sin^{-1}\left(\frac{\mu_2}{\mu_1}\right)$

$i_c = \sin^{-1}\left(\frac{6000}{4000}\right)$

$\sin i_c = 1/2$

$\boxed{i_c = 30^0}$



$v_2 = 2.5 \times 10^8$ m/s

$v_1 = 2 \times 10^8$ m/s.

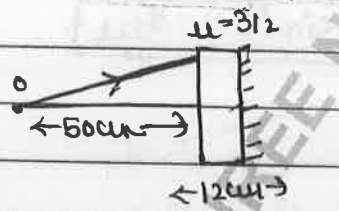
$\mu_1 \sin i_c = \mu_2 \sin 90^0$

$i_c = \sin^{-1}\left[\frac{2 \times 10^8}{2.5 \times 10^8}\right]$

$\sin i_c = 4/5$

$\boxed{i_c = 53^0}$

Q1



$50 + 12 = 62$ cm

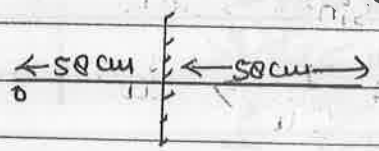
$12\left(1 - \frac{2}{3}\right)$

$12 \times \frac{1}{3} = 4$

Final position of image = ?

$62 - 4 = 58$ cm.

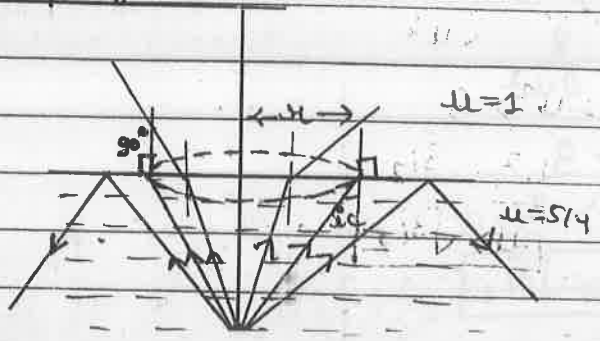
mirror on object

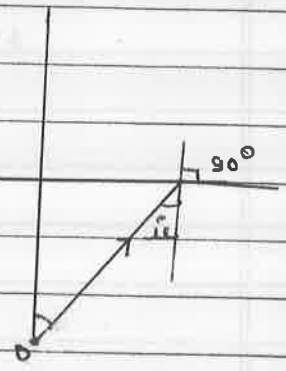


58cm पर appear होगा।

$62 - 8 = 54$ cm.

Most popular profile :-





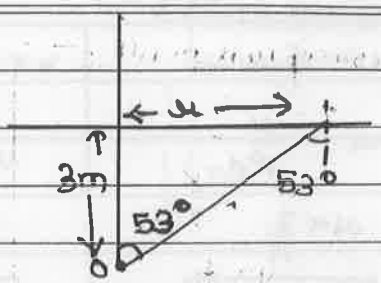
Saathi

Date ___ / ___ / _____

$\frac{5}{4}\sin i_c = 1 \times \sin 90°$

$\sin i_c = 4/5$

$\boxed{i_c = 53°}$



$\tan 53° = P/B$

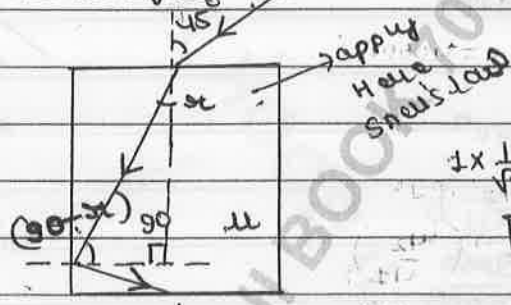
$4/3 = x/y$

$\boxed{x = 4m}$

It have asked that -

$x^2 = 16 \times 2\mu^2$ -

Q2 Calculate the RI of material so that total internal reflection takes place at surface BC



$1 \times \frac{1}{\sqrt{2}} = \mu \times \sin r$

$\boxed{\frac{1}{\sqrt{2}\mu} = \sin r}$

First Basic requirement :-

$90 - r > i_c$

Sin Both side

$\sin(90-r) = \sin i_c$

$\cos r > \sin i_c$

$\sqrt{1-\sin^2 r} > \sin i_c$

$\sqrt{1 - \frac{1}{\sqrt{2}\mu}} > \frac{1}{\mu}$

square Both side

$1 - \frac{1}{2\mu^2} > \frac{1}{\mu^2}$

$1 > \frac{3}{2\mu^2}$

$2\mu^2 > 3$

$\mu^2 > 3/2$

$\boxed{\mu > \sqrt{3/2}}$

Sin i_c का मूल्य

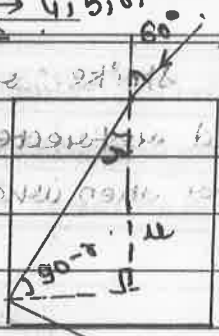
$\mu \sin i_c = 1 \times \sin 90°$

$\boxed{\sin i_c = 1/\mu}$

Neg Box = 3, 4
Solved eg = 15, 16, 17
Ex I → 26, 28, 29, 32, 36, 37, 38, 39, 40
Ex II → 5, 9, 11, 39, 41
Ex III → 4, 5, 6, 11
Homework

Saathi

Q2



$90-r > i_c$

$\sin(90-r) > \sin i_c$

$\cos r > \sin i_c$

$\sqrt{1-\sin^2 r} > \sin^2 i_c$

$1-\left(\frac{\sqrt{3}}{2\mu}\right)^2 \geq (1/\mu)^2$

$1-\frac{3}{4\mu^2} \geq \frac{1}{\mu^2}$

$1 \geq \frac{1}{\mu^2}+\frac{3}{4\mu^2}$

$1 \geq \frac{4+1}{4\mu^2}$

$1 \geq \frac{5}{4\mu^2}$

$4\mu^2 \geq 5$

$\mu = \frac{\sqrt{5}}{2}$

$1 \times \frac{\sqrt{3}}{2} = \mu \times \sin r$

$\frac{\sqrt{3}}{2\mu} = \sin r$

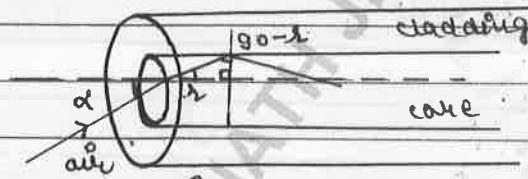
$\sin i_c$ का मूल्य से

$\mu \sin i_c = 1 \sin 90^\circ$

$\sin i_c = \frac{1}{\mu}$

Q3. Popular

Optical Fiber :— Based on phenomenon on TIR.



Basic eq

$90-r > i_c$

sin both side

$\sin(90-r) > \sin i_c$

$\cos r > \sin i_c$

$\sqrt{1-\sin^2 r} > \sin i_c$

$\sqrt{\frac{1-\sin^2\alpha}{\mu^2_{core}}} > \frac{\mu_{cladding}}{\mu_{core}}$

$\frac{1-\sin^2\alpha}{\mu^2_{core}} > \frac{\mu^2_{cladding}}{\mu^2_{core}}$

$1-\frac{\mu^2_{cladding}}{\mu^2_{core}} > \frac{\sin^2\alpha}{\mu^2_{core}}$

$1 \times \sin\alpha$ is more $\sin r$

$\sin r = \frac{\sin\alpha}{\mu_{core}}$

$\sin i_c$ का मूल्य से

$\frac{\mu_{air}}{\mu_{core}} \sin i_c = \mu_{cladding} \sin 90^\circ$

$\sin i_c = \frac{\mu_{cladding}}{\mu_{core}}$

$\mu^2_{core} - \mu^2_{cladding} > \sin^2\alpha$

$\sin^2\alpha < \mu^2_{core} - \mu^2_{cladding}$

$\sin\alpha = \sqrt{\mu^2_{core} - \mu^2_{cladding}}$

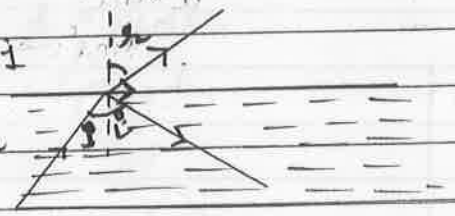
Learn

$S = \frac{D}{t} = \frac{5x}{t_1}$

Saathi

Date ___ / ___ / _____

Q. A ray of light from denser medium strike rarer m. at an angle of i° if the reflected and refracted rays are mutually perpendicular to each other then what is the value of critical angle?



$\mu + i + 90 = 180$

$\mu + i = 90$

$\boxed{r = 90 - i}$

$\mu \sin i = 1 \sin r$

$\mu \sin i = \sin(90 - i)$

$\mu = \frac{\cos i}{\sin i} = \cot i$

sin i_c ka value —

$\mu \sin i_c = 1 \times \sin 90^\circ$

$\mu \sin i_c = 1$

$\sin i_c = \frac{1}{\cot i}$

$\sin i_c = \tan i$

$\boxed{i_c = \sin^{-1}(\tan i)}$

Q. If light travels a distance $5x$ in time t_1 in air and distance $7x$ time t_2 in a certain medium then calculated the critical angle for that medium?

$\mu_1 = c \, t_1 / 5x$

Let velocity in air be $v_1 = \frac{5x}{t_1}$

velocity in medium $v_2 = \frac{7x}{t_2}$

$\mu_2 = \frac{c}{v_2} = \frac{c \times t_2}{7x}$

$\mu_2 = \frac{c t_2}{7x}$

critical angle $= \mu_2 \sin i_c = \mu_1 \sin 90^\circ$

$= \frac{c t_2}{7x} \sin i_c = \frac{c t_1}{5x} \times 1$

$= \sin i_c = \frac{c t_1}{5x} \times \frac{7x}{c t_2}$

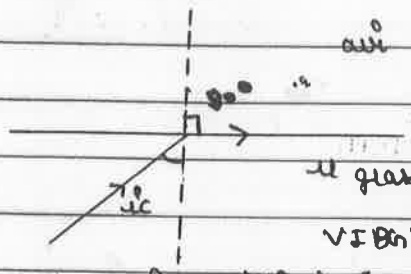
$\boxed{i_c = \sin^{-1}\left(\frac{7 t_1}{5 t_2}\right)}$

Page No.

Date ___/___/_____

Saathi

Q6 In a given situation.



VIBGYOR most

किस colour के critical angle sabse ज्यादा angle Hoga?

$\mu \sin i_c = 1 \times \sin 90^\circ$

$\boxed{\sin i_c = 1/\mu}$

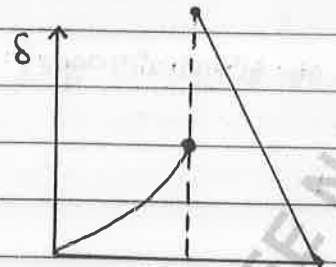
$\mu \propto \frac{1}{\lambda}$ Hence $\boxed{\sin i_c \propto \lambda}$

∴ In VIBGYOR → λ increases

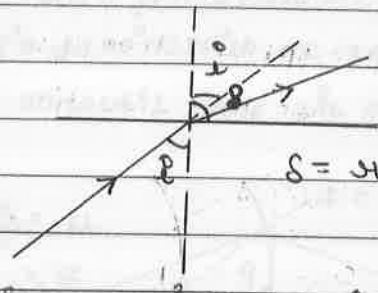
critical angle of Red colour is more.

Graph :-

δ vs i :-



Denser to rarer medium



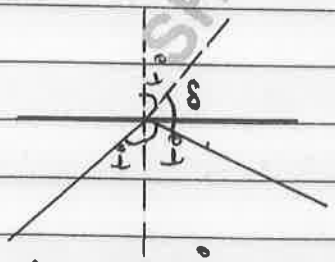
$\delta = r - i$

$\mu \sin i = 1 \times \sin r$

$\sin^{-1}(\mu \sin i) = r$

Now $\delta = r - i$

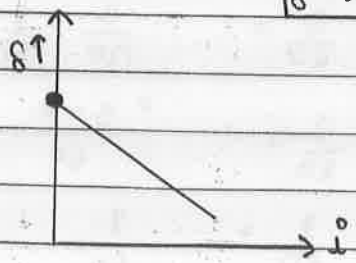
$\boxed{\delta = \sin^{-1}(\mu \sin i) - i}$



$\delta = 180 - 2i$

$\delta = -2i + 180$

$y = mx + c$



Q1 In the given situation find out the position of final image from the silvered surface?

Date ___/___/_____

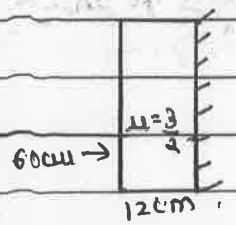
2	20, 30
2	10, 15
3	5, 15
5	5, 5

$\frac{3-2}{2}$ $\frac{1}{20} - \frac{1}{30}$

$\sin 53^\circ \frac{6}{8} \frac{12}{16}$ $\cos 53^\circ \frac{8}{64}$

$\tan \frac{4}{3} \theta = 53^\circ$

Sarthi



$d = t\left(1 - \frac{1}{\mu}\right)$

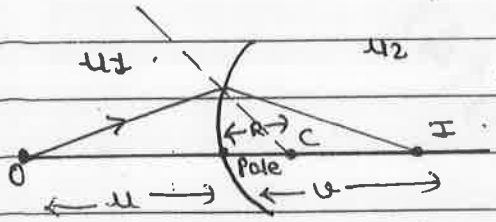
$d = 12\left(1 - \frac{1}{3/2}\right)$

$d = \frac{12 \times 1}{3} = 4cm$

$60 + 12 = 72cm$

$72cm - 8cm = 64cm$

Refraction from curved surface :—



$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

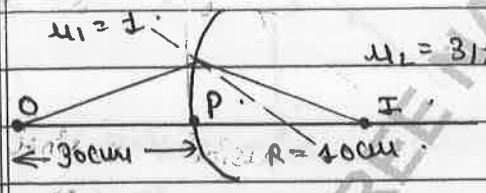
→ Always put u, v and R with their sign.

→ all the distance are measured from pole.

→ In the direction of light = ⊕ve

→ opp. to direction of light = ⊖ve

Q2 In the given situation calculate the position of final image?



Solve,

$\frac{3}{2v} + \frac{1}{30} = \frac{\frac{3}{2} - 1}{10}$

$\frac{3}{2v} = \frac{1}{20} - \frac{1}{30}$

$\frac{3}{2v} = \frac{3-2}{60}$

$\frac{3}{2v} = \frac{1}{60}$

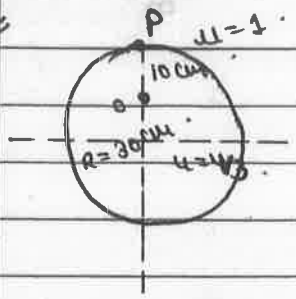
$\frac{3 \times 60}{2} = v$

$v = 90cm$

Saathi

Date ___ / ___ / _____

Q2 In the given situation Find out the apparent depth of bubble.



$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\frac{1}{v} + \frac{4}{30} = \frac{1 - 4/3}{30}$$

$$\frac{1}{v} = -\frac{1}{30} - \frac{4}{30}$$

$$\frac{1}{v} = \frac{-1-4}{30}$$

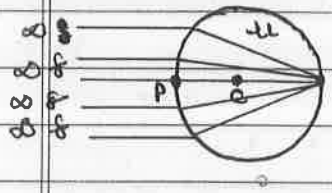
$$\frac{1}{v} = -\frac{5}{30}$$

$$-5v = 30$$

$$v = -\frac{30}{5}$$

$$\boxed{v = 6\,cm}$$

Q3 In given situation find out μ_2?



$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\frac{\mu}{2R} - \frac{1}{\infty} = \frac{\mu - 1}{R}$$

$$\frac{\mu}{2R} = \frac{\mu_1 - 1}{R}$$

$$\mu = 2\mu - 2$$

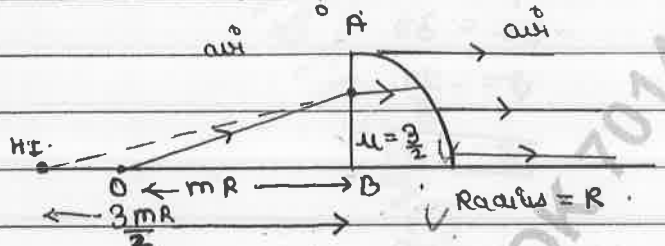
$$\boxed{\mu = 2}$$

$\frac{3}{2}mR + R$.
$\frac{5mR}{2}$.

Saathi

Date ___ / ___ / _____

Q1 IIT Find out the value of m. so that emergent ray becomes parallel to the surface?



Solve.

$$\frac{H_I}{H_O} = \frac{\mu_R}{\mu^0}.$$

$$\frac{2}{mR} = \frac{3}{2}$$

$$2x = 3mR$$

$$\boxed{x = \frac{3mR}{2}}$$

Now curve surface.

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}.$$

Here $V \to \infty$ b/c ray becomes parallel.

$R \to -R$.

$$\frac{1}{\infty} + \frac{3}{2 \times \frac{5mR}{2}} = \frac{1 - \frac{3}{2}}{R}.$$

$$\frac{3}{5mR} = \frac{-1}{2R}.$$

~~$6R = +5mR$~~

~~$\boxed{m = \frac{+6}{5}}$~~.

Table :-

$\mu_2 = 1$.

$\mu_1 = 3/2$.

$V = HUGE \to (1.5mR + R)$.

$V \to \infty$ check

H.W
Solved Ex → 18, 19
Beg Box → 5
Ex 1 → 55, 56
Ex 3 → Q7

Date ___/___/___

$\frac{3}{4}x = 21 - x$

$3x = 4(21-x)$

$12 = 84 - 4x$

$7x = 84$

$x = 12$ cm

$\frac{1}{\infty} - \frac{3/2}{-(1.5mR+R)} = \frac{1-3/2}{-R}$

$\frac{3}{2(1.5mR+R)} = \frac{1}{2R}$

$\frac{3}{2(\frac{3}{2}mR+R)} = \frac{1}{2R}$

$\frac{3}{3mR+2R} = \frac{1}{2R}$

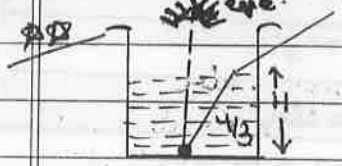
$\frac{3}{2R(\frac{3}{2}m+1)} = \frac{1}{2R}$

$3 = \frac{3}{2}m + 1$

$3-1 = \frac{3}{2}m$

$2 = \frac{3}{2}m \Rightarrow \boxed{\frac{4}{3} = m}$

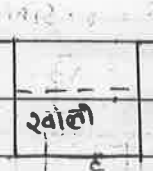
Conceptual points :-



$\frac{H_I}{H_O} = \frac{\mu_A}{\mu_a}$

$\frac{H_I}{H} = \frac{1}{4/3}$

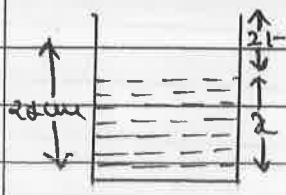
$H_I = 3/4 H$



Optical → बदलेगा नहीं
H → बिखरी हुई होगा

Q2 If :- Beaker → 21 cm

कितना पानी भरा ; Half filled Half empty



$\frac{3}{4}x = 21 - x$

$\boxed{x = 12 \text{ cm}}$

$r = 15 + 45$

$r = 60°$

$\delta = i - r$

$\delta = r - i$

$15 = r - 45$

Saathi

Date __/__/____

Approach No = 2 [always work]

$$\frac{\frac{3}{4}x}{24-x} = \frac{50\%}{50\%} = 1$$

$$\frac{3x}{4(24-x)} = 1$$

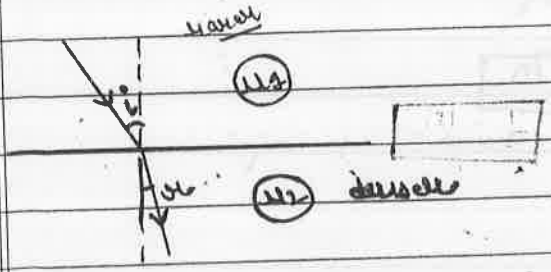
$$3x = 96 - 4x$$

$$7x = 96$$

$$\boxed{x = 12\text{ cm}}$$

Concept = 2

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

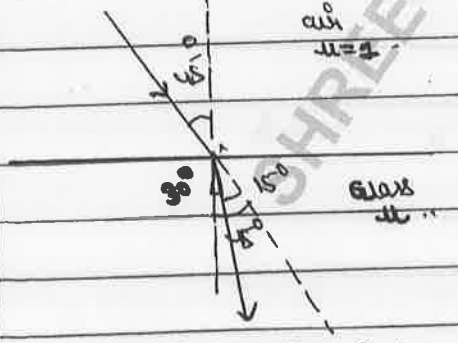


Ex. air → glass

incident ray → 45°

angle of deviation → 15°

$\mu_{glass} = ?$



$1 \sin 45° = \mu \sin 30°$

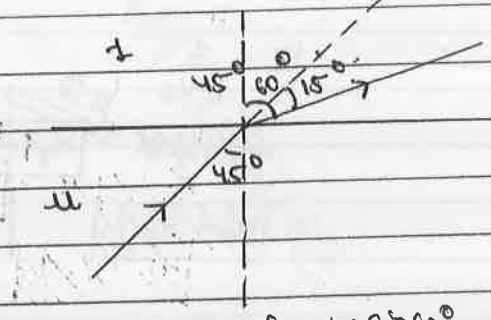
$\frac{1}{\sqrt{2}} = \mu \times \frac{1}{2}$

$\boxed{\mu = \sqrt{2}}$

Ex glass → air

incident ray = 45°

angle of deviation = 15°



$\mu \sin 45° = 1 \times \sin 60°$

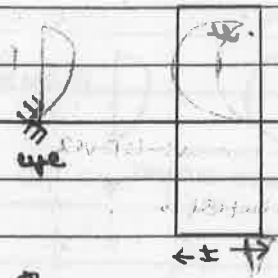
$\mu \times \frac{1}{\sqrt{2}} = \frac{\sqrt{3}}{2}$

$\boxed{\mu = \sqrt{\frac{3}{2}}}$

Saathi

Date ___ / ___ / _____

Concept = 3



Glycine $\frac{\mu_1}{\mu_1}$	Quartz $\frac{\mu_2}{\mu_1}$	Glycine $\frac{\mu_1}{\mu_1}$
eye		

Here put $\mu = \frac{\mu_2}{\mu_1}$

Both divide by μ_1

$$\text{shift} = t\left(1 - \frac{1}{\mu}\right)$$

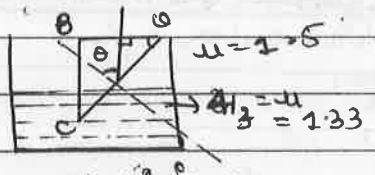
$\mu = \frac{\mu_2}{\mu_1}$ जीतना हो

$$\text{slab} = t\left(1 - \frac{1}{\mu}\right)$$

If 3 medium then derivation only can solve

Exercise-3

Q5



$\theta > \sin^{-1}c$

$\sin\theta > \sin^{-1}c$

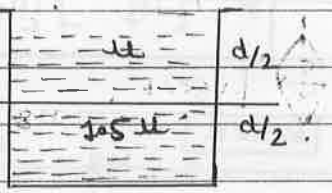
$\frac{3}{2} \times \sin^{-1}c = \frac{4}{3}\sin 90°$

$\sin^{-1}c = \frac{4}{3} \times \frac{2}{3}$

$$\sin^{-1}c = \frac{8}{9}$$

$\sin\theta > \frac{8}{9}$.

Q6



Shift = dactual - dapp

$$\text{dapp} = \frac{d/2}{1.5\mu} + \frac{d/2}{\mu}$$

$\frac{80}{100}[d] = \frac{d}{3\mu} + \frac{d}{2\mu}$

$\frac{d}{2} = \frac{d}{3\mu} + \frac{d}{2\mu}$

$\frac{1}{2} = \frac{1}{3\mu} + \frac{1}{2\mu}$

$\frac{1}{2} = \frac{2+3}{6\mu}$

$10 = 6\mu$

$\mu = \frac{10}{6}$

$$\mu = 5/3$$

incident ray diverging then object is real.
If ✱ convergent then object is virtual.

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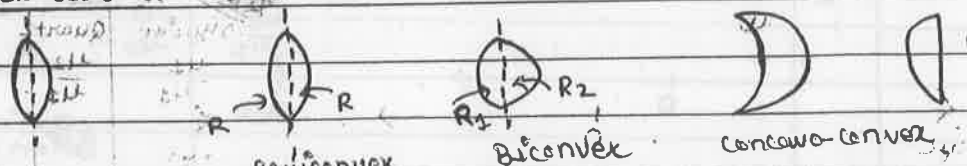
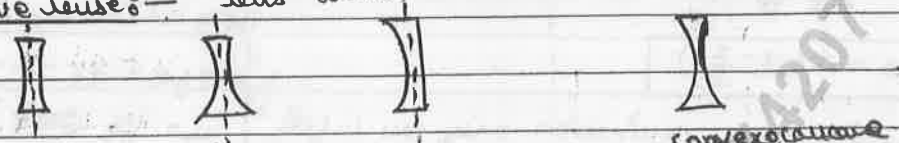
Date 07/08/2019

Lens :-

1. Convex lense :- lens which is thicker at center.



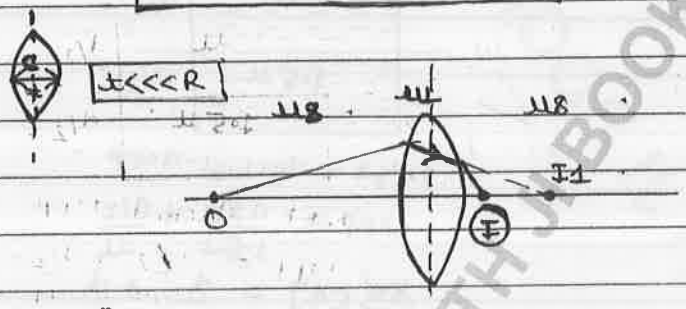
2. Concave lense :- lens which is thinner at center.



Lens maker formula :-

$$\frac{1}{f} = \left[\frac{\mu_L}{\mu_S} - 1\right]\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

" all distance are measured from optical center C ".



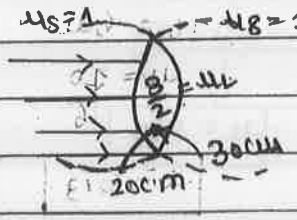
Step 1 :- $\frac{\mu_2}{V} - \frac{\mu_1}{U} = \frac{\mu_2 - \mu_1}{R}$

object → I1 Image = (I)

Step 2 :- $\frac{\mu_L}{V} - \frac{\mu_1}{U} = \frac{\mu_2 - \mu_1}{R}$

Q In the given situation find out the focal length of lens?

Case (i)



$R_1 = +20$ cm

$R_2 = -30$ cm.

Sign ka dhyan rakhna

$$\frac{1}{F} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

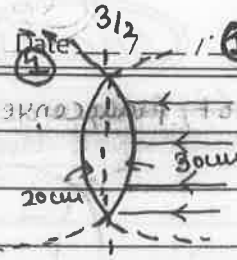
$$\frac{1}{f} = \left[\frac{3/2}{1} - 1\right]\left[\frac{1}{20} - \left(\frac{-1}{30}\right)\right]$$

$$\boxed{f = +24 \text{ cm}}$$

Date

$R_1 = +30\,cm$

$R_2 = -20\,cm$

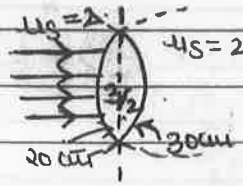


$\frac{1}{f} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$f = +24\,cm$

NOTE → Focal length of lense does not depend on direction of incident ray.

Q2.



$\mu_S = 2$

$R_1 = +20\,cm$

$R_2 = -30\,cm$

Sign की मार्क बाकी

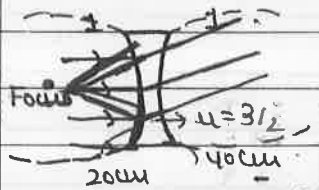
$\frac{1}{f} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$= \left(\frac{3/2}{2} - 1\right)\left(\frac{1}{20} + \frac{1}{30}\right)$

$\frac{1}{f} = -\frac{1}{4} \times \frac{1}{12}$

$f = -48\,cm$

Q3 In the given situation calculate the focal length of the lens?



$R_1 = -20$

$R_2 = +40\,cm$

$\frac{1}{f} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = \left(\frac{3/2}{1} - 1\right)\left[\frac{1}{-20} - \frac{1}{40}\right]$

$\frac{1}{f} = \left(\frac{1}{2}\right)\left(\frac{-2-1}{40}\right)$

$\frac{1}{f} = -\frac{3}{80}$

$f = -\frac{80}{3}\,cm$

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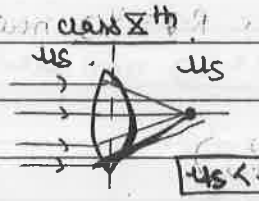
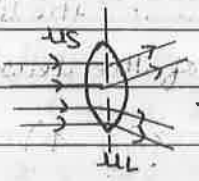
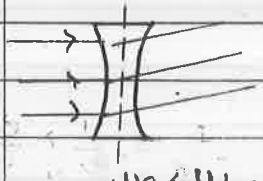


$\mu_S < \mu_L$



$\mu_S > \mu_L$

$\mu_S = \mu_L$



$\mu_S < \mu_L$.

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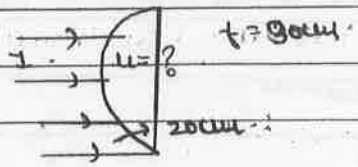
Q1 In a given situation find out refractive index of plano convex lense if its focal length = 30cm ?



$R_1 = +20cm$
$R_2 = \infty$

$$\frac{1}{30} = \left(\frac{\mu}{1} - 1\right)\left[\frac{1}{20} - \frac{1}{\infty}\right]$$

$$\frac{1}{30} = \mu - 1 \times \frac{1}{20}$$

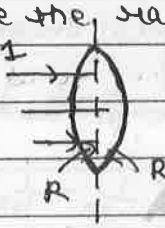
$$20 = 30\mu - 30$$

$$50 = 30\mu$$

$$\mu = 5/3$$

equiconvex

Q2 The focal length of Biconvex lense is 40cm and RI of the lense is 3/2 then calculate the radius of curvature ?



$\mu_s = 1$

$\mu_L = 3/2$

$R_1 = +R$

$R_2 = -R$

$f = 40cm$

$$\frac{1}{40} = \left(\frac{3}{2} - 1\right)\left[\frac{1}{2R}\right]$$

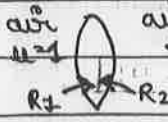
$$\frac{1}{40} = \frac{1}{2} \times \frac{2}{R}$$

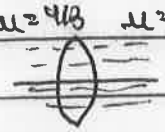
$$\frac{3}{2} \times \frac{2}{4} = \frac{3}{4}$$

$$R = 40cm$$

Q3 The focal length of a Biconvex lense ($\mu = \frac{3}{2}$) is 100cm when placed in air. when the lense is immerged in the liquid have R.I = 4/3. now calculate the new focal length of the lense ?

Solve





$$\frac{1}{100} = \left(\frac{3/2}{1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{3/2}{4/3} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{\frac{1}{100}}{\frac{1}{f}} = \frac{\frac{1}{2}}{\left(\frac{9}{8} - 1\right)}$$

$$\frac{f}{100} = \frac{1}{4} \times \frac{8}{1}$$

$$\frac{f}{100} = \frac{8}{4}$$

** focal length depend on Radius of curvature

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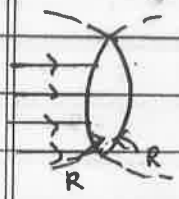
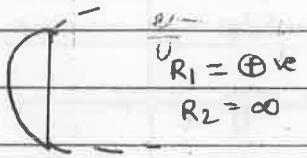
conceptual point :—



R_1 = ⊕ve
R_2 = ⊖ve
Sign convention



R_1 = ⊕ve
$R_2 = \infty$

R_1 = ⊕ve
R_2 = ⊖ve

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$\frac{1}{f} = \left(\frac{\mu}{1} - 1\right)\left[\frac{1}{R_1} + \frac{1}{R_2}\right]$$

$$\frac{1}{f} = (\mu - 1) \times \left(\frac{2}{R}\right)$$

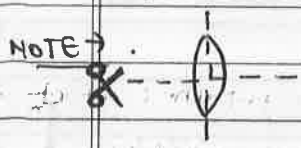
$$\boxed{f = \frac{R}{2(\mu - 1)}}$$

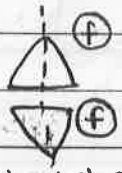
$$\boxed{f = \frac{R}{\mu - 1}}$$

$$f = (\mu - 1) \times \frac{2}{R}$$

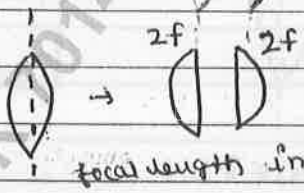
$$\boxed{f = \frac{R}{2(\mu - 1)}}$$

NOTE →



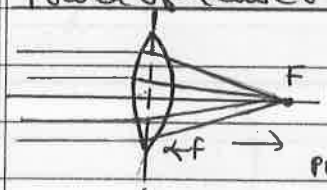


focal do not change



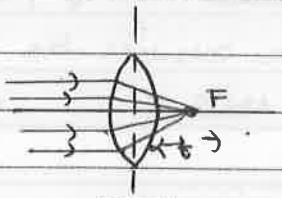
focal length increases

Power of lense :—



Power less

$$\text{Power} \propto \frac{1}{f}$$



Power more

unit of Power = dioptere (D)

** also put f in meter [always remember]

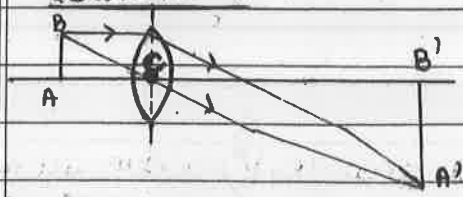
magnification produce by lense :—

$$\boxed{\frac{H_I}{H_O} = \frac{v}{u}}$$

** not for mirror

H_I → Height of image
H_O → Height of object

derivation :—



all distance are measured from optical center

$$\frac{AB}{A'B'} = \frac{CB}{CB'}$$

$$\frac{+H_O}{-H_I} = \frac{-u}{+v}$$

$$\boxed{\frac{H_I}{H_O} = \frac{v}{u}}$$

☆ convex (converging) $f = \oplus ve$

☆ concave (diverging) $f = \ominus ve$

Ex I → Q74, 73, 72, 71, 70, 68, 66, 64, 63, 62, 60, 59, 58, 57.

Ex II → 1, 2, 3, 4, 5, 6, 9, 11, 31, 36, 39, 41, 54

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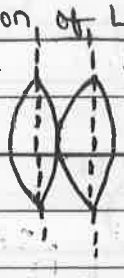
lens — mirror

$P = 1/f$	$P = -1/f$
$\frac{HI}{HO} = \frac{v}{u}$	$\frac{HI}{HO} = \frac{-v}{u}$
$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ lens formula	$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ mirror formula

Combination of Lens :— (Thin lens in contact)



$$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$P_{net} = P_1 + P_2$$

☆☆ For lens ② the object is image made by lens ①.

Question practice :—

Q1. 2 lenses having power +2.5 D and −3.75 D are put in contact ; then calculate the effective focal length of the combination?

solve →

$$P_{net} = +2.5 + (-3.75)$$
$$= -1.25\ D$$

$$f = 1/P = \frac{100}{-125} \times 4 = \frac{4}{5}$$

$$\boxed{f = -4/5\ m}$$

Q2. 2 lenses each having focal length 25 cm are put in contact out of them one is convex, another is concave. then calculate the eff power of lenses?

solve.

$$\frac{1}{f_{net}} = \frac{100}{25} - \frac{100}{25}$$

$$\frac{1}{f_{net}} = 0 \qquad f = \infty$$

☆☆ Power : $P = \frac{1}{f_{net}}$

$$\boxed{P = \frac{1}{\infty} = 0}$$

Q3. A Biconvex lens [$\mu = 1.5$] having focal length 0.2 m act as a divergent lens of power 1 Diopter when immerge in liquid. then calculate the RI of liquid?

solve.

$\frac{1}{20} \times \frac{5}{100}$ $\quad \frac{3}{2\mu} - 1 \cdot \frac{3-2\mu}{2\mu}$

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$\frac{1}{f} = \left(\frac{3/2}{1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ — ① in air

☆☆ $P = -1D$ b/c it is diverging.

$P = 1/f$.

$= -1m = -100cm$

$\frac{1}{-100}\left[\frac{3/2}{\mu} - 1\right]\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$\frac{\frac{1}{20}}{-1/100} = \frac{1/2}{\frac{3-2\mu}{2\mu}}$

$\frac{1}{20} \times \frac{5}{1}$ $\quad -5 = \frac{3-2\mu}{2\mu}$

$-10\mu = 3 - 2\mu$

$9\mu = 15$

$\boxed{\mu = 5/3}$

Q An equiconvex lense has power = 5D if it is made of glass of $\mu = 3/2$. then calculate the radius of curvature of each surface?

solve $P = 5D$

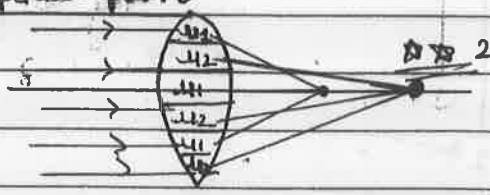
$\frac{1}{f} = \frac{1}{5D}$ $\quad f = 1/P$ $\quad f = 1/500$

$\frac{100}{5} = \left[1/2\right]\left[\frac{1}{R} + \frac{1}{R}\right]$

$\frac{20}{1} = \frac{1}{2} \times \frac{2}{R}$

$\boxed{20 = R}$

NOTE . Conceptual point.



☆☆ 2 image will form.

Page No.

Saathi

Date ___ / ___ / _____

Exercise ③ Q7 :-

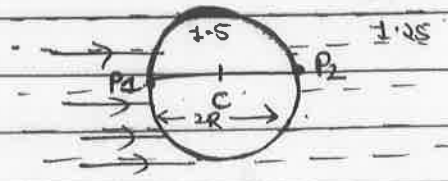


Table :-

$u_2 \to 1.5$
$u_1 \to 1.25$
$v \to \infty$
$v \to ?$
$R \to +R$

$$\frac{u_2}{v} - \frac{u_1}{v} = \frac{u_2 - u_1}{R}$$

$$\frac{1.5}{v} - \frac{1.25}{\infty} = \frac{1.5 - 1.25}{R}$$

$$\frac{1.5}{v} = \frac{1}{4R}$$

$$\frac{3}{2v} = \frac{1}{4R}$$

$$\boxed{v = 6R}$$

Now P1 & P2

Table

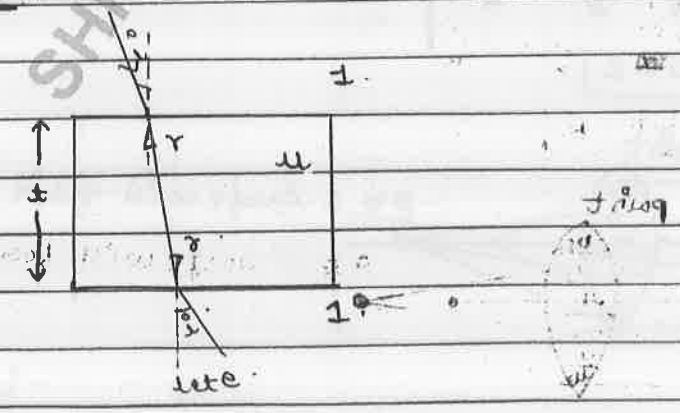
$u_2 \to 1.5$
$u_1 \to 1.5$
$v \to 4R$
$v \to ?$
$R \to -R$

on solving

$$\boxed{v = 2R}$$

but $v = 2R + R = 3R$

Concept :-



$1 \sin i = u \sin r$ — ④

$u \sin r = 1 \sin e$ — ②

on comparing

$\sin i = \sin e$

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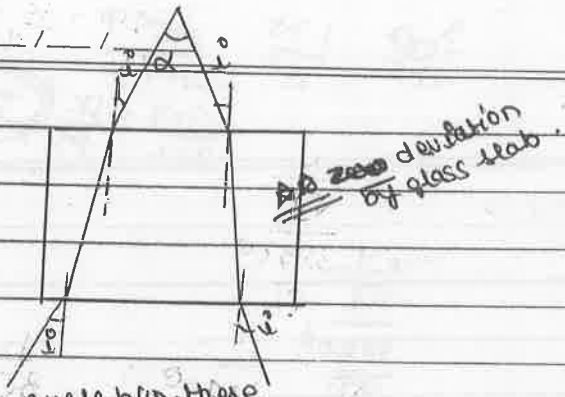
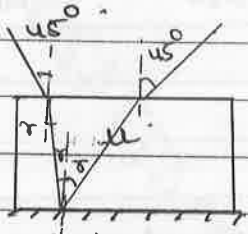
Date ___/___/___



Q2.



(i) find angle b/w incident ray and final emergent ray?

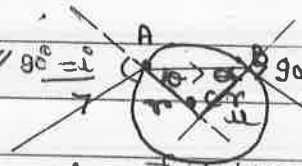
(ii) deviation produced = ?

(i) angle b/w incident and final emergent ray = 45°.

$\delta + 90^\circ = 180^\circ$

$\delta = 90^\circ$.

Q3.



angle of incidence = ?

so that grazing emergence will takes place at B?

B at 90° ray pass

90° પર જાઈ incidence θ માં આવી

at A = $1 \sin i^\circ = \mu \sin\theta$

at B = $\mu \sin\theta = 1 \times \sin 90^\circ$

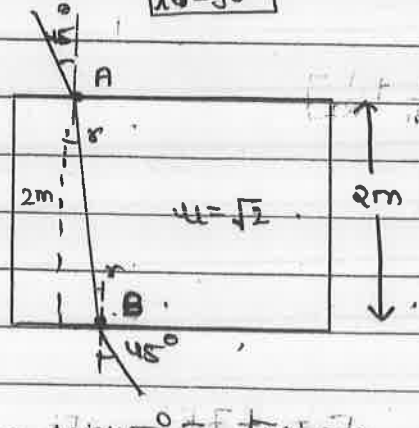
$\mu \sin\theta = 1$

$1 \sin i^\circ = 1$

$\sin i^\circ = 1$

$i = 90^\circ$

Q4.



$1 \sin 45^\circ = \sqrt{2} \sin r$

$1 \times \frac{1}{\sqrt{2}} = \sqrt{2} \times \sin r$

$\sin r = \frac{1}{2}$

$r = 30^\circ$

$\cos 30^\circ = \frac{2}{AB}$

$\frac{\sqrt{3}}{2} = \frac{2}{AB}$

$AB = 4/\sqrt{3}$

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If time of AB asked then

$t = \frac{\text{distance}}{\text{Speed}} = \frac{4/\sqrt{3}}{v}$

$\frac{4}{\sqrt{3}} \times \frac{\sqrt{2}}{3\times10^8} = \frac{4\sqrt{2}}{3\sqrt{3}} \times 10^{-8}$ sec.

$u = \frac{c}{v}$

$\sqrt{2} = \frac{3\times10^8}{v}$

$v = \frac{3\times10^8}{\sqrt{2}}$

Q2. 45°

$u = 1$

$u = \sqrt{3}$

$u = \sqrt{2}$

$u = 2$

$u = 1.6$

calculate the angle made by light ray with normal in the medium of RI $= \sqrt{2}$

☆ Snell's law can applied directly b/w 2 RI

b/c $\boxed{u\sin i = \text{constant}}$

$1\times\sin45^\circ = \sqrt{2}\sin r$

$1\times\frac{1}{\sqrt{2}} = \sqrt{2}\sin r$

$\frac{1}{2} = \sin r$ $\boxed{r = 30}$

Q3 A concave lense of glass $u = 1.5$ Has Both surface of same radius of curvature on emerging in medium of $u = 1.75$ then calculate its Focal length?

Solve

$\frac{1}{f} = \left[\frac{3/2}{7/4} - 1\right]\left[\frac{1}{R_1} + \frac{1}{R_2}\right]$

$\frac{1}{f} = \left[\frac{-1}{7}\right] \times \frac{2}{R}$

$\frac{1}{f} = \frac{-1}{7}\times\frac{2}{R}$

$\frac{1}{f} = +2$

For $+7R$ [convergent]

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Date ___ / ___ / _____

Q4 What is the RI of material of planoconvex lense if the Radius of curvature of the curved surface is 10cm and focal length of lense = 30cm?

solve

$$\frac{1}{30} = \left[\frac{x}{1} - 1\right]\left[+\frac{1}{10} - \frac{1}{\infty}\right]$$

$$\frac{1}{30} = (x-1) \times +\frac{1}{10}$$

$$3 \cancel{30} \quad \frac{1}{3} = x - 1$$

$$1 + \frac{1}{3} = x = \frac{4}{3}$$

$$\boxed{x = 4/3}$$

Q5 ..

Silvering :-

lense → $\frac{1}{f} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$P = \frac{1}{f}$.

$P_{eff} = P_1 + P_2 + P_3 + P_4 \ldots$

mirror :-

$f = \frac{R}{2}$.

$P = \frac{1}{-f}$.

Sign :-

Convex :-

Concept :-
Convex = f = ⊕ve
Concave = f = ⊖ve

Concave :-

Q6 In the given situation and plano convex lense Have radius of curvature 20cm and its plane surface is silvered. The μ of material of lens = 3/2 then calculate the Fnett of the system?

solve

$R_1 = \oplus 20cm$ rays comes Back

$R_2 = \infty$

$P_{nett} = P_L + P_m + P_L$.

$\frac{\ominus 1}{f_{nett}} = \frac{1}{f_L} - \frac{1}{f_m} + \frac{1}{f_L}$

$\boxed{\frac{1}{f_{nett}} = \frac{2}{f_L} - \frac{1}{f_m}}$

what i need? f_L and f_m.

$\frac{1}{f_L} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

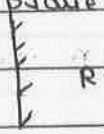
$\frac{1}{f_L} = \left(\frac{3/2}{1} - 1\right)\left(\frac{1}{20}\right) = \frac{1}{2} \times \frac{1}{20}$ $\quad \boxed{f_L = 40cm}$

Page No. ____

Saathi

Date ___ / ___ / _____

Now plane surface



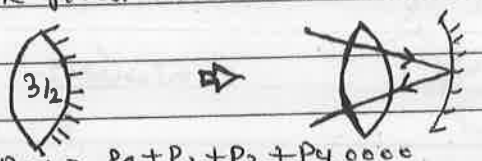
$f_m = +\frac{R}{2} = \frac{\infty}{2} = \infty$

$\frac{-1}{f_{nett}} = \frac{2}{40} - \infty$

$\frac{-1}{f_{nett}} = \frac{1}{20}$

$f_{nett} = 20\ cm$

Q2 In the given situation calculate the Fnett of the combination?

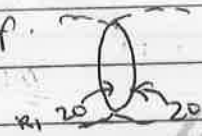


$F_{net} = P_1 + P_2 + P_3 + P_4$ ....

$\frac{1}{f_{net}} = \frac{1}{f_L} + \left(-\frac{1}{f_m}\right) + \frac{1}{f_L}$

$\frac{1}{f_{nett}} = \frac{2}{f_L} - \frac{1}{f_m}$ $f_L = ?$ $f_m = ?$

f_L की पर्वी



$\frac{1}{f_L} = \frac{1}{2} \times \left[\frac{1}{20} - \left(-\frac{1}{20}\right)\right]$

$\frac{1}{f_L} = \frac{1}{2} \times \frac{1}{10}$

$f_L = 20\ cm$

f_m की पर्वी

$f_m = \frac{R}{2}$

$f_m = \ominus 10\ cm$

↳ concave

$\frac{1}{f_{nett}} = \frac{2}{20} - \frac{1}{10}$

$\frac{2}{20} + \frac{1}{10}$

$\frac{1}{f_{net}} = \frac{2}{10}$

$\frac{1}{f_{nett}} = -\frac{1}{5}$

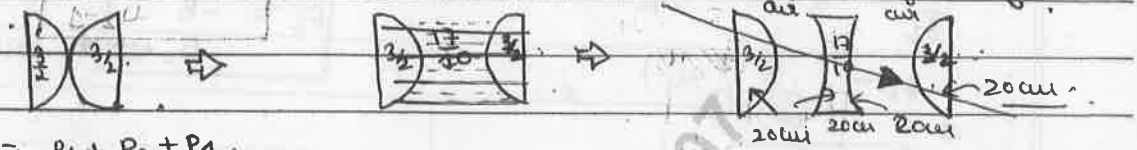
$f_{nett} = -5\ cm$

Date ___/___/_____

Saathi

Q3 AIPMT-2015 .2 Identical thin planoconvex lenses $\mu = 1.5$ (3/2) each having radius of curvature 20cm are placed with their convex surface in contact at centre the space b/w the lenses is filled with oil ($\mu = 1.7$) then calculate the focal length of the combination?

Solve.



$P_{net} = P_1 + P_2 + P_1$

$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_1}$

$\boxed{\frac{1}{f_{net}} = \frac{2}{f_1} + \frac{1}{f_2}}$

$f_1 = ?$ $f_2 = ?$

$\frac{1}{f} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = \left[\frac{\frac{3}{2}}{1} - 1\right]\left[\frac{1}{\infty} - \left(\frac{1}{20}\right)\right]$

$\frac{1}{f} = \frac{1}{2} \times \frac{1}{20}$

$\boxed{f_2 = 40cm}$

$f_2 = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$f_2 = \left(\frac{17}{10} - 1\right)\left(\frac{-1}{20} - \left(\frac{1}{20}\right)\right)$

$f_2 = \frac{7}{10}\left(\frac{-1-1}{20}\right)$

$\frac{1}{f_2} = \frac{7}{10} \times \frac{-2}{20}$

$\frac{1}{f_2} = \frac{7}{10} \times \frac{-1}{10}$

$f_2 = \frac{-100}{7}$

$\frac{1}{f_{net}} = \frac{2}{40} + \left(\frac{-100}{7}\right) = \frac{1}{20} - \frac{7}{100}$

$\frac{1}{f_{net}} = \frac{(5 + (-7))}{100}$

$\frac{1}{f_{net}} = \frac{5-7}{100}$

$\boxed{f_{net} = -50cm}$

Q4 A planoconvex lense fit exactly into a planoconcave lense their plane surface are pressed to each other. If lenses are made of different materials having μ_1 and μ_2 then calculate the focal length of the combination (R = Radius of curvature of the curved surface).

Solve.

$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$.

Saathi

Date ___ / ___ / ___

$\frac{1}{f_1} = \left[\frac{\mu_1}{1} - 1\right]\left[\frac{1}{\infty} - \frac{1}{-R}\right]$

$\frac{1}{f_1} = (\mu_1 - 1)\left(+\frac{1}{R}\right)$.

$\frac{1}{f_1} = (\mu_1 - 1) \times \left(+\frac{1}{R}\right)$

$f_1 = \frac{R}{\mu_1 - 1}$

$\boxed{f_1 = \frac{R}{\mu_1 - 1}}$.

$\frac{1}{f_2} = (\mu - 1)\left[\frac{-1}{R} - \frac{1}{\infty}\right]$.

$\frac{1}{f_2} = (\mu_2 - 1) \times \frac{-1}{R}$.

$\boxed{f_2 = \frac{-R}{\mu_2 - 1}}$.

$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$

$= \frac{1}{\frac{R}{(\mu_1 - 1)}} + \frac{1}{\left(\frac{-R}{\mu_2 - 1}\right)}$.

$\frac{1}{f_{net}} = \frac{R(\mu_2 - 1) - R(\mu_1 - 1)}{(\mu_1 - 1)(\mu_2 - 1)}$

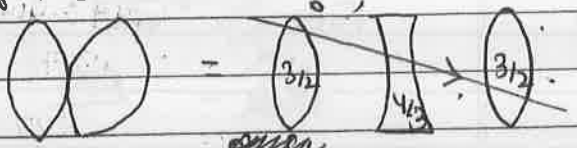
$\frac{1}{f_{net}} = \frac{\mu_1 - 1 - \mu_2 + 1}{R}$.

$\boxed{f_{net} = \frac{R}{\mu_1 - \mu_2}}$.

Q5 NEET = 2016.

Two identical equiconvex lense [$\mu = \frac{3}{2}$] of focal length (f) each are kept in contact. space b/w 2 lenses is filled with water ($\frac{4}{3} = \mu$) then calculate the focal length of the combination?

(1) 3f/4 ..
(2) f/4
(3) f/3
(4) 5f/4 ..



Solve

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_2}$

$\boxed{\frac{1}{F} = \frac{2}{f} + \frac{1}{f_2}}$.

$\frac{1}{f_2} = \left(\frac{\frac{3}{2}}{\frac{3}{4}} - 1\right)\left[\frac{-1}{R} - \frac{1}{R}\right]$

$\frac{1}{f_2} = \frac{1}{3} \times \frac{-1-1}{R}$

$\frac{1}{f_2} = \frac{-2}{3R}$.

$\boxed{f_2 = \frac{3R}{2}}$

$= \frac{1}{F} = \frac{2}{f} + (3R) = ?$.

$\frac{1}{F} = \frac{1}{2} \times \frac{2}{R}$

$\boxed{F = R}$.

$= \frac{2}{f} + \frac{(-3R)}{2}$.

$= \frac{2}{f} + \frac{-2}{3R}$..

=

Saathi

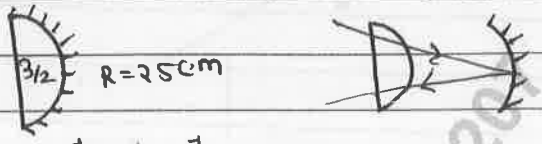
Date ___ / ___ / _____

$$\frac{1}{f_{nett}} = \frac{2}{f} + \frac{1}{-3f/2}$$

$$= \frac{2}{f} - \frac{2}{3f}$$

$$= \frac{6-2}{3f} = \boxed{3f/4 = f_{nett}}$$

Q6. In the given situation calculate the Fnet of the system?



$$-\frac{1}{f_{nett}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_1}$$

$$-\frac{1}{f_{nett}} = \frac{2}{f_1} + \frac{1}{f_2}$$

$$f_m = -R/2 = -25/2$$

$$\frac{1}{f_1} = \frac{1}{2} \times \left[\frac{1}{\infty} - \frac{1}{25}\right]$$

$$\frac{1}{f_1} = \frac{1}{2} \times \frac{1}{25}$$

$$\boxed{f_1 = \frac{50}{}}$$

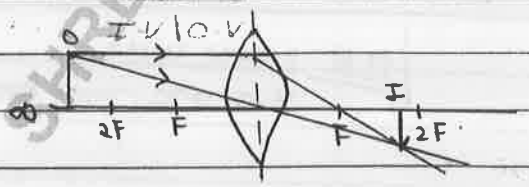
$$-\frac{1}{f_{nett}} = \frac{1}{25} + \left(\frac{-2}{25}\right)$$

$$= \frac{1-2}{50}$$

$$= \boxed{F_{nett} = -\frac{25}{3}}$$

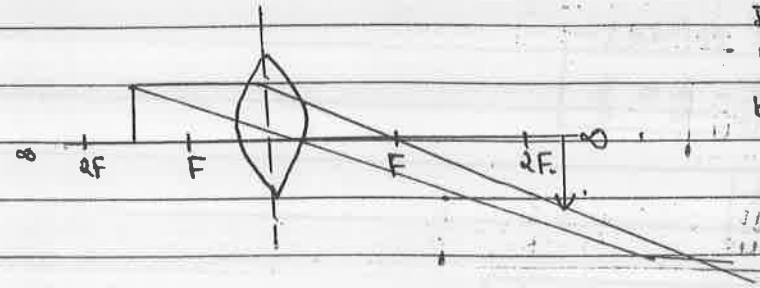
Ray tracing concept 8 –

① Object is placed b/w ∞ and 2F 8 –



→ Real object
→ Inverted
→ F and 2F
→ Diminished

② B/w 2F and F



Inverted
Real
b/w 2F and ∞
Enlarged

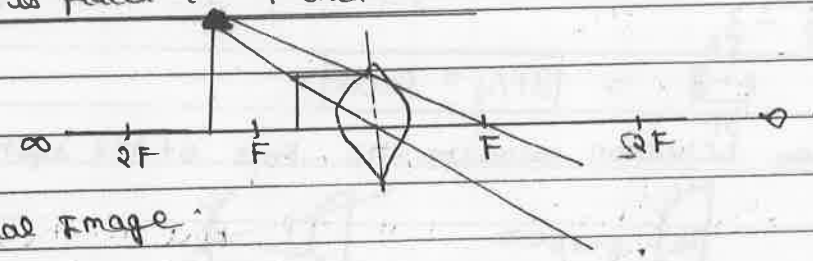
$= \frac{1}{+f}$

Page No. ____

Saathi

Date ___ / ___ / ____

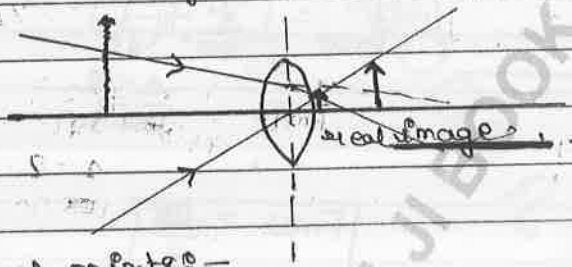
object is placed b/w F and C :-



→ virtual image
→ Enlarged
→ Erect
→ same-side

what about virtual object :-

If incedence rays are converging in nature = • virtual object



real image
diminished
Erect

Important points :-

→ Real object की real image always inverted [RORI concept].
→ Real object & real image (For sense) हमेशा opp. side वाली होते हैं।
For real object = U = -ve
→ अगर object के बारे में कुछ भी mention नहीं हो तो take as real object

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

→ Convex lense f = +ve
concave lense f = -ve

** convex lense
V.O / V.I · not possible

conceptual points :-

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

$$\frac{H_I}{H_O} = \frac{v}{u}$$

$$\frac{1}{f_{net}} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Saathi

Date ___ / ___ / _____

Q1 NEET 2011

A equiconvex lense has a radius of curvature 20cm. An object is place at a distance of 30cm from a lense and height of object is 2cm then describe the properties of image?

solve.

$\mu = 3/2$

$\frac{1}{f} = \left[\frac{3}{2}\right]\left[\frac{1}{R_1} - \left(\frac{-1}{R_2}\right)\right]$

$\frac{1}{f} = \frac{1}{2}\left[\frac{2}{20}\right]$

$\boxed{f = 20cm}$

lense is convex.

object $u = -30cm$ · [real object]

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

$\frac{1}{v} - \left(\frac{-1}{30}\right) = \frac{1}{20}$.

$\frac{30 + v}{30v} = \frac{1}{20}$

$600 + 20v = 30v$

$60\phi = 10v$ $\boxed{v = 60cm}$

$\frac{H_I}{H_O} = \frac{60}{-30} \cdot 2$

$\boxed{H_I = -4cm}$.

inverted, Real image.

Q2 lenses of diopter 3D and -5 diopter form compound lense. An object is placed at distance of 50cm from lense, then calculate the position of image?

solve $P_{net} = P_1 + P_2$

$= 3D + (-5D) = -2D$.

$\frac{1}{f} = P$.

$f = -\frac{1}{2}cm$.

$f = \frac{100}{-2}$.

$\boxed{f = -50cm}$.

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

$\frac{1}{v} - \left(\frac{-1}{50}\right) = \frac{-1}{50}$.

$\frac{1}{v} + \frac{1}{50} = -\frac{1}{50}$.

$\frac{1}{v} = -\frac{1}{50} - \frac{1}{50} = \frac{1}{v} = \frac{-1-1}{50}$

$\boxed{v = -25cm}$

Test-Q
Q16, 19, 22, 21

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Date __/__/____ Beg. Box = 6

Q3. A convex lense of focal length of f produces a real image of size $\frac{1}{n}$ times the size of the object. calculate the position of object?

solve object → real real

Real object का image हमेशा inverted.

$$H_I = \ominus \frac{1}{n} H_O$$

$$\frac{H_I}{H_O} = \frac{v}{u}$$

$$\frac{-\frac{1}{n} H_O}{H_O} = \frac{v}{u}$$

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

$$\boxed{v = -\frac{u}{n}}$$

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

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

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

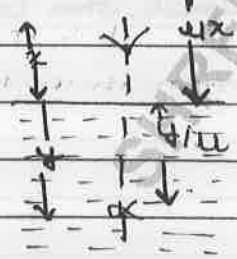
$$u = f(-n-1)$$

$$\boxed{u = f(n+1)}$$

object is placed at $(n+1)f$.

Question paper questions solution :-

Q16 Solve



$$\frac{H_I}{H_O} = \frac{uu}{uu^0}$$

$$\frac{H_I}{x} = \frac{u}{1}$$

$$\boxed{H_I = ux}$$

$$\frac{H_I}{H_O} = \frac{uu}{uu^0}$$

$$\frac{H_I}{y} = \frac{1}{4}$$

$$\boxed{H_I = \frac{u}{4}}$$

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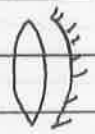
Date ___ / ___ / _____

Q20 2f પર object put karenge to image 2f પર જ બનેગી.

Q19

Ans



$P_{net} = P_1 + P_2 + P_3$

$\frac{-1}{f_{net}} = \frac{1}{L} + \frac{1}{m} + \frac{1}{L}$

$\frac{-1}{f_{net}} = \frac{2}{L} + \frac{1}{m}$

$\frac{1}{f_L} = (\mu - 1)\left[\frac{1}{R} + \frac{1}{R}\right]$

$\frac{1}{f_L} = (\mu - 1) \times \frac{2}{R}$

$\boxed{f_L = \frac{R}{2(\mu - 1)}}$

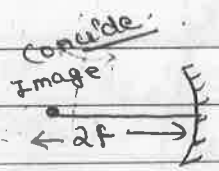
$f_m = -\frac{R}{2}$

$-\frac{1}{f_{net}} = \frac{2}{\frac{R}{2(\mu-1)}} - \frac{1}{-R/2}$

$= \frac{4(\mu-1)}{R} + \frac{2}{R}$

$= \frac{4\mu - 4 + 2}{R}$

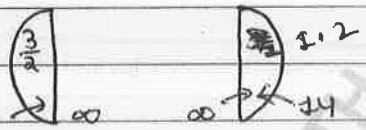
$\boxed{f_{net} = \frac{R}{2(2\mu - 1)}}$



$D = 2f = \frac{R}{(2\mu - 1)}$

$\boxed{D = \frac{R}{(2\mu - 1)}}$

Q22



$\frac{1}{f_1} = (1.5 - 1) \times \frac{1}{14}$

$\frac{1}{f_1} = 0.5 \times \frac{1}{14}$

$\boxed{\frac{1}{f_1} = \frac{0.5}{14}}$

$\frac{1}{f_2} = (1.2 - 1) \times \frac{1}{14}$

$= \frac{0.2}{14}$

$\boxed{\frac{1}{f_2} = \frac{0.2}{14}}$

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

$\frac{0.5}{14} + \frac{0.2}{14}$

$f = \frac{20}{\frac{14}{0.7}}$

$\boxed{f = 20 cm}$

$u = 40 cm$

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

$\frac{1}{v} + \frac{1}{40} = \frac{1}{20}$

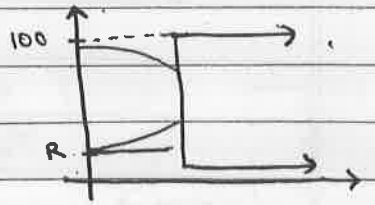
$\frac{1}{v} = \frac{1}{20} - \frac{1}{40}$

$\frac{1}{v} = \frac{2 - 1}{40}$

$\frac{1}{v} = \frac{1}{40}$

$\boxed{v = 40 cm}$

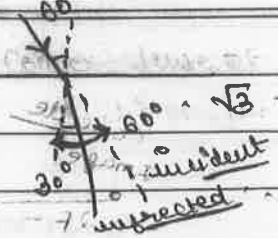
Q21



Saathi

Date __ / 10 / ____

Q8.



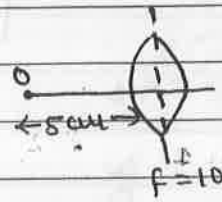
$1 \sin 60° = \sqrt{3} \sin r$

$\frac{\sqrt{3}}{2} = \sqrt{3} \sin r$

$\sin r = \frac{1}{2}$

$\boxed{r = 30°}$

Q5.



$\frac{H_I}{H_O} = \frac{v}{u}$

$= \frac{-16}{-8}$

$\boxed{H_I = 2H_O}$

Q5 erect virtual.

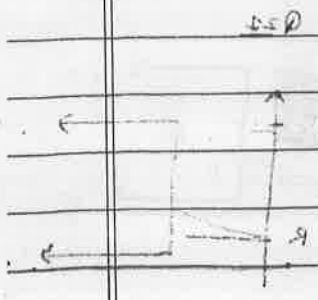
$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{-5} = \frac{1}{10}$

$\frac{1}{v} = \frac{1}{10} - \frac{1}{5}$

$v = \frac{1}{-10}$

$\boxed{v = -10cm}$



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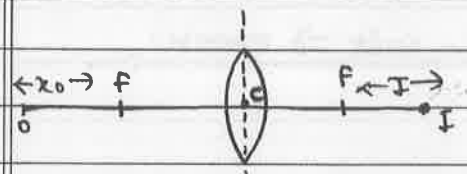
Date ___ / ___ / _____

Newton's Formula For lense :-



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

$\begin{matrix} v \\ u \end{matrix}$ → measure From C.

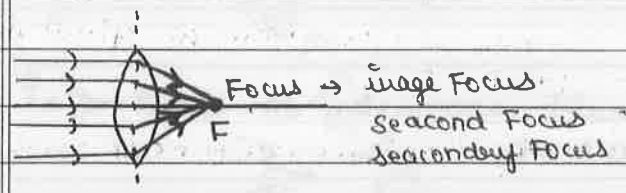
x_0 → distance of object from Focus.

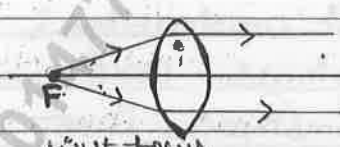
x_i → distance of image from Focus.

$x_0 x_i = f^2$

Newton's Formula

object Focus and Image Focus :-





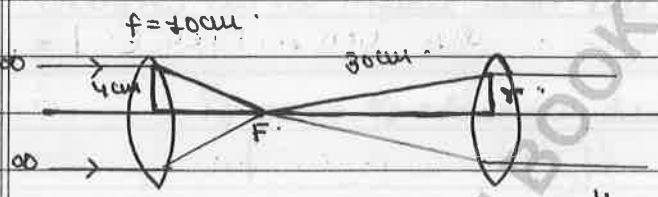
$v = \infty$

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

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

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

$v = \infty$

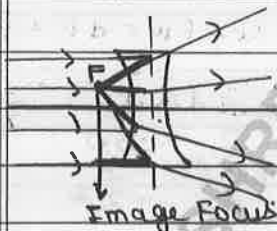


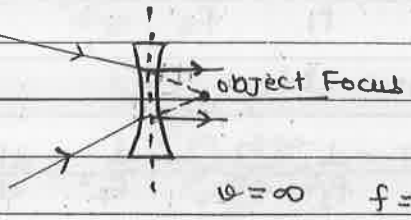
$\frac{4}{10} = \frac{r}{30}$

$r = 12cm$

object Focus :-

It is a point on principle axis where if the object is kept then light rays becomes parallel after refraction.





$v = \infty$ $f = -f$

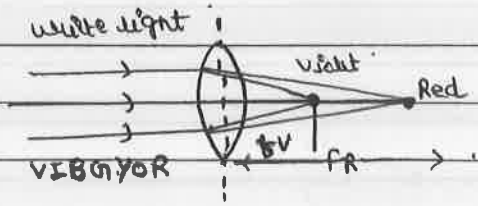
concave

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

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

$u = f$

chromatic Abberation :-



$\frac{1}{f} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ $f \propto \frac{1}{\mu}$

Cauchy's relation :-

$\mu \propto \frac{1}{\lambda}$ VIBGYOR →

μ → अलग अलग λ ↑

μ Red सबसे कम

f → अलग

$f \propto \frac{1}{\mu} \propto \lambda$ = f_{Red} सबसे ज्यादा

I. ST → 01

Date ___ / ___ / _____

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Chromatic
Longitudinal ~~Chromatic~~ abberations :- unit ⇒ meter.

$$L.C.A = f_R - f_V = f\omega$$

f → focal length of mean colour

ω → dispersive power

$$\omega = \frac{\mu_V - \mu_R}{\mu_y - 1} \qquad \mu_y = \frac{\mu_R + \mu_V}{2}$$

Achromatic combinations :-

1. ऐसा combination जिसमें chromatic abberation की बीमारी नहीं हो।
2. ऐसा combination जिसका L.C.A = 0
3. ऐसा combination जिसमें Net focal length for all colour constant हो।
4. ऐसा combination जो chromatic abberation से free हो।

Chromatic combinations

$$\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$$

ω_1, ω_2 → dispersive power

f_1, f_2 → focal length

$$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$$

diff. Both side.

$$0 = -\frac{1}{f_1^2}\cdot\frac{df_1}{d\mu} - \frac{1}{f_2^2}\cdot\frac{df_2}{d\mu}$$

$$0 = \frac{1}{d\mu}\left[\frac{df_1}{f_1^2} + \frac{df_2}{f_2^2}\right]$$

$$0 = \frac{f_1\omega}{f_1^2} + \frac{f_2\omega}{f_2^2}$$

$$\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$$

$\frac{1}{x} \times \mu$

$f_R - f_V = df = f\omega$

$\frac{d}{dx}\left[\frac{1}{x}\right] = -\frac{1}{x^2}$

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Date ___ / ___ / _____

Conceptual Notes:-

$\omega = \omega_V - \omega_R$

$\omega = \mu_V - \mu_R$

Achromatic Combination

$\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$

$\frac{\omega_1}{\omega_2}$ > always positive

Combination →

one lense → Convex

one lense → Concave

Convex . Concave

Combinations

$P_{net} = P_1 + P_2$

Possibility	Possibility
$P_1 = +4D$	$P_1 = +1D$
$P_2 = -1D$	$P_2 = -4D$
$P_{net} = P_1 + P_2$	$P_{net} = P_1 + P_2$
$= 4 + (-1)$	$= +1 + (-4D)$
$= +3D$	$= -3D$
Overall combination converging	Overall comb. Diverging

Q1 An Achromatic convergent doublet of 2 lenses in contact has a power of +2D. The convex lense has a power +5D. Calculate the ratio of disp. Power of convergent and divergent lenses?

Solve. $P_{net} = P_1 + P_2$

$+2 = 5 + (-x)$

$2 - 5 = x \quad \boxed{x = -3D}$

$\frac{\omega_1}{F_1} + \frac{\omega_2}{F_2} = 0$

$\frac{\omega_1}{F_1} = -\frac{\omega_2}{F_2}$

$\frac{\omega_1}{\omega_2} = -\frac{F_1}{F_2}$

$\boxed{\frac{\omega_1}{\omega_2} = 3/5}$

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Q2 If the magnitude of dis. power of 2 lenses are 0.012 and 0.024 respectively then their focal length will be for Achromatic combination?

(a) a = 10cm, −30cm

(b) 5cm, −20cm.

(c) 10cm, −20cm

(d) 20cm, −30cm

only by option method no other way of soln.

solve:

$$\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$$

$$\frac{0.012}{f_1} + \frac{0.024}{f_2} = 0$$

$$\frac{f_1}{f_2} = \frac{-\omega_1}{\omega_2} = \frac{0.012}{0.024} = -\frac{1}{2}$$

Q3 The dispersive power of material of 2 lenses are in the ratio 1:2.

483 If the achromatic combination of these 2 lenses in contact is a convex lense of focal length 60cm then the focal length of component lenses are?

(i) −20cm, 25cm = 415 — (X)

(ii) 20cm, −25cm. −415 — (X)

(iii) −20cm, +15cm −413 — ✓

(iv) +20cm, −15cm −413 ✓

$$\frac{\omega_1}{\omega_2} = \frac{-f_1}{f_2}$$

$$\frac{1}{3} = \frac{-f_1}{f_2}$$

60 f1

solve: $\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$

$$\frac{\omega_1}{f_1} = \frac{-\omega_2}{f_2}$$

$$\frac{\omega_1}{\omega_2} = \frac{-f_1}{f_2}$$

$$\frac{-\omega_1}{\omega_2} = \frac{f_1}{f_2}$$

$$\boxed{\frac{1}{3} = \frac{-f_1}{f_2}}$$

$$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{60} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{60} = \frac{f_2 + f_1}{f_1 f_2}$$

$$60 = \frac{f_1 f_2}{f_2 + f_1}$$

$$\frac{1}{60} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{3} = -f_1 \times \frac{1}{60}$$

Now option ko check karo

③ and ④.

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option ③

-20cm, +15cm

$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$

$= \frac{-1}{20} + \frac{1}{15}$

$= \frac{-3+4}{60}$

$= 1/60$ convex

$f_{net} = +60cm$ ✓ option ③ right.

option - ④

20cm, -15cm

$\frac{1}{f_{net}} = \frac{1}{20} - \frac{1}{15}$

$= \frac{3-4}{60}$

$= -1/60$

$f_{net} = -60cm$

Lense displacement Method :-

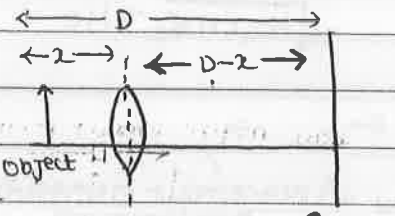
This method is used to calculate focal length of the convex lense in the laboratory.

3 lines :-

★ $f = \frac{D^2 - (\Delta x)^2}{4D}$

★ $D \geq 4f$

★ $H_0 = \sqrt{H_{I_1} \times H_{I_2}}$



AIM → to calculate focal length of lense

Derivation

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

$u \to -x \quad v = [D-x]$

$\frac{1}{(D-x)} - \frac{1}{-x} = \frac{1}{f}$

on solving →

$x^2 - xD + fD = 0$

$x^2 - xD + fD = 0$

$a = 1 \quad b = -D \quad c = fD$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$x_1 = \frac{D - \sqrt{D^2 - 4fD}}{2}$

For real values of x

$D^2 - 4fD > 0$

$D^2 > 4fD$

$D > 4f$ two values.

case ≠ 2

$D^2 - 4fD \geq 0$

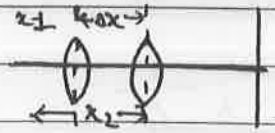
$D^2 \geq 4fD$

$D = 4f$

In this situation only one value of x is possible.

AIPMT → min separation

$D = 4f$



$\Delta x = x_2 - x_1$

$x = \frac{D \pm \sqrt{D^2 - 4fD}}{2}$, $D - \sqrt{D^2 - 4fD}$

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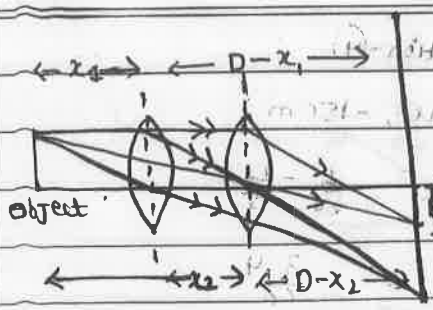


Position 1 .

$$\frac{H_I}{H_O} = \frac{v}{u}$$

$$\frac{H_I}{H_O} = \frac{D-x_1}{-x_1} \quad \text{①}$$

Position-2

$$\frac{H_I}{H_O} = \frac{v}{u}$$

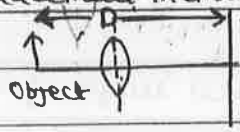
$$\frac{H_{I2}}{H_O} = \frac{D-x_2}{-x_2} \quad \text{②}$$

$$\sqrt{H_{I_1} \times H_{I_2}} = H_O$$

← →

SHORT NOTES .

Lens displacement method :-



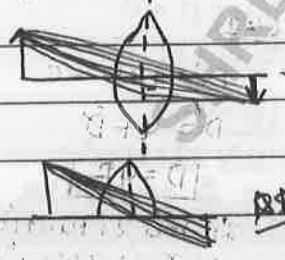
Aim → To calculate focal length

$$H_O = \sqrt{H_{I_1} \times H_{I_2}}$$

$$D \geq 4f$$

$$f = \frac{D^2 - (\Delta x)^2}{4D}$$

Conceptual points :-



Intensity of image ∝ area of aperature

Image की size
की Brightness
की
Intensity of image की .

P.T.O .

Ex I → Q57 - 81 all Discussed (
Ex II → 1, 3, 6, 7, 12, 17, 20, 21, 26, 28, 35, 42, 50, 63.
Ex III → Q12, Q15
77 → ☆☆, 79 - ☆

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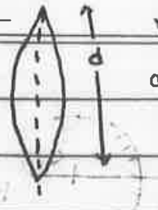
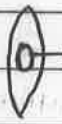
AIPMT →



$r = d/2$

area $= \pi (r)^2 = \pi \frac{d}{4}$

Intensity = I



$r = d/4$.

area $= \pi \frac{d}{16} = \pi \frac{d^2}{16}$.

remaing $= \frac{\pi d^2}{4} - \frac{\pi d^2}{16}$

$\frac{4\pi d^2 - \pi d^2}{16} = \frac{3\pi d^2}{16}$

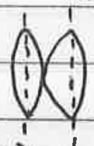
$\frac{I_1}{I_2} = \frac{A_1}{A_2}$

$\frac{I}{I_2} = \frac{\pi d^2/4}{3\pi d^2/16}$.

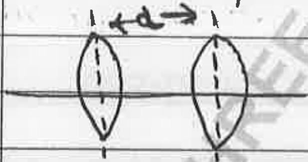
$\boxed{I_2 = \frac{3}{4} I}$ focal length में कोई change नहीं आयेगा।

Conceptual point :-

Case① → when lens are in contact



$$\boxed{\frac{1}{f_{nett}} = \frac{1}{f_1} + \frac{1}{f_2}}$$



d → seperation b/w lenses.

$$\boxed{\frac{1}{f_{nett}} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}}$$

Ex I → Q75

$x_0 x_i = f^2$

$25(40) = f^2$

$f^2 = 1000$

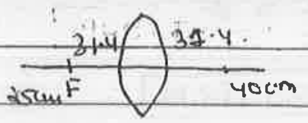
$f = 10\sqrt{10}$.

$\boxed{f = 31.4 cm}$

$m = \frac{H_I}{H_O} = \frac{v}{u}$

$= -\frac{71.4}{56.4} = -1.3$

$m = -1.3$



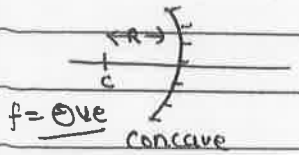
$40 + 31.4 = 71.4$

$25 + 31.4 = 56.4 cm$

Saathi

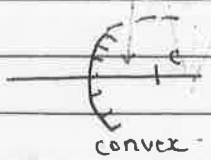
Date ___ / ___ / ____

Mirror :-



f = ⊖ve

Concave



f = ⊕ve

convex

$f = \frac{R}{2}$

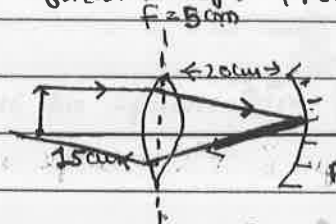
सबसे ध्यान दिया mirror के सामने

front → Negative.

U
v
f
→ negative

Q1 In the given situation lense and mirror are 20cm apart and object is placed 15cm to left of the lense. determine the distance of final image from lense?

Solve



Solve. Total event = 3.

→ Refraction from lense.
→ Reflection from mirror
→ Again Refraction from lense

event # 1.

U = -15 cm.
f = +5cm.

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

$\frac{1}{5} = \frac{1}{v} + \frac{1}{15}$

$\frac{1}{5} - \frac{1}{15} = \frac{1}{v}$

$\frac{3-1}{15} = v$

$v = 7.5\text{cm}$

event = ②

U = 20 - 7.5 = 12.5 = -12.5cm
v = ?
f = ⊖15cm.

mirror

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

$-\frac{1}{15} = \frac{1}{v} + \frac{1}{-12.5}$

$-\frac{1}{15} + \frac{2}{25} = \frac{1}{v}$

$\frac{-10+12}{150} = \frac{1}{v}$

$v = +75\text{cm}$

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Date ___/___/_____

event = 3

$v = +75 + 20 = 95$ cm

$u = ?$

$f = 5$ cm

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

$\frac{1}{5} = \frac{1}{v} + \frac{1}{95}$

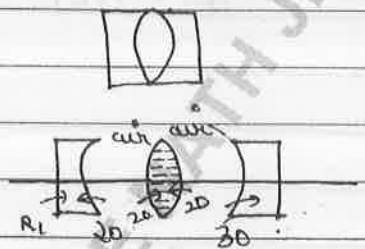
$\frac{1}{5} - \frac{1}{95} = \frac{1}{v}$

$\frac{19-1}{95} = \frac{1}{v}$

$\frac{95}{18} = v$

Q2. 2 plano concave lense of glass ($\mu = 1.5$) have radius of curvature 20cm and 30cm. they are placed in contact with curved surface towards each other and space b/w them is filled with a liquid ($\mu = 4/3$) then calculate the focal length of the system?

Solve



$\frac{1}{f} = \left(\frac{1}{2}\right) \times \frac{1}{20}$ [÷ 1/20]

$\frac{1}{f} = \frac{1}{2} \times \left(\frac{-1}{20}\right)$

$\frac{1}{f} = \frac{1}{-40}$ $\quad f_1 = -40$ cm

event 2

$\frac{1}{f} = \left(\frac{4}{3} - 1\right)\left(\frac{2}{R}\right)$

$\frac{1}{f} = \frac{1}{3} \times \frac{2}{R}$

$f = \frac{3R}{2}$

$f = \frac{60}{2}$ 30

event ③

$\frac{1}{f} = \frac{1}{2} \times -\frac{1}{R}$

$f = -60$ cm

$= \frac{-9 + 10 - 6}{360}$

$= \frac{3 \cdot 80}{-5}$

$= -72$ cm

$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$

$= -\frac{1}{40} + \frac{1}{36} + \left(-\frac{1}{60}\right)$

$= -\frac{1}{40} + \frac{1}{36} - \frac{1}{60}$

900

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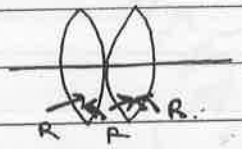
Date ___ / ___ / _____

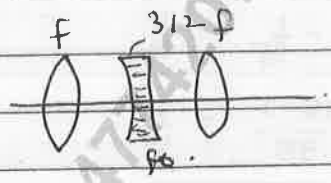
Q2 NEET 2019 :-

Two similar thin equi-convex lense of total length f of each are placed in contact such that focal length of comb. is F_1 when space b/w 2 lenses is filled with glycerine ($\mu = 1.5$) then eq. focal length is f_2

$\frac{F_1}{F_2} = ?$

Solve.





$\frac{1}{f_1} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f_1} = \frac{1}{2} \times \frac{2}{R}$

$\boxed{f = R}$

$\frac{1}{f_1} = \frac{1}{R} + \frac{1}{R}$

$f_{net} = \frac{1}{f} + \frac{1}{f}$

$f_{net} = f/2$

$\boxed{f_1 = f/2}$

$\frac{1}{f_0} = \frac{1}{2} \times \frac{2}{R}$

$\boxed{f_0 = -R}$ $\boxed{f_0 = -f}$

$\frac{1}{f_2} = 2 \times \frac{1}{2} + \frac{1}{-f}$

$\frac{1}{f_{net}} = \frac{1}{f} + \frac{1}{f} + \frac{1}{f}$

$\boxed{f_{net} = f}$ $\boxed{f_2 = f}$

$\frac{f_1}{f_2} = \frac{R}{2f} = 1/2$

Date ___ / ___ / _____

2 | 40, 60
2 | 20, 30
2 | 10, 15
5 | 5, 15
3 | 1, 3
3 | 1, 1

40×3 / 120

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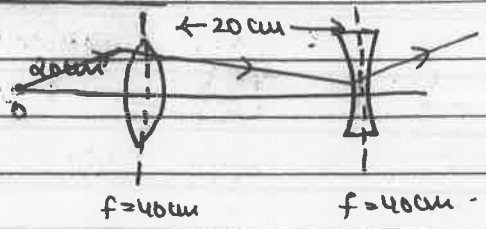
AIIMS = 2018



Position of Final image from O?

Solve $u = -20cm$

$v = ?$

$f = 40cm$

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

$\frac{1}{40} = \frac{1}{v} + \frac{1}{20}$

$\frac{1}{40} - \frac{1}{20} = \frac{1}{v}$

$\frac{1-2}{40} = \frac{1}{v}$

$\frac{-1}{40} = \frac{1}{v}$

$\boxed{v = -40cm}$

event ②

$v = -40 + (-20) = -60cm$

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

$\frac{1}{40} = \frac{1}{v} + \frac{1}{60}$

$-\frac{1}{40} = \frac{1}{v} + \frac{1}{60}$

$-\frac{1}{40} - \frac{1}{60} = \frac{1}{v}$

$\frac{-3-2}{120} = \frac{1}{v}$

$\frac{-5}{120} = \frac{1}{v}$

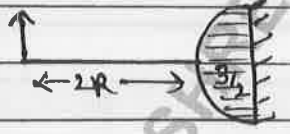
$v = -24$

$\boxed{v = -24cm}$

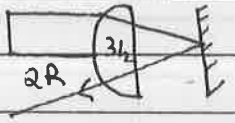
Overall magnification :-

$\boxed{m = m_1 \times m_2 \times m_3 \times m_4 \ldots}$

Q3 Hemisphere of Radius R.



A glass Hemisphere of radius R and material having ($\mu = 3/2$) is silvered on its Flat Face then calculate the position of final image?



$\frac{3}{2} - 1 \quad \frac{1}{2}$

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$$\frac{3}{2V} + \frac{1}{2R} = \frac{3-1}{R}$$

$$\frac{3}{2V} = \frac{1}{2R} + \frac{1}{2R}$$

$$\frac{3}{2V} = \frac{2}{2R}$$

$$\frac{2}{3} = V \qquad V = \infty$$

Event (2)

$f = \frac{R}{2}$

$f = \infty$

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

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

$$\frac{1}{\infty} = \frac{1}{v}$$

$v = \infty$

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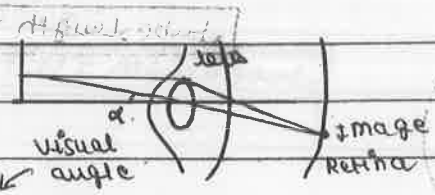
Optical Instruments :—



object ને retina પર બનતો angle.

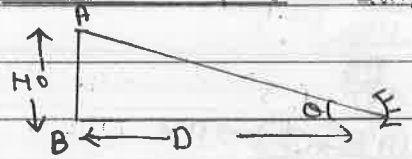
angle substended by object at eye with the instrument.

$$\text{magnifying power} = \frac{\beta}{\alpha}$$

no unit.

angle substended by the object at eye without instrument

For microscope :— tiny objects

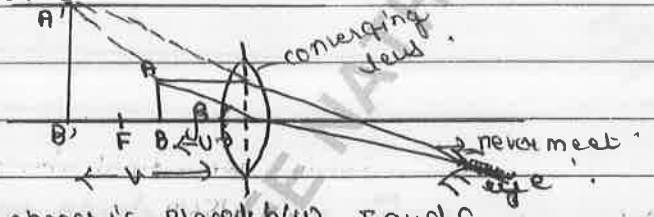


D = 25cm least distance of Distinct vision.

$$\tan\alpha = \frac{AB}{D} = \frac{Ho}{D}$$

$$\boxed{\alpha = \frac{AB}{D}}$$

① Simple Microscope :— (magnifying glass).



object is placed b/w F and C

$\Delta A'B'C$

$$\tan\beta = \frac{A'B'}{v} = \frac{AB}{U}$$

$$\boxed{\beta = \frac{AB}{U}}$$

$$m = \frac{\beta}{\alpha} \qquad \alpha \to \text{fixed}$$

$$\alpha = \frac{AB}{D}$$

$$m = \frac{\frac{AB}{U}}{\frac{AB}{D}}$$

angular magnification

$$\boxed{m = \frac{D}{U}}$$

case(i) final image formed at ∞.

$v = \infty \quad U = -U$

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

$$\boxed{m = \frac{D}{f}}$$ Normal adjustment

mini magnifying power

case(ii) when image formed at 25cm.

$v = -D \quad U = -U$

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

$$\boxed{m = 1 + \frac{D}{f}}$$

max. magnifying power

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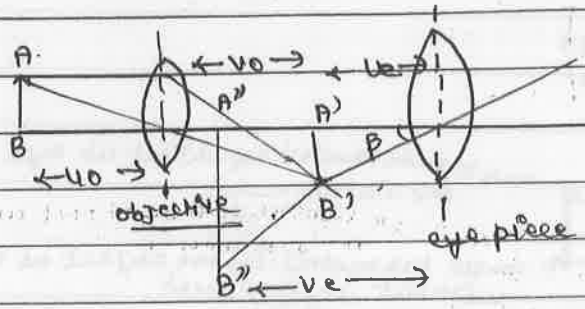
② Compound microscope :-

Tube length = $v_o + v_e$



object AB

$m_o = \frac{H.I}{H.O} = \frac{v}{u}$

$\frac{A'B'}{AB} = \frac{+v_o}{u_o}$ ①

magnification produced by objective lense.

$m_o = \frac{v_o}{u_o}$

$\tan\beta = \frac{A'B'}{v_e}$

$\beta = \frac{A'B'}{v_e}$

$m = \beta/\alpha$

$= \frac{\frac{A'B'}{v_e}}{\frac{AB}{D}}$

$M = \frac{A'B''}{v_e} \times \frac{D}{AB}$ → m_e → m_o

$M = m_o \times m_e$

Case 1 :-

when final image formed at ∞

$M = m_o \times m_e$

$M = \frac{v_o}{u_o} \times \left[\frac{D}{f_e}\right]$

case 2 :- when final image formed at 25cm.

$m = m_o \times m_e$

$M = \frac{v_o}{u_o} \times \left[1 + \frac{D}{f_e}\right]$

f_e = focal length of eye piece.

Date ___/___/_____

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Short Notes :-

1. $M = \frac{D}{U}$ angular magnification ; magnification :- $\frac{HI}{HO} = \frac{v}{U}$ [Transverse mag]

Case 1 final image → ∞

$m = \frac{D}{f}$ [min. magnifying power]

Case 2 final image → 25 cm

$m = 1 + \frac{D}{F}$ [max. magn. power]

Race :-

Q18. $f = 10\,cm$

$D = 8\,cm$.

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

$\frac{1}{v} - \frac{1}{9} = 1/10 \quad v = -90\,cm$.

$m = \frac{HI}{HO} = \frac{v}{u}$

$= \frac{-90}{-9} = \boxed{10 = m}$

Q19. Area of square image $= m^2$ [area of object].

$= 10^2\,[1\,mm^2]$

$= 100\,mm^2$.

angular magnification $= \frac{D}{u} = \frac{25}{9} = 2.8$.

Q20. $m = 1 + D/f = 1 + \frac{25}{10}$ $\frac{10+25}{10} = \frac{35}{10}$.

$m = \frac{HI}{HO}$ $\frac{35}{10}$

$\frac{35}{10} =$ — × — ×

Q21. $v = -25\,cm$.

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

$-\frac{1}{25} - \frac{1}{u} = \frac{1}{10}$

$-\frac{1}{25} - \frac{1}{10} = \frac{1}{u}$

$\frac{-2-5}{50} = \frac{1}{u}$

$-\frac{7}{50} = \frac{1}{u}$

$u = -50/7$. $\boxed{u = -7.14\,cm}$

Q22 $m = \frac{v}{u} = \frac{50}{7} \cdot \frac{1}{25}$

$= \frac{2}{7}$

$= 7/2$.

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

$\frac{1}{25} - \frac{1}{u_o} = \frac{1}{2}$.

$-\frac{1}{25} - \frac{1}{2} = \frac{1}{u_o}$.

$\frac{-2-25}{50}$.

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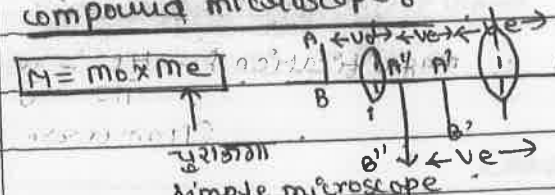
Date

compound microscope —

$M = m_o \times m_e$

$m_o = \frac{v_o}{u_o}$.



युराशाला

simple microscope

Final image ∞.

$M = m_o \times m_e$

$= \frac{v_o}{u_o}\left[\frac{D}{f}\right]$

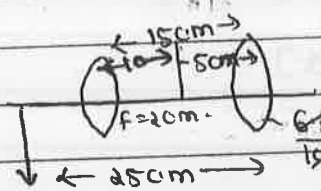
final image at 25cm.

$M = m_o \times m_e$

$= \frac{v_o}{u_o}\left[1 + \frac{D}{f}\right]$.

Q10 tube length = 15cm.

$v_o + v_e =$ [redacted] 15cm.



$\frac{6.25}{100}$ $\frac{25}{4}$ cm.

$\frac{1}{v} - \frac{1}{u} = \frac{4}{25}$

$-\frac{1}{25} - \frac{1}{v_e} = \frac{4}{25}$

$-\frac{1}{25} - \frac{4}{25} = \frac{1}{v_e}$

$\frac{-5}{25}$ $\boxed{v_e = -5cm}$

$v_o = 10cm$

$f_o = 2cm$

$\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f}$.

$= \frac{1}{10} - \frac{1}{u_o} = \frac{1}{2}$

$= \frac{1}{10} - \frac{1}{2} = \frac{1}{u_o}$

$= \frac{1-5}{10} = \frac{1}{u_o}$

$=$ [redacted] $\boxed{u_o = 2.5}$

Homework. Rqco Q=3
Ex II → Q29.38 (same pattern)

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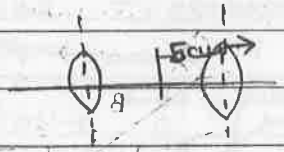
Q23 f_o = 7.5cm final image = ∞

f_e = 5cm.

m = 30.



$m = -30$.

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

$\frac{1}{\infty} - \frac{1}{u_e} = \frac{1}{5}$. $u_e = -5cm$

$m = m_o \times m_e$

$30 = \frac{v_o}{u_o}\left[\frac{25}{5}\right]$.

$30 = \frac{v_o}{u_o} \times 5 = \boxed{v_o = 6u_o}$. $u_o = v_o/6$.

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

$\frac{1}{6u_o} + \frac{1}{u_o} = \frac{1}{1.25}$

$\frac{1}{u_o} + \frac{6}{6u_o} = \frac{100}{125} \frac{4}{5}$

$\frac{7}{u_o} = \frac{4}{5}$

$\frac{7 \times 5}{4} = u_o$ $\frac{35}{4}$ $8.75 = u_o$.

tube length = 8.75 + 5 = 13.75 cm

~~Ext → Q2, Q4, Q7, Q8~~
~~II → 29, 30~~
III →

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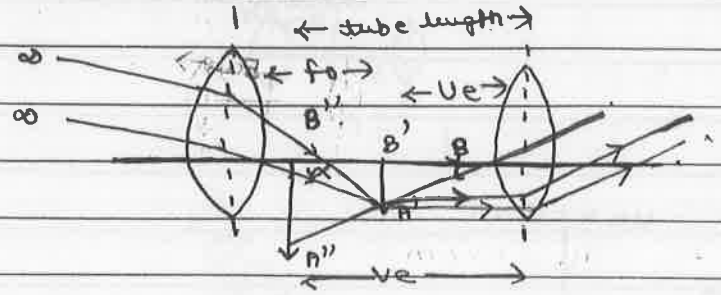
Astronomical Telescope :- It is used to see distant objects.



$\tan\alpha = \frac{p}{B}$

objective

Image → A'B'

object → ∞

eye-piece

$\tan\beta = \frac{A'B'}{Ue}$

$\boxed{\tan\alpha = \frac{A'B'}{fo}}$

$M = \beta/\alpha$

$M = \frac{\frac{A'B'}{Ue}}{\frac{A'B'}{fo}}$

$\boxed{M = \frac{fo}{Ue}}$

case (1)

Final image → ∞

Normal adjustment

Ve → ∞ Ue → -Ue

$\frac{1}{Ve} - \frac{1}{Ue} = \frac{1}{fe}$

$\frac{1}{\infty} - \frac{1}{-Ue} = \frac{1}{fe}$

$\boxed{Ue = fe}$

$\frac{fo}{Ue} = \boxed{\frac{fo}{fe} = m}$

case (2)

Final image → 25cm

$Ve = -D$ $Ue \to -Ue$

$\frac{1}{Ve} - \frac{1}{Ue} = \frac{1}{fe}$

$\frac{1}{-D} - \frac{1}{-Ue} = \frac{1}{fe}$

$\frac{1}{Ue} = \frac{1}{fe} + \frac{1}{D}$

fo से multiply

$\frac{fo}{fe} + \frac{fo}{D} = \frac{fo}{Ue}$

$\boxed{m = fo\left[\frac{1}{fe} + \frac{1}{D}\right]}$

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Short Note on astronomical telescope :-

जब Final image ∞ पर
Normal adjustment
angular magnification को given हो

$$m = \frac{f_o}{f_e}$$

Tube length = $f_o + f_e$
sep. b/w lenses

जब Final image → 25 cm

$$m = m_o\left[\frac{1}{f_e} + \frac{1}{D}\right]$$

Race

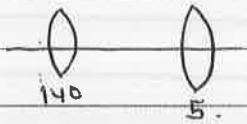
Q24. $f_o = 140$ cm
$f_e = 5$ cm

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

$$\frac{1}{\infty} - \frac{1}{u} = \frac{1}{5}$$

$$u = 5 \text{ cm}$$

$$m = \frac{f_o}{f_e} = \frac{140}{5} = 28$$



Q25. $f_o\left[\frac{1}{f_e} + \frac{1}{D}\right]$

$140\left[\frac{1}{5} + \frac{1}{25}\right]$

$140 \quad \frac{5+1}{25}$

$\frac{140 \times 6}{25} = 33.6$

$5 \times 6 = 30$
$= 33.6$

Q26. $f_o + f_e$ = tube length
$140 + 5 = 145$ cm

Q27. $m_o = \frac{v}{u}$

$= 20$

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

$\frac{1}{v} - \frac{1}{3000} = \frac{1}{140}$

$\frac{1}{v} = \frac{1}{140} + \frac{1}{3000}$

$\frac{1}{v} = \frac{140}{3000}$

$\frac{14}{3} = x$

$\frac{HI}{HO} = \frac{v}{u}$

$\frac{x}{100} = \frac{140}{3000}$

$\frac{140 \times 100}{3000}$

$x = 7$ cm

$\frac{x}{100} = \frac{140}{300000}$

140×300000
300000

7 cm

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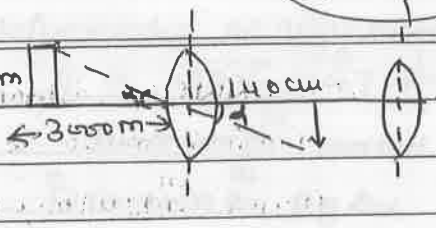
Q27. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$



$\frac{1}{v} - \frac{1}{3000 \times 100} = \frac{1}{140}$.

$v \simeq 140$ cm

Height

$\frac{\text{Image}}{3000\text{ m}} = \frac{HI}{140\text{cm}}$

$\frac{14}{3} = HI$

Q28. $\frac{1}{v} - \frac{1}{u} = \frac{1}{fe}$.

$\frac{1}{-25} - \frac{1}{u} = \frac{1}{5}$

$-\frac{1}{25} - \frac{1}{5} = \frac{1}{u}$

$\frac{-1-5}{25} = \frac{1}{u}$

$u = \frac{25}{-6}$.

$HO = \frac{14}{3}$

$\frac{HI}{HO} = \frac{v}{u}$.

$\frac{3HI}{14} = \frac{+25}{+25} \times 6$.

$\frac{14 \times 6}{3} = HI$.

$HI = 28$cm

Q29. Q4. $fe = 5$cm.

$m = 14$.

tube length = ?

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

$14 = \frac{fo}{5}$

$14 \times 5 = fo$

$70 + 5 = 75$cm.

Q5. $50 = fo + fe$. $50 - fe = fo$.

$9 = \frac{fo}{fe}$.

$9 = \frac{50 - fe}{fe}$ $fo = 45$

$9fe = 50 - fe$

$10fe = 50$

$fe = \frac{50}{10}$ $fe = 5$cm

Ex I → Q1-93. Ex II → Q14, 22, 34
94-100 Ex III → Q9.
Page → Q1-6, Q10, 11, 12, 13, 16, 17, 18-28.

magnification = ⊖ve more accurate b/c image is inverted

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Q13. f_o = 144 cm

f_e = 6 cm.

$$m = \frac{f_o}{f_e} = \frac{144}{6} = 24$$

$f_o + f_e = 144 + 6 = 150$

Eye-defect [Myopia]

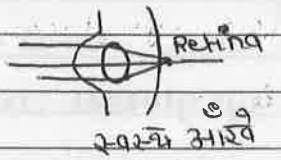
इसमें दूर के object साफ दिखाई नहीं देते हैं।

For Normal eye :—

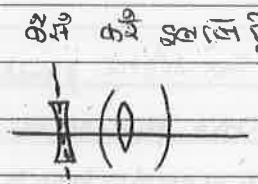
Near point = 25 cm

Far point = ∞

Myopic patient का Far point finite होता है।



दूर से आती



use concave lens

Ex :-

Q1. A person cannot see beyond 2m. In order to see distant objects.

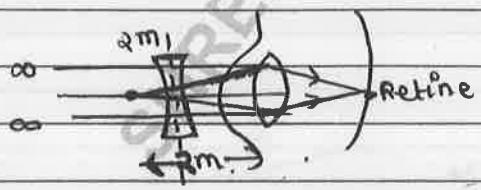
Lense used = ?

Power = ?

Focal length = ?

Sol^n. Cannot see beyond 2m मतलब Myopic patient Hai

दूर की चीज नहीं दिखेगी।



$u = \infty$

$v = -2m$

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

$$\frac{1}{-2} - \frac{1}{\infty} = f$$

$$\boxed{f = -2m}$$

concave

$$\text{Power} = \frac{1}{-2} = \ominus 0.5\ D$$

Date ___ / ___

4×3 = 12 ; 5 / 300 / 60 ; 60×5 / 300 ; 46×5 / 300

1	25, 60
2	25, 30
3	25, 15
4	25, 5
5	25, 1

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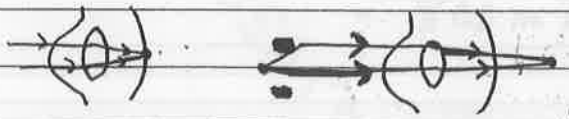
Hypermetropia :- इसमें पास के object साफ दिखाई नहीं देते ।

For normal eye -

Near point = 25 cm

far point = ∞

Hypermetropic Patient की Near point ज्यादा है ।



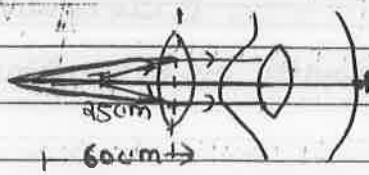
normal eye

Hypermetropic eyes

इसमें Retina के पीछे होगी ।

Q1. A far sight person has a near point 60 cm away. what should be the power of lens, he should use for eye glasses, so that he can read a book at distance of 25 cm?

Solve.



$u = -25\,cm$

$v = -60\,cm$

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

$\frac{1}{-60} - \frac{1}{-25} = \frac{1}{f}$

$\frac{-5-(-12)}{300} = \frac{1}{f}$

$\frac{-5+12}{300} = \frac{1}{f}$

$\frac{300}{7} = \frac{1}{f}$ $\quad f = \frac{300}{7}\,cm$

$\frac{1}{\infty} - \frac{1}{400} = \frac{1}{f}$

$f = 400$

$-4m$

$\frac{r}{4} = 0.25$

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Ex 1

Q89 $M = \frac{F_o}{F_e} = \frac{100}{2}$ $M = 50$.

$M = \beta/\alpha$

$50 = \frac{\beta}{0.5^\circ}$ $\boxed{\beta = 25^\circ}$

Q88 $f_o = 40cm$

$f_e = 4cm$.

$v = 200cm$.

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

$\frac{1}{v} - \frac{1}{-200} = \frac{1}{40}$

$\frac{1}{v} + \frac{1}{200} = \frac{1}{40}$

$v = \frac{1}{40} - \frac{1}{200}$

$v = \frac{5-1}{200}$.

$v = \frac{4}{200}$

$\boxed{v = 50cm}$.

** છુટક નહી પૈકરણ.

$\boxed{v = \infty}$

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

$\frac{1}{\infty} - \frac{1}{u_e} = \frac{1}{4}$.

$u_e = -4cm$

$50 + 4 = 54cm$

Q74 angular magnification

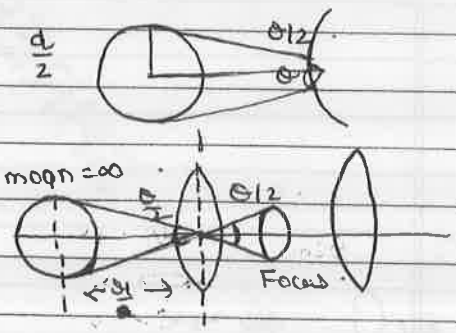
$m = \frac{f_o}{F_e} = \frac{15}{1} = 1500$

Q75 $U = 3.8 \times 10^8 m$.

$\theta = \frac{d}{r}$

$\theta = \frac{d}{2r}$ $\theta = \frac{d}{r}$

$\theta = \frac{3.48 \times 10^6}{3.8 \times 10^8}$



$\frac{d_{object}}{u} = \frac{d_{image}}{f_o}$.

$\frac{3.48 \times 200}{3.8 \times 10^2} = \frac{d_{image}}{1500cm}$.

$\frac{3.48 \times 10^8 \times 15}{3.8 \times 10^4} = d_{image}$.

$9.1 \times 15 \times 10^8 \times 10^{-3}$ 1.3×10^5 $13.74cm$

2	70, 90
5	45, 35
3	9, 7
5	3, 7
7	1, 7

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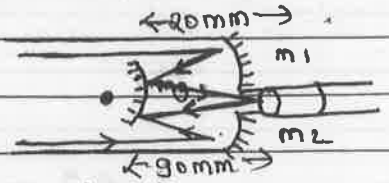
Casegrain telescope :—



large mirror

object → ∞

image → focus.

↓

focus lies

f = 110 mm

large mirror

$f = \frac{220}{2} = 110$ mm

small mirror

$f = \frac{R}{2} = \frac{140}{2} = 70$ mm

u = +90mm

f = 70cm

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

$\frac{1}{v} + \frac{1}{90} = \frac{1}{70}$

$\frac{1}{v} = \frac{1}{70} - \frac{1}{90}$

$= \frac{90 - 70}{90 \times 70}$

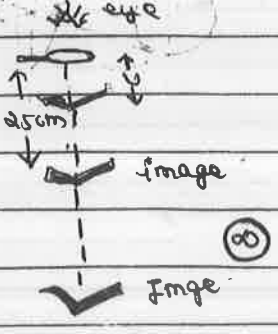
$= \frac{20}{6300}$

$\frac{6300}{20}$ 315

v = 315 mm

v = 31.5 cm

Q.16



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

$\frac{1}{u} + \frac{1}{25} = \frac{1}{5}$

$\frac{1}{u} = \frac{1}{5} - \frac{1}{25}$

$= \frac{5-1}{25}$

$u = \frac{25}{4}$

... 6.2

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Date ___ / ___ / _____

Q6. $\frac{1}{\infty} + \frac{1}{-100} = \frac{1}{f}$

$f = -200\,cm$

Q7. $-\frac{1}{75} \cdot \frac{-1}{\infty} = \frac{1}{f}$

$f = -75$

$P = \frac{1}{-75} = -\frac{100}{75}\frac{4}{3} = -1.33$

Q8. ~~$-\frac{1}{3}\frac{-1}{12}$~~

$-\frac{1}{3} + \frac{1}{12} = \frac{1}{f}$

$\frac{-4+1}{12} = \frac{1}{f}$

$f = -4\,m$

Q9. $\frac{1}{-25} + \frac{10}{5} = \frac{1}{f}$

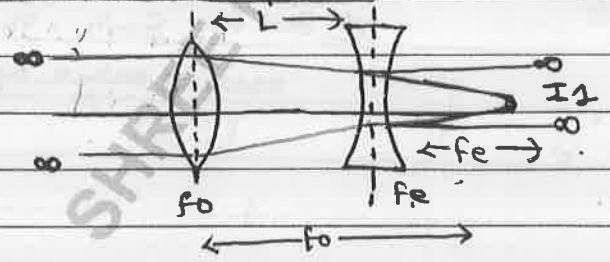
$\frac{-1+50}{25} = \frac{1}{f}$

$f = 50$

$P = \frac{100}{50} = 2\,D$

[ ]

Galilean Telescope :-



Concave

$v = +fe$

$f = -fe$

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

$\frac{1}{v} + \frac{1}{fe} = \frac{1}{fe}$

$v = \infty$

Length of telescope = fo + fe

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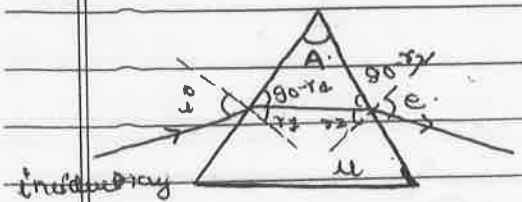
Date ___ / ___ / _____

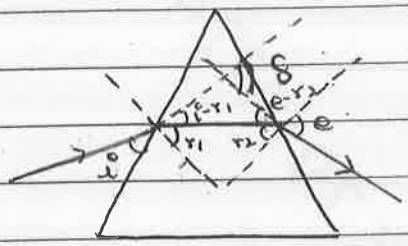
Prism :-



$A + 90 - i + 90 - r = 180^\circ$

$\boxed{A = r_1 + r_2}$

** angle of prism.



$\boxed{\delta = i + e - A}$

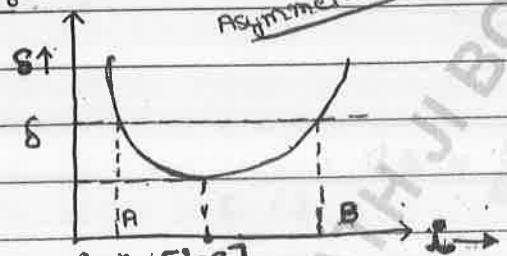
$\delta \rightarrow$ angle of deviation.

$i \rightarrow$ incidence angle.

$e \rightarrow$ emergence angle.

$A \rightarrow$ Prism angle.

graph :-



Practice curve

at A ⇒ $\delta = i + e - A$

$\delta = x + y - A$

at B ⇒ $i + e - A = \delta$

$\delta = x + y - A$

Conclusion →

** For every value of δ there are two possible values of i.

** But for δ_{min} there is only 1 value of i.

$\boxed{i = e}$

condition for minimum deviation :-

1. $i = e$.
2. $r_1 = r_2$.
3. $A = r_1 + r_2$

$\boxed{A = 2r}$

deviation (2)

$1 \sin i = 1 \sin r_1$.

$1 \sin e = 1 \sin r_2$

since $i = e$.

$\boxed{r_1 = r_2}$.

deviation (3)

since $i = e$

$r_1 = r_2$.

$A = r_1 + r_2$

$\boxed{A = 2r}$

$r = A/2$

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Date ___ / ___ / _____

$\delta = i + e - A$

at δ_{min}

$\boxed{\delta = 2i - A}$

$i = \frac{\delta_{min} + A}{2}$

Snell's law :-

$1 \sin i = \mu \sin r_1$

$\sin\left(\frac{\delta_{min} + A}{2}\right) = \mu \sin(A/2)$

$\boxed{\mu = \frac{\sin\left(\frac{A + \delta_{min}}{2}\right)}{\sin(A/2)}}$

Condition of min. deviation

Short notes →

a. $\angle i = \angle e$

b. $\angle r_1 = \angle r_2$

c. $\delta_{min} = 2i - A$

d. $\mu = \frac{\sin\left(\frac{A + \delta_{min}}{2}\right)}{\sin(A/2)}$

e. $A = 2r$

** NOTE → at minimum deviation ray PQ is parallel to Base [condition of min deviation]

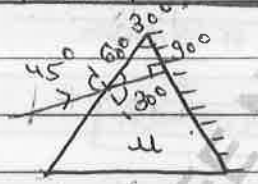
Standard Points :-

(a) $A = r_1 + r_2$

(b) $\delta = i + e - A$

(c) Snell's law

Popular Profile :-



one face silvered

ray → retrace its path (at 90°)

Solve $1 \times \sin 45° = \mu \sin 30°$

$\frac{1}{\sqrt{2}} = \mu \times \frac{1}{2}$

$\boxed{\mu = \sqrt{2}}$

3 questions [self practice]

NEET 2016 $\angle i = 45°$ $A = 60°$

ray → suffer minimum deviation

then find $\delta_{min} = ?$ $\mu = ?$

$\delta_{min} = 2i - A$

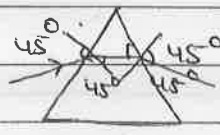
$= 2 \times 45° - 60°$

$\delta_{min} = 30°$

$A = 2r$

$A = 2 \times 45°$

$A = 90°$



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$\mu = \frac{\sin(90+0)}{\sin 45^\circ} = \frac{1}{1/\sqrt{2}}$ $\mu = \sqrt{2}$.

~~$1 \sin 45^\circ = \mu \times 45^\circ$~~

~~$\frac{1}{\sqrt{2}} = \frac{\mu \times \sqrt{2}}{\sqrt{2}}$~~

~~$\mu = 1$~~

$\mu = \frac{\sin\left(\frac{60^\circ+30}{2}\right)}{\sin\frac{60^\circ}{2}} = \frac{\sin 45^\circ}{\sin 30^\circ}$.

$\mu = \frac{1}{\sqrt{2}} \times \frac{2}{1}$ $\boxed{\mu = \sqrt{2}}$.

Q2 angle of prism = A.

$\mu = \cot\left(\frac{A}{2}\right)$.

$\delta_{min} = ?$

(i) $180 - 2A$.

(ii) $90 - A$.

~~(iii)~~ $180 + 2A$.

(iv) $180 - 3A$

$\mu = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin A/2}$

$\cot\frac{A}{2} = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin(A/2)}$

$\frac{\cos(A/2)}{\sin(A/2)} = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin(A/2)}$

$\sin\left(90 - \frac{A}{2}\right) = \sin\left(\frac{A+\delta_{min}}{2}\right)$

$90 - \frac{A}{2} = \frac{A+\delta_{min}}{2}$

$180 - A = A + \delta_{min}$

$\boxed{\delta_{min} = 180 - 2A}$

Q3. angle of prism = A

$2i = 2A$.

return back to same path one face is silvered find $\mu = ?$

solve $1 \times \sin 2A = \mu \sin A$.

$2 \sin A \cos A = \mu \sin A$

$\mu = 2\cos A$.

$\boxed{\mu = 2\cos A}$

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Date ___ / ___ / _____

Q4. Prism

$\mu = \sqrt{2}$ $\angle A = 30^\circ$ $\angle i = ?$

One of the refracting surface is made a mirror by silvering. A beam of light entering prism from other face and retrace its path (after reflection from silvered surface).

Solve. $1 \sin i = \sqrt{2} \sin 30^\circ$

$\sin i = \sqrt{2} \times \frac{1}{2}$

$\sin i = 1/\sqrt{2}$

$\boxed{i = 45^\circ}$

Q5. For the angle of min deviation of prism is equal to angle of prism must be made of material whose μ = ?

(i) less than 1.

(ii) greater than 2.

(iii) lies b/w $\sqrt{2}$ and 1.

(iv) lie b/w 2 and $\sqrt{2}$

$\delta_{min} = 2i - A$

$A = 2i - A$

$\boxed{i = A}$

Solve. $\mu = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin A/2}$

$\mu = \frac{\sin\left(\frac{A+A}{2}\right)}{\sin A/2} = \frac{\sin A}{\sin(A/2)} = \frac{2\sin\frac{A}{2} \times \cos A/2}{\sin A/2}$

$\boxed{\mu = 2\cos\left(\frac{A}{2}\right)}$

$\mu = 2\cos\left(\frac{A}{2}\right)$

i varies from 0° to 90°,

Put $i = 0^\circ$

$2 \times \cos\left(\frac{\pi}{2}\right) = 1$

$\mu = 90^\circ = 2 \times \cos\frac{90}{2}45^\circ = 2 \times \frac{1}{\sqrt{2}} = \sqrt{2}$

Q6. A ray of light is incident at an angle of incidence i on one face of prism (angle → A) assume to small angle and emerge normally from opposite face. If μ is ref. index then angle of incidence is nearly equal to?

(i) A/μ

(ii) $A/2\mu$

(iii) μA

(iv) $\mu A/2$

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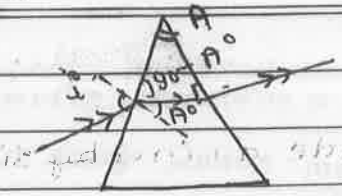
Solve:



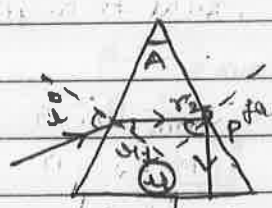
$1 \sin i^\circ = \mu \sin A$

$1(i^\circ) = \mu A$

$\boxed{i^\circ = \mu A}$

condition of No Emergence :-

$\boxed{A > 2i_c^\circ}$



at point P :-

$(\mu_2)_{all} > i_c^\circ$

$(r_2)_{min} > i_c^\circ$

$A = (r_1)_{max} + (r_2)_{min}$

$r_1 \to max \quad i^\circ = max \quad i^\circ = 90^\circ \quad \boxed{r_1 = i_c}$

as $A = r_1 + r_2$

$A = i_c + r_2$

$r_2 = A - i_c$

condition :- $r_2 > i_c$

$A - i_c > i_c$

$A > i_c + i_c$

$\boxed{A > 2i_c}$

ALPMT → $A > 2i_c^\circ$ ઇ $\frac{A}{2} > i_c^\circ$

$\sin\frac{A}{2} > \sin i_c$

$\sin\frac{A}{2} > \frac{1}{\mu}$

$\mu > \boxed{1 + \cot^2\frac{A}{2}}$

$\text{cosec}\frac{A}{2} > \mu$

$\boxed{\mu > \text{cosec}\frac{A}{2}}$

$\theta = A[\mu_V - \mu_R]$.

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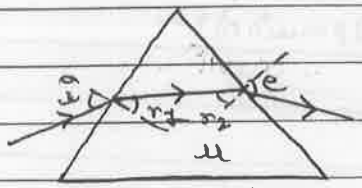
Date ___ / ___ / _____

Thin Prism :- It angle of prism is very small



$1 \sin i = \mu \sin r_1$

$\sin i \approx i$

$\sin r_1 \approx r_1$

$i = \mu r_1$

$\mu \sin r_2 = 1 \times \sin e$

$e = \mu r_2$.

since $\delta = i + e - A$

$\delta = (\mu - 1) A$

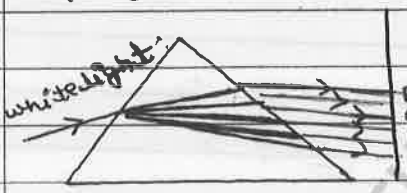
δ Formulas

standard → $\delta = i + e - A$

min-deviation $\delta = 2i - A$

thin prism $\delta = (\mu - 1) A$

Dispersion :- The phenomenon of splitting of white light into its 7 consituent colours is known as dispersion.

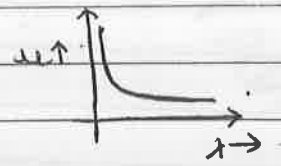


$\delta = (\mu - 1) A$

Cauchy's relation :-

$\mu = A + \frac{B}{\lambda^2} \ldots\ldots$

$\mu \propto \frac{1}{\lambda}$



VIBGYOR → λ increases ..

λred → maximum.

$\mu = \frac{C}{v}$ $\quad v \propto \lambda$.

μred → minimum.

angular dispersion :- angle b/w 2 extreme colours.

$\theta = A(\mu_V - \mu_R)$

$\delta_{mean} = \frac{\delta_V + \delta_R}{2}$.

$\delta_{mean} = (\mu_y - 1) A$

Direct vision prism :- जो prism dispersion और deviation दोनों करता है।

mean deviation →

$\delta_{mean} = (\mu_y - 1) A$

Dispersive power :-

$\omega = \frac{\theta}{\delta_{min}} = \frac{A(\mu_V - \mu_R)}{(\mu_y - 1) A}$

$\omega = \frac{\mu_V - \mu_R}{\mu_y - 1}$

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Combination of ~~prism~~ :

① Deviation without dispersion :—

dispersion नहीं हो

$\theta_{total} = 0$

$\theta_1 + \theta_2 = 0$

$(\mu_{V1} - \mu_{R1}) A_1 + (\mu_{V2} - \mu_{R2}) A_2 = 0$

$[\mu_y - \mu_{R1}] A_1 = -(\mu_{V2} - \mu_{R2}) A_2$

नहीं हटे don't erase it

② Dispersion without deviation :—

deviation → नहीं हो

$\delta_{total} = 0$

$\delta_1 + \delta_2 = 0$

$\delta_1 = -\delta_2$

$|\delta_1| = |\delta_2|$

$(\mu_{y1} - 1) A_1 = (\mu_{y2} - 1) A_2$

II → ~~Q10, 13, 15, 19~~, 24, 25, 27, 32, 44, 46.

I → 43 - 54

III → ~~Q16~~.

~~B.Box - 8~~

Solved eg → ~~31, 32, 33~~, 34

~~B.Box 9~~ → ✓

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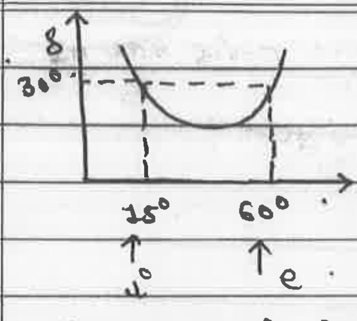
Q1.



find angle of prism ?

find angle of prism :—

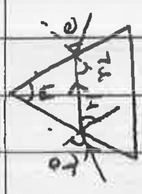
$\delta = i + e - A$

$30° = 15 + 60° - A$

$30° = 75° - A$

$\boxed{A = 45°}$

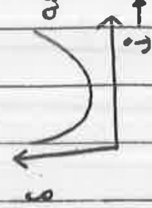
SHORT NOTES ON PRISM :



$A = r_1 + r_2$

$\delta = i + e - A$

Snell's law



② minimum deviation

$i = e, \ r_1 = r_2$

$\delta_{min} = 2i - A$

$\mu = \dfrac{\sin\left(\frac{A + \delta_{min}}{2}\right)}{\sin \frac{A}{2}}$

* PQ is parallel to Base

③ Dispersion

Splitting in 7 colours

Cauchy's relation :-

$\boxed{\mu \propto \frac{1}{\lambda}}$

angular displacement

$\theta = (\mu_V - \mu_R) A$

mean deviation

$\delta_{mean} = (\mu_y - 1) A$

Dispersive power :

$\omega = \frac{\theta}{\delta} = \frac{\mu_V - \mu_R}{\mu_y - 1}$

④ Deviation without dispersion

$\theta = 0$

$|\theta_1| = |\theta_2|$

⑤ Dispersion without deviation :

$\delta_{nett} = 0$

$\delta_1 + \delta_2 = 0$

$(\mu_{y_1} - 1) A_1 = (\mu_{y_2} - 1) A_2$

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Date __/__/____

Q1. without deviation

$\delta_{net} = 0$

$\delta_1 = \delta_2$.

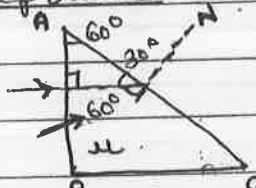
$(\mu_1 - 1) A_1 = (\mu_2 - 1) A_2$

$[1.5 - 1]\ 15^\circ = (1.75 - 1) A_2$

$\frac{7.5}{0.75} = \boxed{A_2 = 10^\circ}$

Beg Box = B

Q2.



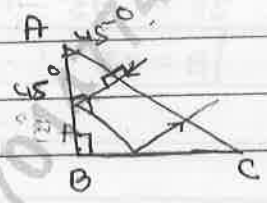
$60^\circ > i_c$

$\sin 60^\circ > \sin i_c$

$\frac{\sqrt{3}}{2} > \frac{1}{\mu}$

$\boxed{\mu > \frac{2}{\sqrt{3}}}$

Ex I Q50.



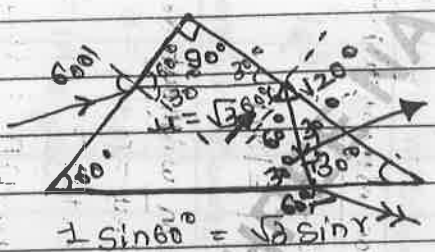
$45^\circ > i_c$

$\frac{1}{\sqrt{2}} > \frac{1}{\mu}$

$\mu = 1 \times \sqrt{2}$

$\boxed{\mu > \sqrt{2}}$

Q3.



$1 \sin 60^\circ = \sqrt{3} \sin r$

$\frac{1 \times \sqrt{3}}{2} = \sqrt{3} \sin r$

$\boxed{r = 30^\circ}$

Condition of TIR.

$60^\circ > i_c$.

$\sin 60^\circ > \sin i_c$

$\frac{\sqrt{3}}{2} > \frac{1}{\mu}$

$\mu = \frac{2}{\sqrt{3}}$.

$\frac{\sqrt{3}}{2} > \frac{1}{\sqrt{3}}$.

$30 > i_c$

$\frac{1}{2} > \frac{1}{\sqrt{3}}$

TIR ✓

total deviation :—

60° c.w

30° a.c.w

$\delta = 60^\circ - 30^\circ$ c.w

$\frac{\sqrt{3}}{2}$

$\sin i_c = \frac{1}{\mu}$

$\sin i_c = \frac{1}{\sqrt{3}}$.

Q54, 49, 50, 51, 48

52 = correction prism angle – ✗
thin prism – ✓

Date ___ / ___ / _____

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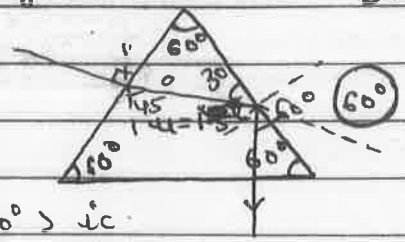
Q2 In the given situation Draw the emergent ray.



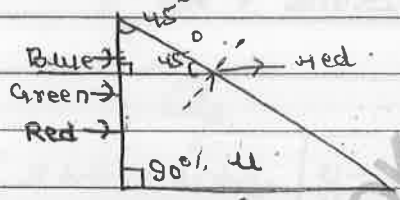
$\sin 60° > i_c$

$\frac{\sqrt{3}}{2} > i_c$

$\frac{\sqrt{3}}{2} > \frac{2}{3}$

TIR ✓

Ex II Q27 →



$\sin 45° > i_c$

$\frac{1}{\sqrt{2}} > \frac{1}{\mu}$

$\boxed{\mu > \sqrt{2}}$

$\mu \propto \frac{1}{\lambda}$

VIBGYOR →

or

Mirror :–

Spherical mirror :–

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

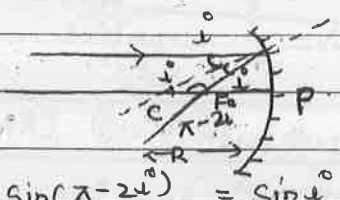
mirror → mirror

$\frac{H_I}{H_O} = \ominus \frac{v}{u}$

$P = -\frac{1}{f}$

$f = R/2$.

Paraxial rays.



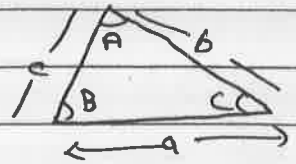
$\frac{\sin(\pi - 2i°)}{R} = \frac{\sin i°}{CF}$

$\frac{\sin 2i°}{R} = \frac{\sin i°}{CF}$

$\frac{2\sin i° \cos i°}{R} = \frac{\sin i°}{CF}$

$\boxed{CF = \frac{R}{\cos i°}}$

Lami's theorem :–



$\boxed{\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}}$

$PF = R - CF$.

Learn $\boxed{PF = R - \frac{R}{\cos i°}}$

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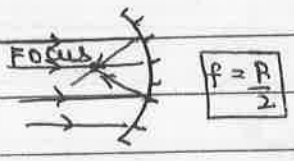
Date ___ / ___ / _____

Paraxial $i \leq 5^\circ$

Hence $f = R/2$

Paraxial rays . $i \leq 5^\circ$



$f = \frac{R}{2}$

Focal length is same for all colour mirror Chromatic ~~Chromosomal~~ abberations ~~नहीं~~

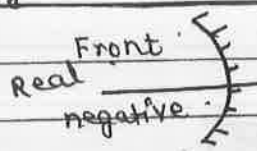
$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

magnification . $m_T = \frac{HI}{HO} = -\frac{v}{u}$ transverse

longitutonal .

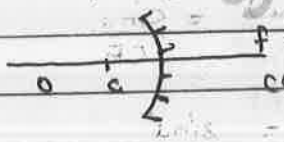
$m_L = \frac{\text{length of image}}{\text{length of object}}$

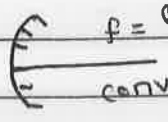
Sign convention .



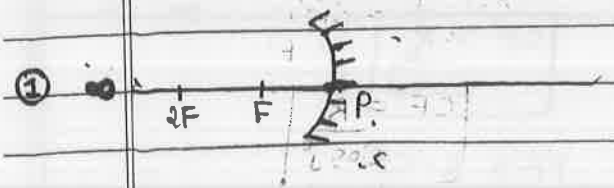
object mention नहीं (Real object)

Real object की Real image हमेशा inverted होती है।





Ray Tracing :—

① 

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Case I

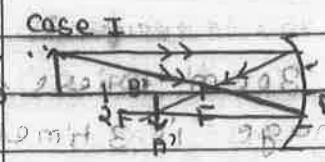
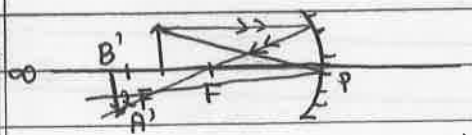
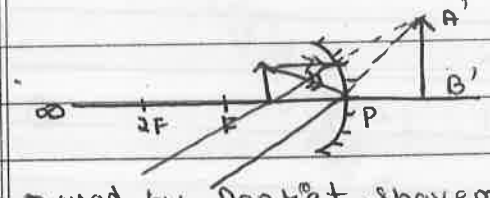


Image
Real image
Inverted
Diminished
F and 2F के बीच



Real Image
Inverted
Enlarged
2F aur ∞ के बीच



Virtual
Erect
Enlarged
Between F and P

used by Dentist, Shave mirror

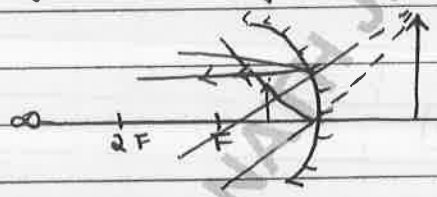
U V

what about virtual object

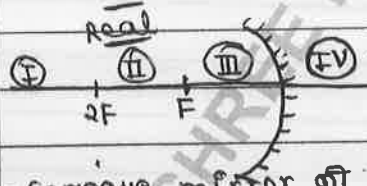
ROD → Real object diverging incident

virtual object – काल्पनिक

Incident ray → converging



Real image, Erect, diminished
F and P के बीच



Concave mirror की VO/VI possible.

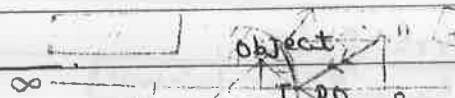


Image
II RI
I RI
IV VOI
III ROI

Q1. A man has shaving mirror of focal length 20cm How far should the mirror be held from his face in order to give an image two fold magnification?

Sol^n. $HI = -2HO$

$\frac{HI}{HO} = -\frac{v}{u}$

$\frac{2}{1} = \frac{v}{u}$

$v = -2u$

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

$\frac{1}{-2u} + \frac{1}{u} = -\frac{1}{20}$

$\frac{-1+2}{2u} = -\frac{1}{20}$

$\frac{1}{2u} = \frac{1}{20}$

$u = 20cm$

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Date __/__/____

Q2 The focal length of concave mirror 30cm where should an object is placed so that its image is 3 times magnified real and inverted?

Sol^n $f = -20cm$

$H_I = +3H_O$

$U = ?$

$\frac{H_I}{H_O} = \frac{-v}{u}$

$\frac{3H_O}{H_O} = \frac{-v}{u}$

$+3u = +v \qquad v = 3u$

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

$\frac{1}{v} + \frac{1}{3v} = -\frac{1}{30}$

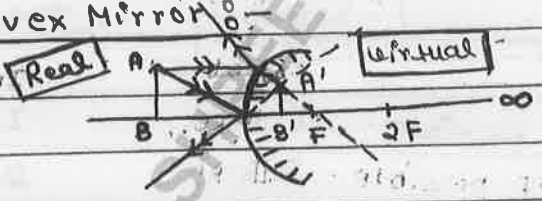
$\frac{4}{3v} = -\frac{1}{30}$

$\frac{30 \times 4}{3}$ $\qquad u = -40$

$v = 3 \times -40$

$v = -120cm$

Convex Mirror



Real object ⇒ Small virtual image, erect diminished

object	Image
I VO	II VI
II VO	I VI
III VO	IV RI
IV RO	III VI

Vechiles side mirror convex mirror are used

Page No.

Convex mirror में real का real image not possible.

H.W → Ex I → ~~Q10, 11, 12, 14, 15, 16, 18, 19, 20, 21, 23, 24~~
~~Beg II → Q1, 2, 3, 4, 5, 6~~

Date ___ II → / Q2, Q3

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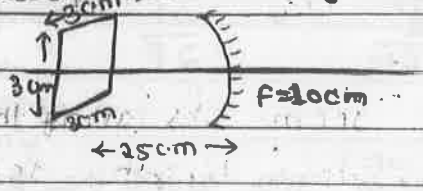
Q. A square of side 3cm is placed at a distance of 25cm from a concave mirror of focal length 10cm. The center of the square is at a axis of mirror and the plane is normal to the axis. Calculate the area enclosed by image of wire?

Solve.



$u = -25cm$

$f = -10cm$

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

$\frac{1}{v} - \frac{1}{25} = -\frac{1}{10}$

$\frac{1}{v} = -\frac{1}{10} + \frac{1}{25}$

$\frac{1}{v} = \frac{-5+2}{50}$

$\boxed{v = -\frac{50}{3} cm}$

$\frac{H_I}{H_O} = -\frac{v}{u}$

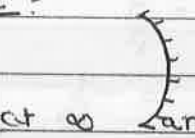
$= -\left(\frac{-50}{3}\right)$

$\frac{H_I}{3} = \frac{+50}{-25}$

$H_I = -2cm$

** area $= (2cm)^2 = 4cm^2$.

NOTE →



1. object ∞ and 2F के बीच में
Image → छोटी

2. Object placed b/w 2F and F.
Image → enlarged

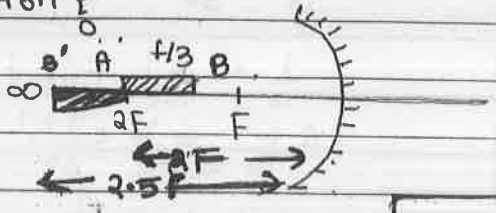
3. object 2F.
Image → 2F [same size]

** conclusion → Image size increased from ∞ to 2F

** Q1. A thin rod of length f/3 is placed along the principle axis of a concave mirror of focal length f such that its image is real elongated just touches one end of the rod. Then calculate the long magnification?

Solve. A → 2F

B → $2f - f/3 = \frac{5f}{3}$



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

$\frac{1}{v} + \frac{1}{5f/3} = \frac{1}{-f}$.

$\frac{1}{v} = -\frac{1}{f} + \frac{3}{5f}$

$v = -\frac{5f}{2}$

$\boxed{v = -2.5f}$

Ex III 2,3,4,5,6,7,9,10,11,12

Saathi

Date __ / __ / ____

Image of rod = 2.5 f − 2f

= 1/2 f

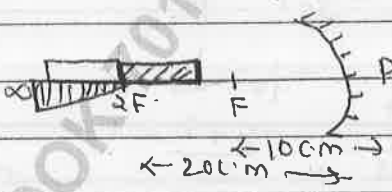
long magnification = $\frac{\frac{1}{2}f}{f/3} = \frac{3f}{2f} = 3/2$

↓ real object, real image, inverted

Q2 AIIMS 2012 ★★ A rod of length 10cm lies along the principle axis of a concave mirror of focal length = 10cm in such a way that its end closer to the pole is 20cm away from the mirror then calculate the length of the image?

Solve

20 − 10 = −10cm



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

$\frac{1}{v} + \frac{1}{-20} = \frac{1}{-10}$

$\frac{1}{v} = \frac{1}{-10} + \frac{1}{10}$

$\frac{1}{v} = \frac{-1+1}{10}$

$\frac{1}{v} = 0$

$v = \infty$

u = −20cm

f = −10cm

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

$\frac{1}{v} - \frac{1}{20} = -\frac{1}{10}$

$v = \frac{-1}{10} + \frac{1}{20}$

$v = \frac{-2+1}{20}$

v = −20cm

B की चर्चा :-

u = −30cm

f = −10cm

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

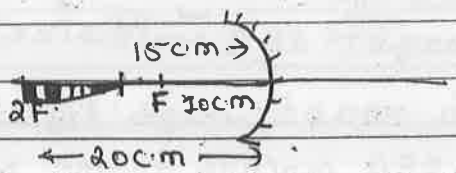
$\frac{1}{v} - \frac{1}{30} = \frac{1}{-10}$

$\frac{1}{v} = -\frac{1}{10} + \frac{1}{30}$

$\frac{1}{v} = \frac{-3+1}{30}$

$\frac{1}{v} = -\frac{2}{30}$

v = −15cm



Length of image = 5cm.

Race Q16, Q14, Q15, Q17.
H.W prism.

24, 60
12, 30
6, 15
3, 15
Sakthi
120

Date ___/___/___

velocity concept :-

x-axis :- along principle axis

$$v_{I/m} = -m^2 \vec{v}_{o/m}$$

Only 1 ques. rarely question asked

y-axis :- perpendicular to principle axis

$$v_{I/m} = m^2 \vec{v}_{o/m}$$

m → magnification

$$m = \frac{H_I}{H_O} = -\frac{v}{u}$$

$$m = \frac{f}{f-u}$$

Q1 EX I Q17: A point object is moving on the principle axis of a concave mirror of focal length 24 cm towards the mirror. when it is at a distance of 60 cm from the mirror its velocity is 9 cm/sec then calculate the velocity of image at that instant?

$f = -24\,cm$

$u = -60\,cm$

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

$$\frac{1}{v} - \frac{1}{60} = -\frac{1}{24}$$

$$\frac{1}{v} = -\frac{1}{24} + \frac{1}{60}$$

$$\frac{1}{v} = \frac{-5+2}{120}$$

$$v = \frac{120}{-3} \qquad \boxed{v = -40\,cm}$$

$$m = -\frac{v}{u} = -\frac{(-40)}{60} = 4/6 = 2/3$$

$$m = \frac{f}{f-u} = \frac{-24}{-24}$$

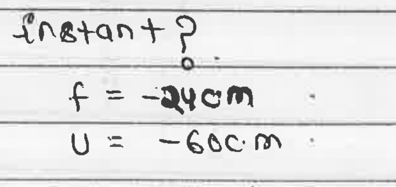
$$v_{I/m} = -\left(\frac{2}{3}\right)^2 [v_o - v_m]$$

$$v_I - v_m = -\frac{4}{9}[9\hat{i} - 0]$$

$$v_I - 0 = -\frac{4}{9} \times 9\hat{i}$$

$$\boxed{v_I = -4\hat{i}}$$

Q16



Double reflection?

$$1 \sin 60^\circ = \sqrt{3} \sin r_1$$

$$\frac{\sqrt{3}}{2} = \sqrt{3} \times \sin r_1$$

$$\boxed{r_1 = 30^\circ}$$

Q13 Ex I → length — x Height ✓.

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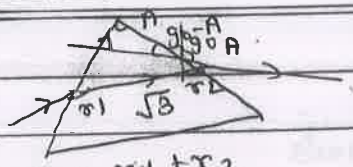
Date __/__/____

જો object 2F પર હોય તો image 2F પર જ બનશે.



$A = r_1 + r_2$

$A = 30° + r_2$

$\boxed{r_2 = A - 30}$

$\sqrt{3}\sin r_2 = 1 \sin A$

$\sqrt{3}\sin(A-30) = 1 \times \sin A$

$\sqrt{3}[\sin A\cos 30° - \cos A \sin 30°] = \sin A$

$\sqrt{3}[\sin A \times \frac{\sqrt{3}}{2} - \cos A \times \frac{1}{2}] = \sin A$

$\frac{\sqrt{3}}{2}[\sqrt{3}\sin A - \cos A] = \sin A$

$3\sin A - \sqrt{3}\cos A = 2\sin A$

$3\sin A - 2\sin A = \sqrt{3}\cos A$

$\frac{\sin A}{\cos A} = \sqrt{3}$

$\tan A = \sqrt{3} \Rightarrow \boxed{A = 60°}$

Q2. AIIMS

focal length = $+f$

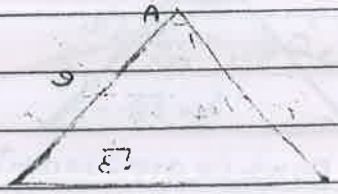
$H_I = +\frac{I}{n} H_O$

$\frac{H_I}{H_O} = \frac{-V}{U}$

$\frac{I H_O}{n H_O} = \frac{-V}{U}$

$\boxed{\frac{-U}{n} = V}$

$\frac{1}{V} + \frac{1}{U} = \frac{1}{f}$



$-\frac{n}{U} + \frac{1}{U} = \frac{1}{f}$

$\frac{-n+1}{U} = \frac{1}{f}$

$U = (-n+1)f$.

$\boxed{U = -(n-1)f}$

Date __/__/____

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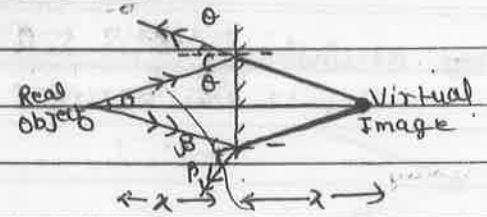
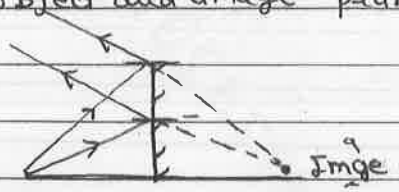
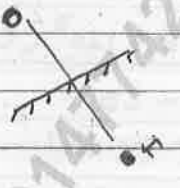
Plane Mirror



line joining object and image is always ⊥ to mirror.

object and image plane mirror के opp. side

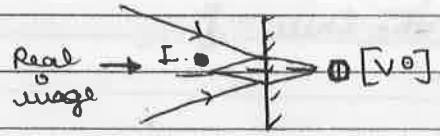




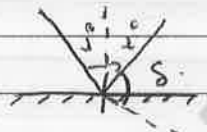
plane mirror
3 नहीं पूरी

Real object → V I.
V. object → R. image

** Incident - converging → virtual object

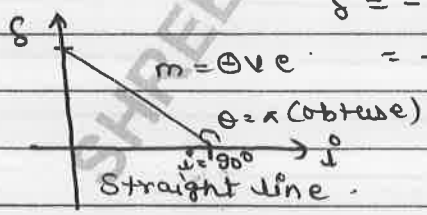


Angle of Deviation (δ) :-



$\delta = 180 - 2i$

graph b/w = δ and i



$\delta = -2i + 180°$

$= -2i + \pi$

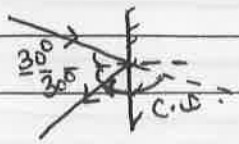
** If $i = 90°$ than $\delta = 0°$

if $i = 90°$

$\delta = 180 - (90 \times 2)$

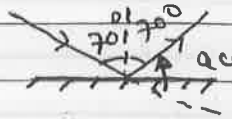
$\delta = 0°$

δ c.w ≷ π a.cw = ? let see How to check



$\delta = 180° - 2(30)°$

$\boxed{\delta = 120°}$



$\delta = 180 - 2(70°)$

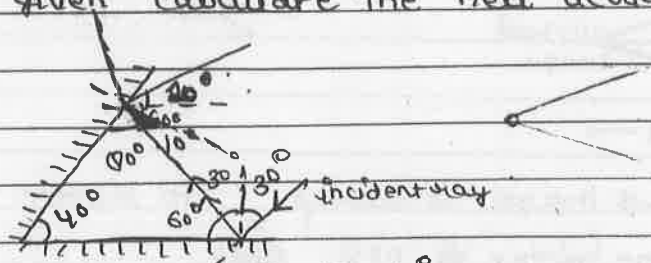
$\boxed{\delta = 40°}$

Page No.

Saathi

Date __ / __ / ____

Q1 In given calculate the nett deviation?



$\delta = 180 - 2\theta$

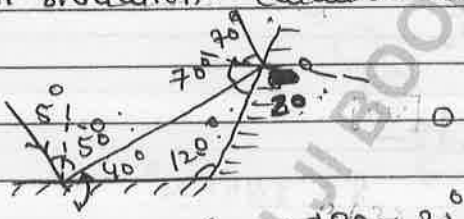
$\delta = 120^\circ$ (CW)

$\delta = 180 - 20$

$\delta = 160^\circ$ (CW)

$\delta_{nett} = 160 + 120^\circ = 280^\circ$ CW

Q2 In the given situation calculate the δ_{nett} = ?



$\delta_1 = 180 - 2\theta$

$\delta_1 = 80^\circ$ [aCW]

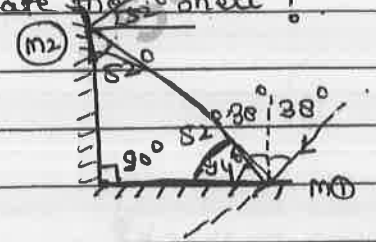
$\delta_2 = 180 - 2\theta$

$= 180^\circ - 140$

$= 40^\circ$ (aCW).

$\boxed{\delta_{nett} = 120^\circ}$

Q3 Calculate the δ_{nett} ?



$\delta_2 = 180 - 76$

$= 104^\circ$ CW

$\delta_1 = 180 - 2 \times 82$

$= 76$

$\delta_{nett} = 104 + 76$

$= 180^\circ$

H.W → Ex II → Q1 – Q27
Ex III → Q1 – Q8

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Date ___ / ___ / _____

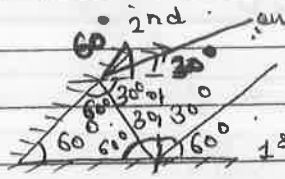
SHORT TRICK ⇒ $\theta_{net} = 360 - 2\theta$

θ → angle b/w (mirror) → ☆☆

☆☆ If 2 mirrors are perpendicular to each other then incident ray and emergent ray are antiparallel to each other.

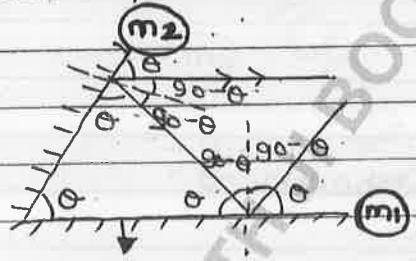
Q4 Two plane mirror are inclined to each other at an angle 60° If ray of light incident on first mirror is parallel to second mirror, it is reflected from 2nd mirror.

Solve conceptual Question.



emergent ray and 1st mirror are parallel.

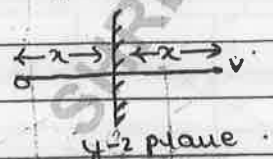
☆☆ Concept get from pervious Question.



In this Δ $3\theta = 180°$

$\theta = 60°$

Velocity concept in plane mirror :-



y axis :- $\vec{v_I} = \vec{v_0}$

z-axis :- $\vec{v_I} = \vec{v_0}$

$\vec{x}_{0/m} = -\vec{x}_{I/m}$

$\frac{d}{dt}\vec{x}_{0/m} = -\frac{d}{dt}\vec{x}_{I/m}$

$\vec{v}_{0/m} = -v_{I/m}$

$\vec{v_0} - \vec{v_m} = -[\vec{v_I} - \vec{v_m}]$

$\vec{v_0} - \vec{v_m} = -v_I + \vec{v_m}$

$v_I = 2\vec{v_m} - \vec{v_0}$

Sirf

Spherical

$v_{I/m} = -m^2 v_{0/m}$

$m = (1)$

$\vec{v_{I/m}} = -\vec{v_{0/m}}$

If mirror x-z plane.

$v_I = 2\vec{v_m} - \vec{v_0}$ y-axis.

mirror
$yz = xfx = x$ formula.
$xy = xfy = z$ formula.
$yx = xfy = z$ formula.
$zx = xyx = y$ formula.

Date ___ / ___

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Q Plane mirror is moving with velocity $4\hat{i}+5\hat{j}+0\hat{k}$. A point object in front of mirror moves with velocity $3\hat{i}+4\hat{j}+5\hat{k}$. the mirror is placed in y-Z plane then calculate the velocity of image?

$\vec{v_I} = 2\vec{v_m} - \vec{v_O}$ → along (x)

x comp + y comp + z comp.

Formula यहाँ से object वाले i.

$v_I = 2(4\hat{i}) - (3\hat{i})$.

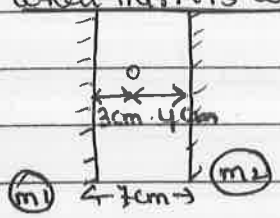
$= 8\hat{i} - 3\hat{i}$.

$= 5\hat{i}$.

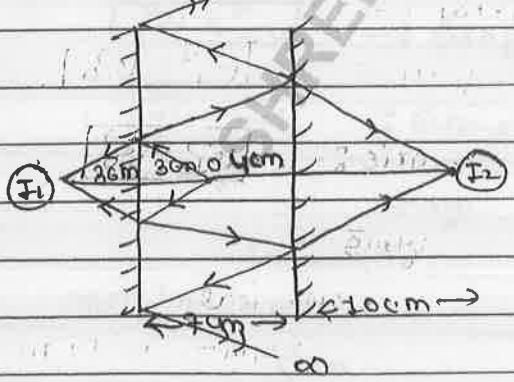
$\vec{v_I} = 5\hat{i}+4\hat{j}+5\hat{k}$

Multiple reflection :-

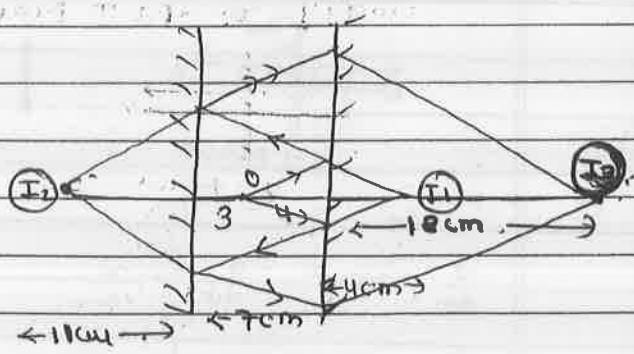
(i) when mirrors are parallel to each other →

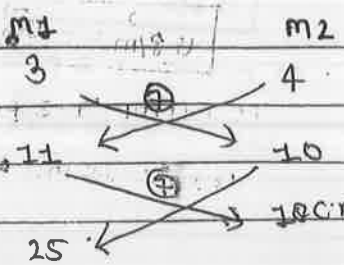


माना पहला reflection m_1 से :-



माना पहला reflection m_2 से :-





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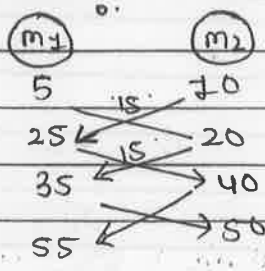
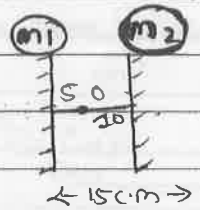
Q. In given situation calculate the distance of first 3 image from mirror m_2?

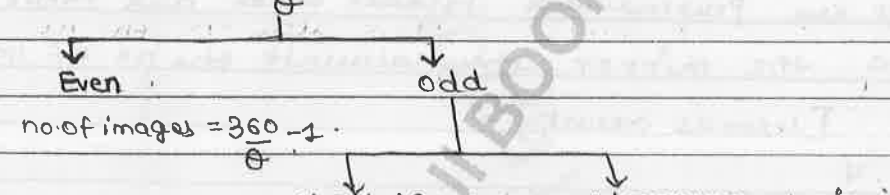
Ans:





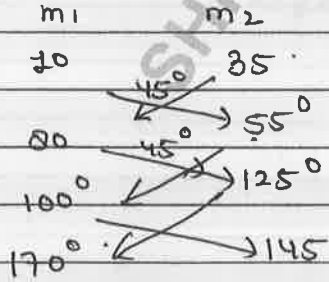
Case(ii) When mirrors are inclined to each other:-

(i) first find $\frac{360}{\theta}$



method:- always works

ક્યાં image overlapp કરશે ?



~~Race 1 → Q1, Q4, Q6, Q7, Q8~~

~~CXI → Q1, Q2, Q3, Q4, Q5, Q6, Q9~~

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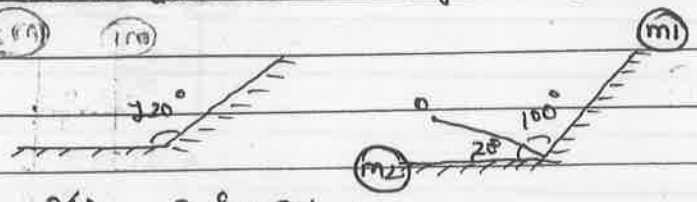
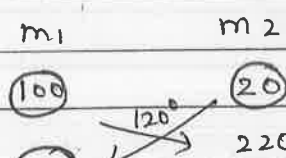
Q1. Calculate the no. of images in given situation?



Solve

~~360~~ / 120 → 3 images.



3 images

220 − x

x

m1 की last = 140

m2 की last = 20

160

angle = 120

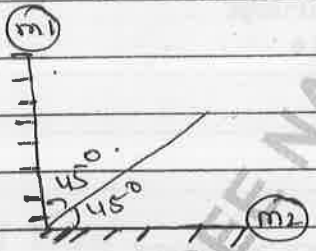
280

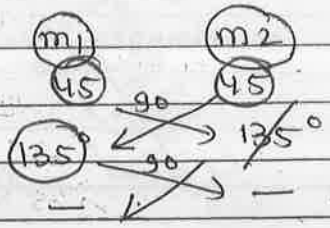
∴ no overlapping

Q2. Two mirrors are perpendicular to each other and there is lamp in b/w the mirror then calculate the no. of images of lamp? [learn as result]

Solve $\frac{360^\circ}{90^\circ} = 4$

4 − 1 = 3 images.





3 images

Overlapping = ?

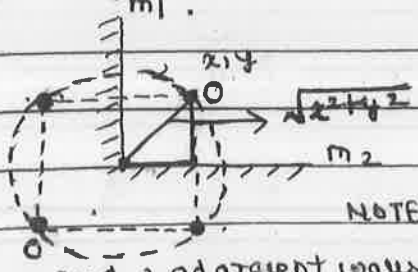
m1 की last = 135

m2 की last = 135

mirror = 90

360

How image formed →



All image lie in a circle.

center → कौन

point of intersecting of mirror.

NOTE → A person is in a room whose ceiling and 2 adjacent walls are mirror then total 7 images are formed.

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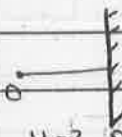
Velocity concept :- Applications :-

** If nothing given then consider the always consider in x y-z plane



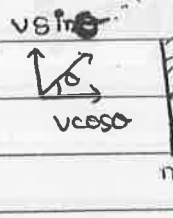
y-z plane

$$\vec{v_I} = 2\vec{v_m} - \vec{v_0}$$

y axis $\vec{v_I} = \vec{v_0}$

z axis $\vec{v_I} = \vec{v_0}$

eg → [IIT]



y-axis

$$\vec{v_I} = -v\cos\theta\hat{i} + v\sin\theta\hat{j}$$

x-axis

$$v_I = 2(0) - (v\cos\theta\hat{i})$$

$$\vec{v_I} = -v\cos\theta\hat{i}$$

y-axis $\vec{v_I} = v\sin\theta\hat{j}$

Sometimes ask →

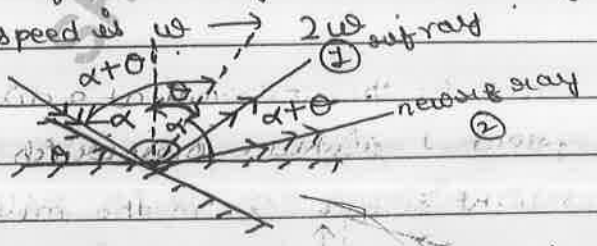
$$\vec{v_{I/0}} = \vec{v_I} - \vec{v_0}$$

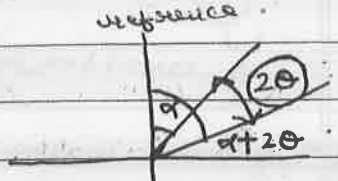
$$= -v\cos\theta\hat{i} + v\sin\theta\hat{j} - [v\cos\theta\hat{i} + v\sin\theta\hat{j}]$$

$$\vec{v_{I/0}} = -2v\cos\theta\hat{i}$$

NOTE → If mirror is rotated by an angle θ keeping incident ray fixed then reflected ray is rotated by an angle 2θ [same direction]

** If speed is v → 2v





Q. A Beam of light from a source is incident normally on a plane mirror fixed at a certain distance x from a source. When a mirror is rotated through a small angle θ the spot of a light is found to move through a distance y. then calculate the angle θ ?

① y/x ② x/2y ③ x/y ④ y/2x

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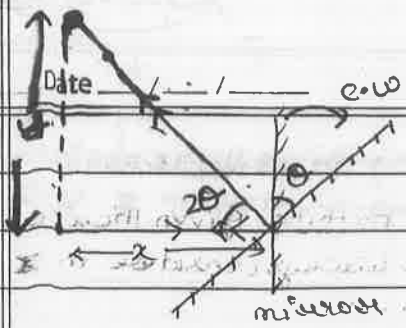
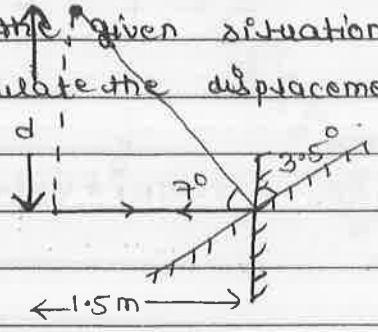
Date / / e.w → reflected ray also rotate clockwise.



$\therefore \tan 2\theta = \frac{y}{x}$

$\therefore 2\theta = \frac{y}{x}$ $\quad \boxed{\theta = \frac{y}{2x}}$

Q. In the given situation mirror is rotated by 3.5° then calculate the displacement of reflected spot?



$\tan 7° = \frac{d}{1.5}$

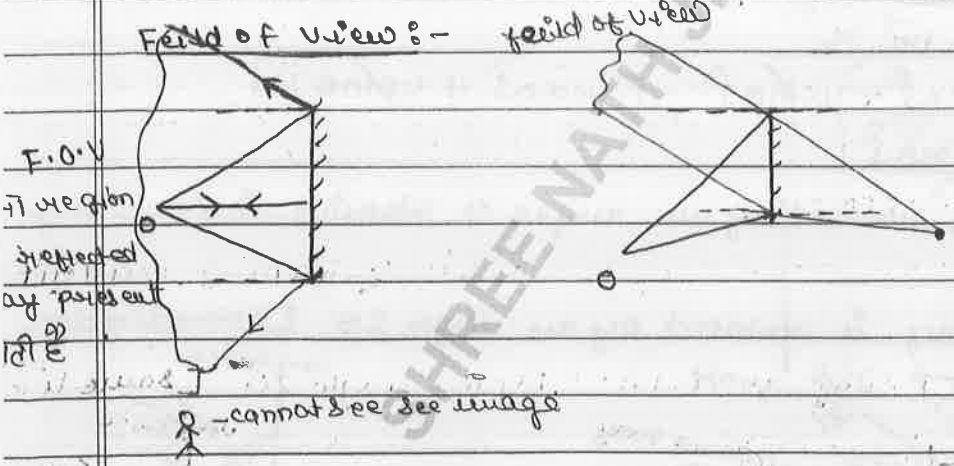
$\tan\theta = 7 \times \frac{\pi}{180}$

$\tan 7° \rightarrow \times 7°$

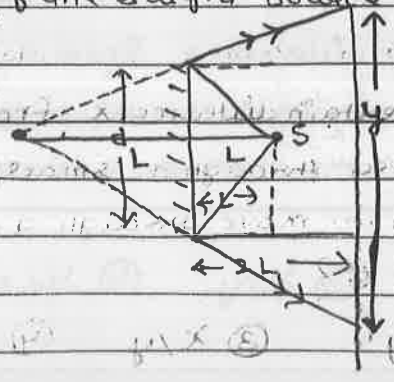
Convert into radian must: $\frac{7\pi}{180} = \frac{d}{1.5}$

$\boxed{d = \frac{10.5\pi}{180}}$

Field of view :- field of view



Q. A man walks in front of the mirror at a distance 2L as shown. The greatest distance over which he can see the image of the light source S in the mirror?



$\Rightarrow \frac{d}{L} = \frac{y}{3L}$

$\boxed{y = 3d}$

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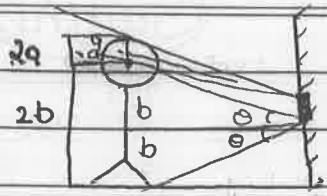
Parivar.

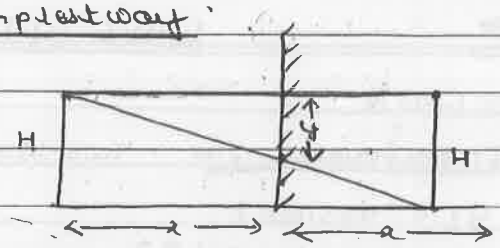
Date ___ / ___ / _____

Ex. 29



$H = 2a + 2b$

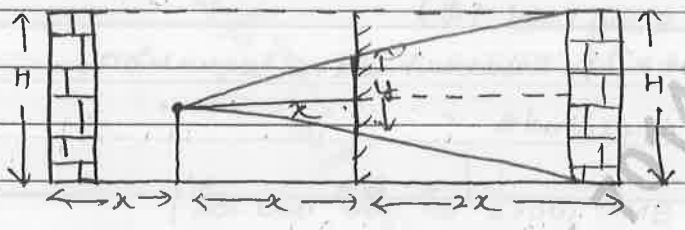
Simplest way.



$\frac{y}{x} = \frac{H}{2x}$

$y = H/2$

Q2.



$\frac{y}{x} = \frac{H}{3x}$

$y = H/3$

Page No.

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Date __/__/____ WAVE OPTICS

Section-A

Interference :— · Two waves

$y_1 = a_1 \sin \omega t$ ω → frequency

$y_2 = a_2 \sin(\omega t + \phi)$ a → amplitude

Principle of Superposition

$y_{net} = y_1 + y_2$

$y_{net} = a_1 \sin \omega t + a_2 \sin(\omega t + \phi)$

$y_{net} = R \sin[\omega t + \alpha]$ Resultant wave equation

↓ resultant amplitude

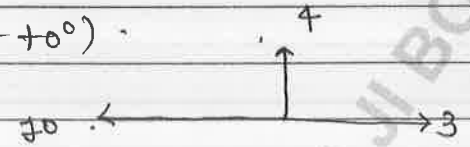
Phasor → add

दो/ज्यादा SHM wave को कैसे add करें।

$3\sin \omega t + 4\sin\left[\omega t + \frac{\pi}{2}\right] + 10\sin[\omega t + \pi]$

↓

$3\sin(\omega t + 0°)$



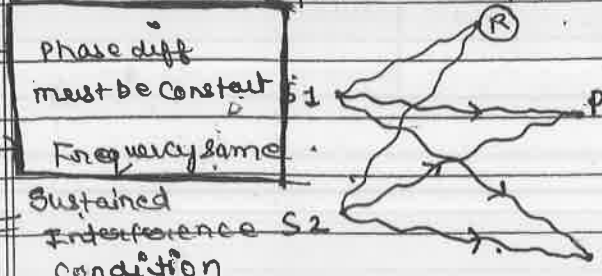
$R = \sqrt{16 + 49} = \sqrt{65}$

$R = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi}$ → phase diff

$\tan\alpha = \frac{a_2 \sin\phi}{a_1 + a_2\cos\phi}$

angle made from a_1

Interference is a phenomenon in which redistribution of energy taked places at some points Energy become maximum [Cons. In] and at some points Energy becomes minimum [Destruc. Inter].



Phase diff must be constant
Frequency same.

Sustained Interference condition

** Interference position dependent -

P · Energy maximum.

Q Energy minimum.

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Constructive

$n = 0, 1, 2, 3$

Phase diff $= 0, 2\pi, 4\pi, 2n\pi$

$R = \sqrt{a_1^2 + a_2^2 + 2ab\cos\theta}$

$\cos\theta = 1$

$\cos 2\pi = 1$

$\boxed{R = a_1 + a_2}$

Bright fringes

Destructive

$n = 0, 1, 2, 3$

Phase diff $\pi, 3\pi, 5\pi \ldots (2n+1)\pi$

$\cos\pi = -1$

$\cos 3\pi = -1$

$\boxed{R = a_1 - a_2}$

Dark fringes

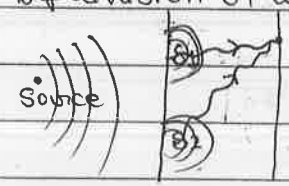
Two independent source can never be coherent

Independent source always incoherent

Methods to produce coherent source →

Method I

By division of wavefront

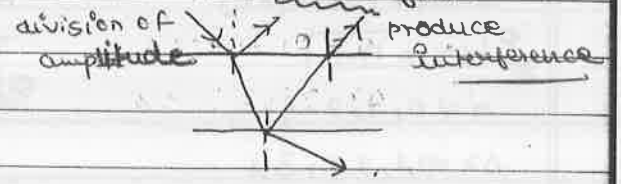


YDSE

Method II

By division of amplitude

Colour in thin film



Intensity Concept →

Intensity $\propto$ [amplitude]^2

$\boxed{I = K(\text{amp})^2}$

$I_1 = K(a_1)^2$

$I_2 = K(a_2)^2$

$I = K(R)^2$

We know that

$R = \sqrt{R_1^2 + R_2^2 + 2R_1R_2\cos\phi}$

Squaring

$R^2 = R_1^2 + R_2^2 + 2R_1R_2\cos\phi$

$R^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\phi$

$\frac{I}{K} = \frac{I_1}{K} + \frac{I_2}{K} + 2\frac{\sqrt{I_1}}{\sqrt{K}}\frac{\sqrt{I_2}}{\sqrt{K}}\cos\phi$

$\boxed{I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi}$

Constructive Interference

$\cos 0, 2\pi = 1$

$\boxed{I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2}$

Destructive Interference →

$\boxed{I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2}$

Concept :- $\Delta x \rightarrow$ path diff.

$\Delta\phi =$ Phase difference.

Relation →

$\boxed{\Delta\phi = \frac{2\pi}{\lambda} \cdot \Delta x}$

$\Delta x \rightarrow$ Path difference

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Path ① = $2x + 2r$

Path ② = $x + 2x + \pi r$

$\Delta x = [\pi r + 2x] - [2x + 2r]$

$= \pi r - 2r$

$= [\pi - 2] r$

Short notes :—

Constructive	Destructive
$\Delta\phi = 0, 2\pi, 4\pi \ldots 2n\pi$	$\Delta\phi = \pi, 3\pi, 5\pi \ldots (2n+1)\pi$
	$n = 0, 1, 2 \ldots$
$R_{max} = a_1 + a_2$	$R_{min} = a_1 - a_2$
$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$	$I_{min} = [\sqrt{I_1} - \sqrt{I_2}]^2$
$\boxed{\Delta x = n\lambda}$	$\boxed{\Delta x = (2n+1)\frac{\lambda}{2}}$
$n = 0, 1, 2 \ldots$	$n = 0, 1, 2 \ldots$
$\Delta x = 0, \lambda, 2\lambda, 3\lambda$	$\Delta x = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}$

$\frac{I_1}{I_2} = \frac{a_1^2}{a_2^2}$.

$R = \sqrt{a_1^2 + a_2^2 + 2a_1 a_2 \cos\phi}$

$I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$

$\cos 120^\circ = -1/2$

$\cos 60^\circ = \sqrt{3}/2$

Practice → 5 Questions

Q1. NEET-2016. $\frac{I_1}{I_2} = \frac{n}{1}$.

Calculate the value of $\frac{I_{max} - I_{min}}{I_{max} + I_{min}} = ?$

$\frac{I_1}{I_2} = \frac{n}{1}$

$I_{max} = [\sqrt{I_1} + \sqrt{I_2}]^2$

$= I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}$, $I_{min} = \sqrt{I_1} + \sqrt{I_2} - 2\sqrt{I_1}\sqrt{I_2}$

$n + 1 - 2\sqrt{n}$.

Date ___/___/___

Phenomenon of interference is shown by all types of waves eg → electro, Transverse, light, Sound etc

$$= \frac{n+1+2\sqrt{n}-(n+1-2\sqrt{n})}{n+1+2\sqrt{n}+(n+1-2\sqrt{n})}$$

$$= \frac{n+1+2\sqrt{n}-n-1+2\sqrt{n}}{n+1+2\sqrt{n}+n+1-2\sqrt{n}}$$

$$= \frac{4\times 2\sqrt{n}}{4(n+1)}$$

$$= \frac{2\sqrt{n}}{n+1}$$

Q2. Intensity of two waves are $9\hat{i}$ and $1\hat{i}$ resp. find out the resultant intensity if the phase diff b/w them is π?

AIIMS -2016

Sol^{n}

$$I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$$

$$I = 9 + 1 + 2\sqrt{9}\sqrt{1}\cos 180^\circ$$

$$I = 10 - 6$$

$$I = 4\hat{i}$$

छोटी काम की बात :—

$$\frac{a_1}{a_2} = \frac{3}{1} \Rightarrow \frac{I_1}{I_2} = \frac{9}{1}$$

Q3 If the ratio of amplitude of 2 source is 3:5 then calculate the ratio of $\frac{I_{max}}{I_{min}}$?

Solve: $\frac{a_1}{a_2} = \frac{3}{5} \Rightarrow \frac{I_1}{I_2} = \frac{9}{25}$

$$\frac{I_{max}}{I_{min}} = \frac{(\sqrt{I_1}+\sqrt{I_2})^2}{(\sqrt{I_1}-\sqrt{I_2})^2} = \frac{[\sqrt{9}+\sqrt{25}]^2}{[\sqrt{9}-\sqrt{25}]^2} = \frac{9+25+2\times 3\times 5}{9+25-2\times 3\times 5}$$

$$= \frac{9+25+30}{}$$

Q4. If the intensity ratio of 2 waves is 9:1 then calculate the ratio of $\frac{A_{max}}{A_{min}}$.

$$\frac{I_1}{I_2} = \frac{9}{1} \Rightarrow \frac{a_1}{a_2} = \frac{3}{1} \qquad \frac{R_{max}}{R_{min}} = \frac{4}{2}$$

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Date __ / __ / ____

Q5 If interference Have max and min in 36 : 1 ratio then calculate the ratio of amplitude?

Solve $\frac{I_{max}}{I_{min}} = \frac{36}{1}$.

$$\frac{(\sqrt{I_1}+\sqrt{I_2})^2}{(\sqrt{I_1}-\sqrt{I_2})^2} = \frac{36}{1}.$$

$$\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}} = \frac{6}{1}.$$

$$\sqrt{I_1}+\sqrt{I_2} = 6\sqrt{I_1} - 6\sqrt{I_2}$$

$$7\sqrt{I_2} = 5\sqrt{I_1}$$

$$\frac{\sqrt{I_1}}{\sqrt{I_2}} = \frac{7}{5}.$$

$$\boxed{\frac{a_1}{a_2} = \frac{49}{25}}$$

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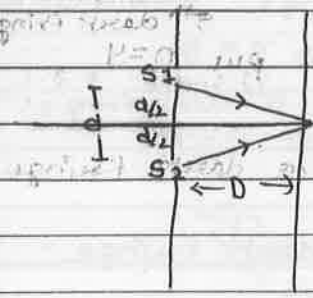
Date ___ / ___ / _____

Young double slit experiment [YDSE] :-

Thomas Young

experiment proove → Interference.

[light → wave nature]



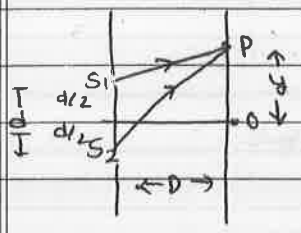
d → distance b/w slits

D → distance b/w S.W and screen.

$\Delta x = 0$ at O

Constructive central fringe always Bright.

Screen.



$$\Delta x = S_2P = \frac{yd}{D}$$

If $y = 0$ then $\Delta x = 0$ [center of Screen (I)].

① Case(i) P Bright fringe :-

[HIGH]

Constructive interference

$\Delta x = n\lambda$ → [already Cramed]

$$\Delta x = \frac{yd}{D} = n\lambda$$

If $n = 0$

$y = 0$

$$y = \frac{n\lambda D}{d}$$

location / position / distance of nth Bright fringe.

If $n = 1$ $\frac{\lambda D}{d}$ 1st Bright fringe.

$n = 2$ $\frac{2\lambda D}{d}$

Fringe width = distance b/w two successive Bright fringe.

$$= \frac{2\lambda D}{d} - \frac{\lambda D}{d}$$

Fringe width → $\beta = \frac{\lambda D}{d}$

② [HIGH] P 42 Dark fringe :-

$$\Delta x = [2n+1]\frac{\lambda}{2}$$

$$\Delta x = \frac{yd}{D} = (2n+1)\frac{\lambda}{2}$$

$$y = (2n+1)\frac{\lambda D}{2d}$$ → location / position / distance of nth dark fringe.

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Date ___ / ___ / _____

$n=0$ $y_1 = \frac{1D}{2d}$ → 1st dark fringe.

$n=1$ $y_2 = \frac{3\lambda D}{2d}$ → 2nd dark fringe

$n=2$ $y_3 = \frac{5\lambda D}{2d}$ → 3rd dark fringe.

** n^{th} dark fring :-
→ put $n = [n^{th} - 1]$

eg :- 7th dark fringe.
→ put $n = 9$.

5th dark fringe
put $n = 4$

Fringe width → distance b/w successive dark fringe.

$\beta = y_2 - y_1$

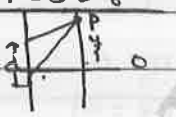
$= \frac{3\lambda D}{2d} - \frac{\lambda D}{2d}$.

$\boxed{\beta = \frac{\lambda D}{d}}$ same as that of bright fringe

** In YDSE → equal width (β).

Key-points For YDSE :-

1. $\Delta x = \frac{yd}{D}$.



2. location of n^{th} bright fringe → [Constructive Interference].

$\boxed{y = \frac{n\lambda D}{d}}$

3rd Bright → put $n=3$.
7th Bright → put $n=7$.

3. location of n^{th} ~~bright~~ dark fringe

$\boxed{y = \frac{(2n+1)D}{2d}}$

पूंछा →
2nd dark → $n=1$
3rd dark → $n=2$
1st dark → $n=0$.

4. width :-
$\boxed{\beta = \frac{\lambda D}{d}}$.

** $I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$.

If $I_1 = I_2 = I_0$.

$\boxed{I = 4I_0 \cos^2\left(\frac{\Delta\phi}{2}\right)}$

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Date ___ / ___ / _____

$I = 4I_0 \cos^2\left(\frac{\Delta\phi}{2}\right)$

$I_{max} = [\sqrt{I_1} + \sqrt{I_2}]^2$

$I_1 = I_2 = I$.

$I_{max} = 4I_0$.

$$\boxed{I = I_{max} \cos^2\left(\frac{\Delta\phi}{2}\right)}$$

max intensity पर, यहाँ, वहाँ Bright fringe constructive Interference

$I = I_{max} \cos^2\left(\frac{\Delta\phi}{2}\right) = I_{center} \cos^2\left(\frac{\Delta\phi}{2}\right)$.

$I = I_{max} \cos^2\left(\frac{\Delta\phi}{2}\right) = I_{center} \cos^2\left(\frac{\Delta\phi}{2}\right)$

$\Delta d \rightarrow$ यात्रिक

$$\boxed{\Delta\phi = \frac{2\pi}{\lambda}\Delta x} \rightarrow \text{Path difference}$$

↑ Phase difference.

$\cos\pi = -1$, $\cos 2\pi = +1$.

$\frac{2\pi\lambda}{\pi}$. 2λ. $\Delta\phi = \frac{2\pi}{100} \times \lambda$. $\frac{2\pi\lambda}{100}$

Q1. In YDSE the intensity of a light at a point on the screen where the path difference is λ is K. Calculate the intensity at a point where the path difference is $\frac{1}{4}$. $\Delta\phi = \frac{2\pi \times \lambda}{100\lambda}$

(i) K (ii) K/2 (iii) K/4 (iv) 0

$\Delta x = \lambda$. $I \rightarrow K$. $\frac{2\pi}{\lambda} \times \lambda$. 2λ.

$I = I_{0max} \cos^2\left(\frac{\Delta\phi}{2}\right)$. $K =$ $\Delta\phi = \frac{2\pi}{100} \times \frac{\lambda}{4} 2$

$I = I_0 \times \cos^2\left(\frac{2\pi}{2}\right)$ $\Delta x = \lambda/4$ $\frac{2\pi}{\lambda} \times \frac{\lambda}{4} 2$. I_2.

$\boxed{I = I_0}$ $\Delta x = \frac{\pi}{2}$.

$\frac{K}{I} = 2$. $I = I_0 \times \cos^2\left(\frac{90}{2}\right)$

$I = I_0 \times \frac{1}{\sqrt{2}}$

$\boxed{I = K/2}$

$$\boxed{I = \frac{I_0}{2}}$$

Q2 In YDSE experiment the intensity of the central bright fringe is 8 milli watt/m^2. Calculate the intensity at a point where the path difference is $\lambda/3$.

AIIMS 2005

Sodium lamp illuminates yellow light. $\frac{2\pi}{\lambda} \times \frac{\lambda}{3}$ $\frac{2\lambda}{3}$

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Date __/__/____

$$8\times10^{-3} \times \cos^2\left(\frac{2\lambda}{3\times2}\right)$$

$$8\times10^{-3} \times \frac{1}{4}$$

$$I = 2\times10^{-3}\ w/m^2$$

Q3 In YDSE the intensity of central bright fringe is 0.01 watt/m² then calculate the intensity at a point having path difference $\lambda/3$.

JMS 2017

Solve.

$$\Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{3}$$

$$= \frac{2\pi}{3}$$

$$\frac{2\pi}{\lambda} \times \frac{\lambda}{3}$$

$$\frac{2\pi}{3}$$

$$I = 1\times10^{-2}\cos^2(120^\circ)$$

$$1\times10^{-2} \times \frac{1}{4}$$

$$I = \frac{1}{4}\times10^{-2}$$

$$\boxed{I = 0.25\times10^{-2}}\ w/m^2$$

Q4 The maximum Intensity in YDSE is I_0. then calculate Intensity in front of one of the slits given.

JET-2016

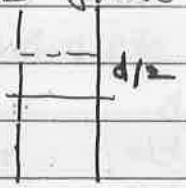
$D = 20\,d$

$d = 5\lambda$.

Solve.

$$\Delta x = \frac{y\,d}{D}$$

$$\Delta x = \frac{d/2 \times d}{20d}$$



$$I_{max} = I_0\cos^2\left(\frac{90}{2}\right)$$

$$= I_0 \times \frac{1}{2}$$

$$\boxed{I_{max} = \frac{I_0}{2}}$$

$$\Delta x = \frac{d\lambda}{2\times10d}$$

$$\Delta x = \frac{d}{20}$$

$$\Delta x = \frac{5\lambda}{20}$$

$$\boxed{\Delta x = \lambda/4}$$

$$\Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{4}$$

$$\Delta x = \frac{\pi}{2}$$

Date ___/___/_____

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$I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos(\Delta\phi)$

$I = I_0 \max \cos^2\left(\frac{\Delta\phi}{2}\right)$

dark

less dark.

$I_{max} = [\sqrt{I_1} + \sqrt{I_2}]^2$

$I_{min} = [\sqrt{I_1} - \sqrt{I_2}]^2$

अगर Interference → Both source Have same Intensity.

dark → बहुत बढ़िया Dark.

Q अगर एक source की Intensity change कर दें तो क्या होगा?

Contrast of fringes will decrease.

dark become less dark.

Q1. AIIMS 2018. In YDSE experiment the $\lambda = 600nm$. at a point, the Intensity is 50% of the max value. then calculate the path difference at that point?

Solve. $I_{max} = I_0 \cos^2\left(\frac{\Delta\phi}{2}\right)$.

$\frac{50}{100} I_{max} = I_{max} \cos^2\left(\frac{\Delta\phi}{2}\right)$

$\frac{1}{2} = \cos^2\left(\frac{\Delta\phi}{2}\right)$

$\cos\frac{1}{\sqrt{2}} = \cos\left(\frac{\Delta\phi}{2}\right)$

$\frac{\pi}{4} = \frac{\Delta\phi}{2}$

$\Delta\phi = \frac{\pi}{2}$.

$\frac{\pi}{2} = \frac{2\pi}{\lambda} \times \Delta x$

$\frac{1}{4} = \Delta x$

$\frac{600 \times 10^{-9}}{4}$

$150nm = \Delta x$.

Q2. AIIMS 2017. Instity of 2 coherent sources is 9 unit and 4 unit resp. then calculate the max. intensity in the interf pattern

Solve. $I_{max} = [\sqrt{I_1} + \sqrt{I_2}]^2$

$= [\sqrt{9} + \sqrt{4}]^2$ $(3+2)^2$

$= 9 + 4 + 2 \times 3 \times 4$ $= 25$ unit.

$= 13 + 24$

$=$

H.W Ex I → ~~Q8, Q9, Q11, Q12, Q13, Q14, 15, 16, 17, 18, 20, 21, 22, 24, 25, 26, 27, 28, 30, 31, 32, 33, 36, 37, 39, 41, 42 43, 46, 48, 49, 50, 53, 54, 68, 69~~.

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Date __/__/____

Q3 AIIMS 2012 Two waves having intensity I and same frequency superimpose each other at a point, calculate the resultant intensity if they interfere constructively.

Solve. $I_{max} = [\sqrt{I_1} + \sqrt{I_2}]^2$

$I_{max} = 2I * 2$

$\boxed{I_{max} = 4I}$

w_1 ~~Intensity of light~~

w_2 Intensity of light ∝ width of slit.

$\boxed{\frac{I_1}{I_2} = \frac{w_1}{w_2}}$

कभी कभार प्रश्न में width of slit का ratio देता है $\frac{w_1}{w_2} = \frac{4}{9}$. मुझे समझना चाहिए।

$\boxed{\frac{I_1}{I_2} = \frac{4}{9}}$ जो width का ratio है वही intensity का ratio है।

Q3 Two slit in YDSE experiment have width ratio 1 & 25. Calculate the ratio of $\frac{I_{max}}{I_{min}}$?

$\frac{I_1}{I_2} = \frac{1}{25}$.

$I_{max} = 1 + 25 + 2 \times 1 \times 5$

$= 26 + 10 = 36$.

$I_{min} = 1 + 25 - 2 \times 1 \times 5$

$= 26 - 10$

$= 16$

$\frac{I_{max}}{I_{min}} = \frac{36}{16} = \frac{9}{4}$.

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Date ___ / ___ / _____

NOTE → 

$I_{max} = 4I_0$.

If one of the slit is closed.

Interference होगी नहीं

$I_{net} = I_0$

Result → In YDSE if one of the slit is closed

$$I_{बंद} = \frac{I}{4} \text{ चमकीली}$$

Q1. In YDSE, the central maxima is observed to be I_0. If one of the slit is closed then intensity at central maxima will be?

(i) $\frac{I_0}{2}$ (ii) $\frac{I_0}{\sqrt{2}}$ (iii) $\frac{I_0}{4}$ (iv) I_0.

Solve $I_{बंद} = \frac{1}{4} I_{चमकीली}$

$I_{बंद} = \frac{1}{4} I_0$.

Q2. In Intensity of central fringe obtained in the pattern due to two identical slit is I. When one of the slit is closed, the intensity at same I_0 then correct relation

(i) $I = I_0$.

(ii) $I = 2I_0$

(iii) $I = 4I_0$

(iv) $I = \frac{I_0}{4}$.

$I_{बंद} = \frac{1}{4} I_{चमकीली}$

$I_0 = \frac{1}{4} I$.

$I = 4I_0$

When YDSE setup is immersed in a liquid :-

$\lambda \propto 1/\mu$.

$$\lambda_w = \frac{\lambda_{air}}{\mu}$$

$$\beta_w = \frac{\beta_{air}}{\mu}$$

medium में immerse करने पर.

β घटता.

Date __/__/____

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सूचना :- λ की replace करके λ/μ put करें.

air	medium
$\beta = \frac{\lambda D}{d}$	$\beta = \left[\frac{\lambda}{\mu}\right]\frac{D}{d}$
→ Bright position	Bright position
$y = \frac{n\lambda D}{d}$	$y = n\times\left[\frac{\lambda}{\mu}\right]\frac{D}{d}$
→ dark position	dark position.
$y' = [2n+1]\frac{\lambda D}{2d}$	$y' = [2n+1]\frac{\lambda}{\mu}\frac{D}{2d}$.

Q1

NEET2017. YDSE 1st performed in air then in medium. It is found that 8th bright fringe in the medium lies where 5th dark fring lies in air then calculate the μ of medium?

Solve. $8\times\frac{\lambda}{\mu}\times\frac{D}{d} = \frac{9\lambda D}{2d}$

$\frac{16}{\mu} = 9$

$\boxed{\frac{16}{9} = \mu}$

Q2. In YDSE $d = 0.12\,mm$.

$D = 1m$

$\lambda = 6000\,A^\circ$

(i) find position of 3rd maxima from centre.

(ii) position of 3rd minima from centre.

(i) $y = \frac{n\lambda D}{d}$ $\quad \frac{3\times 6000\times 10^{-10}\times 1}{12\times 10^{-5}}$

1500×10^{-11}

1.5×10^{-8} meter

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Date ___ / ___ / _____

θ = 3rd minima = $\frac{(2\times2+1)\,6\times10^{-7}\times 1}{2\times12\times10^{-5}}$

$= \frac{5\times6\times10^{-8}}{2\times12\times10^{-5}}$

$= \frac{25\times10^{-3}}{2}$ meter

Q3. In YDSE the slits are 2mm apart and it is illuminated with a light of $\lambda = 12000\,A^0$ and $\lambda_2 = 10,000\,A^0$. At what minimum distance from the common central bright fringe on the screen 2m from the slit a bright fringe from 1 interference pattern coincide with bright fring from other interference pattern?

NEET 2013

Solve. $d = 2mm = 2\times10^{-3}$

$D = 2m$

$y = \frac{n\lambda D}{d} = \frac{1\times12000\times10^{-10}\times 2}{2\times10^{-3}}$

$= 6\times2\times10^{-7}$

$= 12\times10^{-7} \Rightarrow 1.2\times10^{-6}\times10^{3}$

$= 1.2\times10^{-3}\,m$

$y = \frac{2\times10,000\times10^{-10}\times2}{}$

Bright fringe की location.

$y = \frac{n\lambda D}{d}$

$\lambda_1 = 12000\,A^0$

$\lambda_2 = 10000\,A^0$

$y_1 = \frac{n_1\lambda_1 D}{d}$

$y_2 = \frac{n_2\lambda_2 D}{d}$

exactly overlapp →

$y_1 = y_2 \Rightarrow \frac{n_1\lambda_1 D}{d} = \frac{n_2\lambda_2 D}{d}$

or $\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1}$

$\boxed{\frac{n_1}{n_2} = \frac{5}{6}}$

$\lambda_1 = 12000\,A^0$ की 5th Bright

$\lambda_2 = 10000\,A^0$ की 6th Bright

$y = \frac{n\lambda D}{d}$

$= \frac{5\times12000\times10^{-10}\times2}{2\times10^{-3}}$

$= 6\,mm$

Solved; ~~1,2,3,5,6,7,8~~.

~~Book 1 → Complete~~.

2 → ~~1,3,4,6,7,8,10~~,

Ex II → ~~1,2,4,6,8,13,15,17,19,20,22,23,26,28~~

Date ___ / ___ / ~~29,30,36~~

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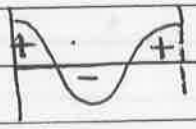
Intensity Average:- [$\cos\phi_{average} = 0$.]

$$I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi.$$



Source → Incoherent.

Phase difference → always change.

$$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} \times [0]$$

$$\boxed{I_{net} = I_1 + I_2}$$

Ex II

Q22. Bright Fringe →

$$y = \frac{n\lambda D}{d}$$

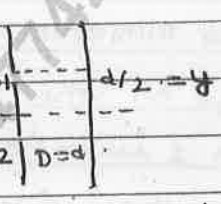
$$y \propto \lambda.$$

$$\frac{y_1}{y_2} = \frac{\lambda_1}{\lambda_2}.$$

$$\frac{6mm}{y_2} = \frac{500 \times 10^{-9}}{550 \times 10^{-9}}$$

$$\boxed{y_2 = 11mm}$$

Shift = $y_2 - y_1 = 1mm$.

Q19. 

$$I = I_0\cos^2\left(\frac{\Delta\phi}{2}\right).$$

$\Delta\phi = ?$

$$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$$

$$\Delta x = \frac{yd}{D}.$$

$$\Delta x = \frac{y/2 \times d}{D}.$$

$$\Delta x = \frac{d^2}{2D}$$

$$\Delta x = \frac{d\gamma}{2d}$$

$$\Delta x = \frac{\lambda}{4}.$$

$$\Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{4}$$

$$\Delta\phi = \frac{\pi}{2}.$$

$$I = \frac{I_0}{2}.$$

Date __/__/____

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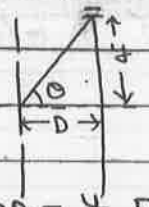
Angular position / Angular Fringe width concept →

NEET = 2018 .
NEET = 2019 . position / location of Bright fringe from centre .



$$y = \frac{n\lambda D}{d}$$

angular position of Bright fringe →

$$\theta = \frac{n\lambda}{d}$$

$\tan\theta = \frac{y}{D}$ Funda

angular fringe width →

$$\alpha = \frac{\lambda}{d}$$

$\alpha \rightarrow$ एक में radian में .

$\alpha_{med} = \frac{\alpha_{air}}{\mu}$.

position Bright

→ $y = \frac{n\lambda D}{d}$

angular position

→ $\theta = \frac{n\lambda}{d}$

→ dark

$y = (2n+1)\frac{\lambda D}{2d}$

→ $\theta = (2n+1)\frac{\lambda}{2d}$

→ Fringe width

$\beta = \frac{\lambda D}{d}$

angular fringe

$\alpha = \frac{\lambda}{d}$

Q1. YDSE . $\lambda \rightarrow$ same .

$\alpha_1 = 0.2mm$. अब $\alpha_2 = 0.2°$

angular fringe width . distance b/w slits $d_2 = ?$

$\alpha_1 = 0.20$.

Solve . $\alpha = \frac{\lambda}{d}$.

$$\frac{\alpha_1}{\alpha_2} = \frac{d_2}{d_1}$$

$$\frac{0.20}{0.21} = \frac{d_2}{0.2}$$

$$\frac{0.20 \times 0.2}{0.21} = \frac{0.40}{0.21} = d = \frac{4}{21} = 0.19\,mm .$$

Q2. In YDSE the distance b/w the slits is $d = 0.2mm$ and the screen is placed at a distance of 25 cm . and wavelength of light used is $5000 A^\circ$ then calculate angular position of first dark fringe ?

Solve . $\theta = \frac{\lambda}{d}$

$= \frac{5000 \times 10^{-7}}{2 \times 0.1 \times 10^{-3}} \times \pi$ $\quad \frac{25}{5} \quad 2.5\pi$.

$= 25 \times 10^{-3}$

$= .25\pi$ =

Page No.

Ex I → 60, 63, 47, 52, 55, 56, 58, 63, 65, 67, 66, 71, 72, 78 [7.5]

II → 2, 3, 4, 10.

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Date __ / __ / ____

$\theta = \frac{1}{100} \times 0.25 \times 10^{-3}$

$\theta = 0.45$ ~~mrad~~ $^{\circ}$

YDSE setup with the help of white light :—

$I = I_0 \cos^2\left(\frac{\Delta\phi}{2}\right)$.

$I \propto \cos^2\theta$ graph.

$\Delta x = 0$ white light

colored fringe

white light

colored fringe

Red

near central fringe

$\beta = \frac{\lambda D}{d}$

$\beta \propto \lambda$.

जिसका λ ज्यादा उसका β भी ज्यादा.

VIBGYOR → λ ज्यादा

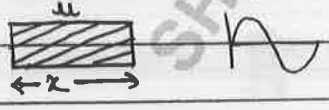
Red ⇒ λ, β ज्यादा

white light → सभी colour का maxima center पर overlap.

central fringe → white → NEET

central fringe के आस-पास कौन सा colour Red colour

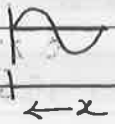
Effect of thin film →



$\mu = \frac{c}{v} = \frac{c}{\frac{x}{t}} = \frac{ct}{x}$

time = $\frac{\text{distance}}{\text{speed}} = \frac{x}{\frac{c}{\mu}}$

$t = \frac{\mu x}{c}$



कितनी distance = ?

distance = speed × time

$x' = c \times \frac{\mu x}{c}$

$x' = \mu x$

medium

$\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x$

vaccum

$\Delta\phi = \frac{2\pi}{\lambda} \Delta x$ रेडियन

$\Delta\phi = 2\pi \times \mu x$

Date ___ / ___ / _____

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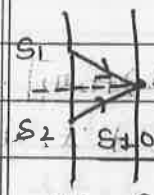
conclusion →

medium में x चलना = vaccum में μx चलना

medium में t चलना = vaccum में μt चलना



O - central bright fringe [Δx=0].

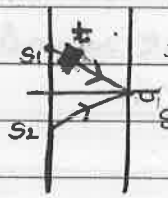
$S_1O = S_2O$

$\Delta x = S_1O - S_2O$

$\Delta x = 0$

central bright fringe

$\Delta x = 0$



t → thickness of slab.

$S_1O = S_2O$

at O.

$\Delta x = [S_1O - t + \mu t] - [S_2O]$

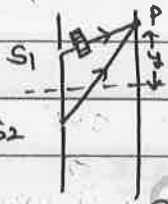
$\Delta x = S_1O - t + \mu t - S_2O$

$\Delta x = \mu t - t$

$\Delta x = t(\mu - 1)$

at O. $\Delta x \neq 0$

इसका मतलब अब O पर central Bright fringe नहीं बनेगी।



$\Delta x = 0$

P ← central bright fringe.

$[[S_1P - t] + \mu t] - [S_2P] = 0$

$S_1P - t + \mu t - S_2P = 0$

$t(\mu - 1) = S_2P - S_1P$

$t(\mu - 1) = \frac{yd}{D}$

learn How to write it. very imp

For Questions asked in NEET & AFMS

$y = \frac{t(\mu - 1)D}{d}$

इतना central bright fringe shift हुआ है।

No. of fringe displaced $= \frac{y}{\beta}$

Short → ☆ t slab = $t(\mu-1) = \frac{yd}{D}$.

☆ 2 slab = $(\mu_1-1)t_1 = (\mu_2-1)t_2$.

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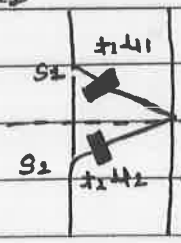
Date ___ / ___ / _____

Practice →

Q1. If central fringe is formed at O. find relation b/w μ_1 and μ_2 t_1 and t_2?



$\Delta x = 0$ होगा यहाँ पर।

$[(S_1O - t_1) + t_1\mu_1] - [(S_2O - t_2) + t_2\mu_2] = 0$

$S_1O - t_1 + \mu_1 t_1 = S_2O - t_2 + t_2\mu_2$

☆☆ Required result: $\boxed{\frac{t_1}{t_2} = \frac{\mu_2 - 1}{\mu_1 - 1}}$

Q2.

Q1 If position of central bright fringe remain unchanged?

Slab 1 = $\mu_1 = 1.5$ $t_1 = 1.2\mu m$.

Slab 2 = $\mu_2 = 2.5$ $t_2 = ?$

Solve. $\Delta x = 0$.

$[[S_1O - t_1] + \mu_1 t_1] - [[S_2O - t_2] + \mu_2 t_2] = 0$

☆☆

Slab बदलने पर Fringe-width पर no effect

$\frac{t_1}{t_2} = \frac{\mu_2 - 1}{\mu_1 - 1}$

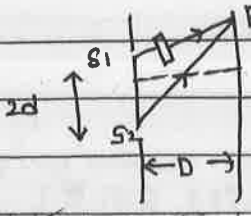
$\frac{1.2\mu m}{t_2} = \frac{1.5 - 1}{2.5 - 1}$

$\frac{1.2}{t_2} = \frac{0.5}{1.5} \frac{1}{3}$

$t_2 = \frac{1.2}{3}$

$t_2 = 0.4\ \mu m$

Q3.



$\mu = 5/3$

calculate displacement of fringe system.

$y = \frac{t(\mu-1)D}{d}$.

$= t\left(\frac{5}{3} - 1\right)\frac{D}{2d}$.

$= t \times \frac{2}{3}\frac{D}{2d}$. $= \frac{2tD}{6d}$.

~~Ex → 51, 52, 57, 60, 61~~

~~62, 70, 73~~

~~II → Q15~~

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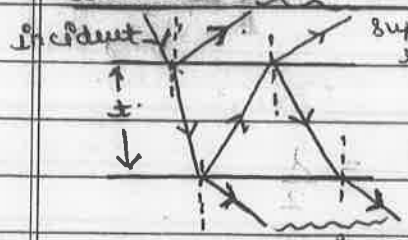
Date ___ / ___ / _____

Colour in a thin Film →



$t = 0.7\ \mu m$ [order]

μ = refrective index

t → thickness of film

r → angle of refraction

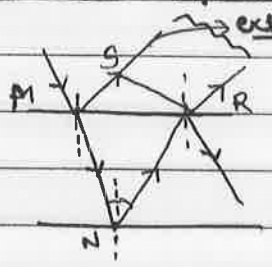
[transmitted system].

Transmitted System: $\Delta x = 2\mu t \cos r$ (x) r → refracted angle

If Bright → $\Delta x = n\lambda$

If dark → $\Delta x = (2n+1)\frac{\lambda}{2}$

What about reflected system →



x^{th} concept [wave theory]

rarer → denser

at boundary i→ $\Delta\phi = \pi$

$\Delta x = ?$

$\pi = \frac{2\pi}{\lambda} \times \Delta x$

$\Delta x = \frac{\lambda}{2}$

$\Delta x = 2\mu t\cos r - \frac{\lambda}{2}$ reflected system

Conclusion → → reflected system → $\Delta x = 2\mu t\cos r - \frac{\lambda}{2}$

→ transmitted system → $\Delta x = 2\mu t \cos r$

→ Bright → $\Delta x = n\lambda$

→ Dark → $\Delta x = [2n+1]\frac{\lambda}{2}$

Q1. Light of $\lambda = 6000\ A^\circ$ is incident on a thin glass plate of $\mu = 1.5$ such that angle of refraction into the plate is 60° then calculate the smallest thickness of the plate which will make it appear dark by reflection? put n = 1 [minimum]

Solve $\Delta x = (2n+1)\frac{\lambda}{2}$

$2 \times 1.5 \times t \times \frac{1}{2} = \frac{3 \times 6 \times 10^{-7}}{2}$

$3 \times t = 3 \times 6 \times 10^{-7}$

$t = \frac{3 \times 6 \times 10^{-7}}{3}$

$t = 6 \times 10^{-7}$

$t = 0.4\ \mu m$

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Date __ / __ / ____

Concept → Reflected system.

$t \to 0$ [thickness negligible]

Dark colour?

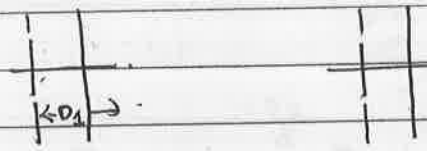
$\Delta x = 2\mu t\cos 0 - \frac{\lambda}{2}$ $\quad \Delta x = -\frac{\lambda}{2} \equiv \frac{\lambda}{2}$

$\boxed{\Delta x = \lambda/2}$ implies

Destructive (dark)

Q5

B.Box (2)



$\beta_2 = \frac{\lambda D_2}{d}$

$\beta_1 = \frac{\lambda D_1}{d}$

$\beta_2 - \beta_1 = \frac{\lambda \Delta D}{d}$

$\Delta\beta = \frac{\lambda \Delta D}{d}$

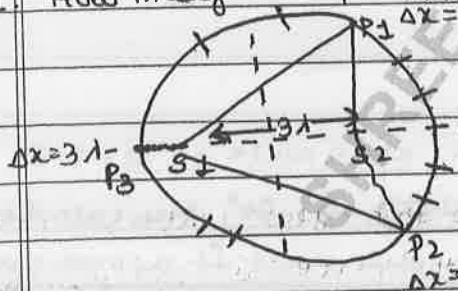
$3\times10^{-5} = \lambda\left(\frac{5\times10^{-2}}{\Delta \; 10^{-3}}\right)$

$\frac{3\times10^{-8}}{5\times10^{-2}} = 0.6\times10^{-6}$

$6\times10^{-7} = \lambda$

$600\,nm = \lambda$

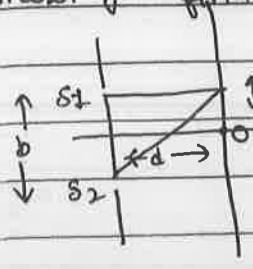
Q1. How many no. of maxima are obtained on circular screen?



$\boxed{n = 12}$

Q2 In the given situation seperation b/w slit is b and screen is placed at d from the slits at a point on the screen directly in front of one of the slits, certain wavelength are missing find these missing wavelengths?

missing → Destructive.



Destructive

$\Delta x = (2n+1)\frac{\lambda}{2}$

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Date ___ / ___ / _____

$\frac{b_2 \times b}{d} = \frac{b^2}{2d}$

$\frac{b^2}{2d} = (2n+1)\frac{\lambda}{2}$

$\boxed{\lambda = \frac{b^2}{(2n+1)}}$ missing wavelengths

put $n=0$ $\lambda = b^2/d$

$n=1$ $\lambda = \frac{b^2}{3d}$ .... and so on.

Q2 In YDSE it is found that the intensity ratio b/w bright and dark fringes is 9 calculate

(i) $\frac{I_1}{I_2}$ Solve. $\frac{I_{max}}{I_{min}} = \frac{9}{1}$

(ii) $\frac{a_1}{a_2}$. $\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}} = \frac{3}{1}$

$\sqrt{I_1} + \sqrt{I_2} = 3\sqrt{I_1} - 3\sqrt{I_2}$

$4\sqrt{I_2} = 3\sqrt{I_1} - \sqrt{I_1}$

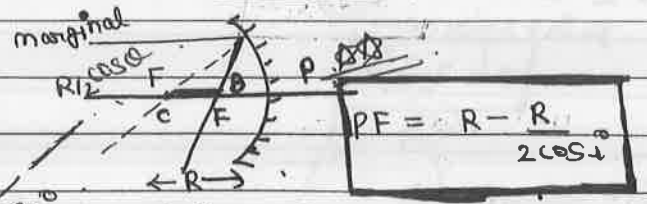
$\frac{4}{2} = \frac{\sqrt{I_1}}{\sqrt{I_2}}$

$\boxed{\frac{2}{1} = \frac{\sqrt{I_1}}{\sqrt{I_2}} = \frac{a_1}{a_2}}$

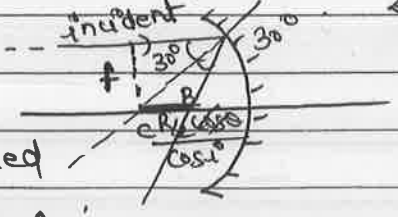
$\boxed{\frac{4}{1} = \frac{I_1}{I_2}}$

** Conceptual points :—

$f = \frac{R}{2}$.



$PF = R - \frac{R}{2\cos i}$



CB → fixed

$\frac{R}{2\cos i}$

$\sin\theta = R/2R$

$\boxed{\theta = 30°}$

$\frac{CB}{f}$ = ? .. distance CB → $\frac{R}{2 \times \sqrt{3}/2} = \frac{R/\sqrt{3}}{R/2}$

$2/\sqrt{3}$

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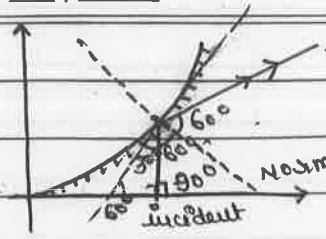
Date ___/___/_____

Paper



$\frac{dy}{dx} = \tan\theta$

$2(2x) = \tan\theta$

$4x = \sqrt{3}$

$x = \frac{\sqrt{3}}{4}$

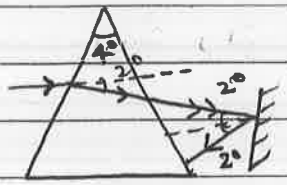
mirror = $\delta = 180 - 2i^\circ$

$60^\circ = 180 - 2i^\circ$

$-120 = -2i^\circ$

$i^\circ = 60^\circ$

Q7



$\delta = (\mu - 1)A$

$= (1.5 - 1) \times 4$

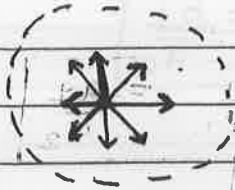
$\delta = 2^\circ$

Q By what angle the mirror is rotated so that ray after reflection become Horizontal?

mirror को θ घुमाएंगे तो reflected ray 2θ घुमेगी।

ray 2° घुमेगी → mirror 1° घुमेगा।

Huygen's Wave Theory :- The locus of all the point which vibrate in same phase is called wavefront.



point source → Spherical wave front

point source

point source

$I \propto 1/r^2$

line source →

cylindrical

$I \propto \frac{1}{r}$

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Date ___ / ___ / _____

Huygen's wave theory :-

Hypothetical medium → Ether.

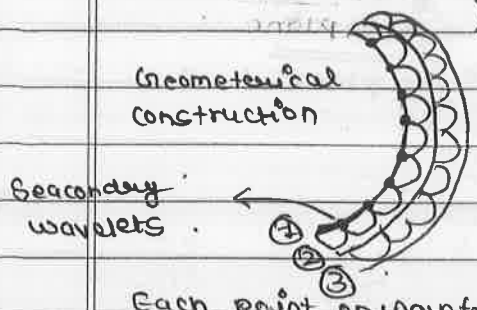
main drawback → explanation of medium ether.

Huygens wave theory is applicable for all types of wave - wave nature.

Interference, diffraction → explation.

photoelectric effect → cannot explain by Huygen's wave theory.

Wavefront kaise travel करता है —



दो consecutive wavefront के बीच का distance = λ

wavefront travels with speed of light

$\Delta x = n\lambda$.

$\Delta x = 0, \lambda, 2\lambda \ldots$

$\Delta x = (2n+1)\lambda/2$

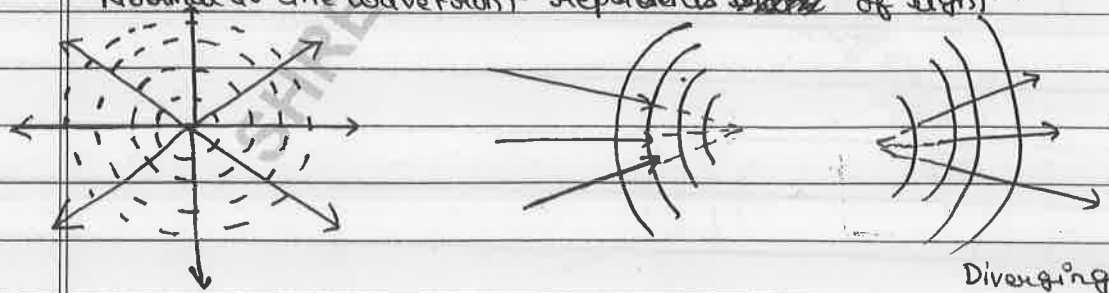
$\frac{\lambda}{2}, \frac{3\lambda}{2} \ldots$

Each point on wavefront acts as a source of secondary wavelength it emits wavelets in all direction which travel with the speed of light.

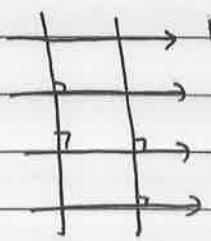
The tangent plane to these secondary wavelets represent new position of the wavefront.

concept →

Normal to the wavefront represents half of light.



Diverging wavefront



Plane wavefront.

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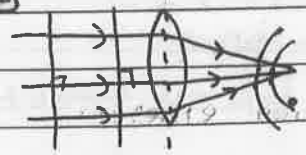
Date __ / __ / ____

(1)



Refracted wavefront
Spherical

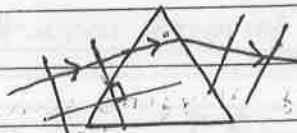
Incident wavefront
(Plane

(2)

Diverging wavefront
refracted

plane
[Incident]

(3)



plane
[refracted]

plane
[Incident]

(4)

Reflected

Incident
plane

P.T.O

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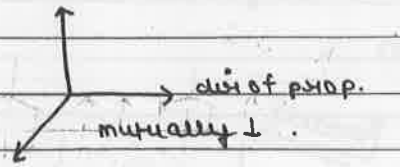
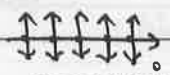
Date ___ / ___ / _____

SECTION-B

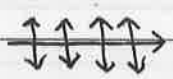
Polarisation → According to maxwell light waves are electromag. transverse wave in which $\vec{E}$, $\vec{B}$ and direction of propagation are are perpendicular to each other.



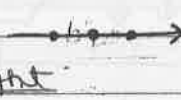
unpolarised light → If dir. of $\vec{E}$ is present in all possible directions then such a light is called unpolarised light.



Polarised light → If direction of E restricted to only in 1 plane.



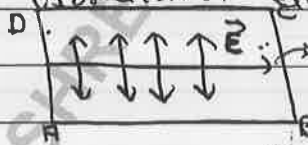
Polarised light



Plane of vibration and plane of polarisation

Plane of polarisation → ~~The plane containing direction of propagation~~ plane which is perpendicular to plane of vibration and there is no vibration of $\vec{E}$ called plane of polarisation.

Plane of vibration → The plane containing direction of propogation and vibration of electric $\vec{E}$ called plane of vibration.



direction of propogation (x).
x y z
x-z plane → plane of polarisation.

ABCD → plane of vibration → dir. of propogation → x-y plane
(x) electric field ($\vec{E}$) ABCD.

Ex(2).

plane of vibration. x-z plane

plane of ~~polarisation~~ = x y ✗

x-y plane.

methods to convert unpolarised light into polarised light →

(A) By dichroism (By polaroid) - [law of malus]

(B) By reflection [Brewster law].

(3) By double refraction (4) By scattering.

Page No. ____

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Date ___ / ___ / _____

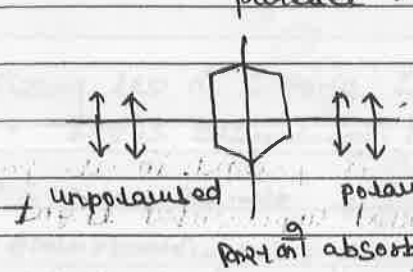
By Dichorism :-

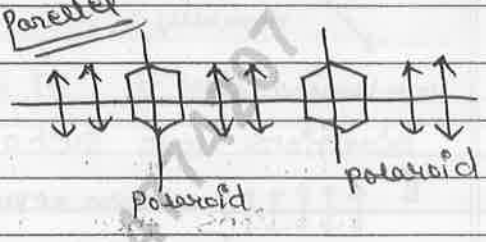
Nature → Special crystal → Tourmaline.

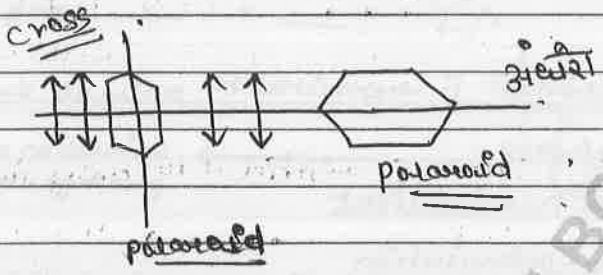
Property → Transmission axis के 1 component को absorb.

property → Dichorism.

parallel → pass.







Race → Interference.

Qy $d = 0.1mm = 1\times10^{-4}\ m$

$D = 20cm \Rightarrow 20\times10^{-2}\ m$

$\lambda = 5480 = 5460\times10^{-10}$

$\theta = \frac{y}{2d}$

$y = \frac{(2n+1)\lambda D}{2d}$

$\theta = \frac{\lambda}{2d} = \frac{5460\times10^{-10}}{2\times1\times10^{-4}}$ (273°)

$= 2730\times10^{-6}\times180$

$= 2.7\times1.8\times10^{-1} = 0.4$

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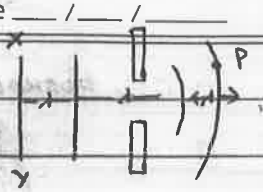
Date ___ / ___ / _____

Q16. 

time = distance / speed

$$t = \frac{3\lambda}{c}$$

Q17. $I = I_0 \cos^2\left(\frac{\Delta\phi}{2}\right)$.

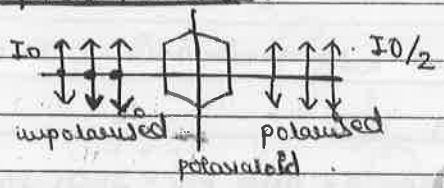
$\lambda \rightarrow I_0$

$\frac{2\pi}{\lambda} \times x \quad (2\pi)$

$\frac{\lambda}{3} \quad \frac{2\pi}{\lambda} \times \frac{\lambda}{3} \quad \frac{\pi}{3} = 60^\circ$

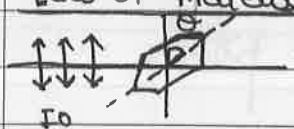
$$I = \frac{I_0}{4}$$

Conceptual point :-

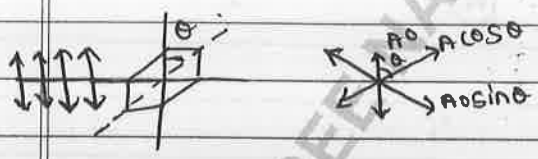


Polaroid → Based on principle of dichroism

Law of malus :-



Transmitted intensity $I_0\cos^2\theta$



Component → $A_0\cos\theta$ [Pass → Transmit]

Intensity = ?

$I \propto (\text{amp})^2$

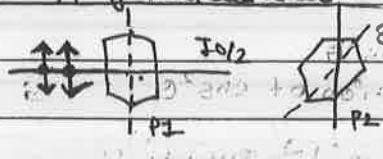
Trans. $I = K(\text{amp})^2$

$= K(A_0\cos\theta)^2$

$= kA_0^2\cos^2\theta$

Trans. $I = I_0\cos^2\theta$

How to apply malus law →

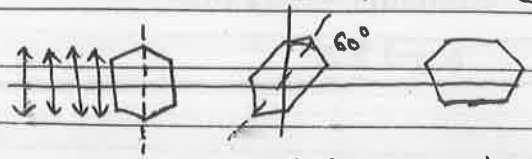
ex① 

Transmitted light ?

$I = \frac{I_0}{2}\cos^2\theta$

$I = \frac{I_0}{2} \times \left(\frac{\sqrt{3}}{2}\right)^2$

$I = \frac{I_0}{2} \times \frac{3}{4} = \frac{3I_0}{8}$

ex② 

P_2 and P_3 are ⊥ to each other

[Malus law में angle consecutive के बीच लिया जाता है]

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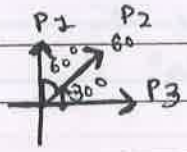
$\frac{I_0}{2} \times \cos\left(\frac{60}{2}\right)^2$

$\frac{I_0}{2} \times \frac{1}{4} = \frac{I_0}{8} = P_2$

$P_3 = I^2 \frac{I_0}{8}$



Malus law →

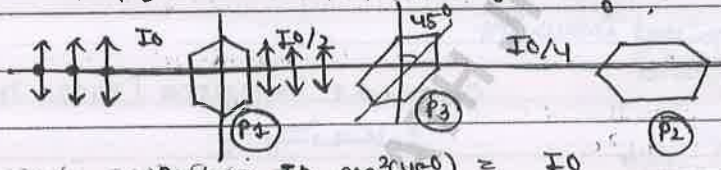
$\frac{I_0}{8} \times \cos^2 30$

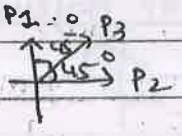
$\frac{I_0}{8} \times \frac{3}{4} = \frac{3I_0}{32}$

Q3. NEET ≠ 2017

Two polaroids P_1 and P_2 are placed with their axis ⊥ to each other. unpolarised light I_0 is incident on P_1. A 3rd polaroid P_3 is kept b/w P_1 and P_2 such that its axis makes an angle of 45° with P_1 then calculate the I of transmitted light through P_2?

Sol^n

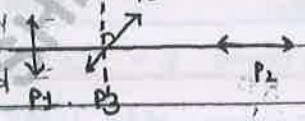




P_3 ka $I = \frac{I_0}{2} \cos^2(45^0) = \frac{I_0}{4}$

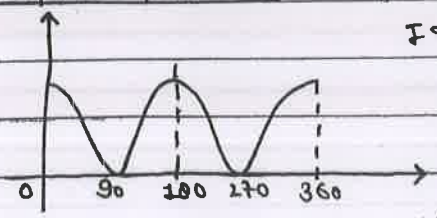
(P_2 ka) $\frac{I_0}{4} \times \cos^2 45^0 = \frac{I_0}{8}$

Simplified diagram:-



Conceptual points :- $I = I_0 \cos^2\theta$

I a fuction of $\cos^2\theta$



Polaroid → Intensity

maximum = 2 times

minimum = 2 times

$0 \rightarrow 2\pi$

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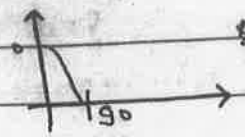
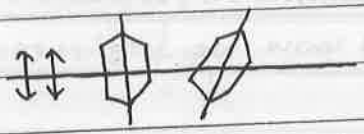
AIPMT. Polaroid ને 90° ફેરવે ત્યારે પ્રકાશ પર શું અસર થશે?

maximum to minimum.



Q. Two polaroids are oriented such that their principle axis's making an angle of 60° with each other. calculate the % of incident unpolarised light which pass p through the system?



$\frac{I_0}{2}\cos 60^\circ = \frac{I_0}{2} \times \frac{1}{4} = \frac{I_0}{8}$

~~$\frac{I_0}{8}$~~ $\frac{I_0}{I_0}$ unpolarised

$\frac{I_0}{8} \times 100 = 12.5\ \%$

Q. A light has a amplitude a_0 and angle b/w analyser and polariser. calculate the amplitude of transmitted light by analyser?

Solve

$= \frac{I_0}{2} \times \frac{1}{4} = \frac{I_0}{8} = \frac{a_0}{2\sqrt{2}}$

$I \propto a^2$

$\frac{I_0}{\sqrt{2}}\cos^2 60^\circ \qquad \frac{I_0}{4\sqrt{2}\times\sqrt{2}} = \frac{a_0}{2\sqrt{2}}$

P.T.O.

Page No.

Ex I → 1-7, 106-121

Ex 3 → 1-5, 7-10

Beg Box (6) → Complete

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Only Transverse wave can be polarised.

light wave are Transverse wave

Electromagnetic wave → Transverse wave

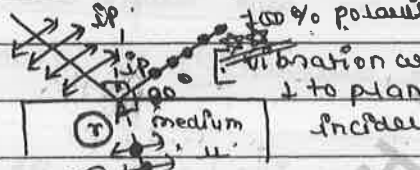
Radio-wave
micro-wave
Infrared
Visible
U.V rays
X-rays
Y-rays

All electromagnetic waves they can be polarised

Sound wave → cannot be polarised because Sound wave are longitutonal waves

Method no. 2 :- By Reflection

Brewster's law :-



ip → polarising angle

↓

angle of incidence at which reflected light is 100% polarised.

↓

polarising angle

NCERT

Experiments →

at particular angle

reflected ray → 100% polarised

extend of polarisation depend on angle of incidence

reflected ray and refracted ray are ⊥ to each other.

Derivation →

$ip + 90 + r = 180°$

$\boxed{r = 90 - ip}$

Snell's law :-

$1 \sin ip = u \sin r$

$1 \sin ip = u \sin(90 - ip)$

$\frac{\sin ip}{\cos ip} = u$

$\boxed{\tan ip = u}$

concept :-

- $u = \tan ip$
- $\boxed{u = c/v}$

critical angle

- $\boxed{\sin ic = 1/u}$

O.T.9

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Ex① angle of polarisation $i_p = 60^\circ$

$\mu = ?$

Speed of light in medium

angle of incidence $= ?$

Solve $\mu = \tan i_p$

① $\boxed{\mu = \sqrt{3}}$

$\mu = \frac{c}{v}$

② $v = \frac{c}{\sqrt{3}} = 1.732 \times 10^8$

③ $\sin i_c = \frac{1}{\sqrt{3}}$

$\boxed{i_c = \sin^{-1}\frac{1}{\sqrt{3}}}$

Ex② medium

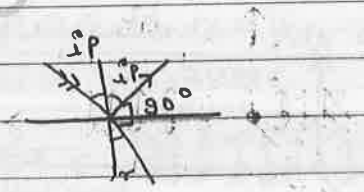
$\mu = 1.732 = \sqrt{3}$

angle of refraction $= r = ?$

$\mu = \tan i_p$

$\sqrt{3} = \tan i_p$

$\boxed{i_p = 60^\circ}$



$i_p + 90 + r = 180$

$\boxed{r = 30^\circ}$

Ex③

Q9 $R = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi}$

$= \sqrt{a^2 + a^2 + 2a^2\cos\delta}$

$= \sqrt{2a^2 + 2a^2\cos\delta}$

$= \sqrt{2a^2(1+\cos\delta)}$

$\cos\delta = 2\cos^2\frac{\delta}{2} - 1$

$R = \sqrt{2a^2(1 + 2\cos^2\delta/2 - 1)}$

$\boxed{I = 2a^2\cos^2(\delta/2)}$

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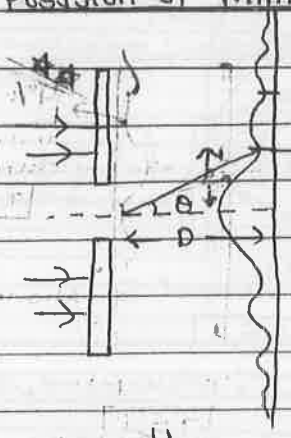
Position of minima :-



$\tan\theta = \frac{y}{D}$

$\theta = y/D$

$I = I_0 \sin^2\left(\frac{\pi a \sin\theta}{\lambda}\right) \Big/ \left(\frac{\pi a \sin\theta}{\lambda}\right)^2$

minima $I = 0$

$\sin^2\left(\frac{\pi a \sin\theta}{\lambda}\right) = 0$

$\sin\left(\frac{\pi a \sin\theta}{\lambda}\right) = 0$

$\sin 0° = 0$ or $\pi, 2\pi, 3\pi, 4\pi \ldots n\pi$

$\sin\left[\frac{\pi a \sin\theta}{\lambda}\right] = \sin n\pi$

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

$a\sin\theta = n\lambda$ condition of minima

put $n = 1, 2, 3$

1st minima →

put $n = 1$

$a\sin\theta = \lambda$

$\sin\theta = \lambda/a$

$\theta = \lambda/a$ angular position of 1st minima

position of 1st secondary minima

$y = \frac{\lambda D}{a}$ Frequent asked Question

a = width of slit

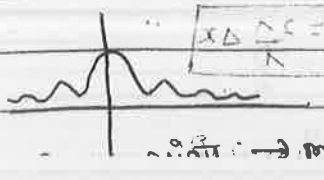
NOTE → width of central maxima $= 2y$

angular width of central maxima $= 2\theta$

SHORT NOTES :-

(i) Fraunhofer single slit diffraction →

wavefront → Plane



pattern → maxima > central maxima

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width → unequal

central maxima → width → other fringes → comparision → double ∴

(5) position of secondary maxima :—

$a \sin\theta = n\lambda$ ☆☆ $n = 1, 2, 3, 4 \ldots$

position of secondary minima :—

$a \sin\theta = (2n+1)\frac{\lambda}{2}$ $n = 1, 2, 3 \ldots$

width of central maxima = $\frac{2\lambda D}{a}$

width of central minima = $\frac{2\lambda}{a}$

☆ If red light replaced by green light

VIBGYOR · λ decreased · pattern → narrower

☆ If slit width narrow :— then ↑width = $\frac{2\lambda D}{a\downarrow}$

pattern → spread

(6) position of first minima → $= \frac{\lambda D}{a}$

position of first angular minima = λ/a

Homework Ex I → 105, 104, 102, 101, 99, 97, 95, 94, 93, 92, 91, 89, 83, 86, 88

Ex II → Q5, Q8, Q10, Q11, Q14, Q21, Q38

Ex III → Q6, Q11, Q12

Solve → 14, 15, 16, 17, 19, 20

Beg Box 4 → pura

Q93. $\lambda = 5000 A^\circ$

distance of 1st minima = 5mm

$D = 2m$

$a = ?$

$y = \frac{\lambda D}{a}$

$5 \times 10^{-3} = \frac{5000 \times 10^{-10} \times 2}{a}$

$a = \frac{5000 \times 10^{-10} \times 2}{5 \times 10^{-3}}$

$= \frac{2 \times 10^{-7}}{10^{-3}} = 2 \times 10^{-4}$

$= 0.2 \times 10^{-3}$

$= 0.2m$

$\frac{600\times10^{-9}}{\frac{1}{6.2}\times10^{-3}}$ $\frac{300}{1000}\times10^{-6}\times\frac{\pi}{180}$

* diff., current, conductor
Ray optics

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Q94 $d = 6000A^0$.

$D = 2m$

$a = 0.2mm$.

width of central maxima = - 2y.

$$\frac{2\lambda D}{a} = \frac{2\times6000\times10^{-10}\times2}{2\times10^{-4}}$$

$$\frac{12\times10^{-7}}{10^{-4}} = 12\times10^{-3}$$

$= 12mm$

Q95 $\lambda = 600\times10^{-9}$.

$a = 1.2$.

$\theta = ?$

$\theta = \frac{\lambda}{a} = \frac{600\times10^{-9}}{1.2}$

$= 500\times10^{-9}\times\frac{\pi}{180}$

$a\sin\theta = n\lambda$.

$a\sin\theta = \lambda$.

$1.2\times10^{-3}\times\sin\theta = 600\times10^{-9}$.

$\sin\theta = \frac{600\times10^{-9}}{1.2\times10^{-3}}$

$\sin\theta = 1/2$

$= \frac{\pi}{6}$ radian.

XII Q88 $a = 0.6mm$.

$y = 1mm$.

$y = \frac{\lambda D}{a}$.

$1\times10^{-3} = \frac{\lambda\times1.2}{6\times10^{-4}}$.

$\frac{6\times10^{-6}}{2}$ 0.5×10^{-6}.

500nm.

Validity of ray optics :-

1st minima.

$y = \frac{\lambda D}{a}$ (उसी दिशा में)

wave-optics dominate

$y > a$.

$\frac{\lambda z}{a} > a$.

$\lambda z > a^2$

Fresnel distance

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Concept:-

AIIMS 2018 . $\cos 15^\circ = ?$

$\cos(45-30) = \cos 45^\circ + \cos 30^\circ + \sin 45^\circ + \sin 30^\circ$

Trick If exact value asked

$= \frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2} + \frac{1}{\sqrt{2}} + \frac{1}{2}$

$= \frac{1}{2\sqrt{2}} [\sqrt{3}+1]$

Resolving power:- NEET = 2013

Telescope :- $R.P = \frac{d}{1.22\lambda}$ → diameter of aperture of objective lense

$R.P \propto \frac{1}{\lambda}$

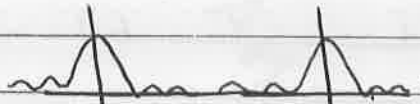
microscope :- $R.P = \frac{2\mu \sin\theta}{1.22\lambda}$

Relay Criteria :-

$R.P \propto \frac{1}{\theta}$

[Just resolved]

[Clearly resolved]



Trick Points are just resolved by an optical system when central max. of diffraction pattern due to 1 falls on the 1st minimum of the diff. pattern of other objective lense :-

NEET=2018 उद्देश्य Telescope की ?

magnifying power ↑ = f_o/f_e f_o ↑ f_e ↓

Resolving power ↑

diameter of aperature of objective lense

$R.Power = \frac{d}{1.22\lambda}$

Ex III Q6 maxima

$a\sin\theta = (2n+1)\lambda/2$

यहाँ maxima ⇒ $n = 1$

$a\sin\theta = \frac{3\lambda}{2}$

Q11

angular width of central maxima = $\frac{2\lambda}{a}$ radian

$\frac{3.14 \times 3}{9.42}$

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$\frac{21}{9} \times \frac{180}{\pi}$ degree

$\frac{2 \times 6000 \times 10^{-10}}{3 \times 10^{-5} \times 10^{-2}} \times \frac{180}{3.14}$ degree

$\frac{360 \times 10^{-7}}{10^{-7} \times 9.42} = 38.2^{\circ}$ ANS