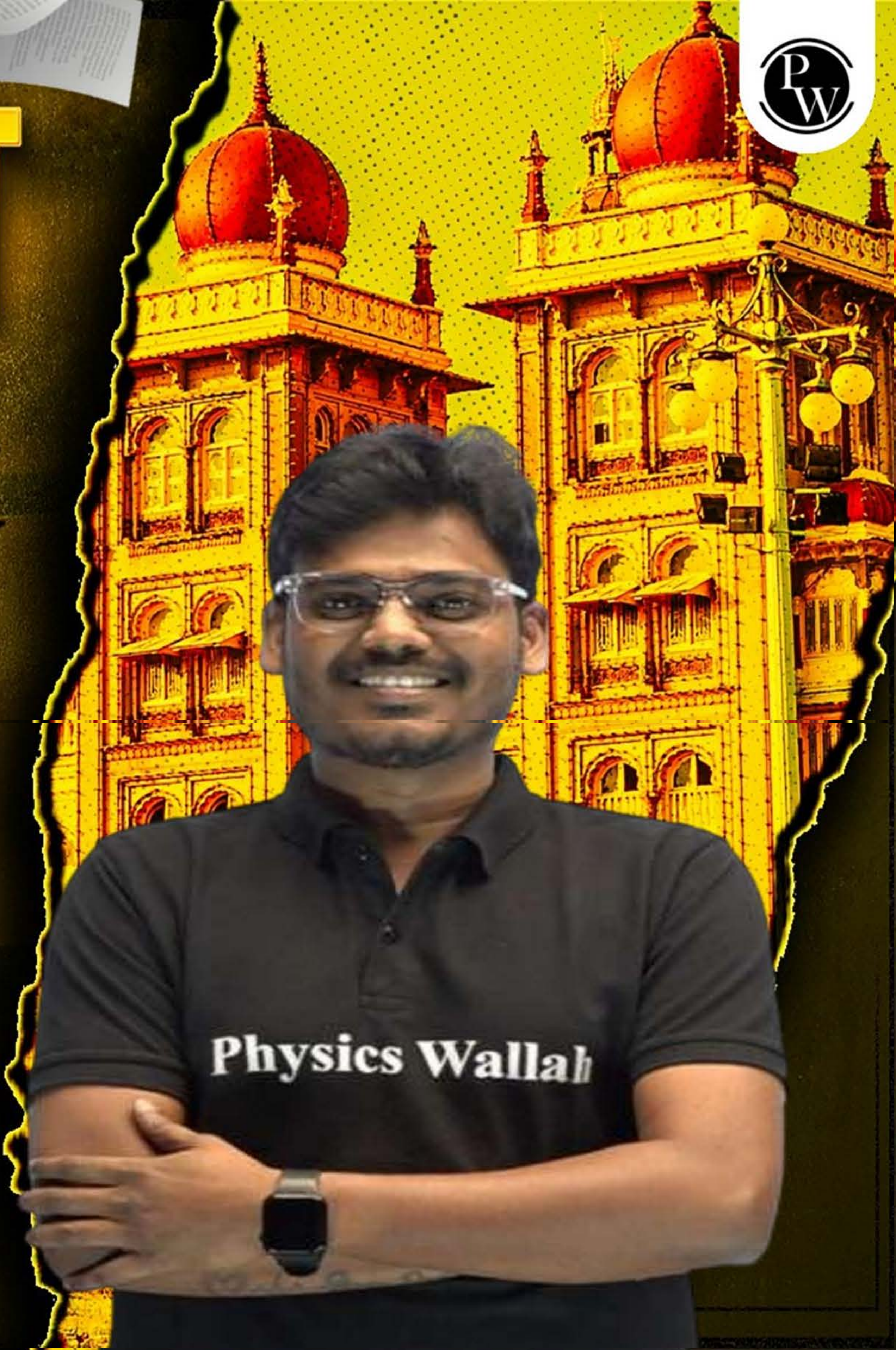
ULTIMATE KCET

CRASH COURSE 2026

PHYSICS | Lecture : 01

WAVE OPTICS

By – AK SIR



Recap *of previous lecture*

1. QUESTIONS ON REFRACTION OF LIGHT
2. REAL AND APPARENT DEPTH (DISTANCE)
3. CRITICAL ANGLE AND TOTAL INTERNAL REFLECTION
4. QUESTIONS

Topics *to be covered*

1. REFRACTION AT CURVED SURFACE AND LENSES
2. REFRACTION BY LENS
3. POWER OF LENS AND COMBINATION OF LENS
4. WAVE OPTICS

Question

Calculate the critical angle for glass-air interface if a ray of light incident on a glass surface is deviated through 15° when angle of incidence is 45°?

Snell's law

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

$$1 \times \sin 45^\circ = \mu \times \sin 30^\circ$$

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

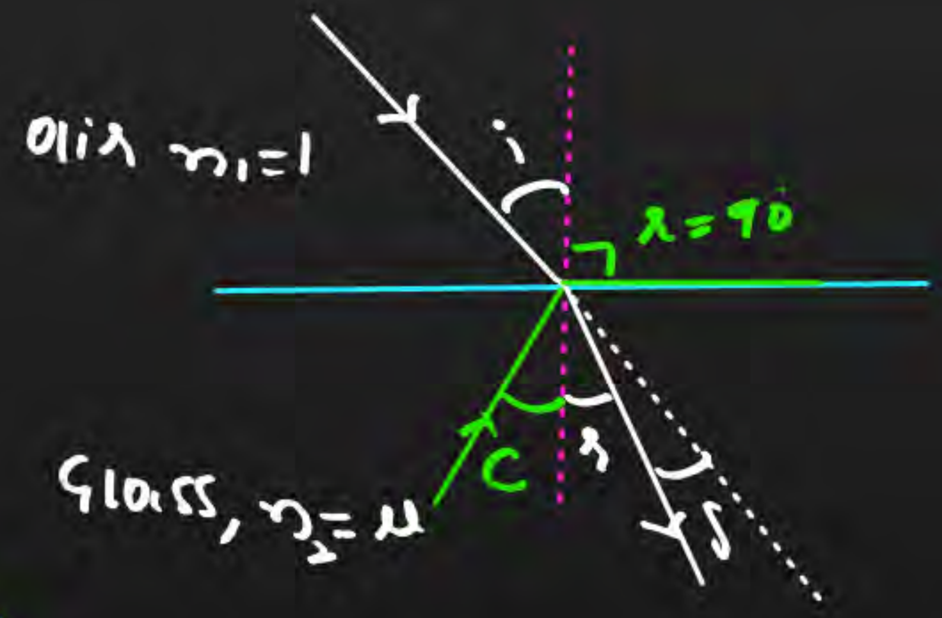
$$\mu = \frac{2}{\sqrt{2}} = \sqrt{\frac{4}{2}} = \sqrt{2}$$

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

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

$$\sin c = \frac{1}{\sqrt{2}}$$

$$\boxed{c = 45^\circ}$$



$$\delta = i - r$$

$$15^\circ = 45^\circ - r$$

$$r = 45^\circ - 15 = 30^\circ$$

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

Question

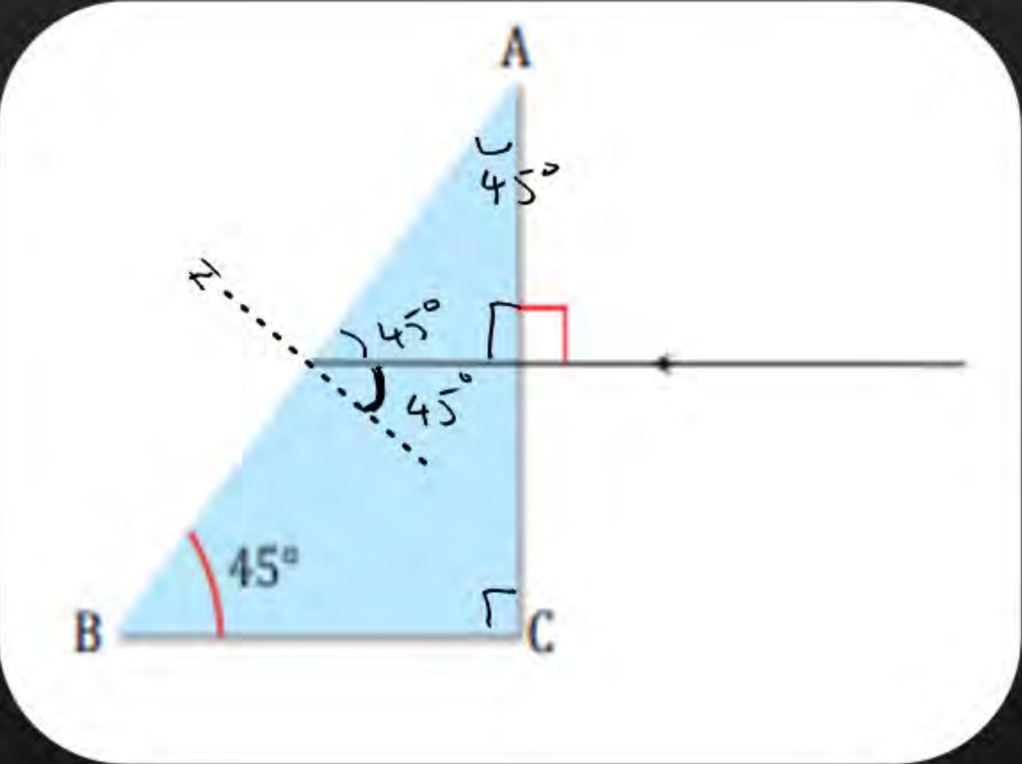
What should be the range of refractive index of prism so that light ray suffers total internal reflection at surface AB?

$i > c$

$\sin 45^\circ > \sin c$

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

* $\boxed{\mu > \sqrt{2}}$ ✓ $\boxed{\mu < \sqrt{2}}$ ✗



Refraction at a spherical surface

Refraction through a single curved surface : The relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$, where the symbols have their usual meaning.

XY – spherical surface

n_1 – refractive index of rarer medium

n_2 – refractive index of denser medium

O – luminous point object placed on the principal axis

I – real image of the object O

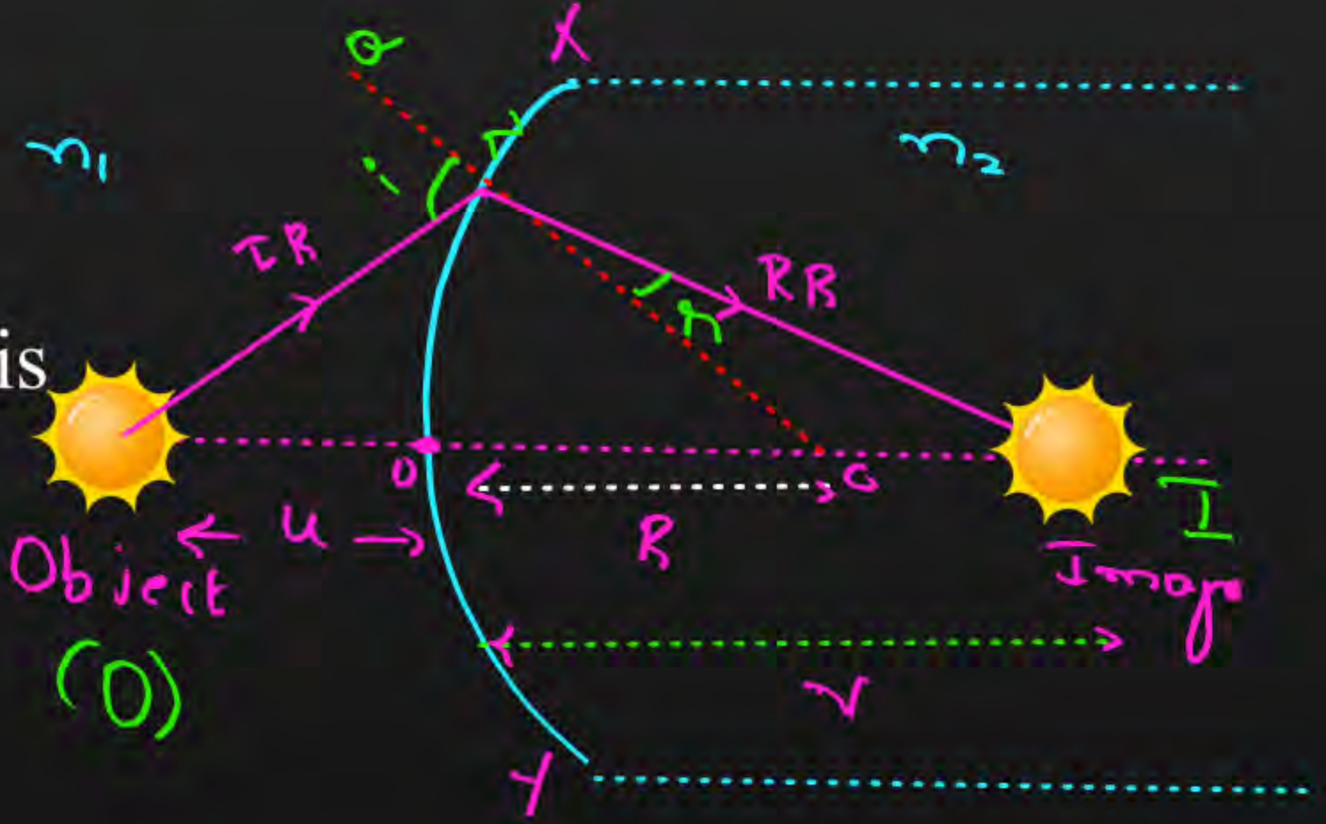
ON – incident ray

CNQ – normal drawn to XY at N

NI – refracted ray

i – angle of incidence

r – angle of refraction



Question

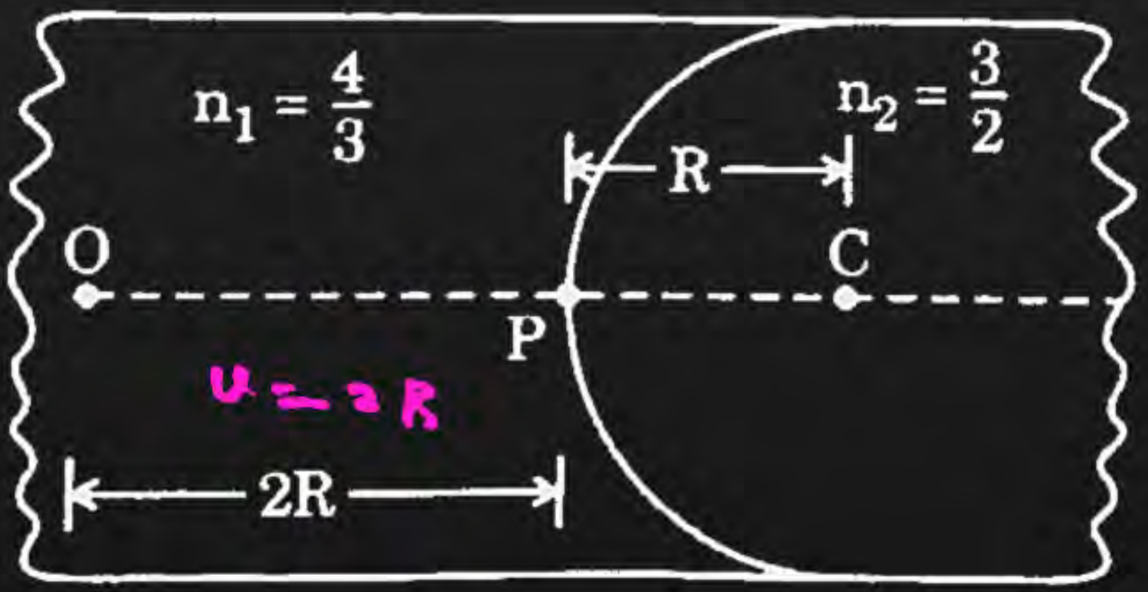
A luminous point object O is placed at a distance 2R from the spherical boundary separating two transparent media of refractive n_1 n_2 as shown, where R is the radius of curvature of the spherical surface. If $n_1 = \frac{4}{3}, n_2 = \frac{3}{2}$ and R = 10 cm, the image is obtained at a distance from P equal to

A. 30 cm in the rarer medium

B. 30 cm in the denser medium

C. 18 cm in the rarer medium

D. 18 cm in the denser medium



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

$$\frac{3}{2v} - \frac{4}{3u} = \frac{\frac{3}{2} - \frac{4}{3}}{R}$$

$$\frac{3}{2v} - \frac{4}{3\times(-2R)} = \frac{\frac{9-8}{6}}{R}$$

$$\frac{3}{2v} + \frac{2}{3R} = \frac{1}{6R}$$

$$\frac{3}{2v} = \frac{1}{6R} - \frac{2}{3R} = \frac{1-4}{6R} = -\frac{3}{6R}$$

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

$v = -3R$

$v = -3\times 10$

$v = -30\,cm$

↳ -ve sign : on the same side of an object.

Question

A point object O is placed in front of a glass rod having spherical end of radius of curvature 30 cm. The image would be formed at

(A) 30 cm left

(B) infinity

(C) 1 cm to the right

(D) 18 cm to the left

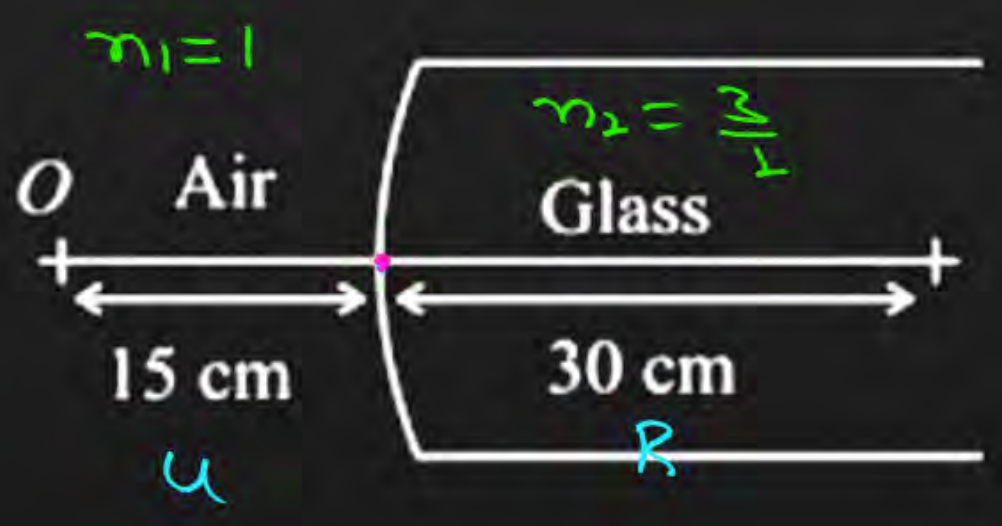
$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

$$\frac{3}{2v} - \frac{1}{-15} = \frac{\frac{3}{2} - 1}{30} = \frac{1}{2 \times 30}$$

$$\frac{3}{2v} + \frac{1}{15} = \frac{1}{60}$$

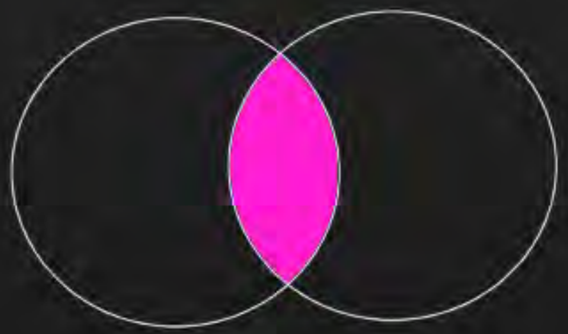
$$\frac{3}{2v} = \frac{1}{60} - \frac{1}{15} = \frac{1-4}{60} = -\frac{3}{60}$$

$$v = -30 \text{ cm}$$

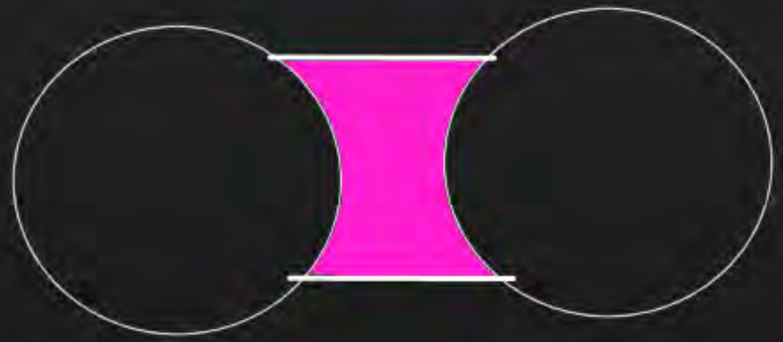


REFRACTION BY SPHERICAL LENSES

Lens : It is a transparent medium which is bounded by at least one curved surface.

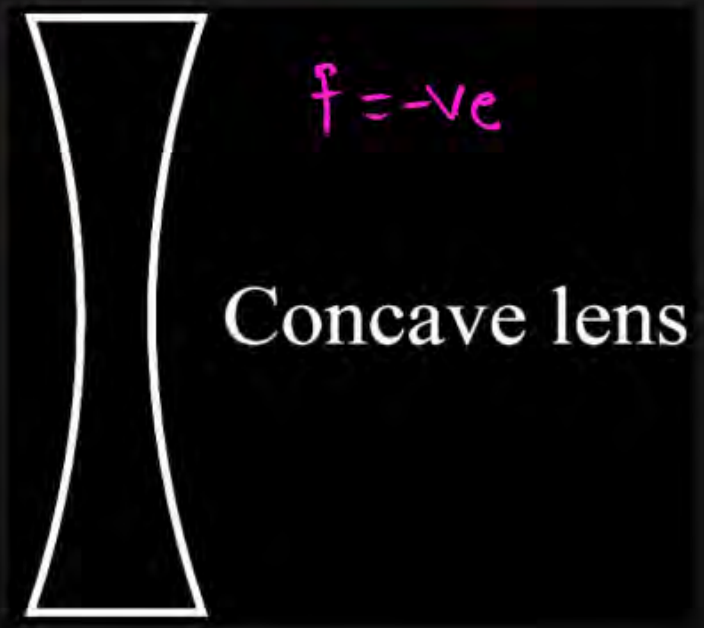


SPHERICAL LENSES



CONVEX LENS

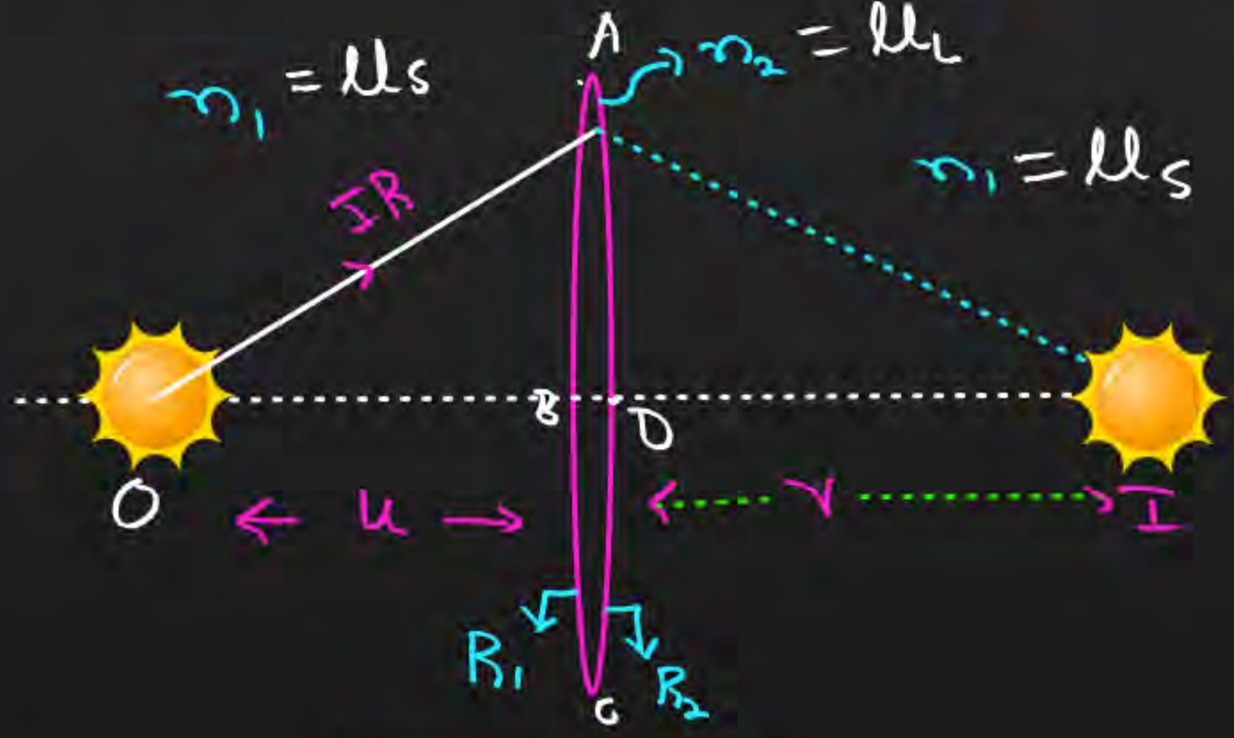
CONCAVE LENS



REFRACTION BY LENS - Derive lens makers formula

Where

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

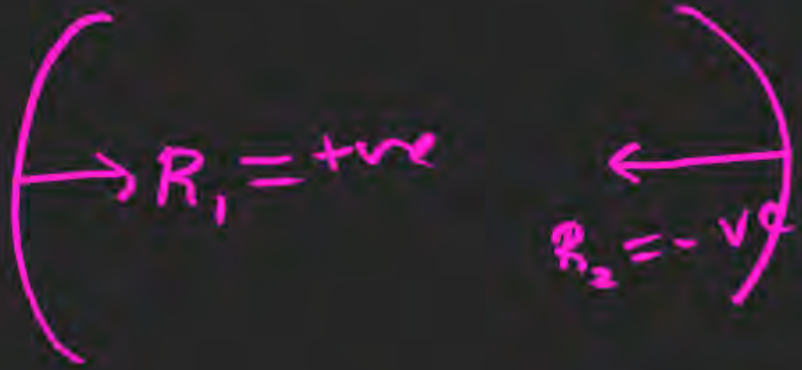


$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

f – focal length of the lens
n_2 – R.I. of the lens
n_1 – R.I. of the surrounding medium
R_1 – radius of curvature of the surface ABC
R_2 – radius of curvature of the surface ADC
O – luminous point object placed on the principal axis
I – real image of the object O
u – object distance
v – image distance

Question

Find out focal length of the following Lens. ($\mu_L = 1.5$)



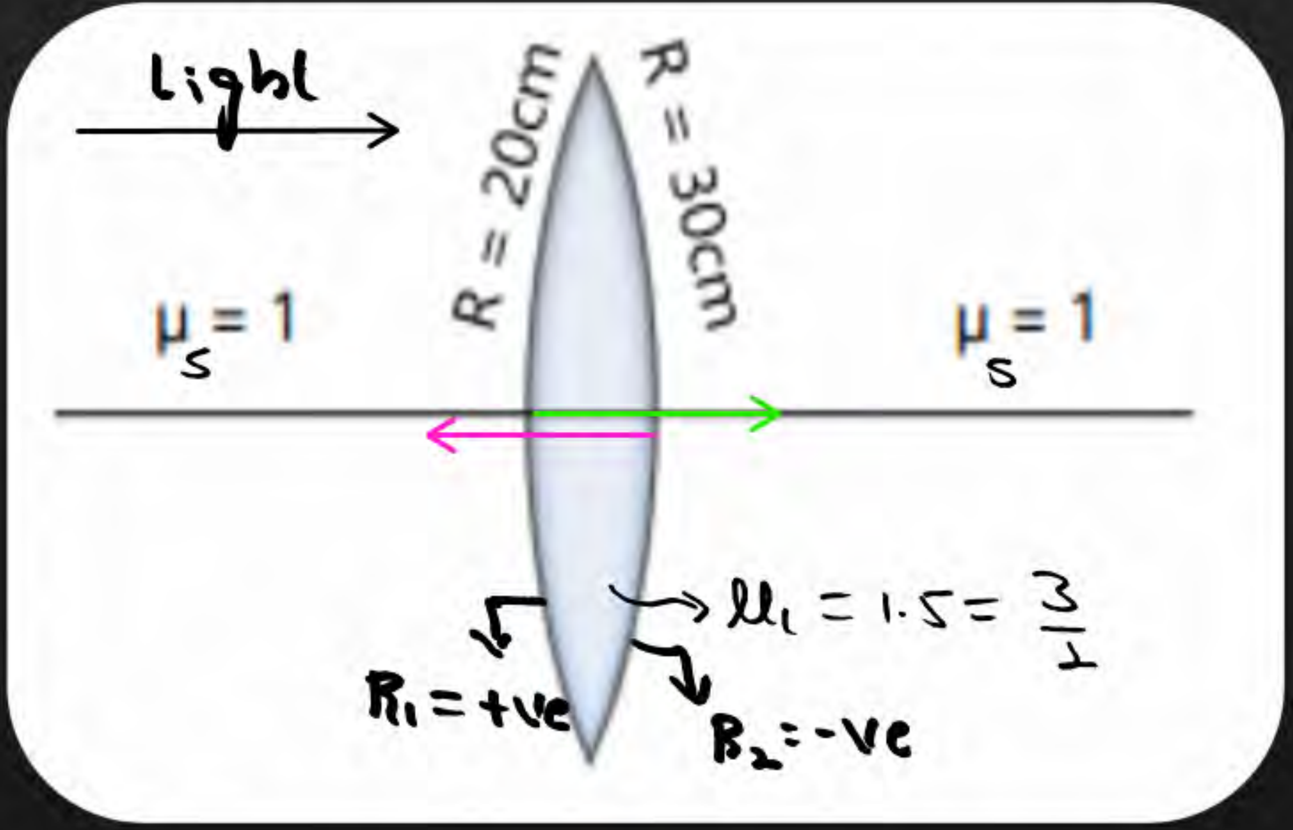
$$\frac{1}{f} = \left(\frac{\mu_L}{\mu_S} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{1.5}{1} - 1\right)\left[\frac{1}{+20} - \frac{1}{-30}\right]$$

$$\frac{1}{f} = (0.5)\left[\frac{1}{20} + \frac{1}{30}\right]$$

$$\frac{1}{f} = \frac{1}{2} \times \left(\frac{3+2}{60}\right) = \frac{1}{2} \times \frac{5}{60} = \frac{1}{2 \times 12}$$

$$\frac{1}{f} = \frac{1}{24} \qquad \boxed{f = 24\,\text{cm}}$$



Question

Find out focal length of the following Lens. ($\mu_L = 1.5$)

$R_1 = -ve$ $\quad$ $R_2 = +ve$

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

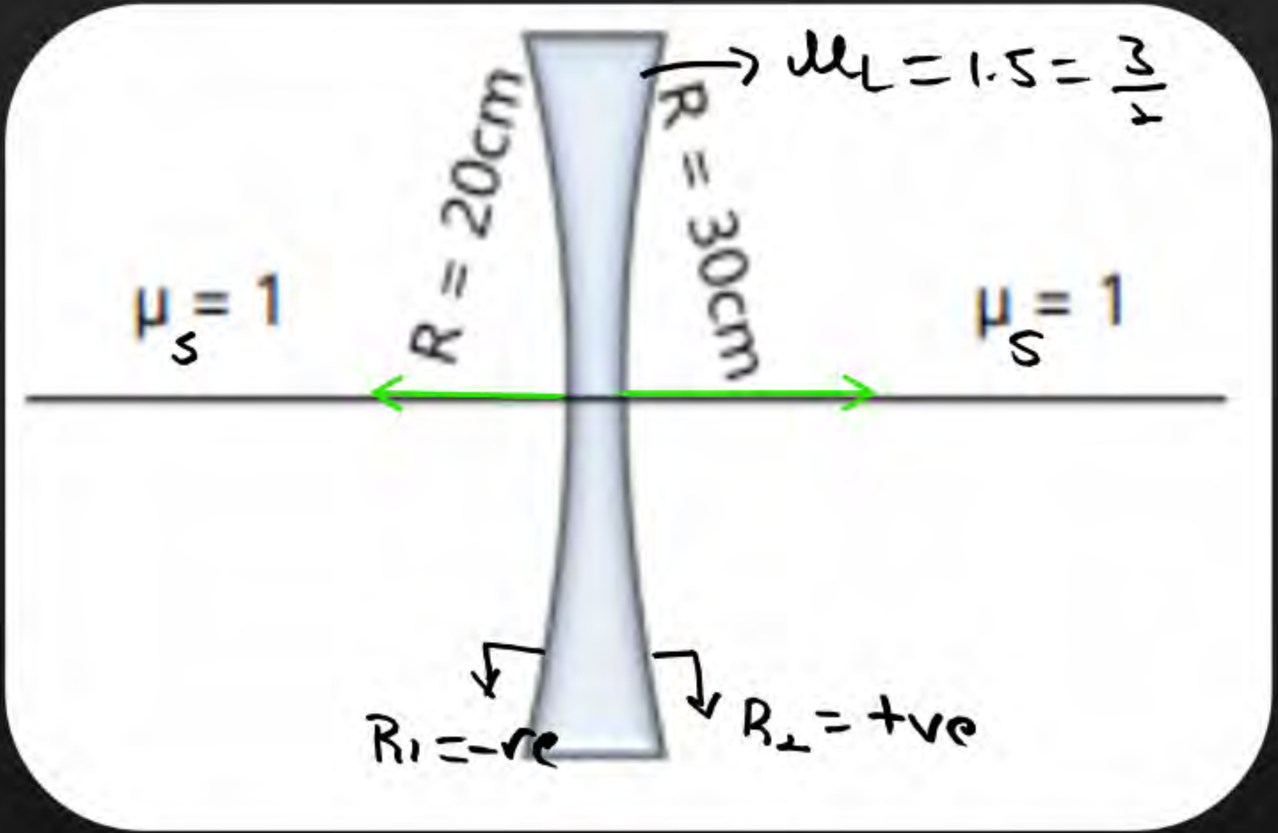
$$\frac{1}{f} = \left(\frac{1.5}{1} - 1\right)\left[\frac{1}{-20} - \frac{1}{+30}\right]$$

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{-20} - \frac{1}{30}\right)$$

$$\frac{1}{f} = -0.5 \times \left(\frac{1}{20} + \frac{1}{30}\right)$$

$$\frac{1}{f} = -0.5 \times \left(\frac{3+2}{60}\right) = -\frac{1}{24}$$

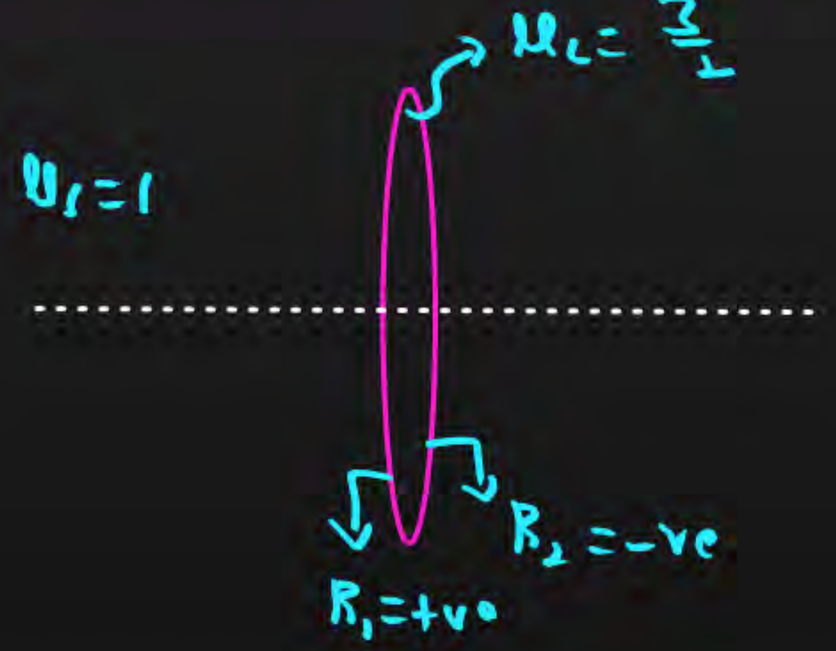
$f = -24\text{ cm}$



Question

If focal length of convex Lens ($\mu_L = \frac{3}{2}$) in air is 20 cm. Find out focal length of same lens in water. ($\mu_W = \frac{4}{3}$)

(i) Lens is in air



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

$$\frac{1}{20} = \left(\frac{3}{2\times 1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

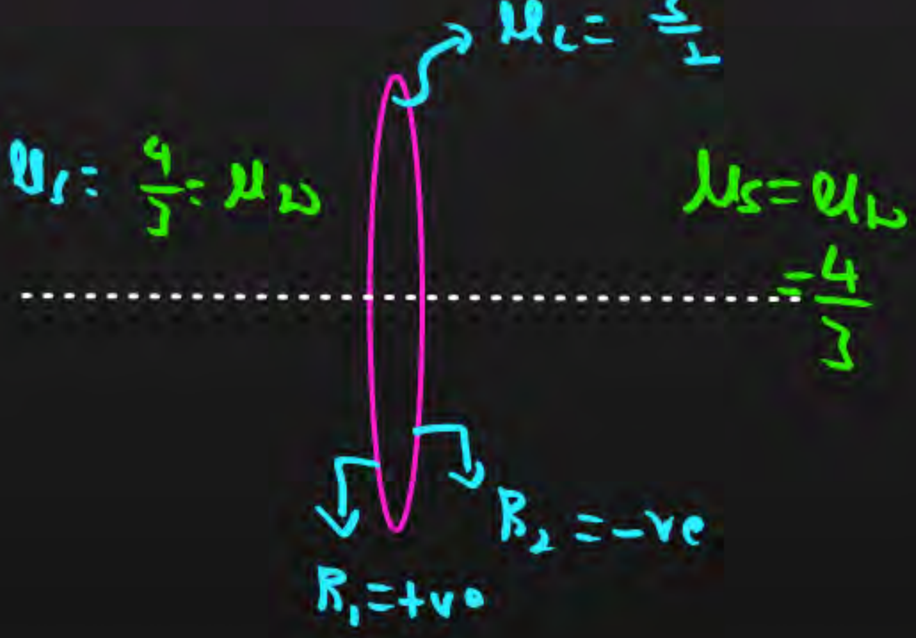
$$\frac{1}{20} = \left(\frac{1}{2}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\boxed{\frac{1}{R_1} - \frac{1}{R_2} = \frac{1}{10}}$$

Question

If focal length of convex Lens ($\mu_L = \frac{3}{2}$) in air is 20 cm. Find out focal length of same lens in water. ($\mu_W = \frac{4}{3}$)

(ii) Lens is in water



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

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

$$\frac{1}{f} = \left(\frac{9}{8} - 1\right) \times \frac{1}{10}$$

$$\frac{1}{f} = \frac{1}{8} \times \frac{1}{10} = \frac{1}{80} \Rightarrow f = 80\,cm$$

Question

$f \propto \mu$

Focal length of a convex lens of refractive index 1.5 is 2 cm (in air). Focal length of lens when immersed in a liquid refractive index of 1.25 will be

(A) 10 cm

(B) 2.5 cm

(C) 5 cm

(D) 7.5 cm

Air

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

$$\frac{1}{2} = \left(\frac{1.5}{1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$\frac{1}{2} = 0.5 \times \left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$\boxed{\frac{1}{R_1} - \frac{1}{R_2} = \frac{1}{1}}$$

Liquid

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

$$\frac{1}{f} = \left(\frac{1.5}{1.25} - 1\right) \times 1 = \frac{1.5 - 1.25}{1.25} = 0.2$$

$$\boxed{f = \frac{1}{0.2} = 5\text{ cm}}$$

Question

$R_1 = R_2 = R$

When a biconvex lens of glass having refractive index 5/4 dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index

(A) Equal to that of glass

(B) Less then one

(C) Greater than that of glass

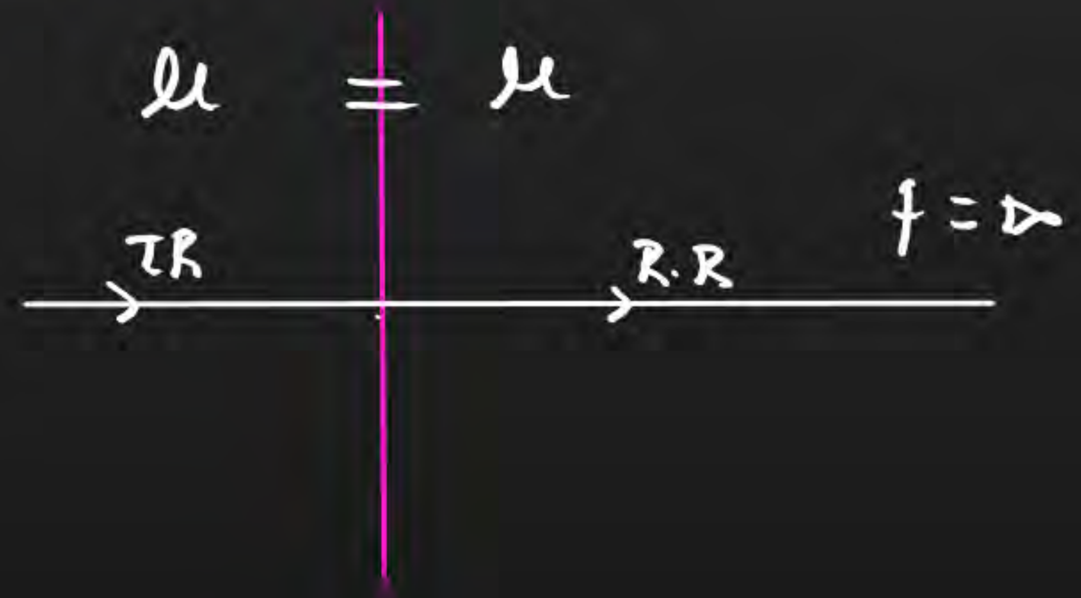
(D) Less then that of glass

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

$$\frac{1}{\infty} = 0 = \left(\frac{\mu_L}{\mu_s} - 1\right)\left[\;''\;\right]$$

$$\frac{\mu_L}{\mu_s} - 1 = 0$$

$$\mu_l = \mu_s$$



Question

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

A convex lens is dipped in a liquid whose refractive is equal to the refractive index of the lens. Then its focal length will:

$P = \frac{1}{f} = 0$

(A) Become zero

(B) Become infinite

(C) Become small, but non-zero

(D) Remain unchanged

Question

(H.W)

The focal length of converging lens is measured for violet green and red colours. It is respectively f_v, f_g, f_r We will be

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

(A) $f_v < f_r$

(B) $f_g > f_r$

(C) $f_v = f_R$

(D) $f_g > f_r$

POWER OF A LENS

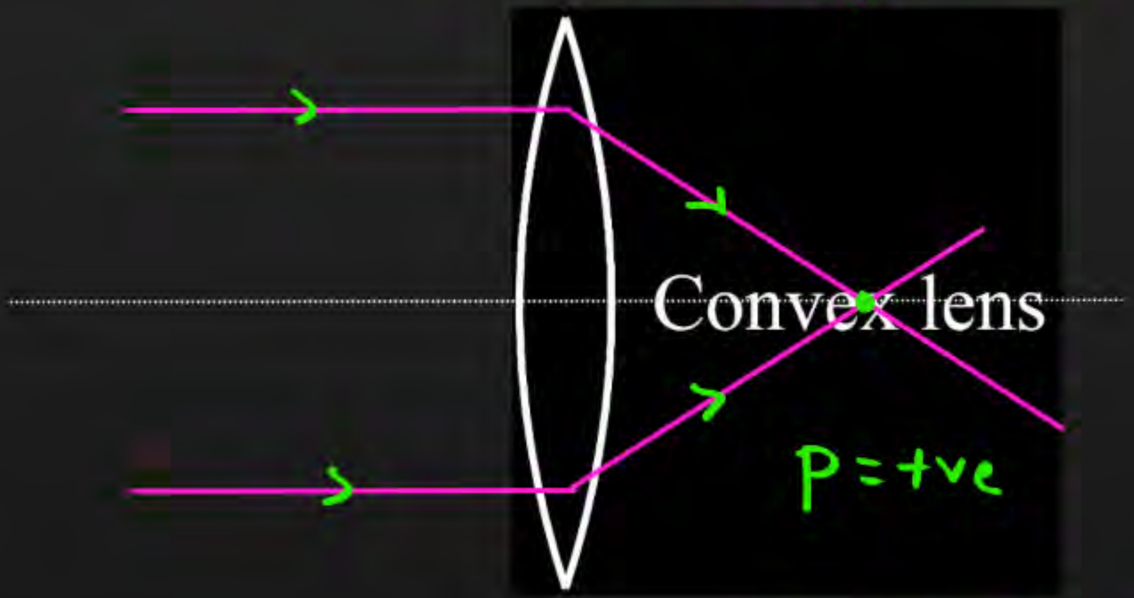
medium (μ), $P = \frac{\mu}{f}$

=> Air

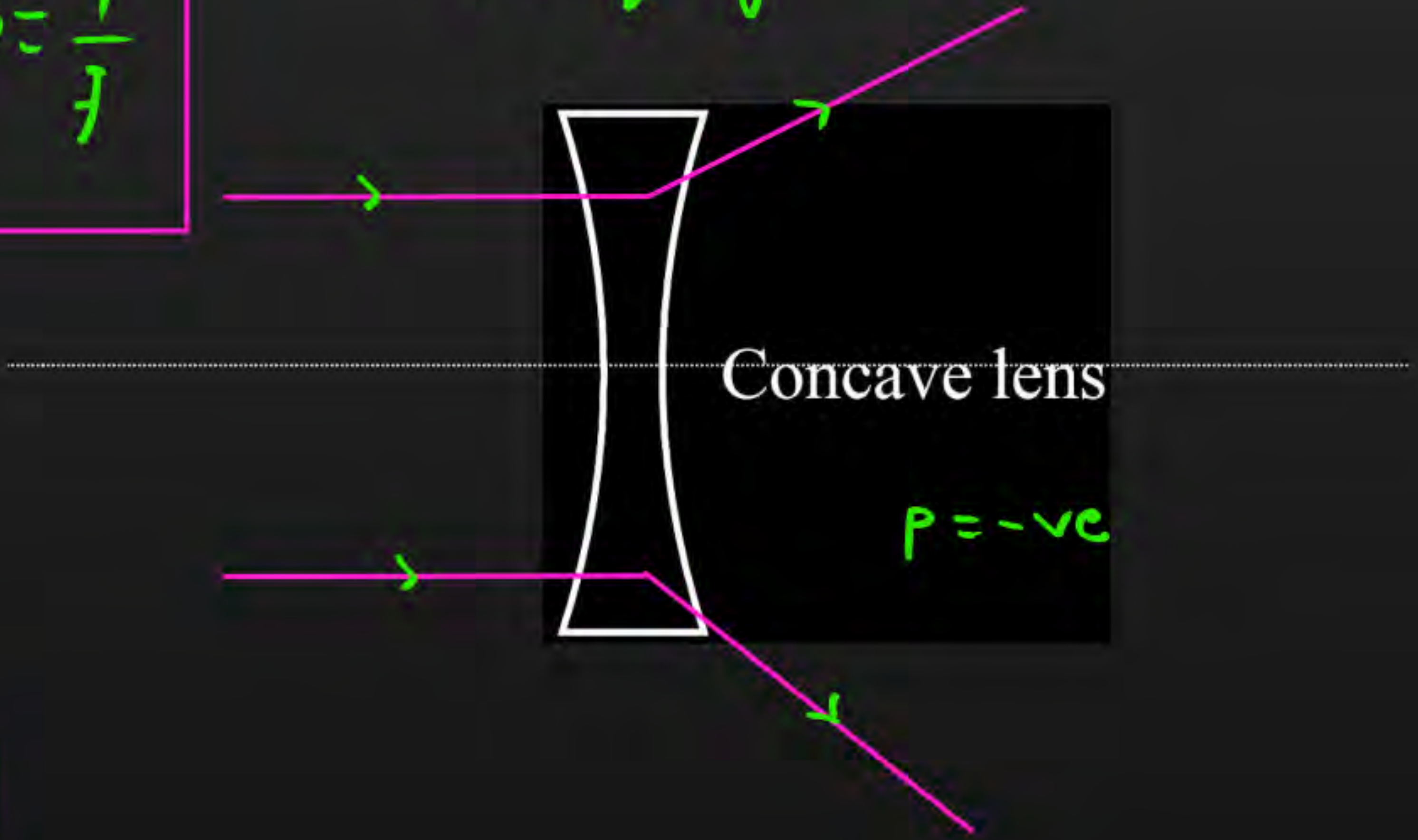
↓

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

Converging lens



Diverging lens



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

POWER OF A LENS

Power of lens : The ability of a lens to converge or diverge light rays depends on its focal length.

Formula :

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

$P = \frac{\mu_s}{f}$

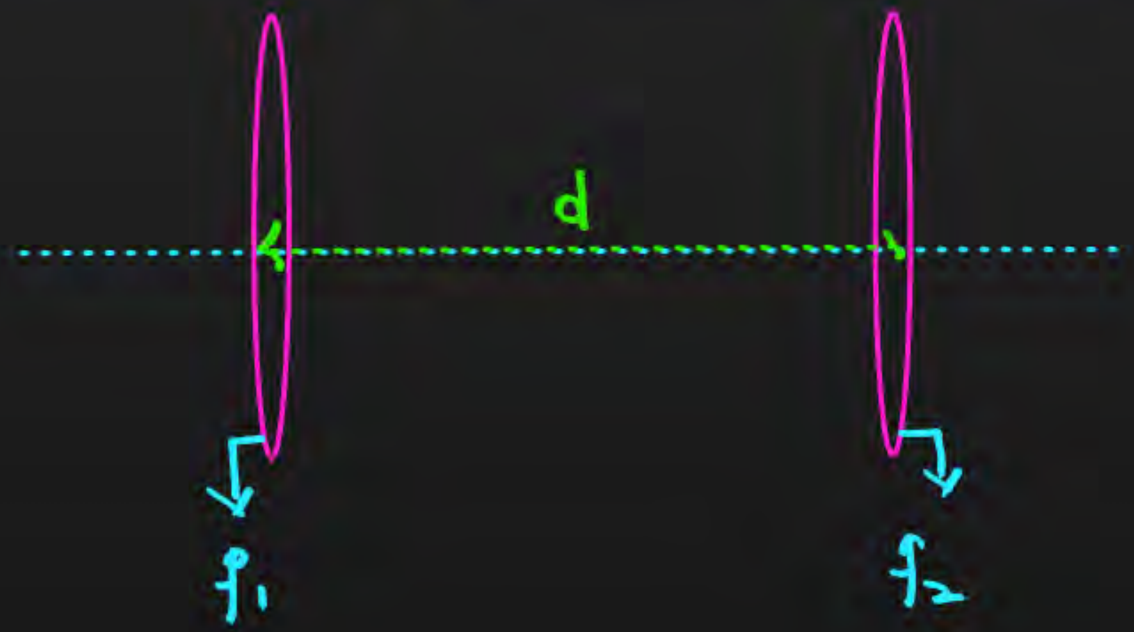
$P = \frac{100}{f(cm)}$

SI Unit :

Dioptre (D)

COMBINATION OF LENSES

Two thin coaxial lenses are placed at a small separation d



$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$$

$$P = \frac{1}{F}$$

Lenses are in contact, d=0

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

$$P = \frac{1}{F}$$

Question

$R_1 = R_2 = R$

A biconvex lens has radii of curvature, 20 cm each. If the refractive index of the material of the lens is 1.5, the power of the lens is:

→ Air

(A) Infinity

(B) +2 D

(C) +20 D

(D) +5 D

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

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

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

$R_1 = +ve$

$R_2 = -ve$

$$P = (1.5 - 1)\left(\frac{1}{R} - \frac{1}{-R}\right)$$

$$P = 0.5\left(\frac{2}{R}\right) = 0.5 \times \frac{2}{20}$$

$$P = \frac{1}{2} \times \frac{2}{20 \times 10^{-2}} = \frac{10^2}{20} = \frac{100}{20}$$

$P = +5D$

Question

A convex lens and a concave lens, each having same focal length of 25 cm , are put in contact to form a combination of lenses. The power in diopters of the combination is

(A) 25

(B) 50

(C) Infinite

(D) Zero

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

$$\frac{1}{F} = \frac{1}{+25} + \frac{1}{-25} = 0$$

$$P = \frac{1}{F} = 0$$

Question

$P = \frac{100}{F}$

If a convex lens of focal length 80 cm and a concave lens of focal length 50 cm are combined together, what will be their resulting power?

A. +7.5 D

B. –0.75 D

C. +6.5 D

D. –6.5 D

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

$\frac{1}{F} = \frac{1}{+80} + \frac{1}{-50} = \frac{1}{80} - \frac{1}{50}$

$\frac{1}{F} = \frac{50-80}{4000} = \frac{-30}{4000} = -\frac{3}{400}$

$P = \frac{1}{F} = -\frac{3 \times 100}{400} = -\frac{3}{4} = -0.75\,D$

Question

The power of a equi-concave lens is –45 D and is made of a material of refractive index 1.6, the radii of curvature of the lens is [H.W]

(A) 36.6 cm

(B) –2.66 cm

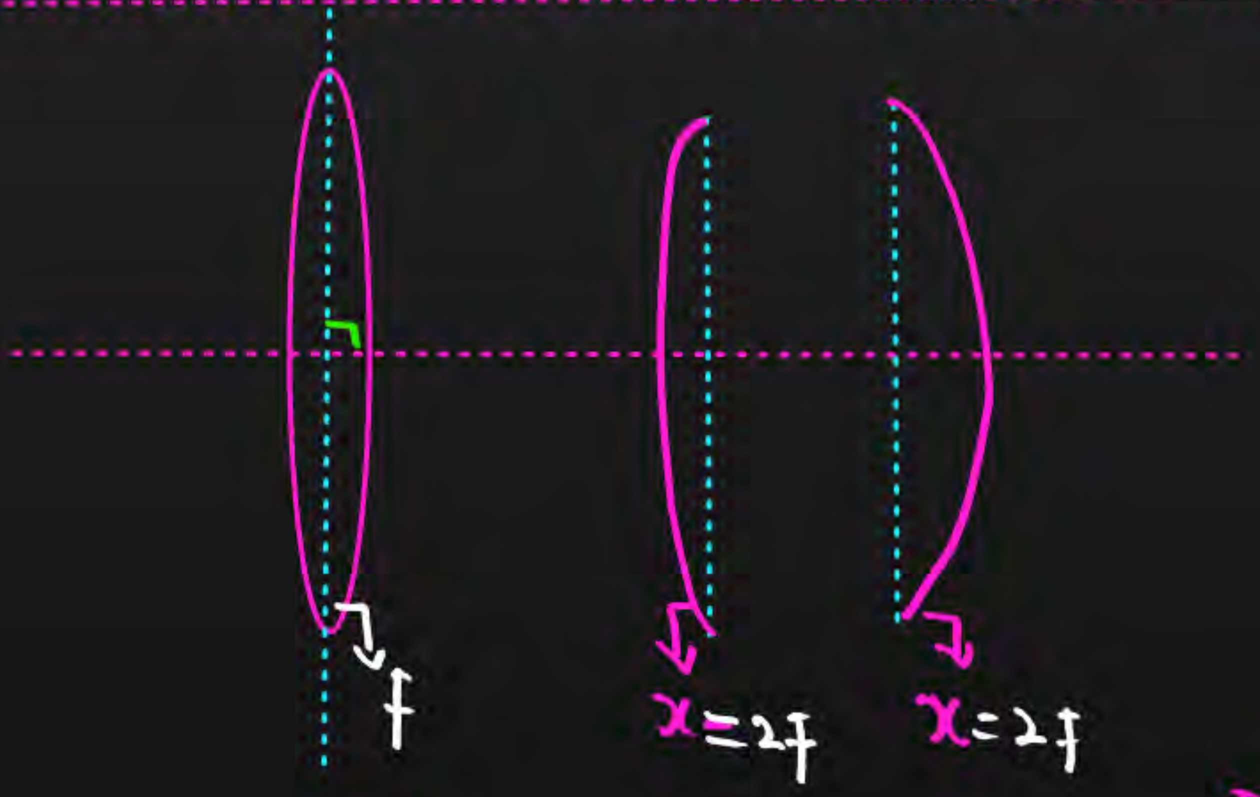
(C) 115.44 cm

(D) –26.6 cm

CUTTING OF LENS

Case (1) : When we cut the lens perpendicular to the principal axis :

If the equiconvex lens is cut into equal parts by a vertical plane, the focal length of each part will be double the initial value but intensity of image will remain unchanged.



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

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

$$x = 2f$$

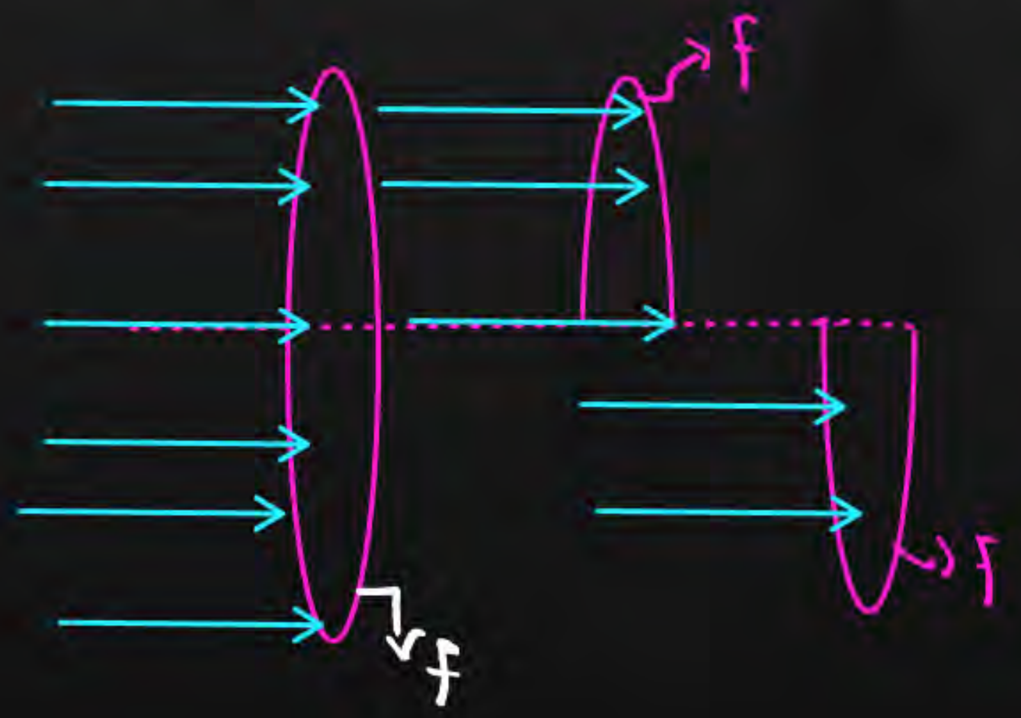
$P = \frac{1}{F}$

$P = \frac{1}{F} = \frac{1}{2f}$

CUTTING OF LENS

Case (2): When we cut the lens parallel to the principal axis:

If an equiconvex lens of focal length f is cut into two identical parts by a horizontal plane AB then the focal length of each part will be equal to that of the initial lens; because μ, R_1 and R_2 will remain unchanged. Only intensity of image will be reduced.



$I \propto$ No. of light rays.

$I \downarrow$

CUTTING OF LENS

Case (3): When we filled the lens with different liquids having different refractive index:

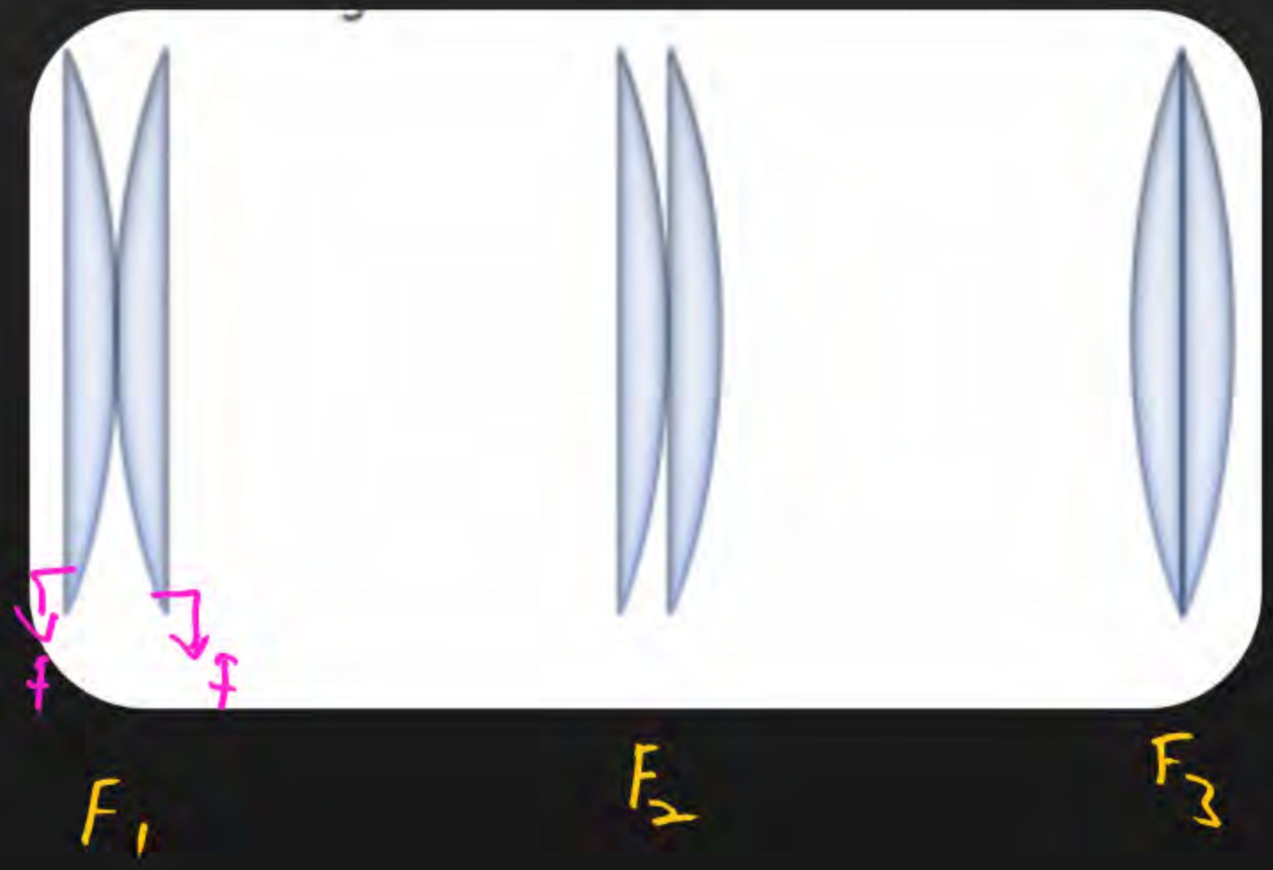
R.I $\propto$ No. of Images

Question

Two similar planoconvex lenses are combined together in three different ways as shown in the figure. The ratio of the focal length in three cases will be.

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

$$F_1 : F_2 : F_3 = 1 : 1 : 1$$



Question

A convex Lens is made up of three different materials as shown in the figure. For a point object placed on its axis, the number of images formed are:

No. of Images = 3

Question

Two thin lenses are of same focal lengths (f), but one is convex and the other one is concave. When they are placed in contact with each other, the equivalent focal length of the combination will be:

(A) Infinite

(B) Zero

(C) $\frac{f}{4}$

(D) $\frac{f}{2}$

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

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

$$\frac{1}{F} = 0 \rightarrow F = \frac{1}{0} = \infty$$

$$F = \infty$$

$$P = \frac{1}{F} = 0$$

$$F = \infty$$

Question

Two thin lenses of focal lengths f_1 and f_2 are in contact and coaxial. The power of the combinations is:

A $\frac{f_1+f_2}{f_1 f_2}$

B $\sqrt{\frac{f_1}{f_2}}$

C

D $\sqrt{\frac{f_2}{f_1}}$

$\frac{f_1+f_2}{2}$

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

$$P = \frac{1}{F} = \frac{f_1+f_2}{f_1 f_2}$$

Simple Microscope

(1) A single converging lens (convex lens) of small focal length.

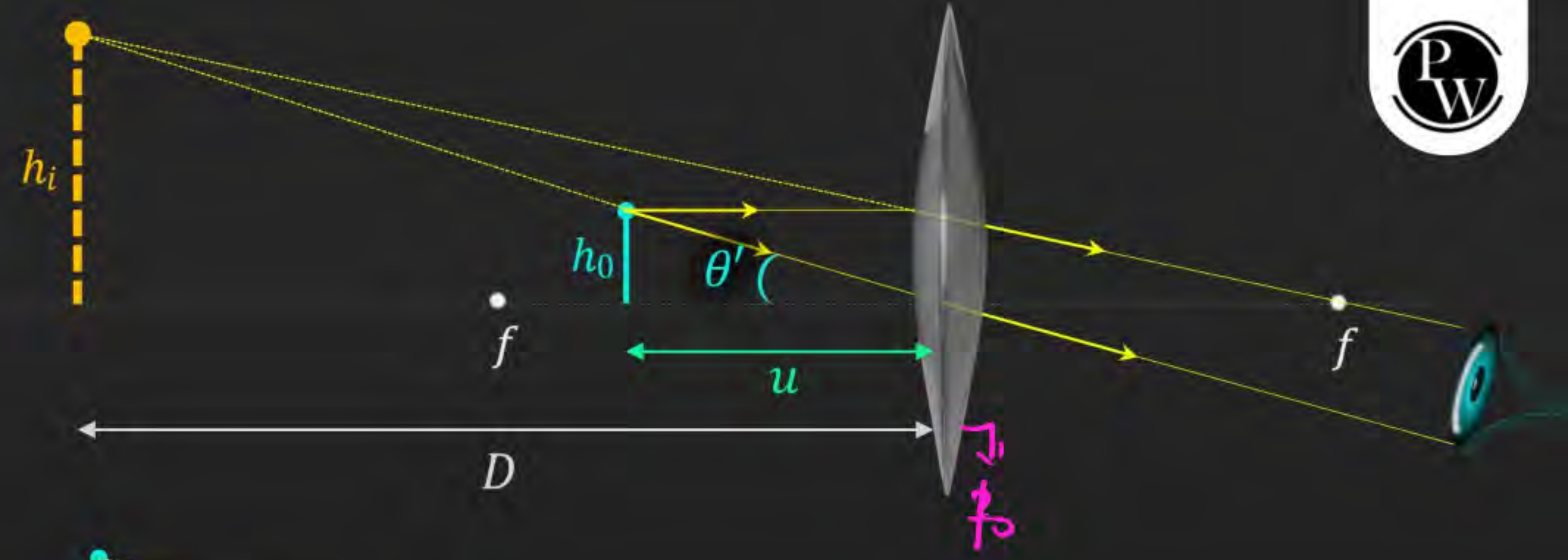
(2) When the object is placed between the focus and the optical centre a virtual, magnified and erect image is formed.

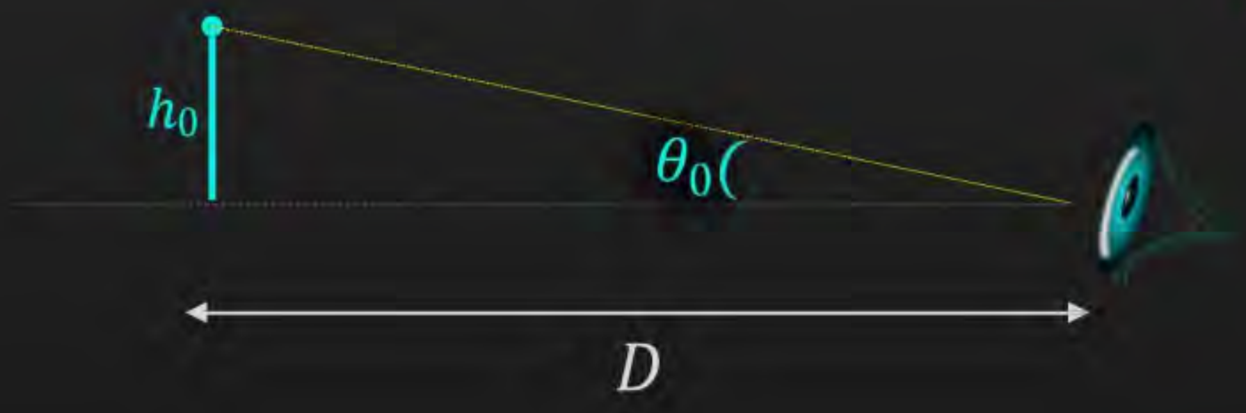
(3) Also known as magnifying glass.

Simple Microscope

Magnification of Simple Microscope (m)

$$m = \frac{\theta_{with\ lens}}{\theta_{without\ lens}} = \frac{\theta'}{\theta_0}$$





Case 1 : When image is formed at Near point

$$m = \frac{h_i}{h_0} = \frac{\theta' \times D}{\theta_0 \times D} = \frac{\theta'}{\theta_0}$$

$$m = \frac{h_0/u}{h_0/D} = \frac{D}{u}$$

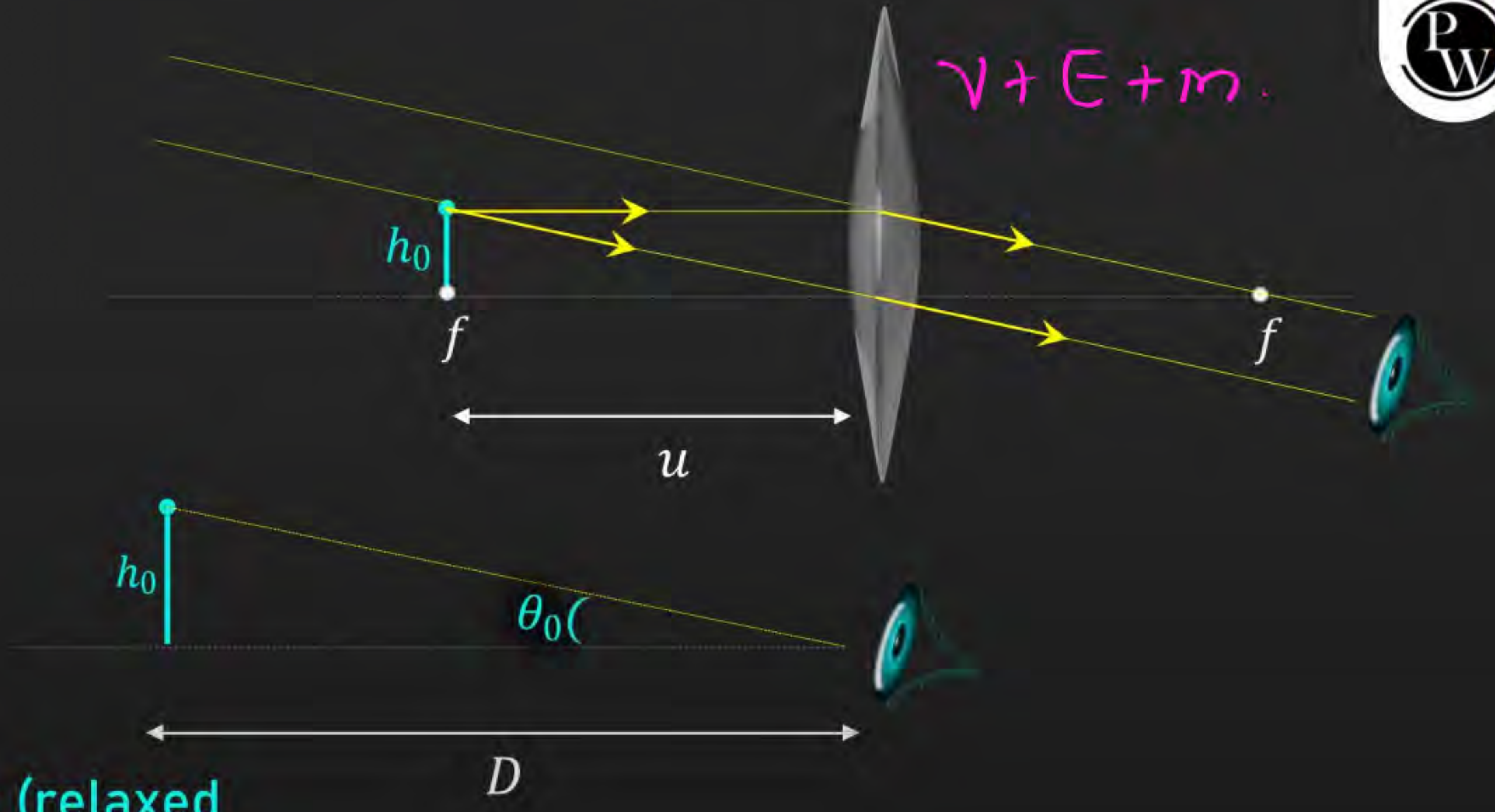
$D = 25\,cm$

$$m = 1 + \frac{D}{f_0} \Rightarrow N.P$$

Simple Microscope

Magnification of Simple Microscope (m)

$$m = \frac{\theta_{with\ lens}}{\theta_{without\ lens}} = \frac{\theta'}{\theta_0}$$



Case 2 : When image is formed at infinity (relaxed eye)

$$m = \frac{D}{f}$$

Question

Focal length of a convex lens is 2.5 cm. Find its maximum and minimum magnifying power when used as a simple microscope

$$m_{max} = 1 + \frac{D}{f_o}$$

$$= 1 + \frac{25}{2.5}$$

$$= 1 + 10$$

$$m_{max} = 11$$

$$M_{min} = \frac{D}{f_o}$$

$$= \frac{25}{2.5}$$

$$m_{min} = 10$$

Question

An object is seen through a simple microscope of focal length 12 *cm*. Find the angular magnification produced if the image is formed at the near point of the eye which is 25 *cm* away from it.

(A) 1.48

(B) 2.0

(C) 3.08

(D) 1.0

$m = 1 + \frac{D}{f_0}$

$m = 1 + \frac{25}{12}$

$m = 3.08$

$m \simeq 3$

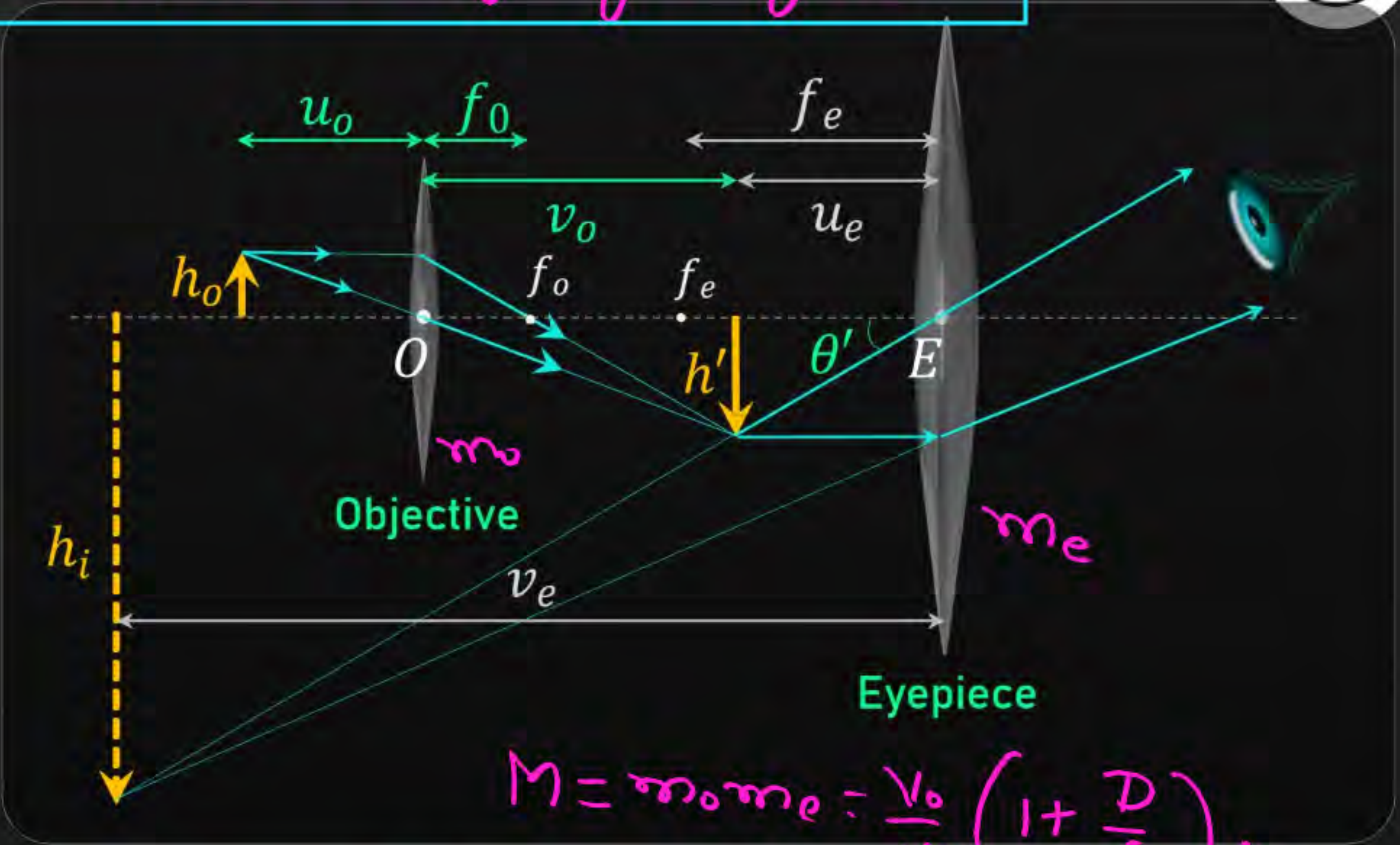
Virtual + Inverted + Highly magnified

Compound Microscope

Magnification of Compound Microscope (m)

$$m = \frac{\theta_{with\ lens}}{\theta_{without\ lens}} = \frac{\theta'}{\theta_0}$$

$f_o < f_e$



$$m = \frac{v_o D}{u_o u_e}$$

$M = m_o m_e = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right)$

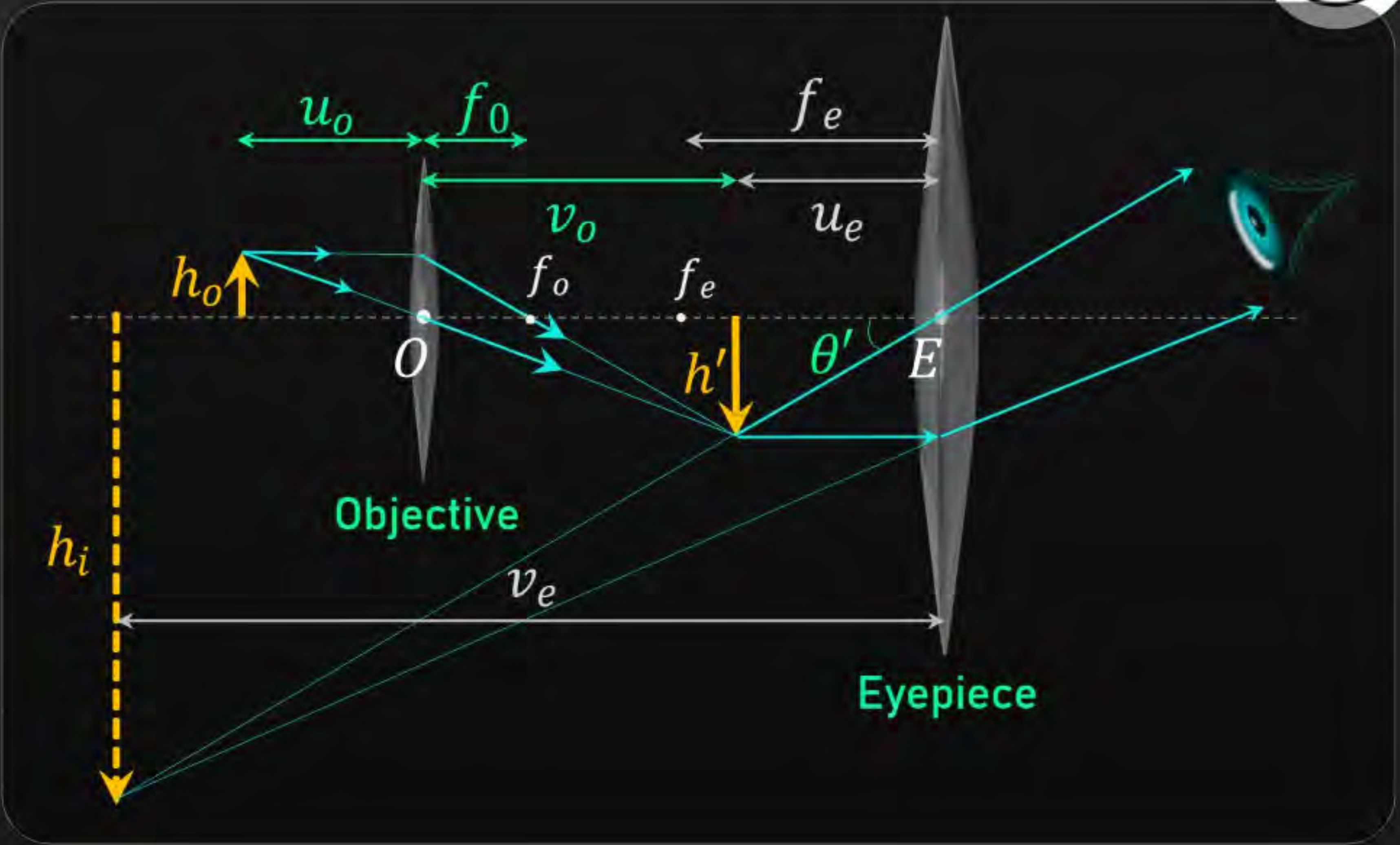
The objective forms a real image of the object beyond the focal length of the eyepiece and the eyepiece acts as simple microscope so that we can get a magnified final image, as shown in the figure.

$$\therefore m_e = \frac{D}{u_e}$$

$$m = m_o \times m_e$$

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

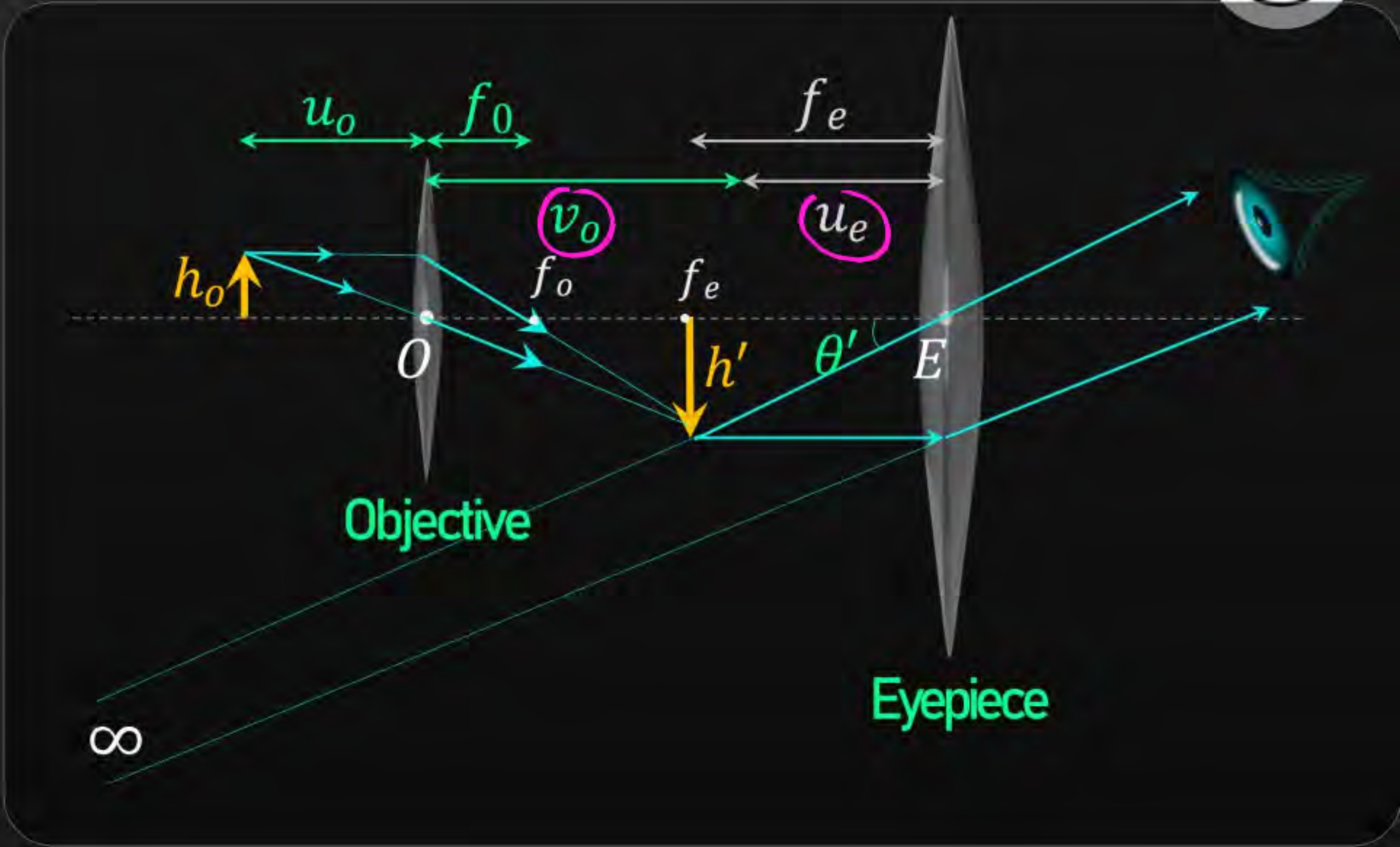
Compound Microscope



Case 1 : When image is formed at Near point

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

Compound Microscope



Case 2 : When image is formed at infinity

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

▶ The length of the microscope tube $|v_o| + |u_e|$

Question

$M = 30$

A compound microscope has a magnifying power 30X. The focal length of its eye-piece is 5 cm. Assuming the final image formed at the least distance of distinct vision (25cm). Calculate the magnification produced by objective.

$$M = m_0 m_e$$

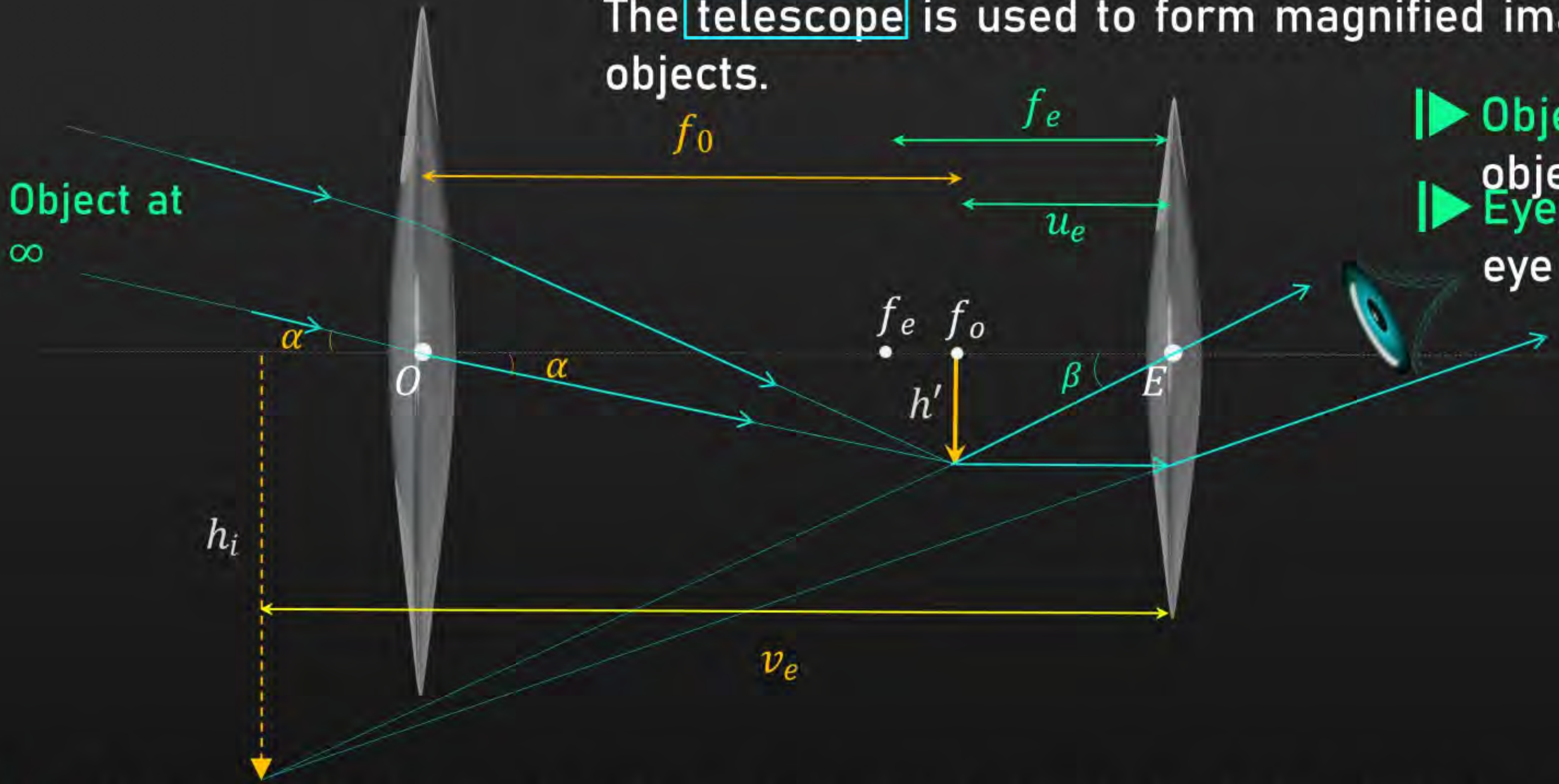
$$30 = m_0\left(1 + \frac{D}{f_e}\right)$$

$$30 = m_0\left[1 + \frac{25}{5}\right]$$

$$\frac{30}{5} = m_0\left[\frac{30}{5}\right] = m_0 \times 6$$

$$m_0 = 5$$

The telescope is used to form magnified images of distant objects.



- **Objective** : Close to object
- **Eyepiece** : Close to eye

- Opposite to the microscope, objective has large aperture than that of the eyepiece in case of telescope so that sufficient light is incident on the telescope from distant object and clear image is formed.

$$MP = \frac{f_0}{u_e}$$

Maximum magnification

Strained eye

When the final image is formed at near point

$$\frac{1}{u_e} = \frac{1}{f_e} + \frac{1}{D}$$

$$MP = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$$

Minimum magnification

Relaxed eye

When the final image is formed at infinity

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

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

Question

f_o

A small telescope has an objective of focal length 140 cm and an eye piece of focal length 5.0 cm . The magnifying power of telescope for viewing a distant object is:

f_e

(A) 17

(B) 32

(C) 34

(D) 28

$$m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$$

$$m = \frac{140}{5}\left(1 + \frac{5}{25}\right)$$

$$m = 28 \times \frac{30}{25}$$

$$m = 33.6$$

$$m \simeq 34$$

Question

A lens of large focal length and large aperture is best suited as an objective of an astronomical telescope since:

(A) A large aperture contributes to the quality and visibility of the images. ✓

(B) A large area of the objective ensures better light gathering power. ✓

(C) A large aperture provides a better resolution. ✓

(D) All of the above.

Question

A refracting telescope is under normal adjustment and magnifying power is 5. If the length of telescope under this condition (when final image is at ∞) is 150 cm, find f_e and f_o.

(A) $f_e = 25\, cm, f_o = 125\, cm$

(B) $f_o = 25\, cm, f_e = 125\, cm$

(C) $f_e = 50\, cm, f_o = 100\, cm$

(D) $f_e = 100\, cm, f_o = 50\, cm$

$L = f_o + f_e$

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

$5 = \frac{f_o}{f_e}$

$f_o = 5f_e$

$L = 5f_e + f_e = 6f_e$

$f_e = \frac{L}{6} = \frac{150}{6} = 25\,cm$

$f_e = 25\,cm$

$f_o = 5f_e = 5 \times 25$

$f_o = 125\,cm$

Question

The focal length of objective lens of refracting telescope is 100 cm and that of eyepiece is 5 cm. If the final image is formed at least distance of distant vision ($D = 25$ cm). Find magnifying power.

(A) 20

(B) 15

(C) 24

(D) 24

Question

If the focal length of objective lens is increased.

(A) Microscope will increase but that of telescope decrease

(B) Microscope and telescope both will decrease

(C) Microscope and will decrease but that of telescope increase

(D) Microscope will decrease but that of telescope will increase

Microscope: $m = \frac{D}{f_0}$, $f_0 \uparrow \; m \downarrow$

Telescope: $m = \frac{f_0}{e}$, $f_0 \uparrow \; m \uparrow$

WAVE OPTICS

KCET analysis of chapter - Marks weightage

Year	Topic
2025 (2Q)	Shape of wavefront and Refraction of plane wave
2024(2Q)	Polarisation and Young's double slit experiment
2023(3Q)	Speed of wavefronts and wavelets, Polarisation and Young's double slit experiment
2022(4Q)	Shape of wave fronts, Fringe width, Fraunhoffer diffraction and Diffraction
2021(3Q)	Single slit experiment(2) and Young's slit experiment

KCET analysis of chapter - Marks weightage

Year	Topic
2020(3Q)	Polarisation, Resolving power and Young's double slit experiment
2019(3Q)	Brewsters angle, Young's double slit experiment and Doppler effect
2018 (4Q)	Angular width, Fraunhofer diffraction, Young's double slit experiment (2)
2017(3Q)	Polarisation, Young's slit experiment and Huygen's principle
2016(3Q)	Young's double slit experiment, Angular width and Aparture
2015 (2Q)	Young's double slit experiment and Diffraction

Huygen's Wave Theory

Huygens' Wave Theory

In 1678, one of Newton's contemporaries, the Dutch scientist Christian Huygens, was able to explain many other properties of light by proposing that light is a wave.

Huygens showed that a wave theory of light could also explain reflection and refraction.

Huygens' Wave theory of light

- The locus of all particles vibrating in same phase is known as wavefront.
- Light travels in a medium in the form of wavefront.
- When light travels in a medium then the particles of medium start vibrating and consequently a disturbance is created in the medium.
- Every point on the wavefront becomes the source of secondary wavelets. It emits secondary wavelets in all directions which travel with the speed of light.
- The tangent plane to these secondary wavelets represents the new position of wavefront

Huygen's Wave Theory

The phenomena explained by this theory

- Reflection, Refraction, interference and diffraction
- Rectilinear propagation of light.
- Velocity of light in rarer medium being greater than that in denser medium.

$V_R > V_D$

The phenomena not explained by this theory

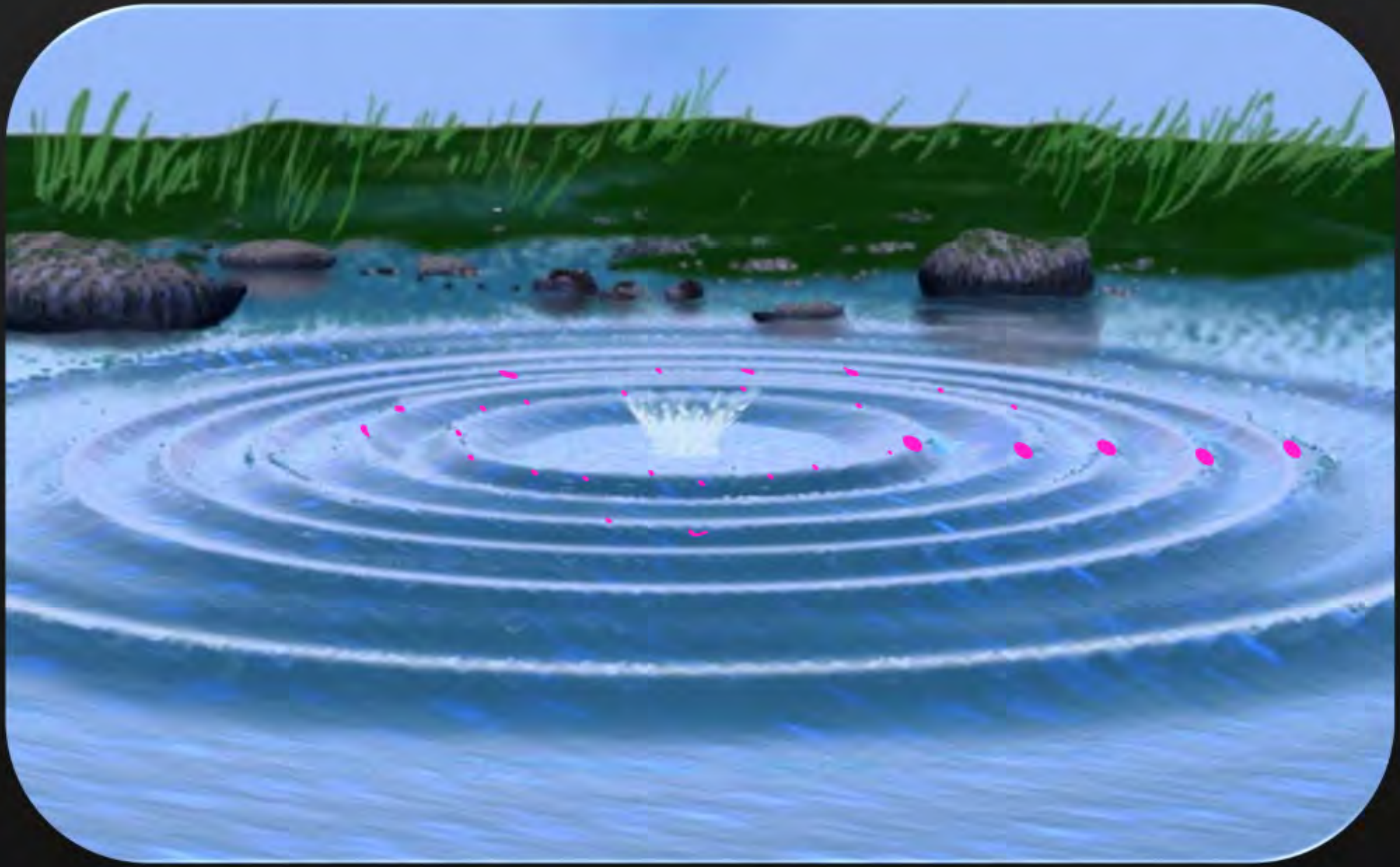
- → Photoelectric effect
- → Polarisation

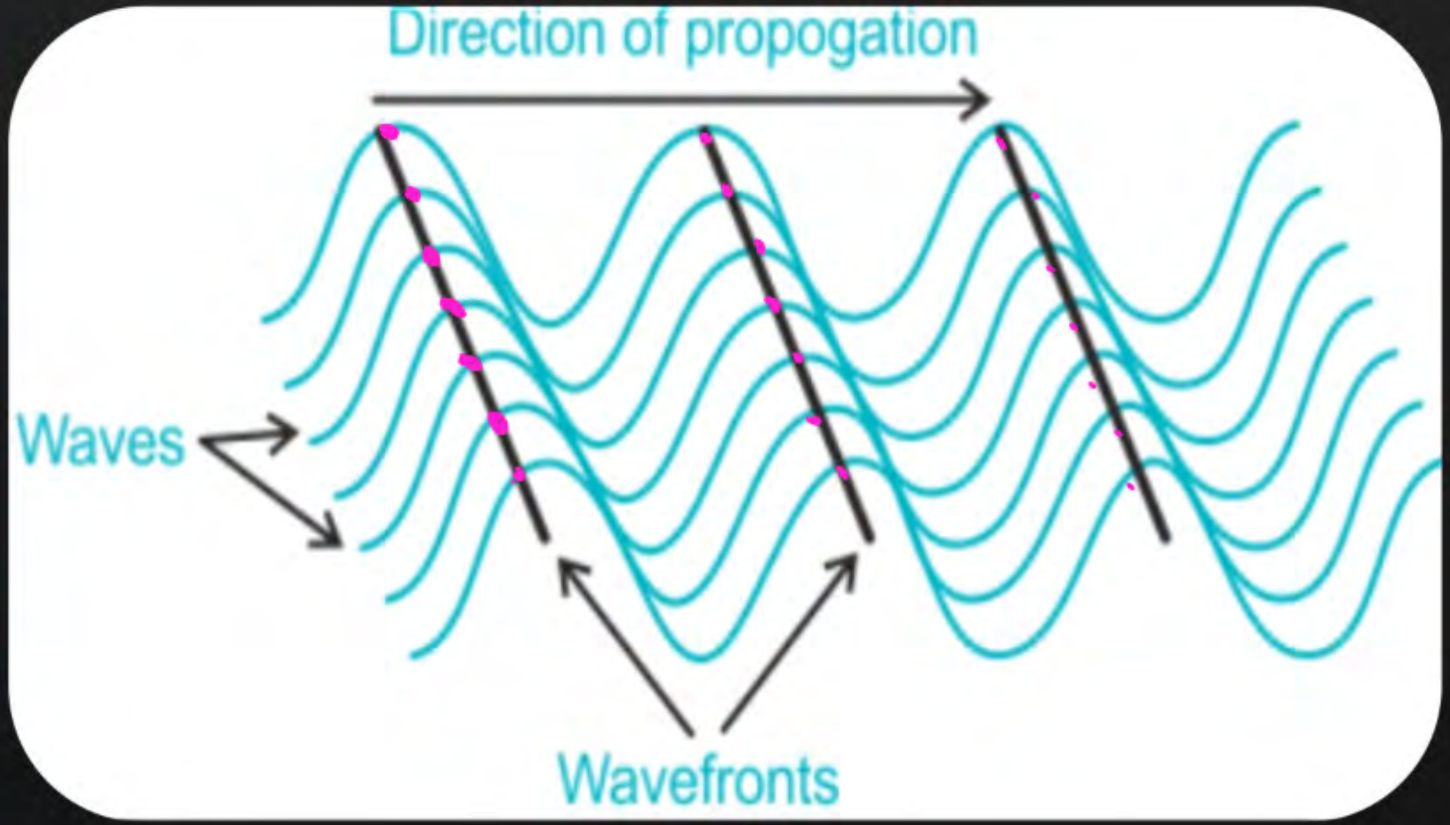
Note:

- Huygens considered that the environment is filled with anisotropic luminiferous ether but later he was proved wrong, later.

Wave front and types

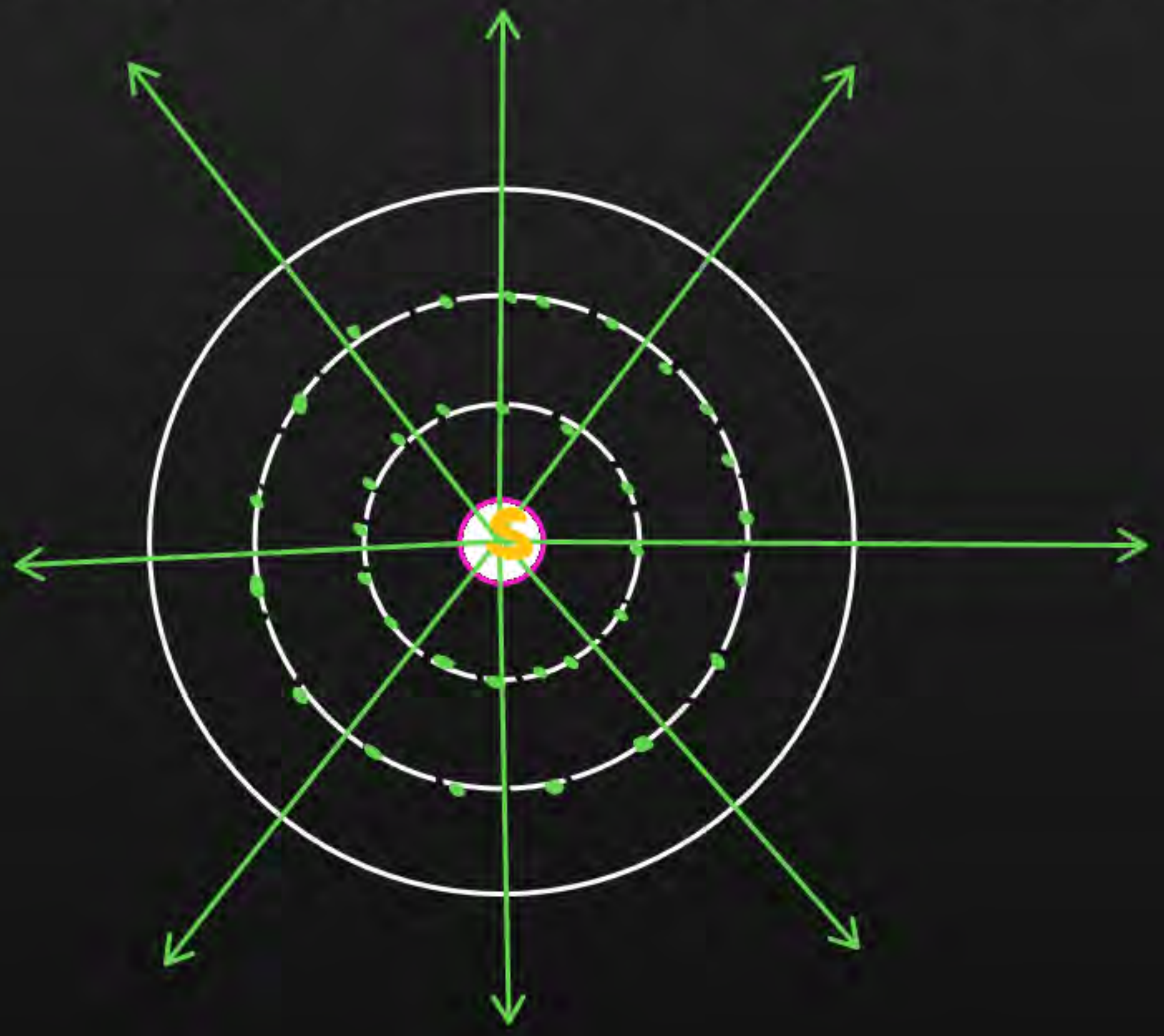
The locus of all particles vibrating in same phase is known as wavefront.

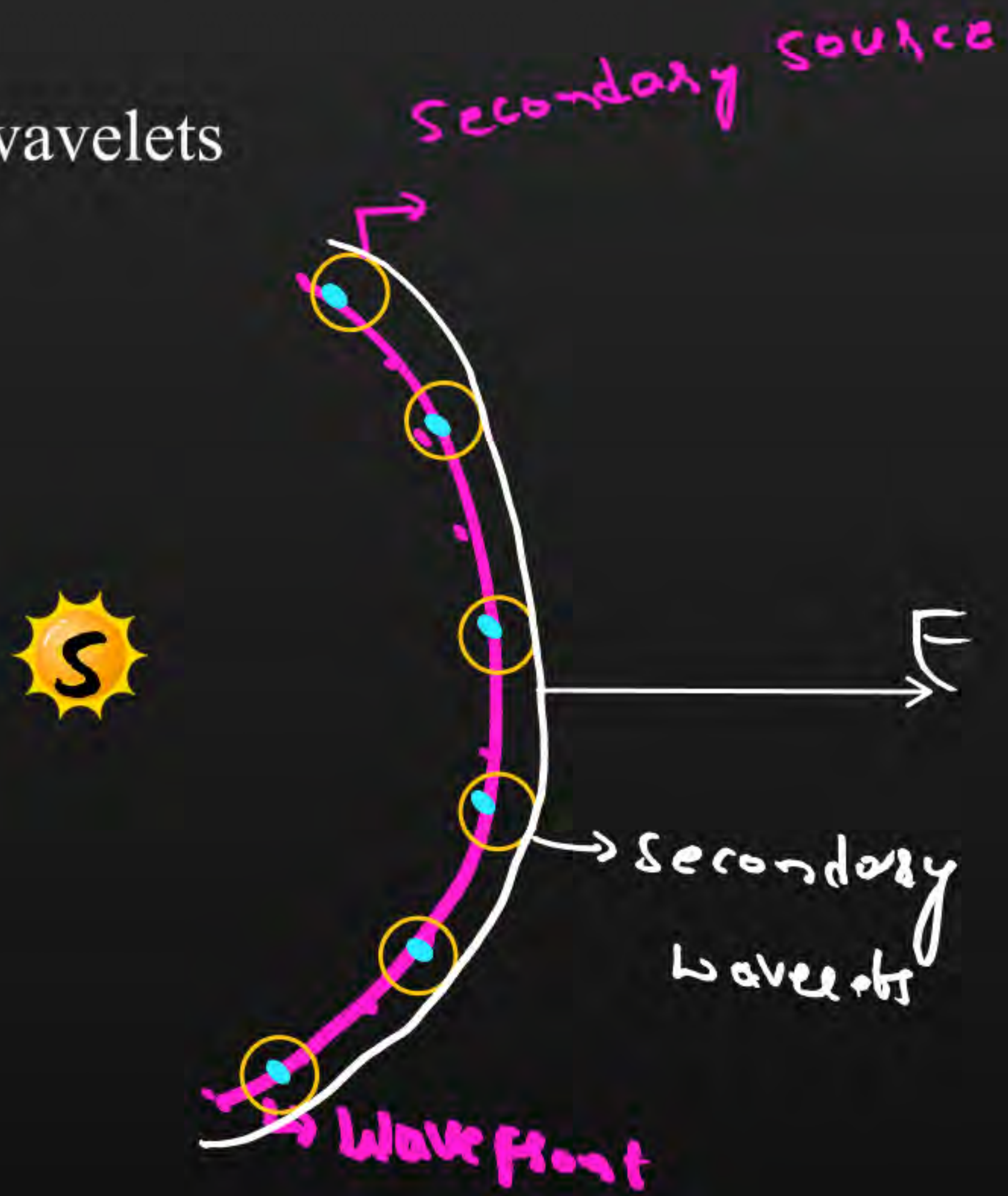




Wave front and types

Source, Secondary source , wave front and secondary wavelets





Question

Which of the following phenomena support the wave theory of light?

1. Scattering 2. Interference 3. Diffraction 4. Velocity of light in a denser medium is less than the velocity of light in the rare medium

(A) 1, 2 and 3

(B) 2, 3 and 4

(C) 1, 2 and 4

(D) 1, 3 and 4

Question

Wavefront is the locus of all points, where the particles of the medium vibrate with the same

(A) phase

(B) amplitude

(C) frequency

(D) period

Question

When light propagates through a given homogeneous medium, the velocities of

(A) primary wavefront are larger than those of secondary wavelets.

(B) primary wavefronts are lesser than those of secondary wavelets.

(C) primary wavefronts are greater than or equal to those of secondary wavelets.

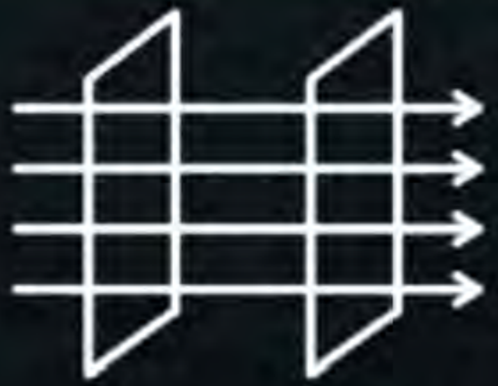
(D) primary wavefront and wavelets are equal.

WAVEFRONT

Wave front is defines as the locus of all such particles which are oscillating in same phase, Normal to the wave front gives the direction of propagation of at same time

TYPES OF WAVEFRONT

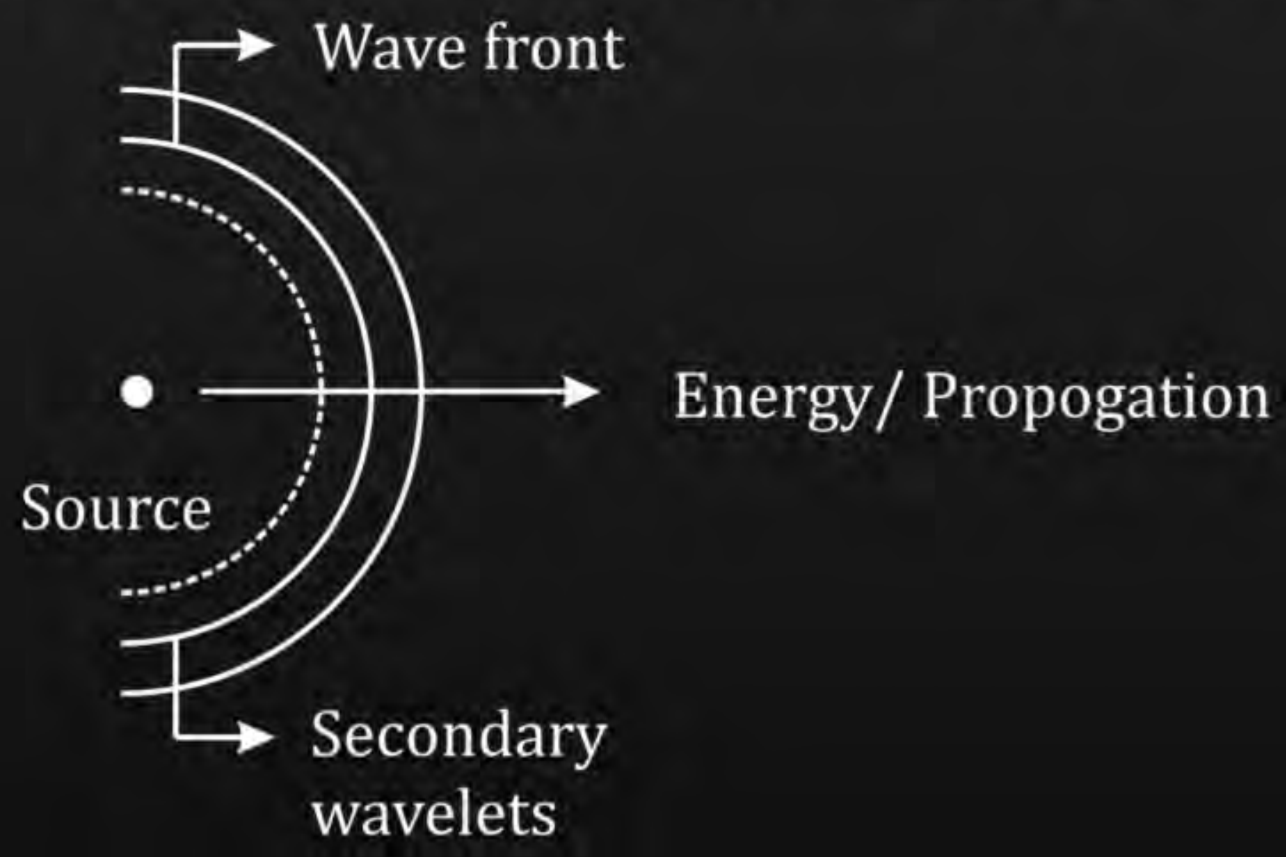
1. Spherical Wave front – Point source
2. Plane wave front – Source at infinity
3. Cylindrical wave front – Linear source

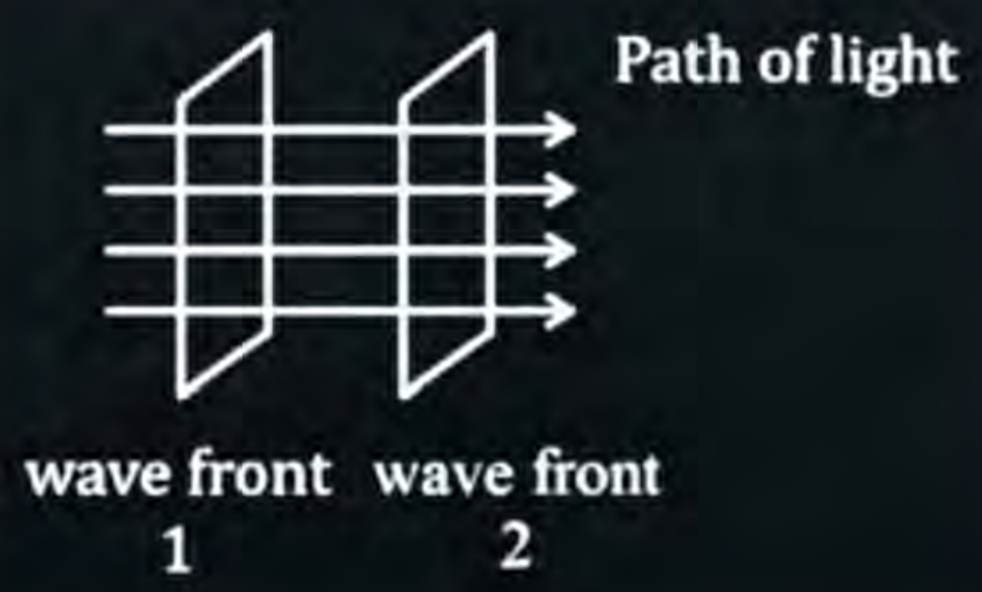


Huygen's Principle

(a) Every point on the given wavefront (called primary wavefront) acts as a source of new disturbance, called secondary wavelets, which travel in all directions with the velocity of light in the medium.

(b) A surface passing these secondary wavelets, tangentially in the forward direction at any instant gives the new wavefront at that instant. This is called secondary wavefront.





Question

$R \to D$ $v\downarrow$

According to Huygens' principle, during refraction of light from air to a denser medium

$c = f\lambda$

$c \propto \lambda$

$f = const$

$v\downarrow$ $\lambda\downarrow$

(A) Wavelength decreases but speed increases

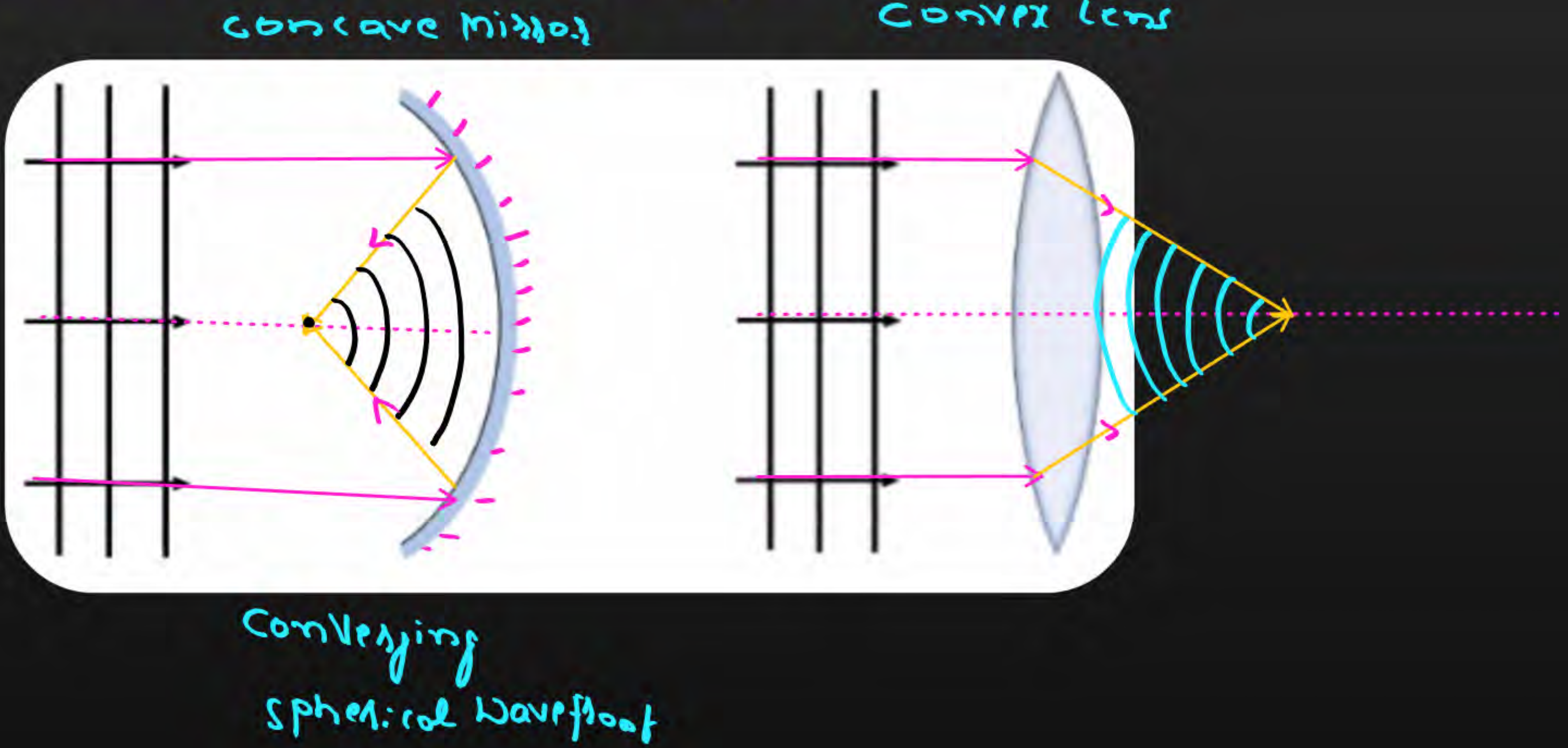
(B) Wavelength increases but speed decreases

(C) Wavelength and speed increases

(D) Wavelength and speed decreases

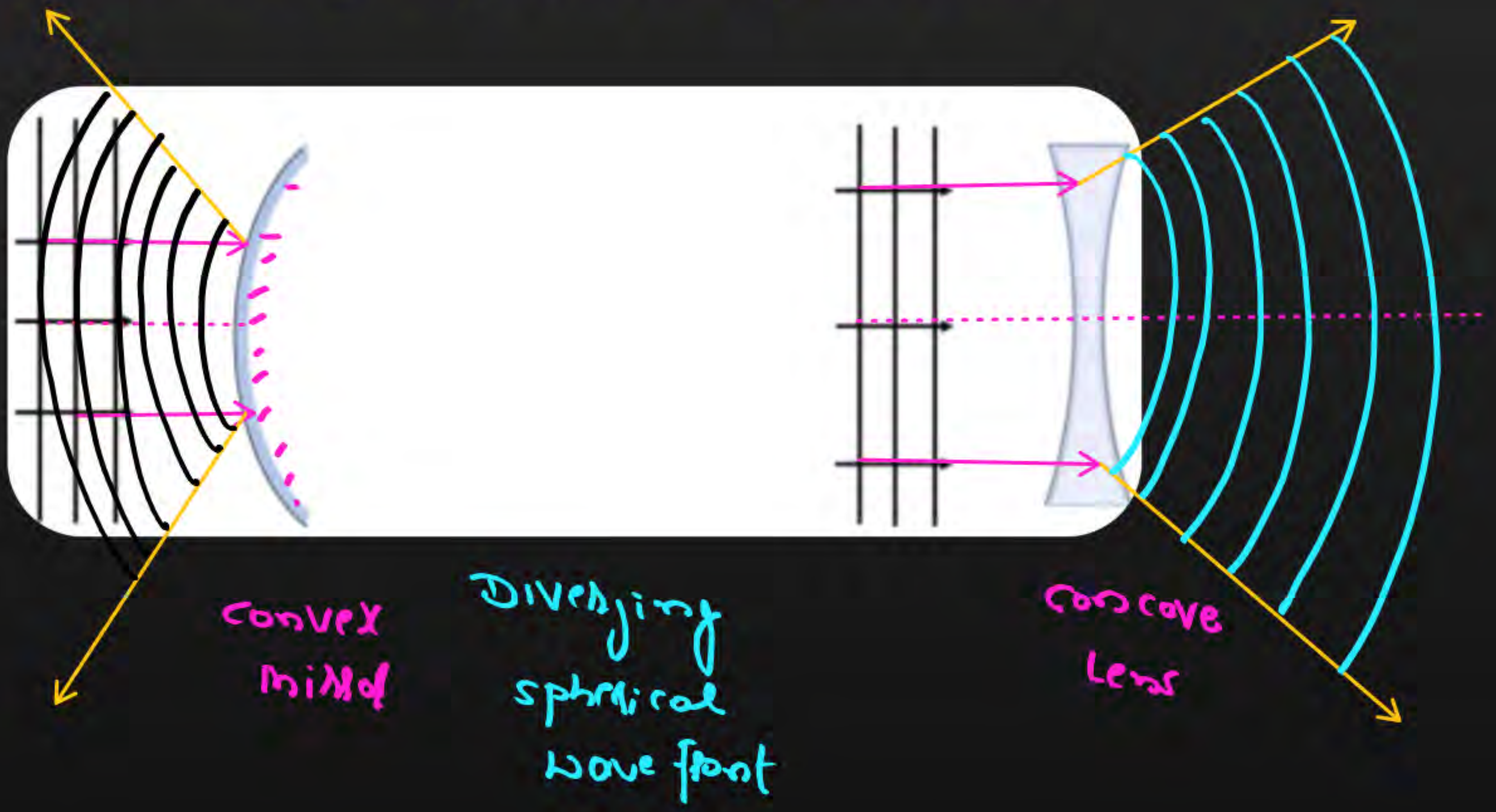
Question

A plane wavefront is incident on given optical device in each case. Draw the correct wavefront after interaction of light ray with the Optical device.



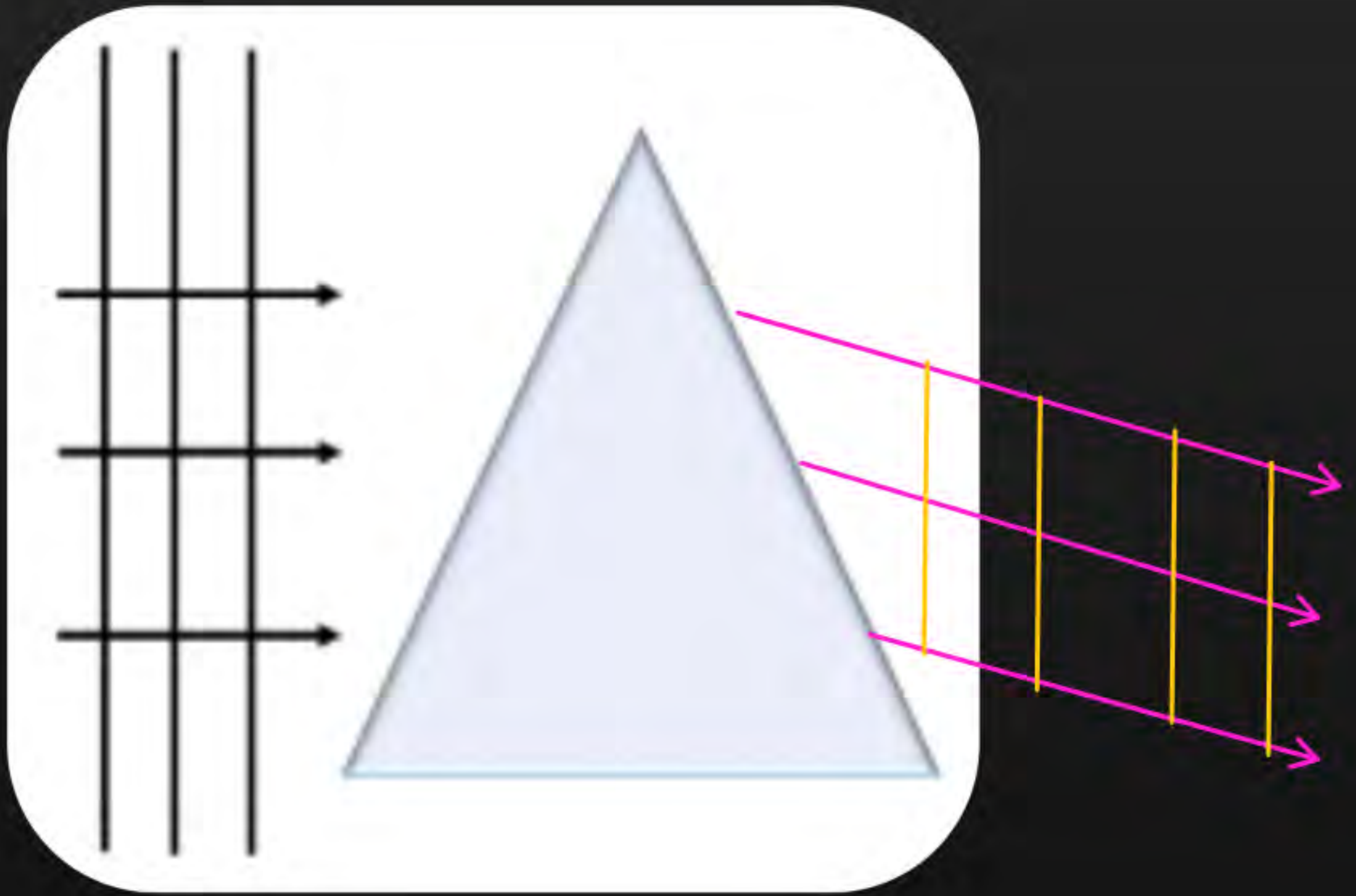
Question

A plane wavefront is incident on given optical device in each case. Draw the correct wavefront after interaction of light ray with the Optical device.



Question

A plane wavefront of monochromatic light is incident on given optical device. Draw the correct wavefront after interaction of light ray with the Optical device.



Question

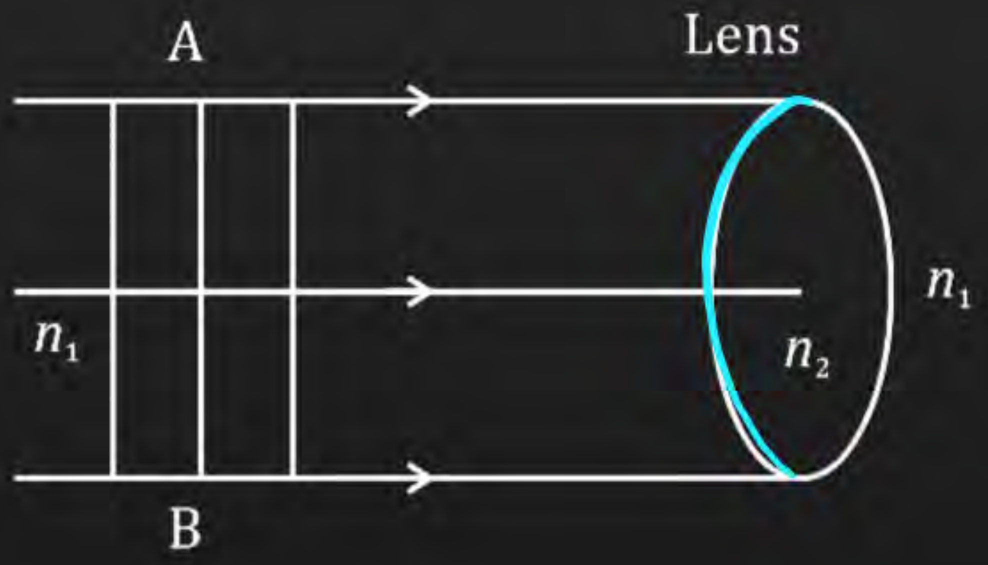
If AB is incident plane wave front, then refracted wave front is $(n^1 \rightarrow n^2)$

A

B

C

D



Coherent and Incoherent sources

- Types of Sources

(1) Coherent sources:

- Two light sources are said to be coherent if they emit light waves of the same frequency and have a constant phase difference. They are obtained from a single source

(2) Incoherent sources

- Two sources are said to be incoherent if their phase difference changes with time.
- Two independent monochromatic sources of same frequency are incoherent because atoms cannot emit light waves in same phase and these sources are said to be incoherent sources.

Interference of Light

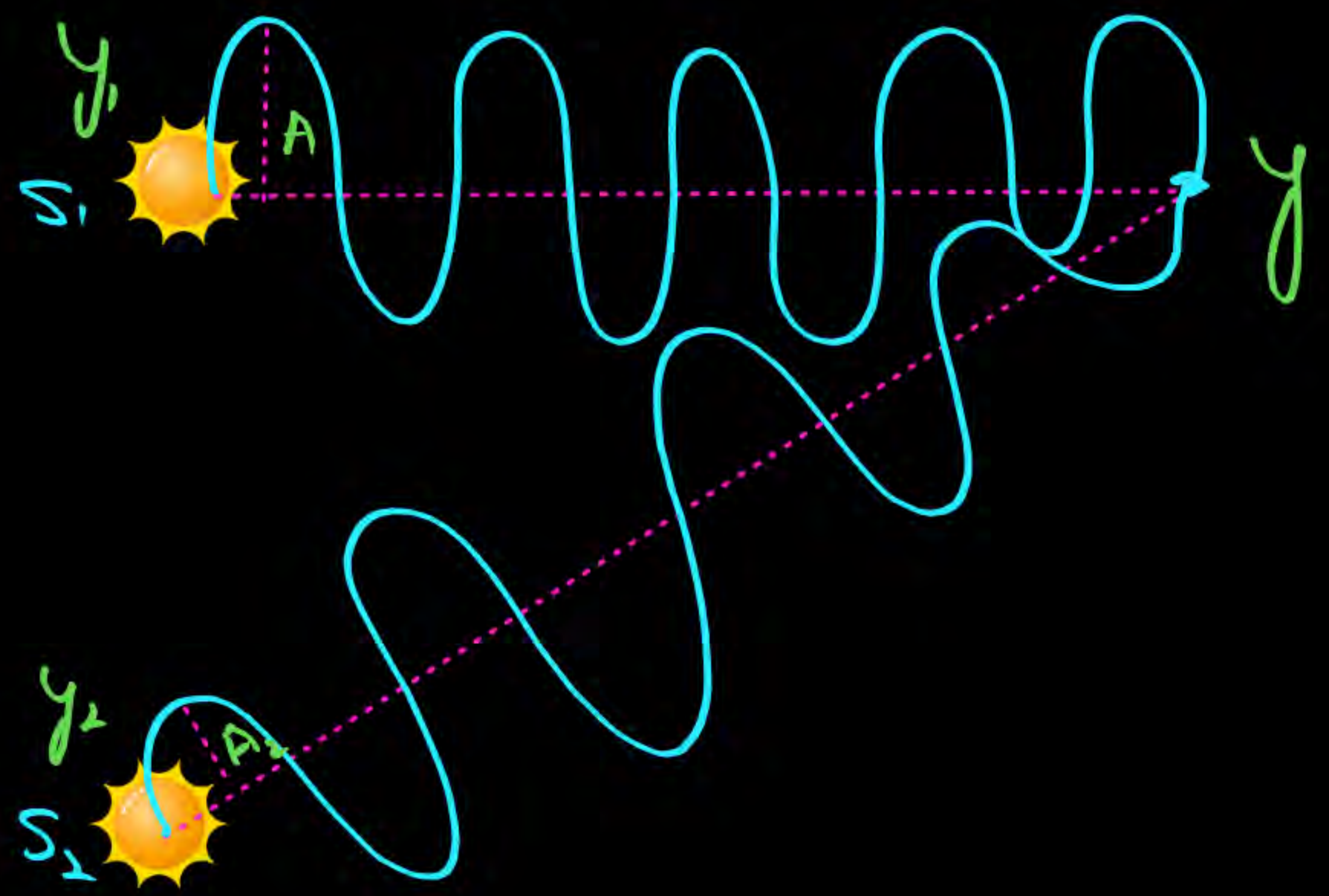
The modification in the distribution of light energy when two or more light waves superpose is know as interference of light.

✓ It is based on energy conservation principle. Total energy of the waves remains constant, only redistribution of energy takes place.

Theory of Interference :

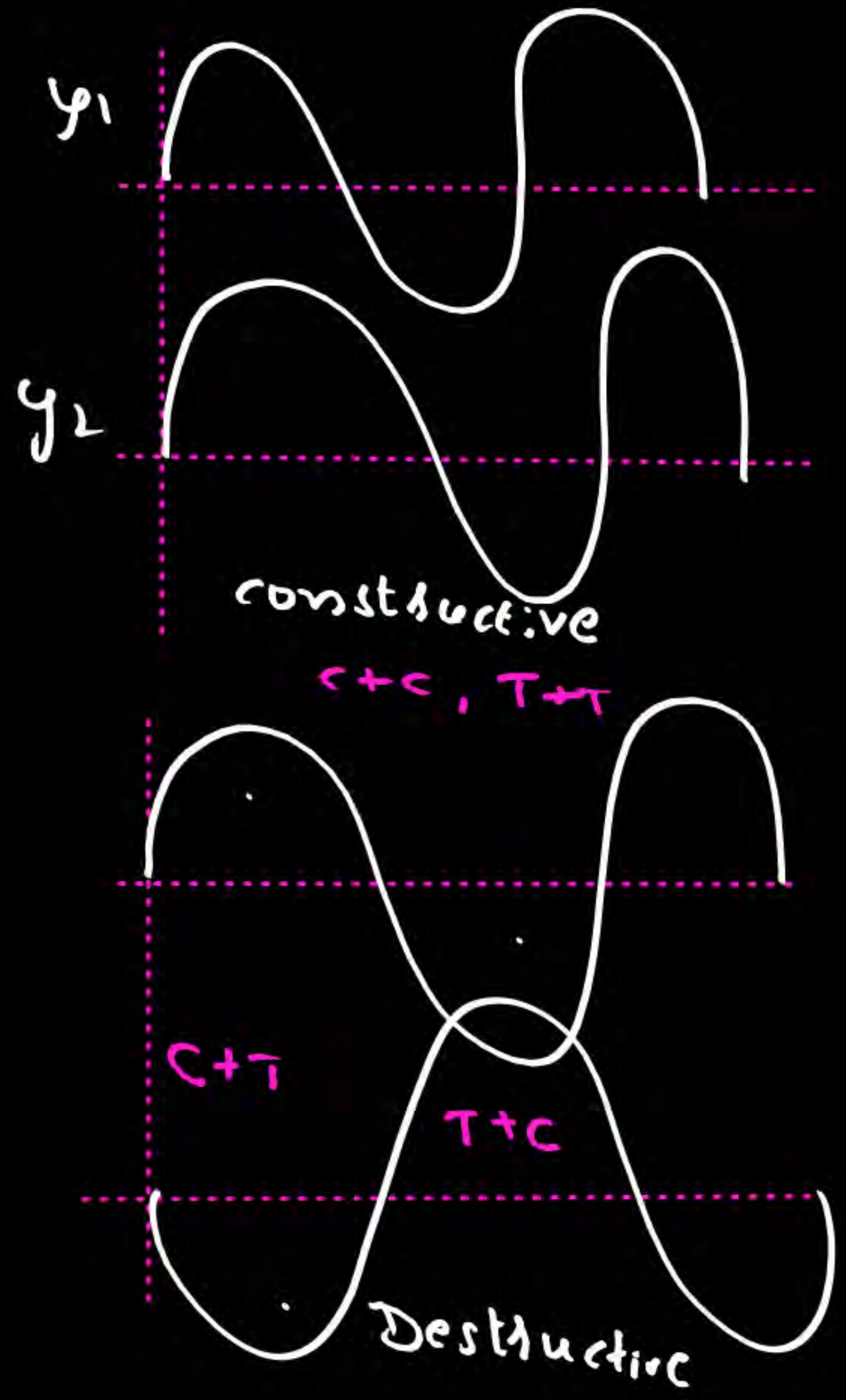
Consider two light waves having angular frequency ω traveling in the same direction. The displacement of any particle in the medium produced by the two waves at any instant is given by

$$y = y_1 + y_2$$



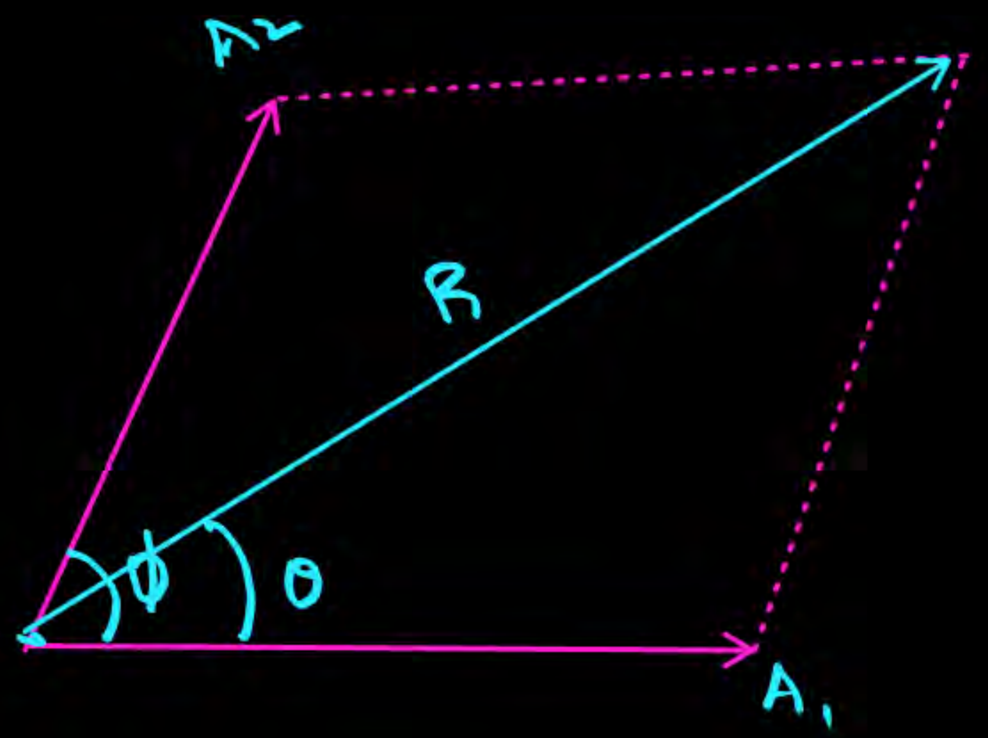
$$y_1 = A_1 \sin \omega t$$

$$y_2 = A_2 \sin(\omega t + \phi)$$



$$y = y_1 + y_2 = A_1 \sin \omega t + A_2 \sin(\omega t + \phi)$$

$$y = R \sin(\omega t + \theta)$$



Resultant amplitude

* $$R = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

Condition for constructive Interference of light

The amplitude of the resultant wave due to superposition of two waves is given by

$$R = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

$R_{max} \rightarrow \cos\phi = +1$

$\phi = 0, 2\pi, 4\pi, 6\pi, \ldots$

Phase Diff $\boxed{\phi = 2n\pi}$

$n = 0, 1, 2, 3 \ldots$

$$\Delta\phi = \frac{2\pi}{\lambda}\cdot\Delta x$$

$$2n\pi = \frac{2\pi}{\lambda}\cdot\Delta x$$

Path Difference, $\boxed{\Delta x = n\lambda}$

Condition for destructive Interference of light

The amplitude of the resultant wave due to superposition of two waves is given by

$$R = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

$$\Delta\Phi = \frac{2\pi}{\lambda} \cdot \Delta x$$

$R_{min} \rightarrow \cos\phi = -1$

$$(2n-1)\pi = \frac{2\pi}{\lambda}\Delta x$$

$$\boxed{\phi = (2n \pm 1)\pi}$$

$\phi = \pi, 3\pi, 5\pi \ldots$

Path Difference, $\boxed{\Delta x = (2n-1)\frac{\lambda}{2}}$

$\phi = (2n+1)\pi$ * $\boxed{\phi = (2n-1)\pi}$

$n = 0, 1, 2, 3 \ldots$ $n = 1, 2, 3, \ldots$

Phase Difference.

Condition for constructive & destructive interference in terms of Intensity

If I_1 and I_2 are the intensities of the two waves, the resultant intensity is given by

$$\text{Intensity} \propto (\text{amp})^2$$

$$R^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$$

$R_{max} \Rightarrow \cos\phi = +1$

$$R_{max}^2 = A_1^2 + A_2^2 + 2A_1A_2$$

$$R_{max} = (A_1 + A_2)$$

$$\boxed{R_{max} = A_1 + A_2}$$

* $$\boxed{R_{max} = A_1 + A_2}$$

$$I_{max} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}$$

$$I_{max} = (\sqrt{I_1})^2 + (\sqrt{I_2})^2 + 2\sqrt{I_1}\sqrt{I_2}$$

$$\boxed{I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2}$$

Max. Values

$$R_{max} = A_1 + A_2$$

$$I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 \quad -(1)$$

Min-Values

$A_1 > A_2$

$$R_{min} = A_1 - A_2 \quad -(2)$$

$$I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$$

Question

The ratio of maximum to minimum intensity when two waves interfere is equal to 16 : 9, find the ratio of Amplitudes of superimposing waves.

$$\frac{I_{max}}{I_{min}} = \frac{16}{9}$$

$$I \propto A^2$$

Question

Two waves having the intensities in the ratio of 16 : 9 produce interference. Find the ratio of maximum to minimum intensity?

Question

If ratio of amplitude of two sources are 2:1. Find

(i) $\frac{I_1}{I_2}$ (ii) $\frac{I_{max}}{I_{min}}$ (iii) $\frac{A_{max}}{A_{min}}$

Thank

You