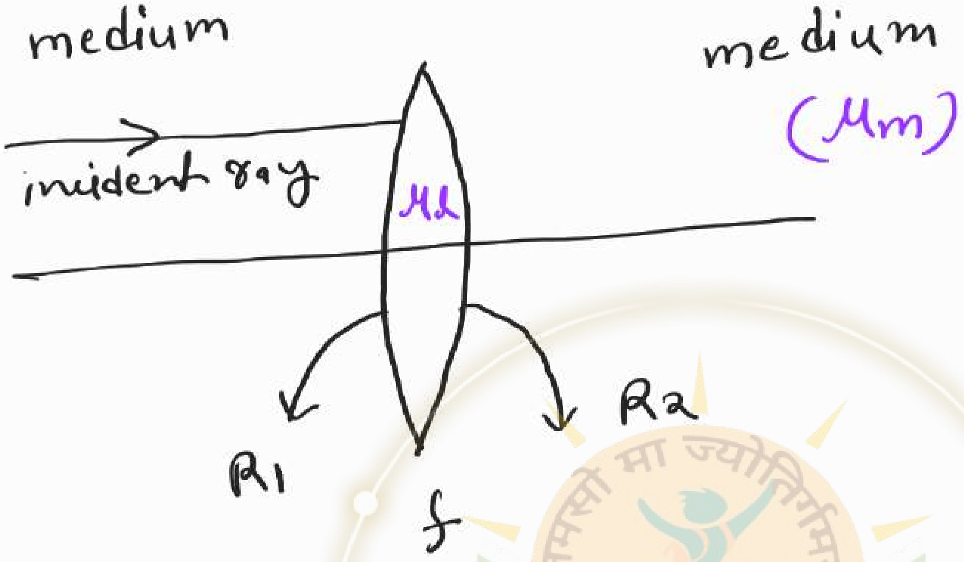
Lens maker's formula



$$\frac{1}{f} = \left(\frac{\mu_l}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

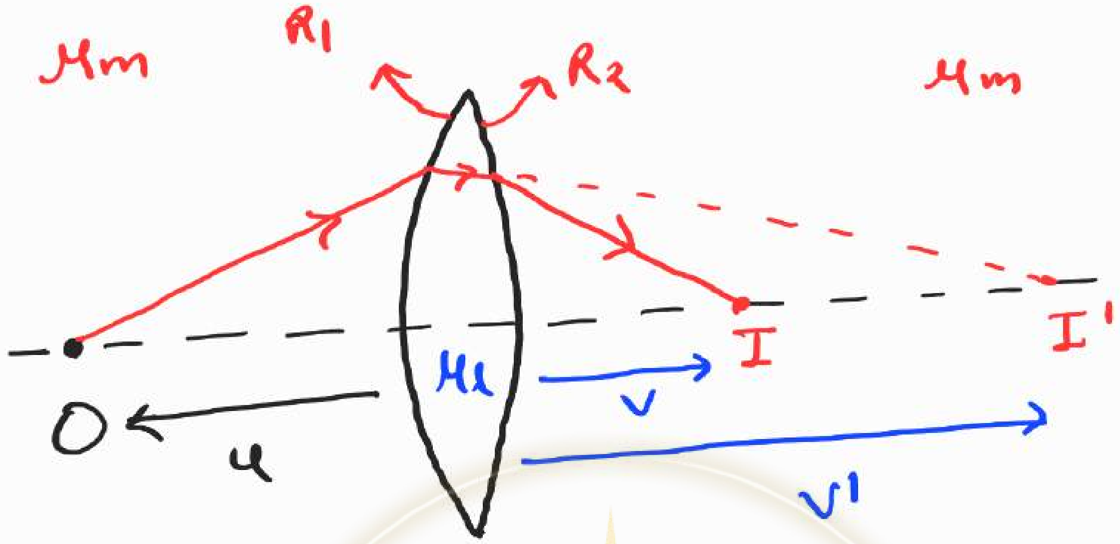
$f \rightarrow$ focal length

$\mu_l \rightarrow$ R.I. of lense

$\mu_m \rightarrow$ R.I. of medium

$R_1, R_2 \rightarrow$ Radius of curvature

Derivation:



Refraction occurs at two surfaces of lens.

Refraction from spherical surface

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

for 1^{st} surface:

$$\frac{\mu_l}{v'} - \frac{\mu_m}{u} = \frac{\mu_l - \mu_m}{R_1} \quad \text{—(i)}$$

Now, I' acts as virtual object for IInd surface.

<u>2nd surface:</u>

$$\frac{\mu_m}{v} - \frac{\mu_l}{v'} = \frac{\mu_m - \mu_l}{R_2} \quad \text{--- (ii)}$$

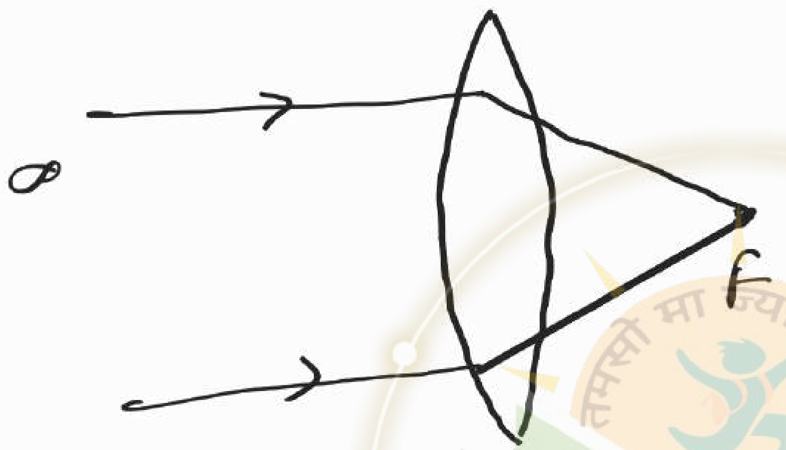
Adding eq^n (i) & (ii)

$$\frac{\mu_l}{v'} - \frac{\mu_m}{u} + \frac{\mu_m}{v} - \frac{\mu_l}{v'} = \frac{\mu_l - \mu_m}{R_1} + \frac{\mu_m - \mu_l}{R_2}$$

$$\frac{\mu_m}{v} - \frac{\mu_m}{u} = \frac{\mu_l - \mu_m}{R_1} + \frac{\mu_m - \mu_l}{R_2}$$

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

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{\mu_l}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{--- (iii)}$$



$u = \infty$

$v = f$

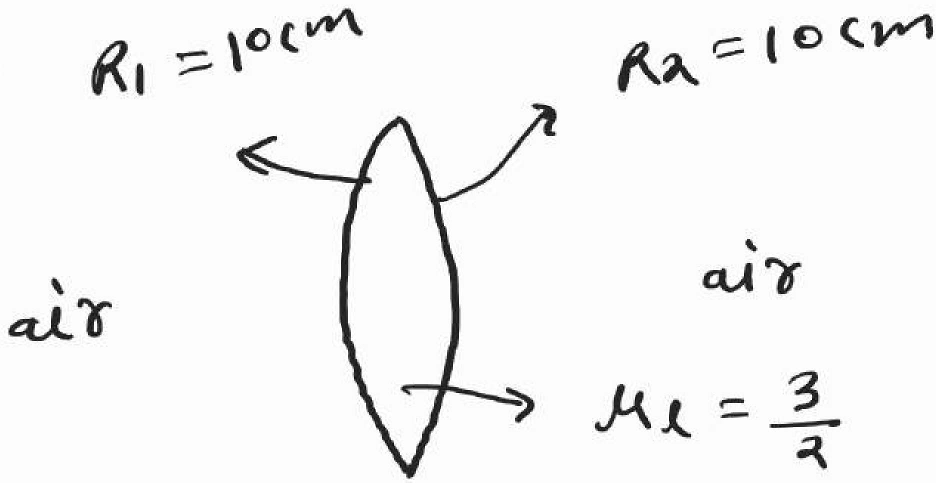
$$\frac{1}{f} - \frac{1}{\infty} = \left(\frac{\mu_l}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Lense maker's formula →

$$\boxed{\frac{1}{f} = \left(\frac{\mu_l}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)} \quad \text{--- (iv)}$$

$$\boxed{\frac{1}{f} = \frac{1}{v} - \frac{1}{u}} \quad \text{--- Lense formula}$$

Que



Bi-convex Lens

$\Rightarrow f = ?$

$$\frac{1}{f} = \left(\frac{\mu_l}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{\frac{3}{2}}{1} - 1\right)\left(\frac{1}{10} - \frac{1}{-10}\right)$$

$$\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{10} + \frac{1}{10}\right)$$

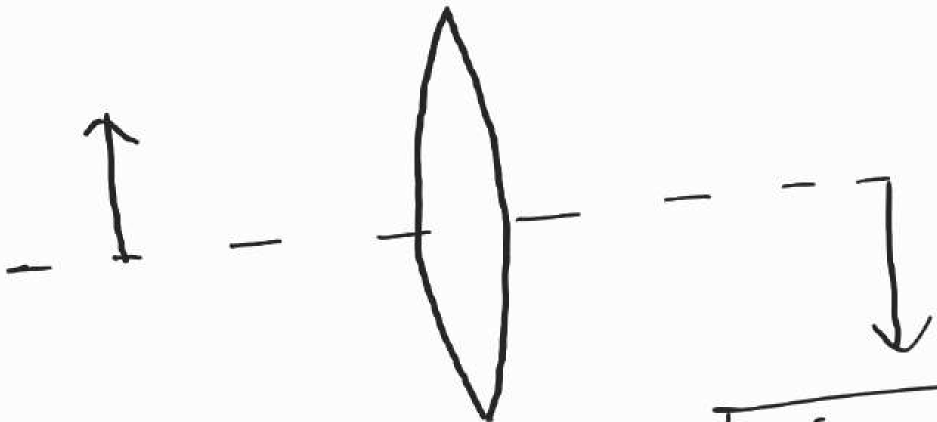
$$\frac{1}{f} = \left(\frac{1}{2}\right)\left(\frac{2}{10}\right)$$

$$\boxed{f = +10cm}$$

Magnification:

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

Que Find the position, size and nature of image formed by a convex lense of focal length 10 cm when a 2 cm long object is kept in front of it at a distance of 15 cm.



$V = 30\,cm$

$$m = \frac{v}{u} = \frac{30}{-15} = -2$$

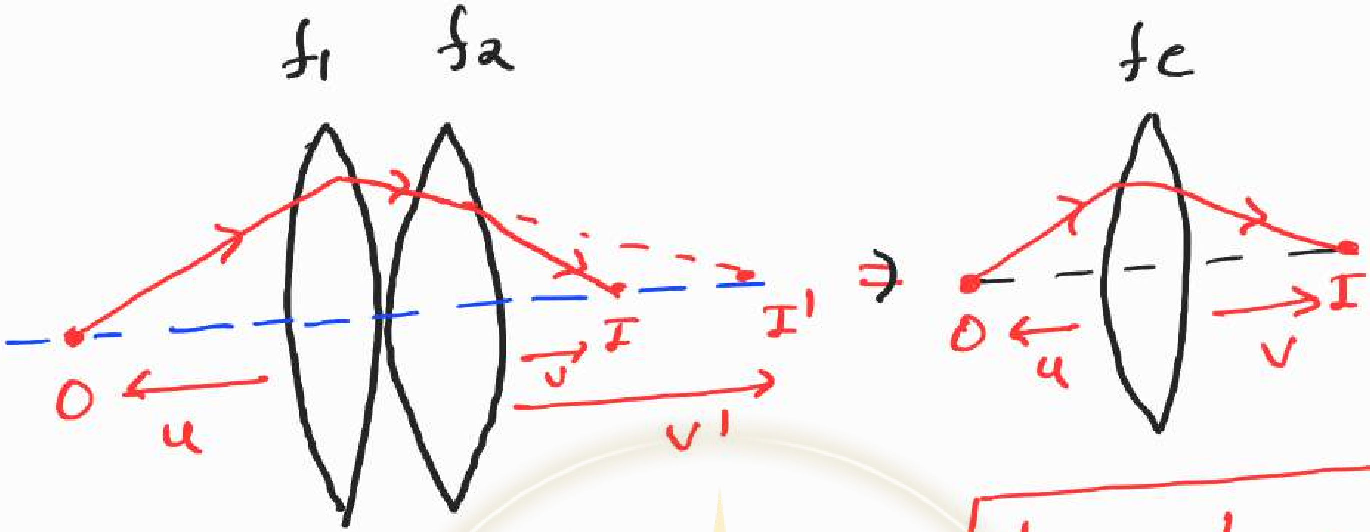
$$\frac{h_i}{h_o} = -2$$

$$\frac{h_i}{2} = -2$$

$$h_i = -2 \times 2 = -4\,cm$$

$$\boxed{h_i = -4\,cm} \Rightarrow \text{Real \& inverted}$$

combination of thin lenses



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

for 1st lense

$$\frac{1}{f_1} = \frac{1}{v'} - \frac{1}{u} \quad \text{--- (i)}$$

for 2nd lense

$$\frac{1}{f_2} = \frac{1}{v} - \frac{1}{v'} \quad \text{--- (ii)}$$

(i) + (ii)

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{v'} - \frac{1}{u} + \frac{1}{v} - \frac{1}{v'}$$

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{v} - \frac{1}{u}$$

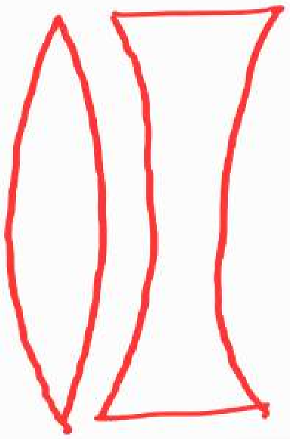
$$\boxed{\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{f_e}}$$ * *

for more than two lenses

$$\frac{1}{f_e} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \cdots$$

$$P_e = P_1 + P_2 + P_3 + \cdots$$

Que.



⇒ find $f_e = ?$

⇒

$f_1 = +5\,cm$

$f_2 = -10\,cm$

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

$$\frac{1}{f_e} = \frac{1}{5} + \frac{1}{-10}$$

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

$$\boxed{f_e = +10\,cm}$$

⇒ Power of an (optical instrument)

Power ⇒ converging or Diverging Ability

{ converging ability ⇒ +ve power }
{ Diverging ability ⇒ -ve power }

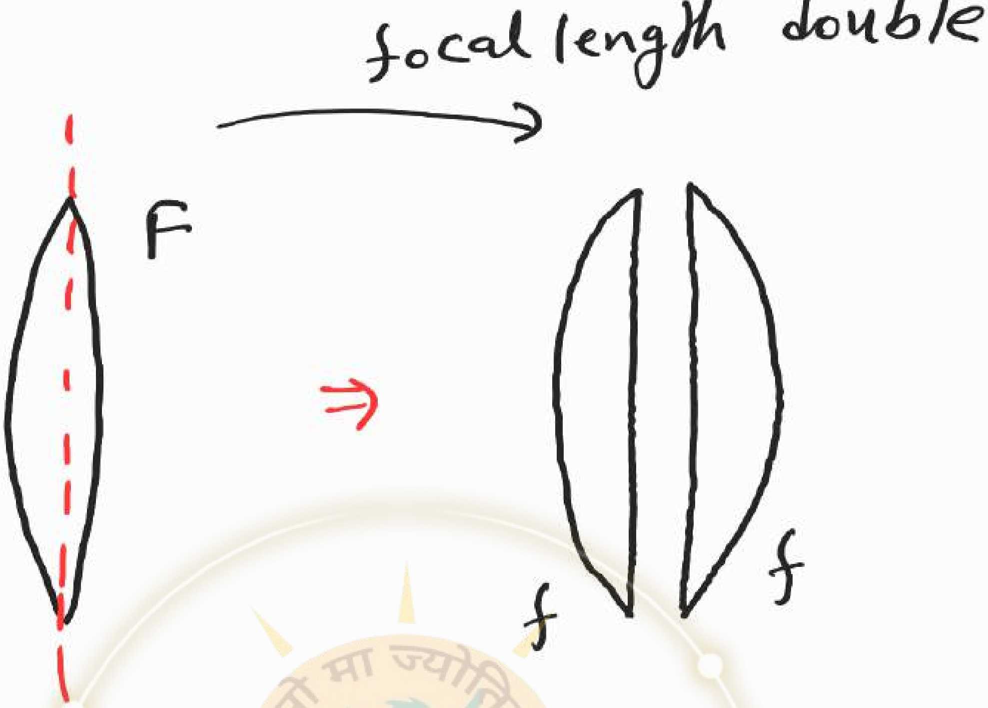
$$P = \frac{1}{f}$$ for lense

f in metre

P in dioptores

Convex lense	f = +ve	P = +ve	converging
concave lense	f = -ve	P = -ve	Diverging

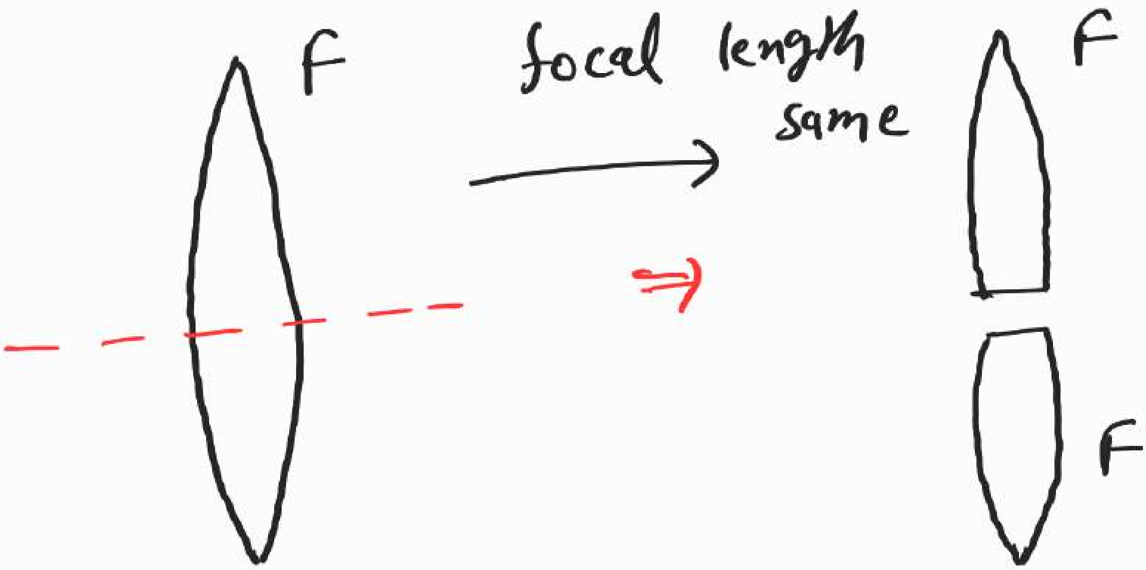
Cutting of lenses



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

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

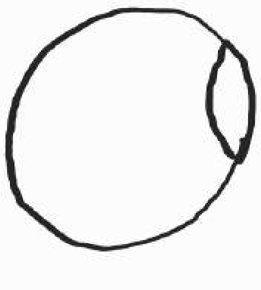
$$\boxed{f = 2F}$$



microscope :

→ it magnify a small object & form it's large image.

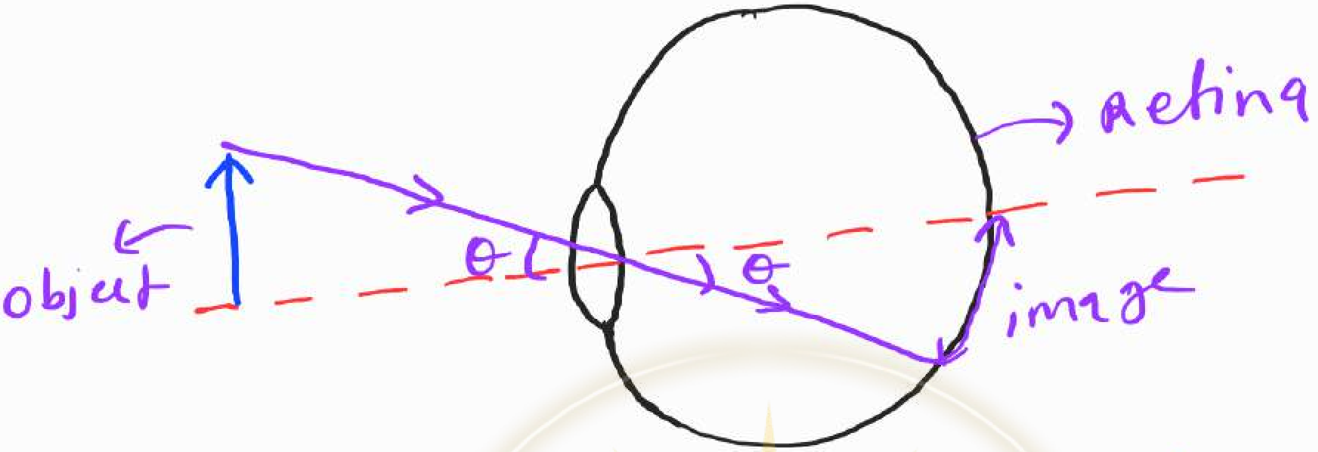
with naked eye :-



Least Distance of Distinct vision

$D = 25\,cm$

Visual Angle:



θ → visual angle

size of image on retina ∝ visual Angle

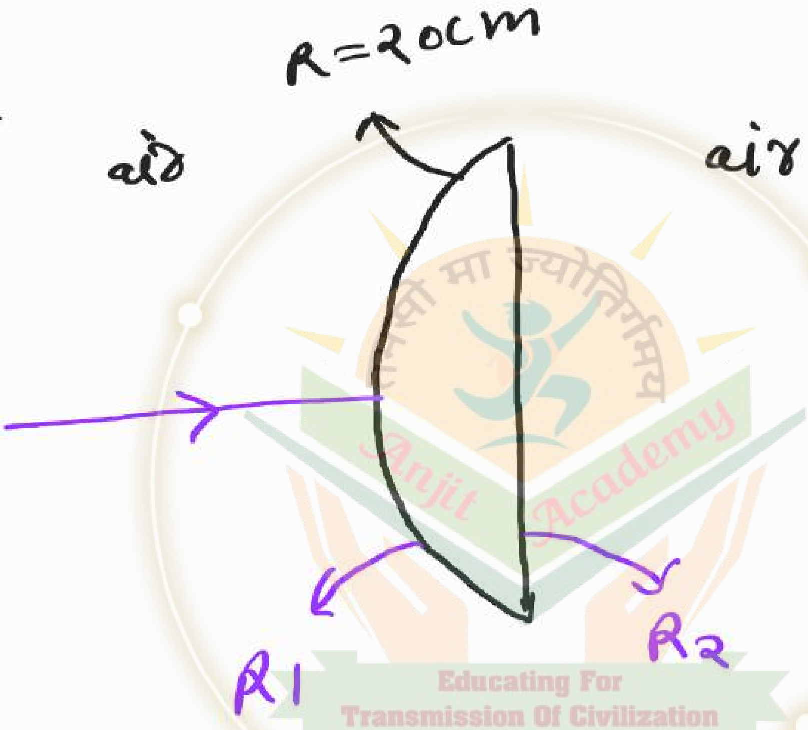
microscope increases this visual Angle

For a microscope, magnification (M)

$$M = \frac{\text{visual angle formed by final image}}{\text{visual angle formed by object kept at D.}}$$

$$M = \frac{\beta}{\alpha}$$

Que.



$\mu_l = 1.5$

find f

$R_1 = +10$ cm

$R_2 = \infty$

$$\frac{1}{f} = \left(\frac{\mu_l}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

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

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{20} - 0\right)$$

$$\frac{1}{f} = (0.5)\left(\frac{1}{20}\right)$$

$$f = \frac{20}{0.5}$$

$$f = \frac{\overset{4}{\cancel{20}} \times 10}{\cancel{5}}$$

$$\boxed{f = +40\,cm}$$ Ans