PRAYAS

JEE 2025

Lecture - 8

Physics

Ray Optics

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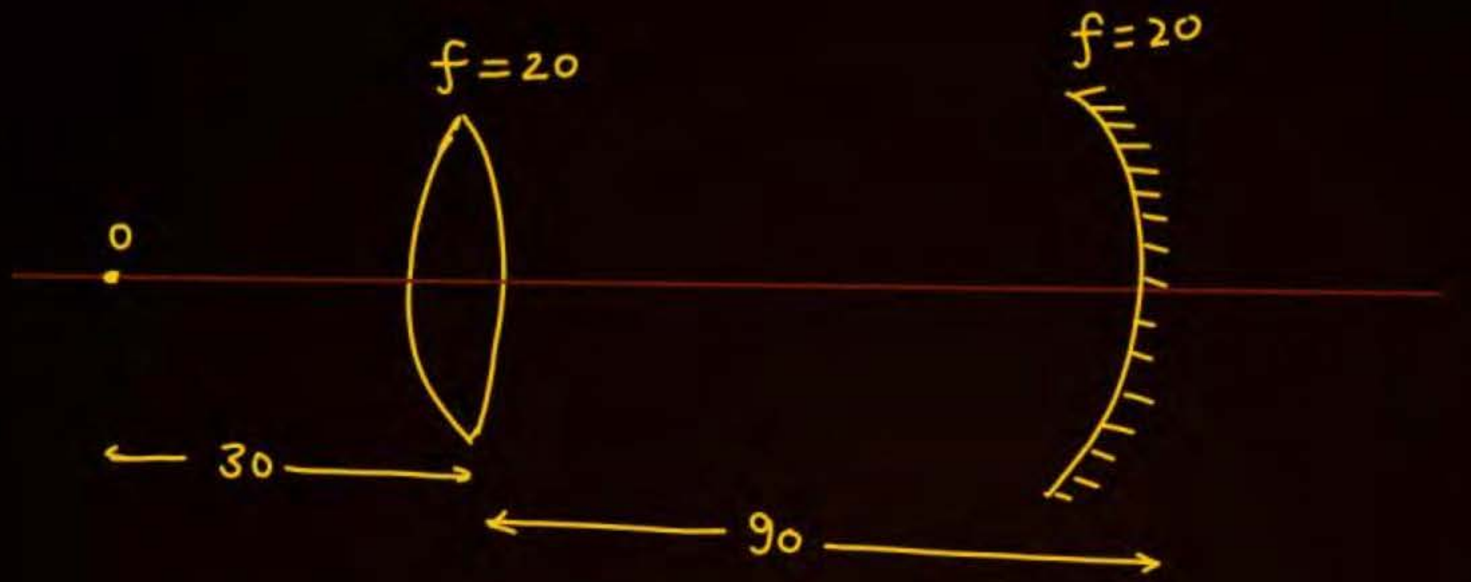
Topics to be covered

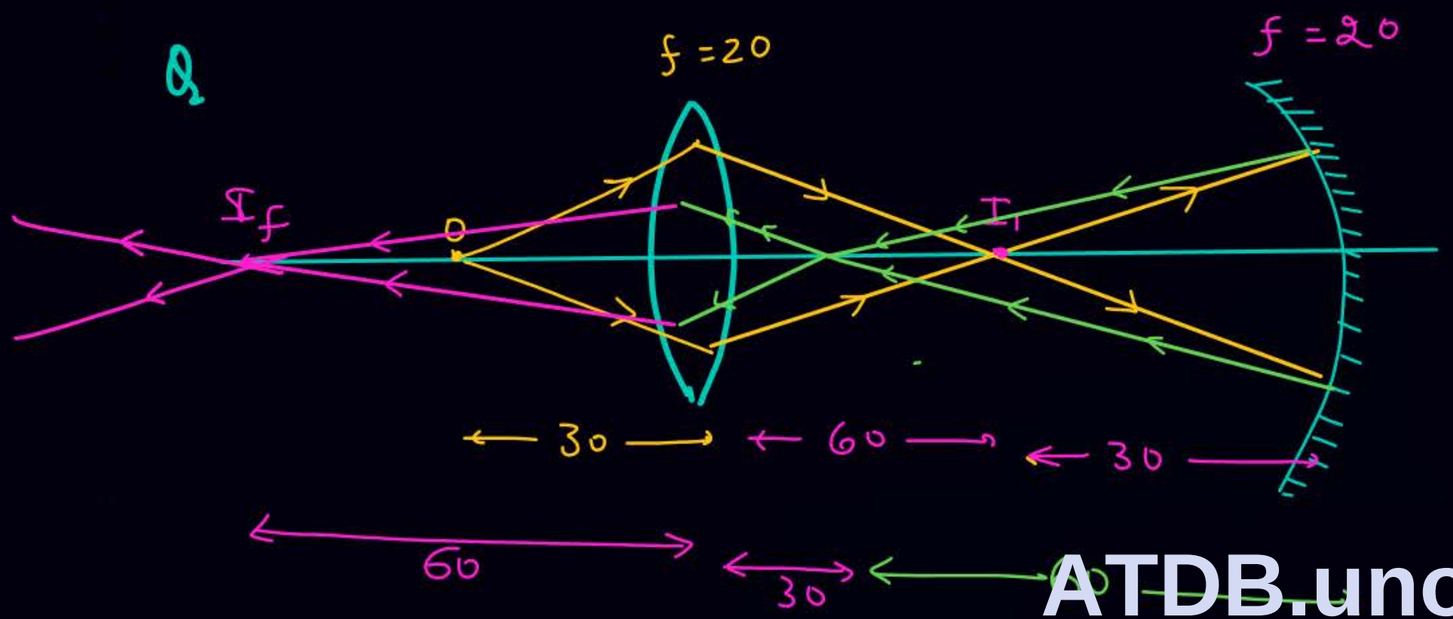
1. Lens formula Based ques
2. Slab insertion
3.
4.

Q

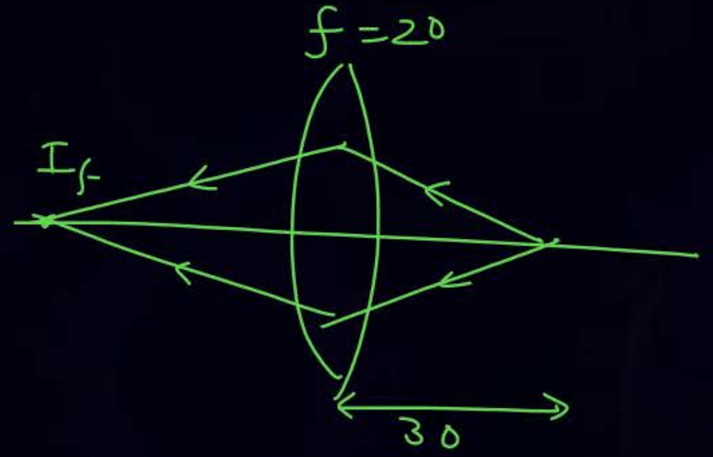


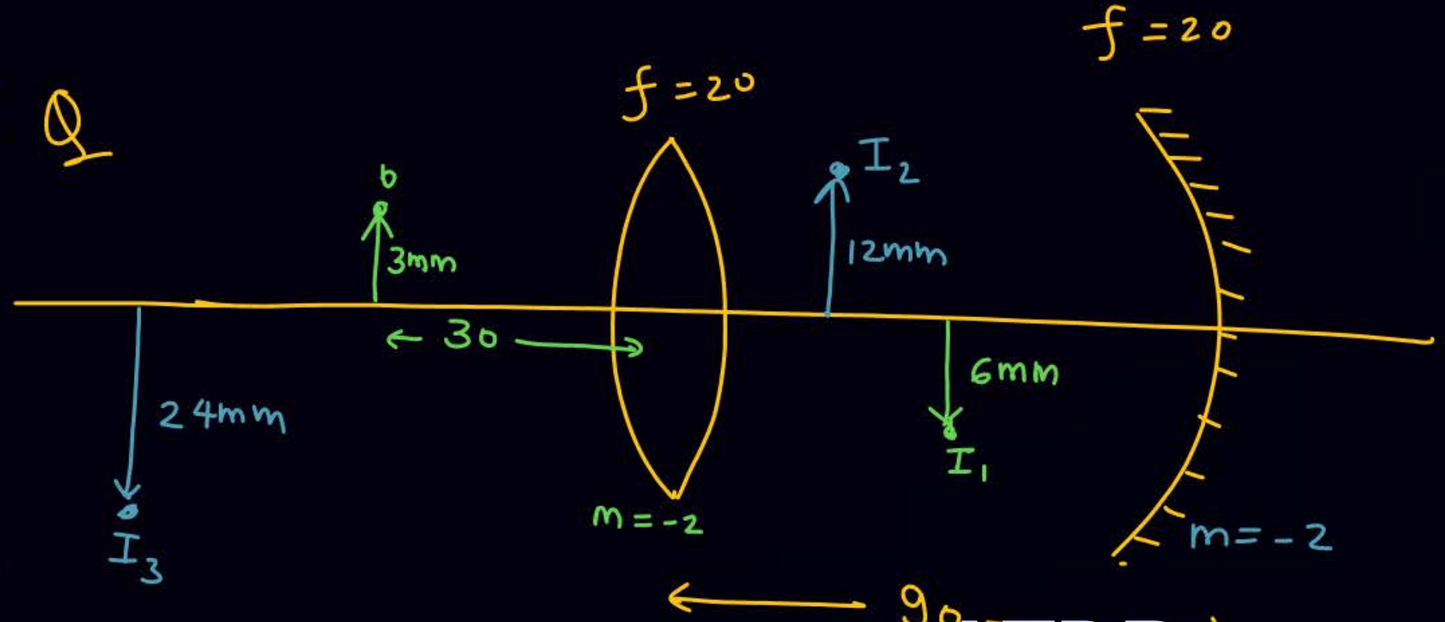
Find location of final image after all possible reflection & refraction.

Distance of final image from mirror.



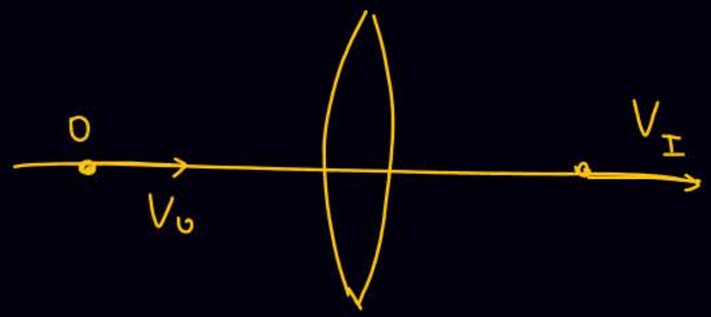
2nd time Lens के साथ





mirror

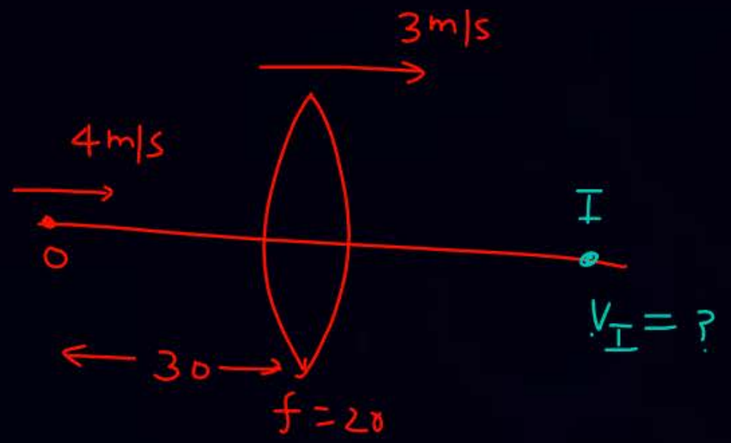
$$m = -\frac{v}{u} = -\frac{-60}{-30} = -2$$



$$\vec{V}_I = m^2 \vec{V}_O$$

$$\vec{V}_{I/L} = m^2 \vec{V}_{O/L}$$

Q



Soln $m = -2$

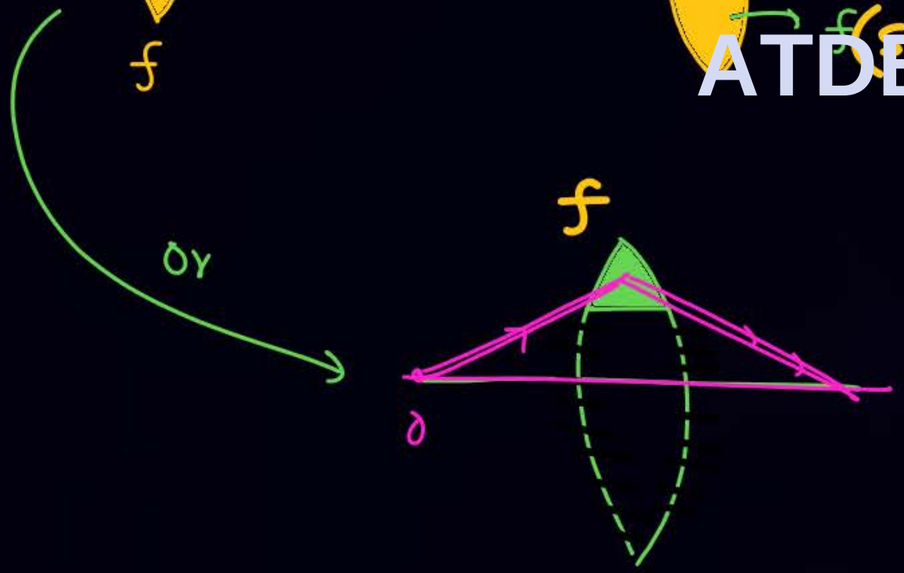
$$\vec{V}_{I/L} = m^2 \vec{V}_{O/L}$$

$$V_I - 3 = 4(4-3)$$

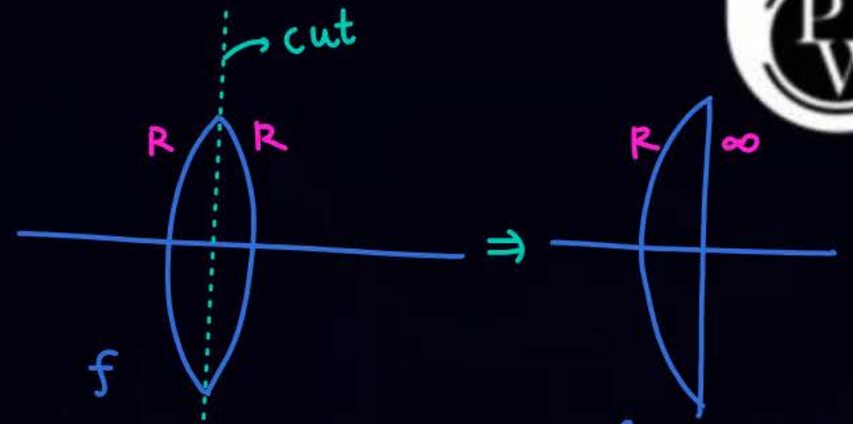
$$\vec{V}_I = 7\hat{i}$$

Cutting of lens

(1)



(2)



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

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

Power of lens $= \frac{1}{f}$

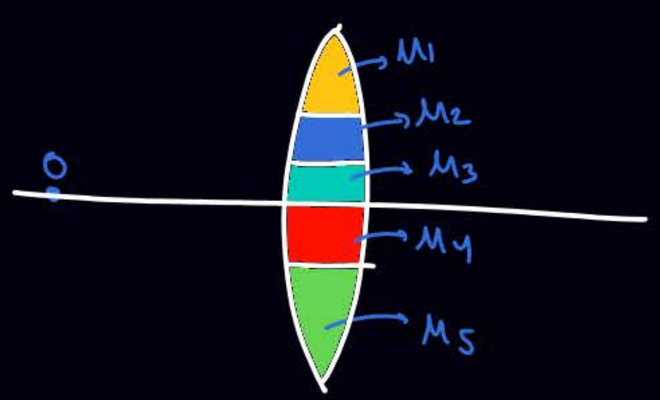
f → change

$\frac{1}{f_{\text{नया}}} = (\mu-1)\left(\frac{1}{R} - \frac{1}{\infty}\right)$

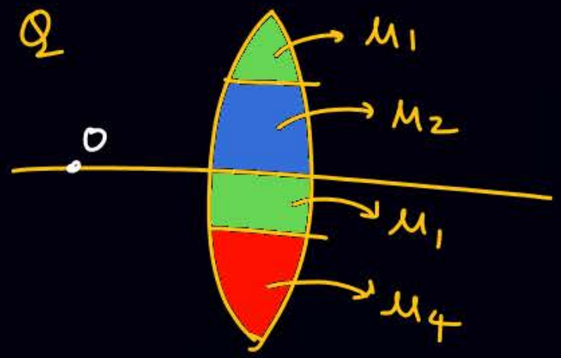
$\frac{1}{f_{\text{नया}}} = \frac{\mu-1}{R} = \frac{1}{2f}$

$f_{\text{नया}} = 2f$

$P_{\text{नई}}$ = half

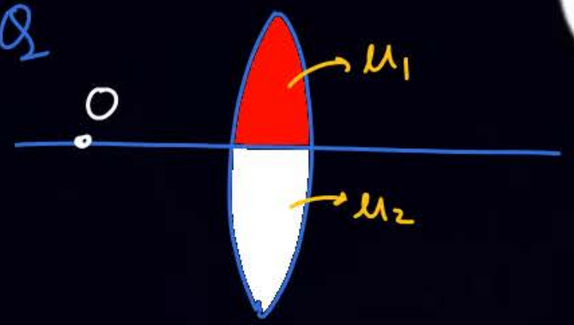


(5 images)



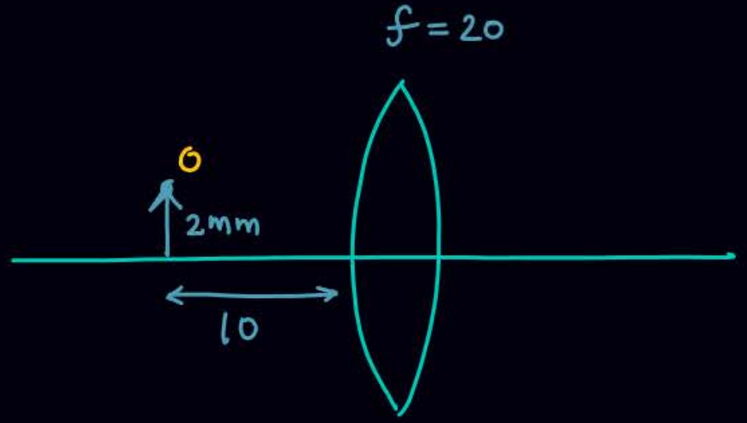
4 image ✗

(3 image)



2 image

Q



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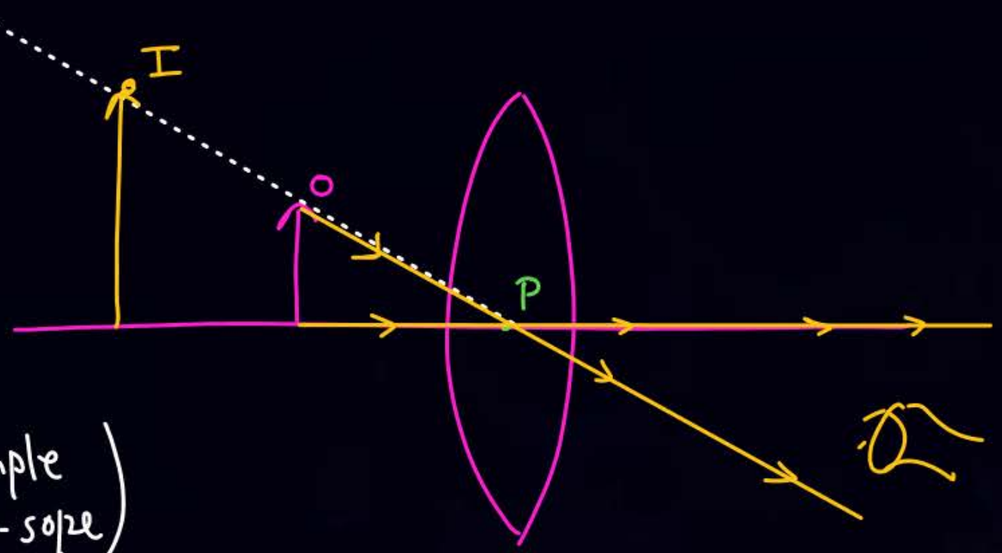


(Simple u-sotze)

$u = -10$

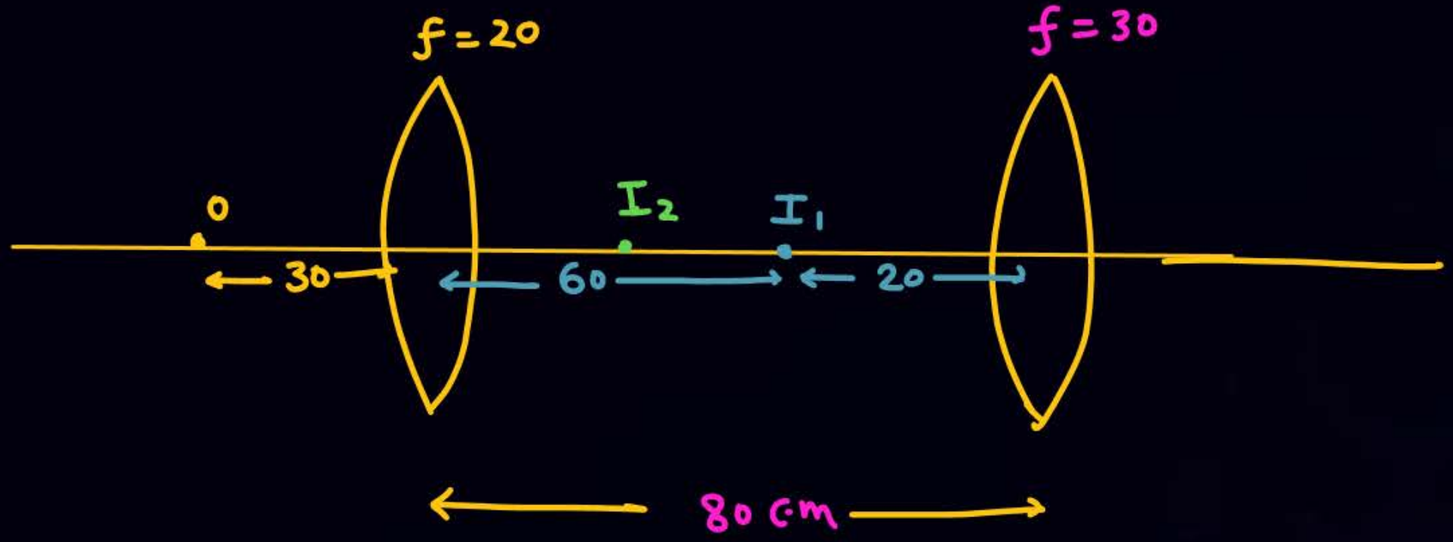
$f = +20$

$$v = \frac{uf}{u+f} = \frac{-200}{-10+20} = -20$$

$$m = \frac{v}{u} = \frac{-20}{-10} = +2 \text{ (erect)}$$

SKC

Q



for 2nd Lens

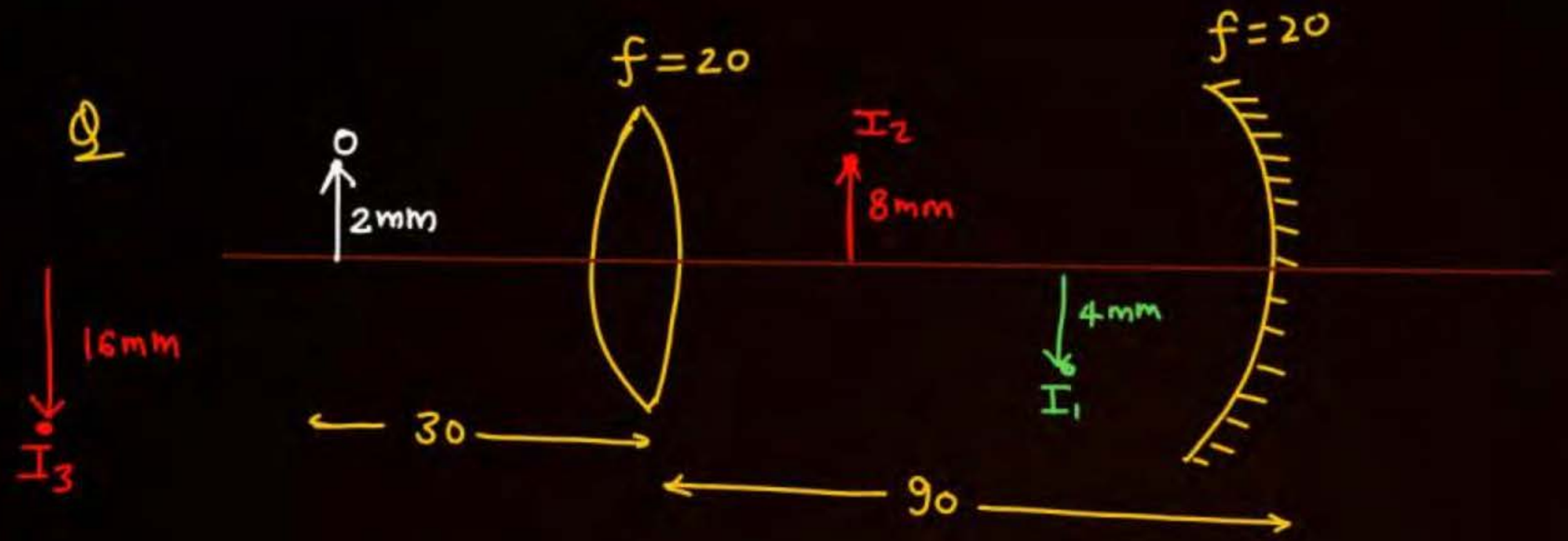
$u = -20$

$f = 30$

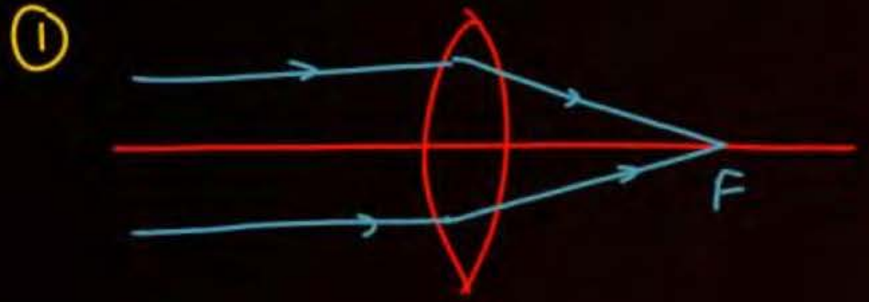
$$v = \frac{uf}{u+f} = \frac{-600}{+10} = -60$$

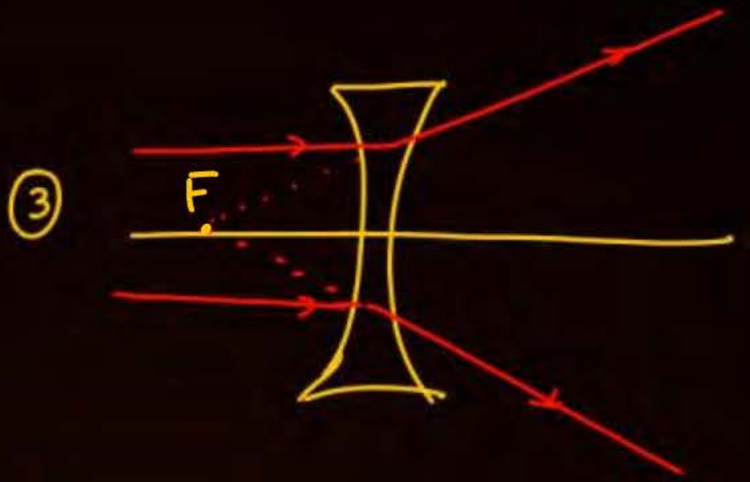
$$m_2 = \frac{v}{u} = \frac{-60}{-20} = +3$$

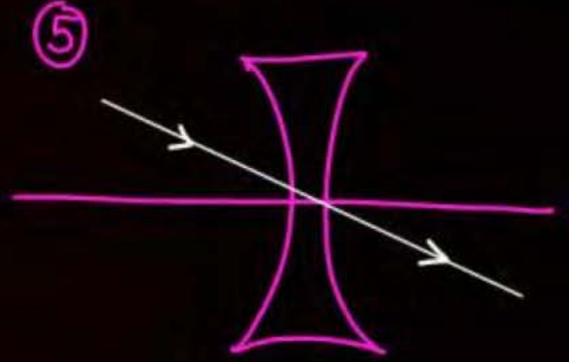
(b)

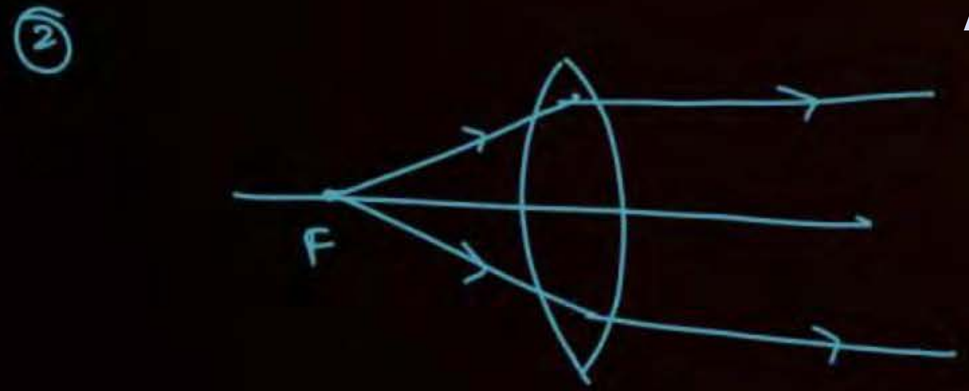


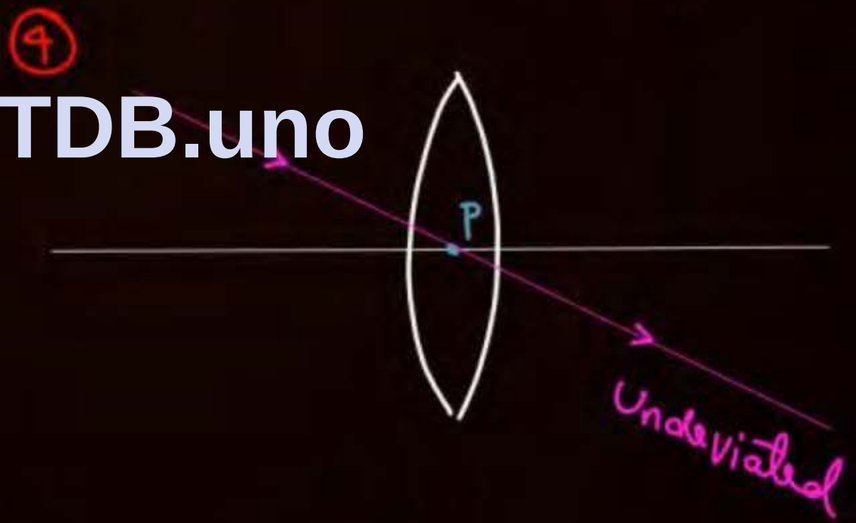
Ray Daigram के लिए हथियार

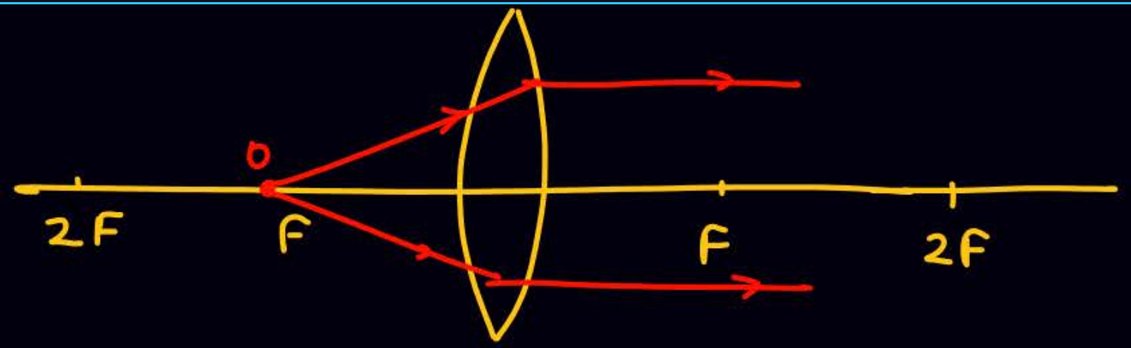


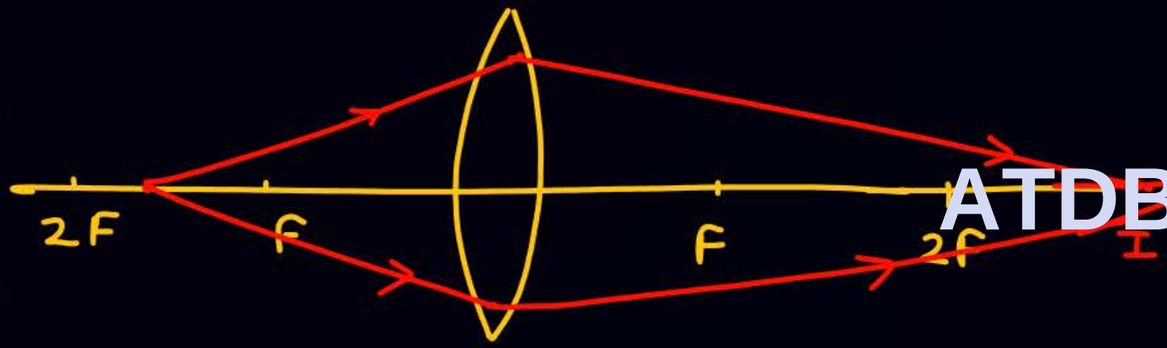


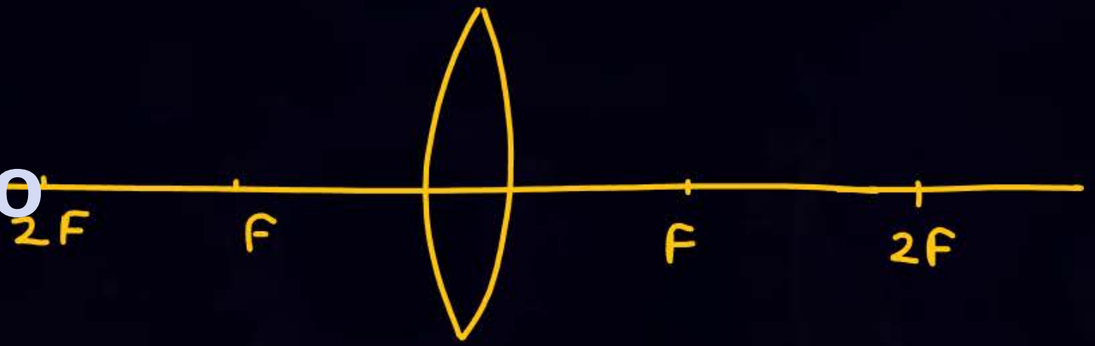


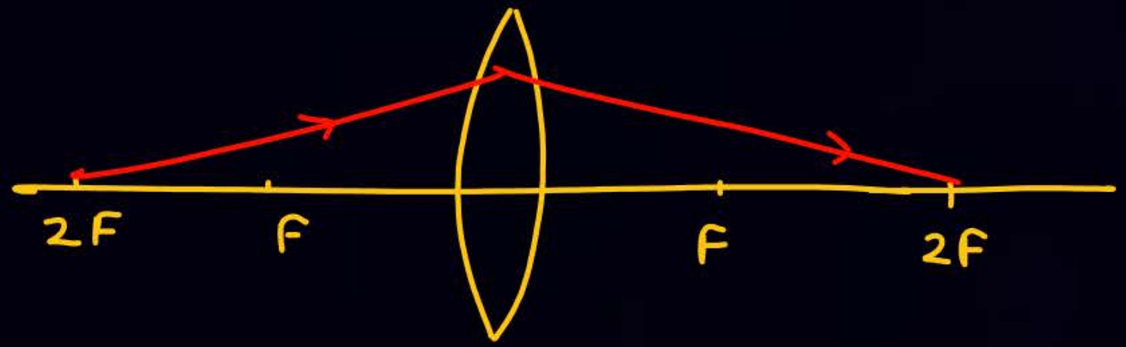










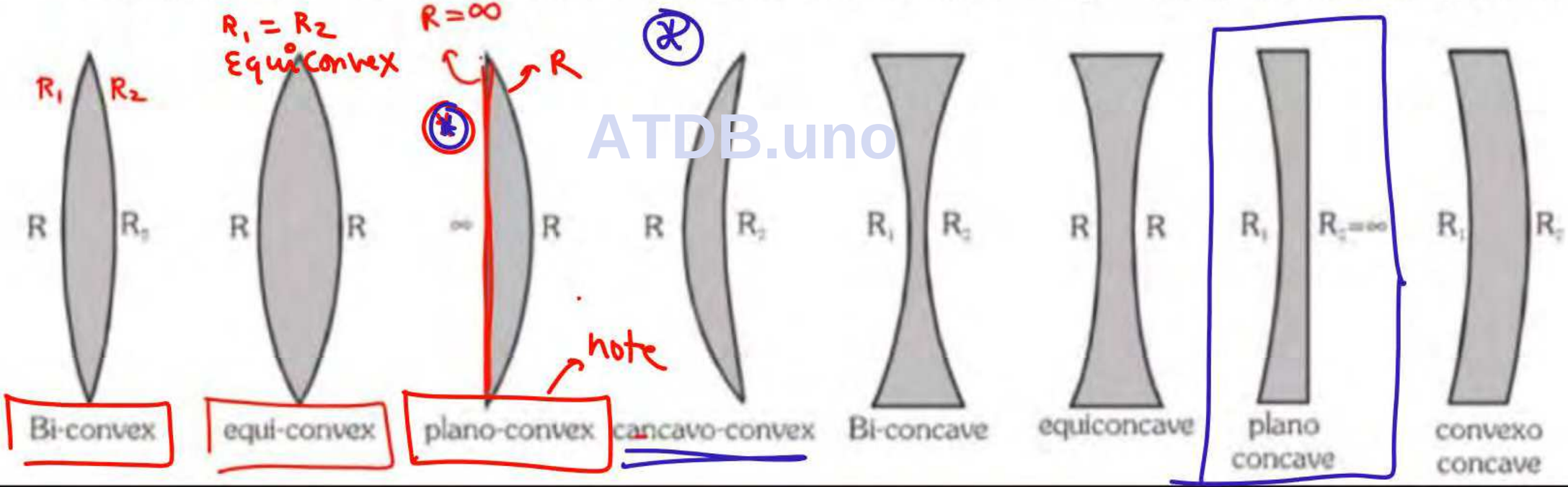


A lens is a piece of transparent material with two refracting surfaces such that at least one is curved and refractive index of its material is different from that of the surroundings.

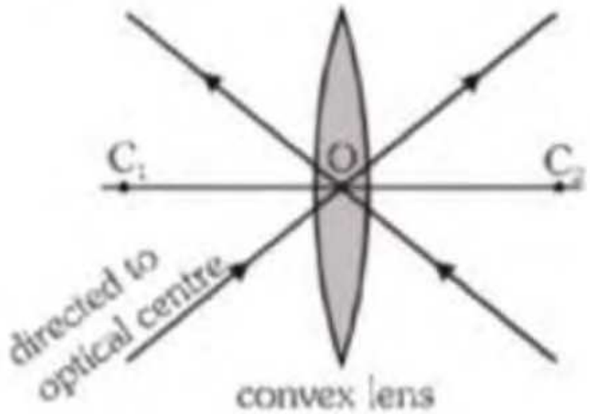
A thin spherical lens with refractive index greater than that of surroundings behaves as a convergent or convex lens, i.e., converges parallel rays if its central (i.e. paraxial) portion is thicker than marginal one.

However if the central portion of a lens is thinner than marginal, it diverges parallel rays and behaves as divergent or concave lens. This is how wse and classify identify convergent and divergent lenses.

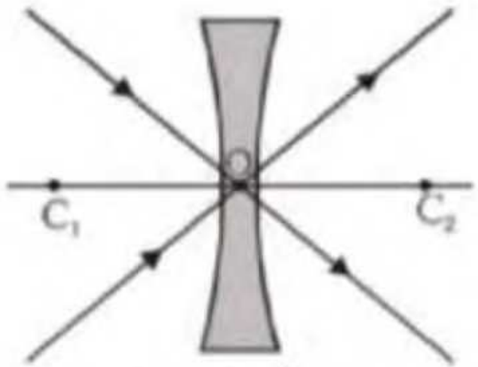
#



Optical Centre : O is a point for a given lens through which any ray passes undeviated

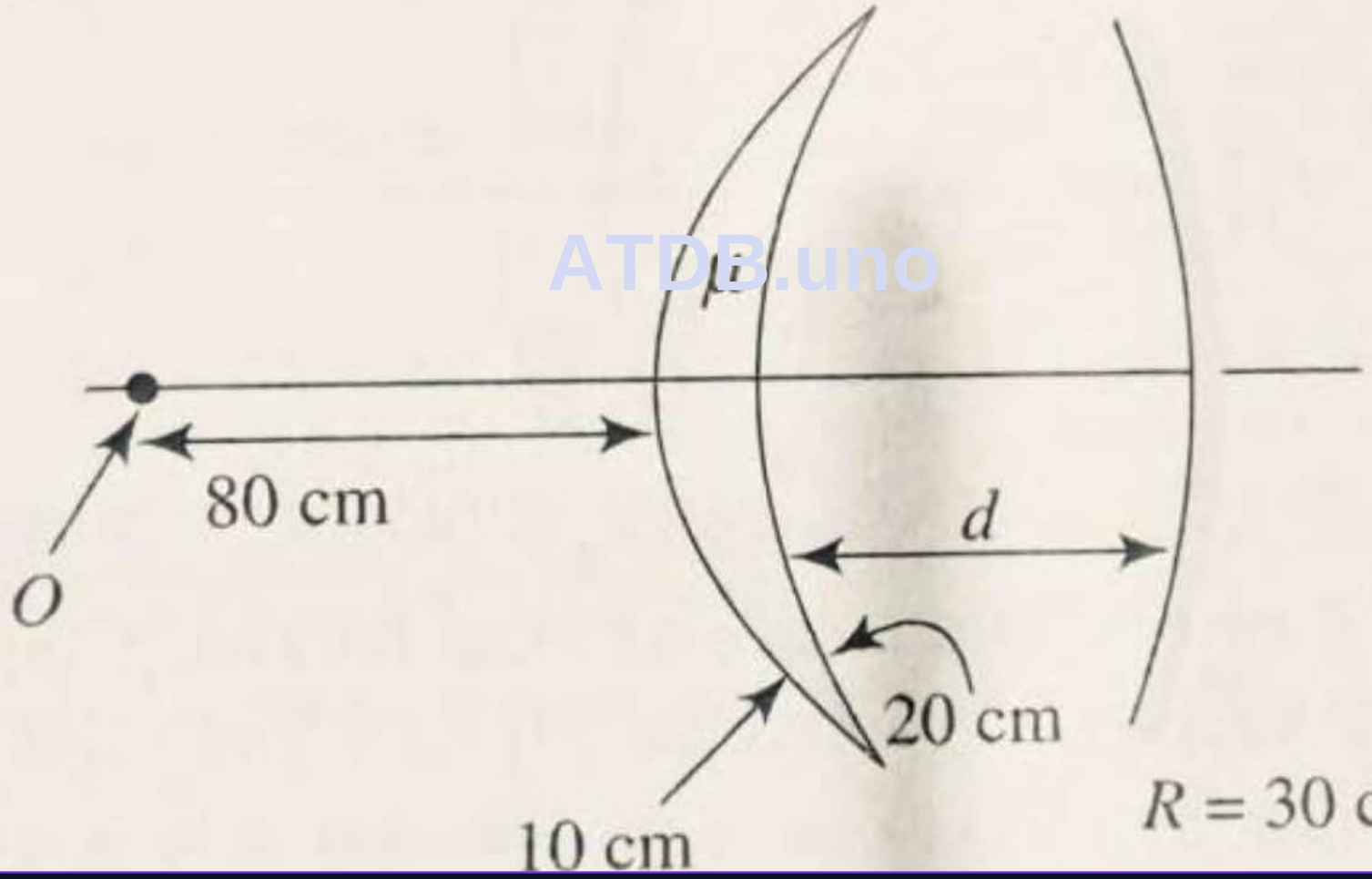


convex lens



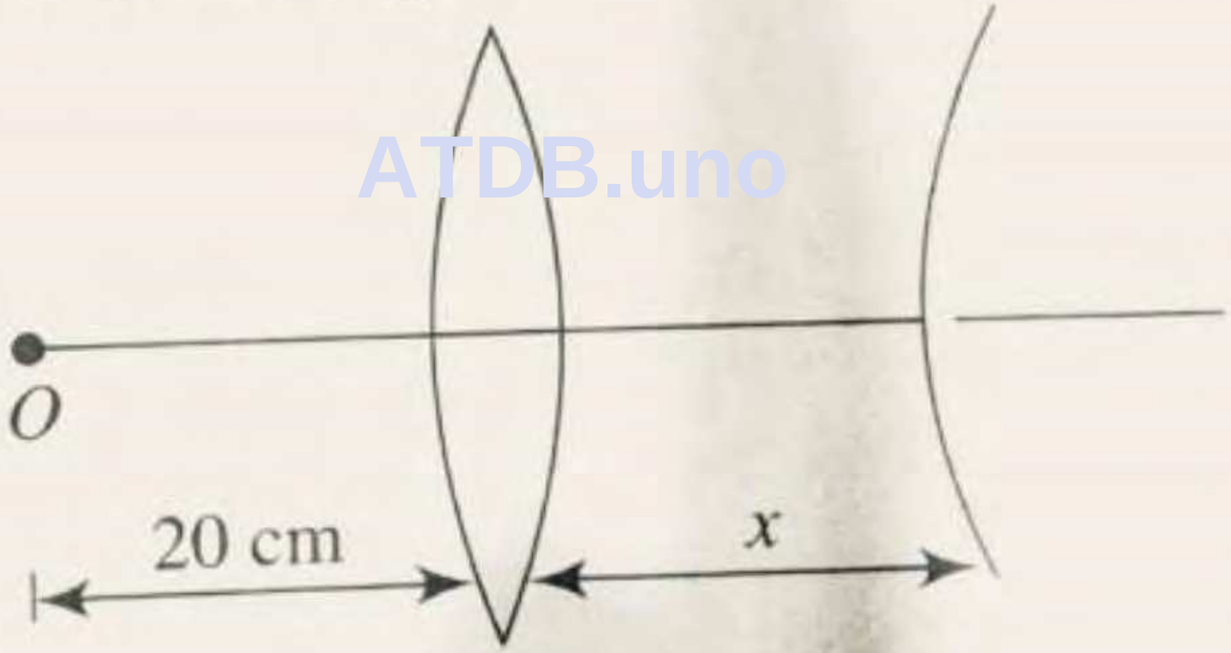
concave lens

8. If final image after two refractions through the lens and one reflection from the mirror forms at the same point O. Refractive index of the material of the lens $\mu = 3/2$. Then find d.



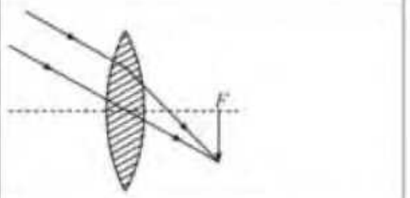
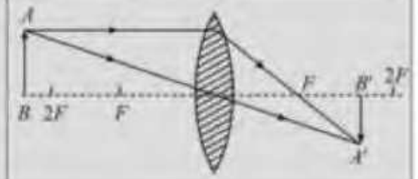
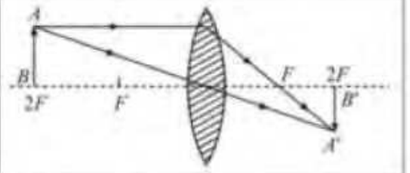
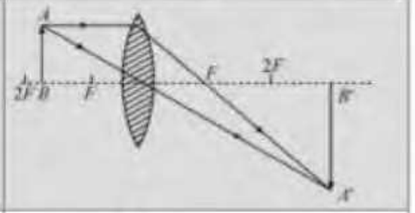
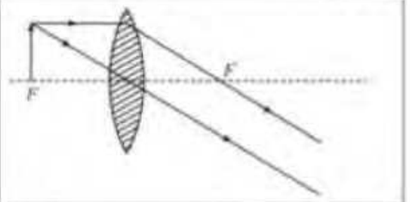
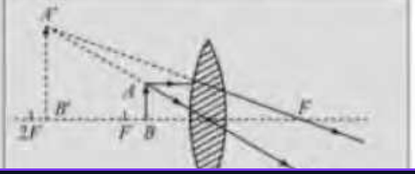
Ans 110

9. Point object O is placed at a distance of 20 cm from a convex lens of focal length 10 cm as shown in figure. At what distance x from the lens should a concave mirror of focal length 60 cm, be placed so that the final image coincides with the object?



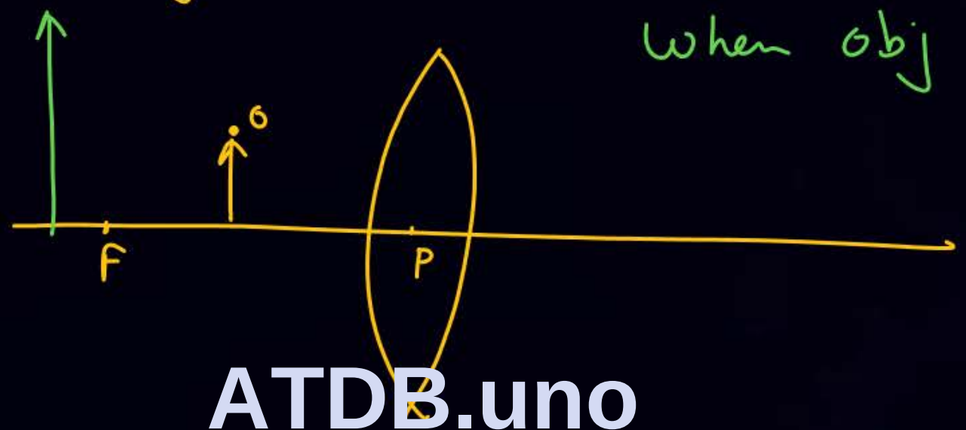
AM 20

For Convergent or Convex Lens

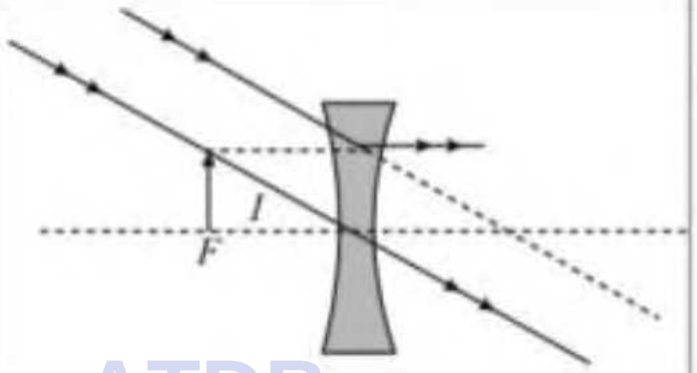
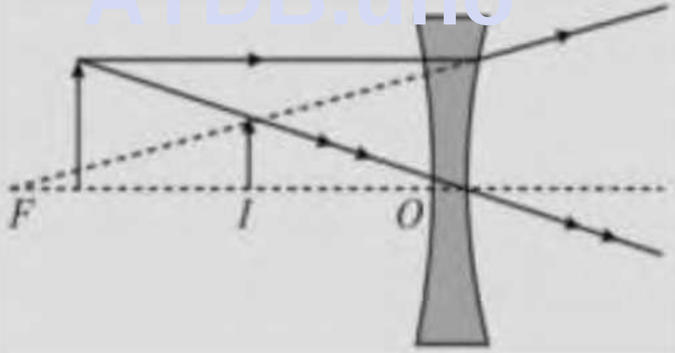
Position of Object	Position of Image	Real/ Virtual	Inverted/ Erect	Magnification and Size of Image	Sign of Magnification	Ray Diagram
at infinity ($u \to \infty$)	at focus ($v = f$)	real	inverted ($m < 0$)	$\|m\| << 1$ greatly diminished	negative	
beyond $2f$ ($\|u\| > 2f$)	between f and $2f$ ($f < v < 2f$)	real	inverted ($m < 0$)	$\|m\| < 1$ diminished	negative	
at $2f$ ($\|u\| = 2f$)	at $2f$ ($v = 2f$)	real	inverted ($m < 0$)	$\|m\| = 1$ same size	negative	
between f and $2f$ ($f < \|u\| < 2f$)	beyond $2f$ ($v > 2f$)	real	inverted ($m < 0$)	$\|m\| > 1$ magnified	negative	
at f ($\|u\| = f$)	at infinity ($v = \infty$)	real	inverted ($m < 0$)	$\|m\| \to \infty$ magnified	negative	
between optical centre and focus ($\|u\| < f$)	at a distance greater than the object distance and on the same side of object ($v > u$)	virtual	erect ($m > 0$)	$\|m\| > 1$ magnified	positive	

* Convex lens Real obj ⟶ Virtual image, enlarge

∴ When obj placed b/w F & P

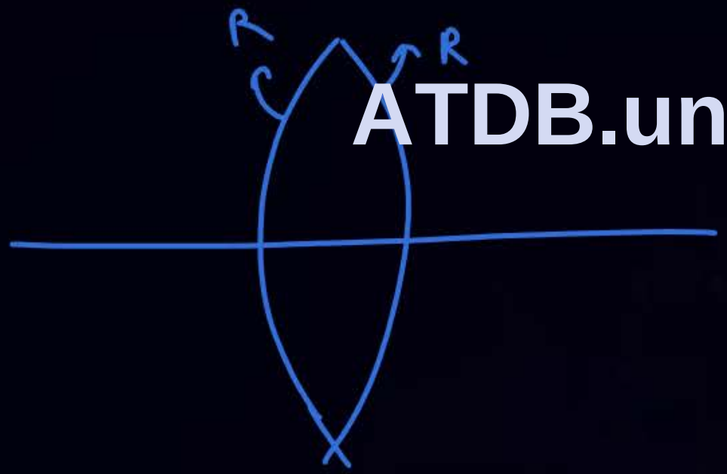


For Divergent or Concave Lens

S.No.	Position of Object	Position of Image	Ray Diagram	Nature of Image	Size
1.	At infinity	At F		Virtual, erect ($m > 0$)	Highly diminished ($\|m\| << +1$)
2	In front of lens	Between F and optical centre		Virtual, erect ($m > 0$)	Diminished ($\|m\| < +1$)

Double convex lenses are to be manufactured from a glass of refractive index 1.5, with both faces of the same radius of curvature. What is the radius of curvature required if the focal length of the lens is to be 20 cm?

2mint



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

$$\frac{1}{20} = (1.5 - 1)\left(\frac{2}{R}\right)$$

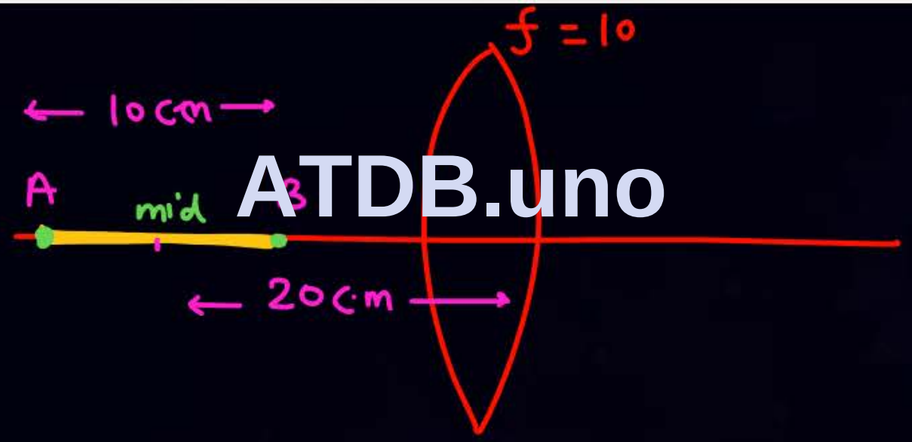
$$\frac{1}{20} = \frac{1}{2} \times \frac{2}{R}$$

$$R = 20$$

A pencil 10 cm long is placed along the axis of a convex lens of focal length 10 cm, such that the middle point of the pencil is at a distance of 20 cm from the lens. Find the length of the image of the pencil.

for B

$u = -15$, $f = +10$ $\Rightarrow v = +30 \equiv B'$



Ans $A'B' \equiv 30 - \frac{50}{3}$

for A'

$u = -25$, $f = +10$ $\rightarrow v = \frac{50}{3} \equiv A'$

note

Q An obj is placed at a distance 150 cm from screen and a convex lens is placed between obj & screen such that magnification is 4. find focal length of lens.

Sol^n (R.O, R.I)

$u<0$
$v>0$

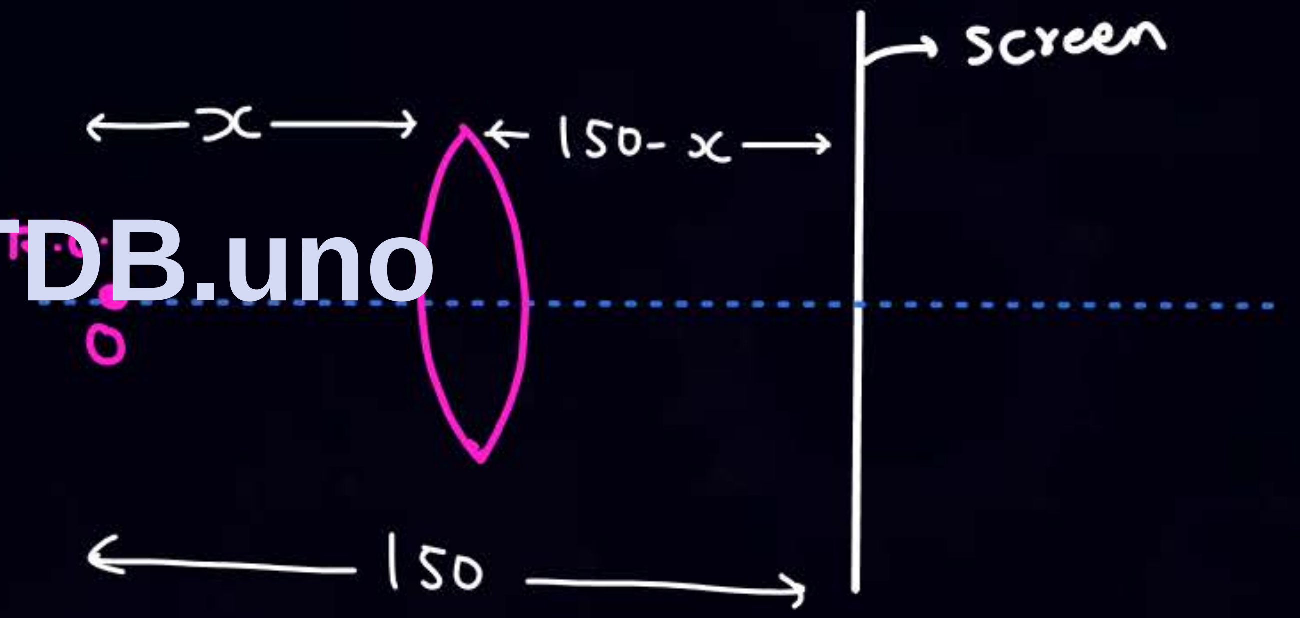
$m = \frac{v}{u}$, $m<0$

$m = 4$ ✗

$m = -4$ ✓

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

$\frac{1}{+(150-x)} - \frac{1}{-x} = \frac{1}{f}$ —— (1)

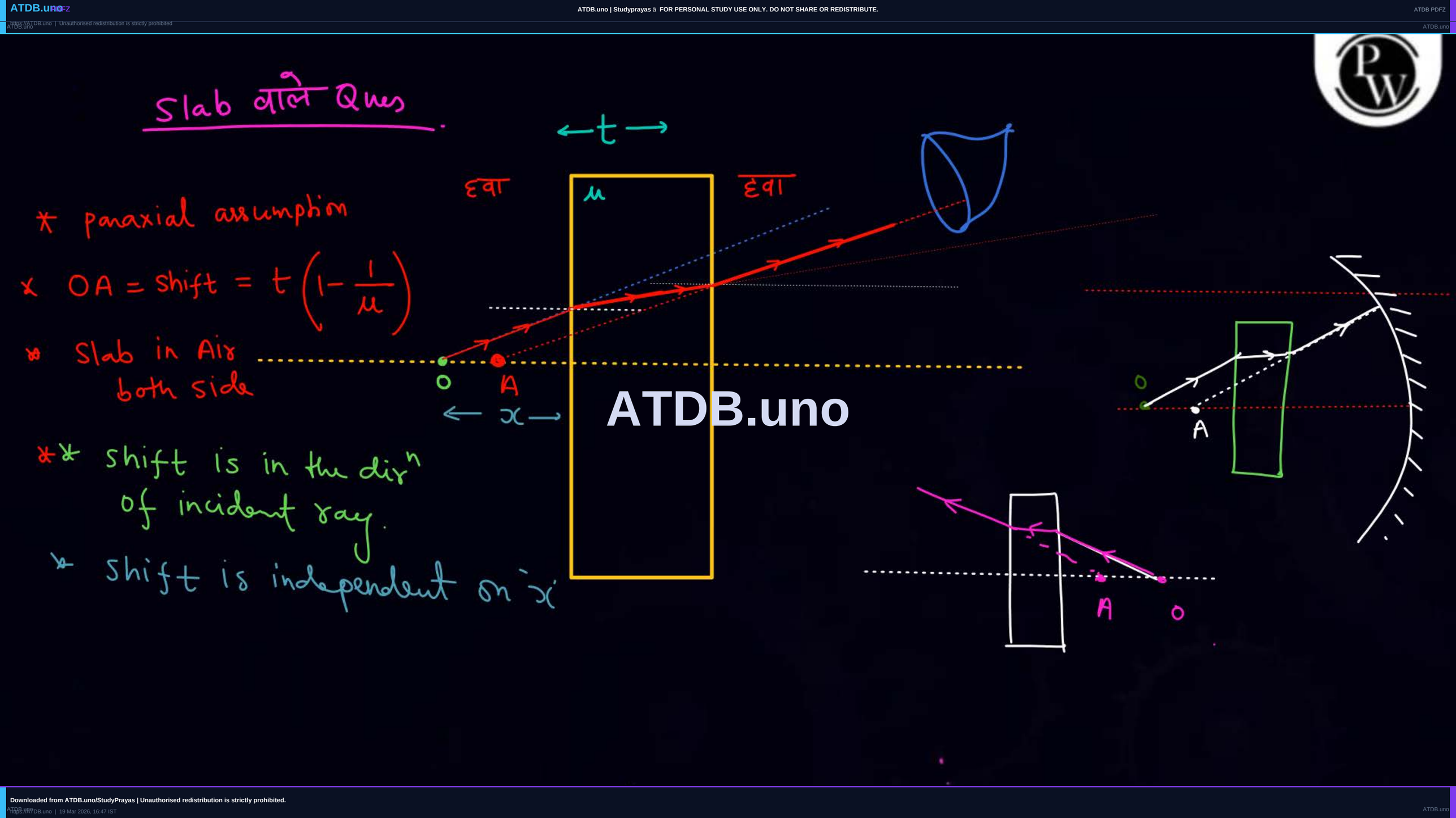


$m = -4 = \frac{+(150-x)}{-x}$ —— (2)

$m = \frac{v}{u}$ withsign

Ans 24 cm

Slab वाले Ques.



* paraxial assumption

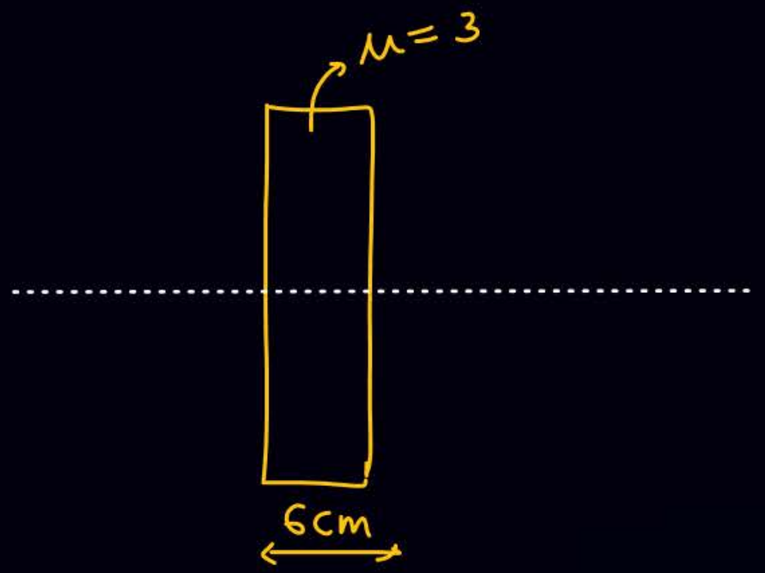
× $OA = \text{shift} = t\left(1 - \frac{1}{\mu}\right)$

* Slab in Air both side

** shift is in the dir^n of incident ray.

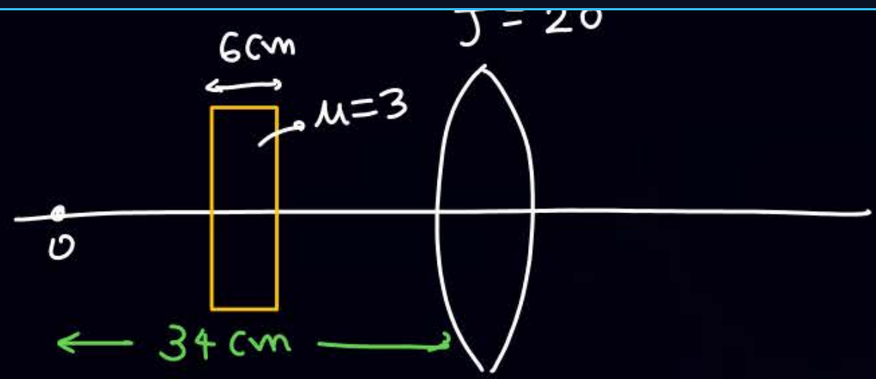
* shift is independent on x

Q



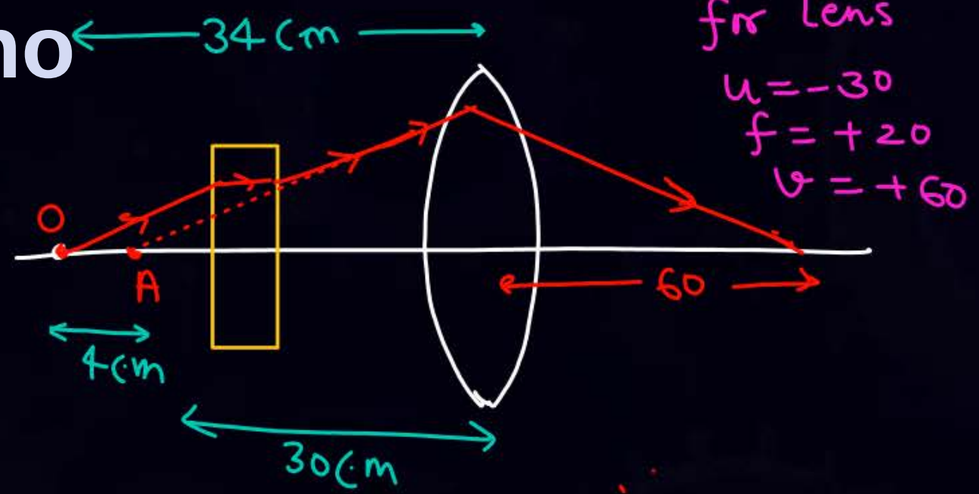
$$\text{Shift} = t\left(1-\frac{1}{\mu}\right)$$
$$= 6\left(1-\frac{1}{3}\right) = 4\,cm$$

Q



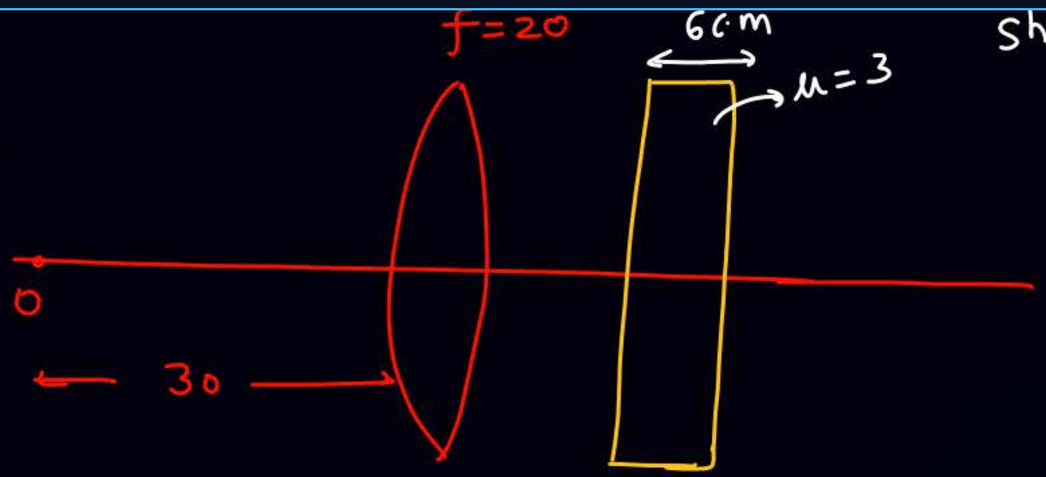
Find location of image

Soln $\text{Shift} = t\left(1-\frac{1}{\mu}\right) = 6\left(1-\frac{1}{3}\right) = 4\,cm$



for lens
u = −30
f = +20
v = +60

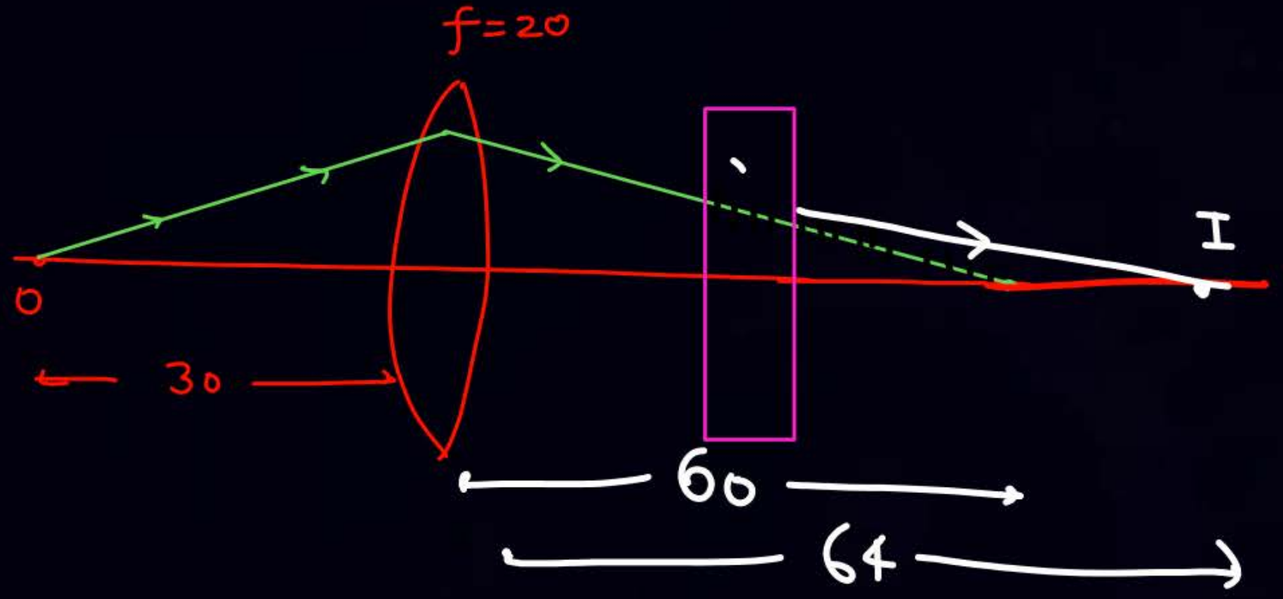
Shift = 6(1 − 1/3) − ...



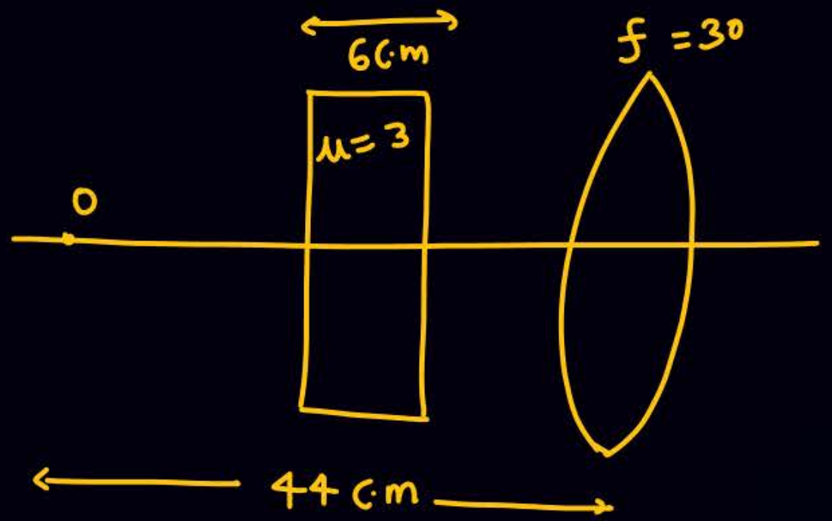
Q

find location of final image

Soln



Q



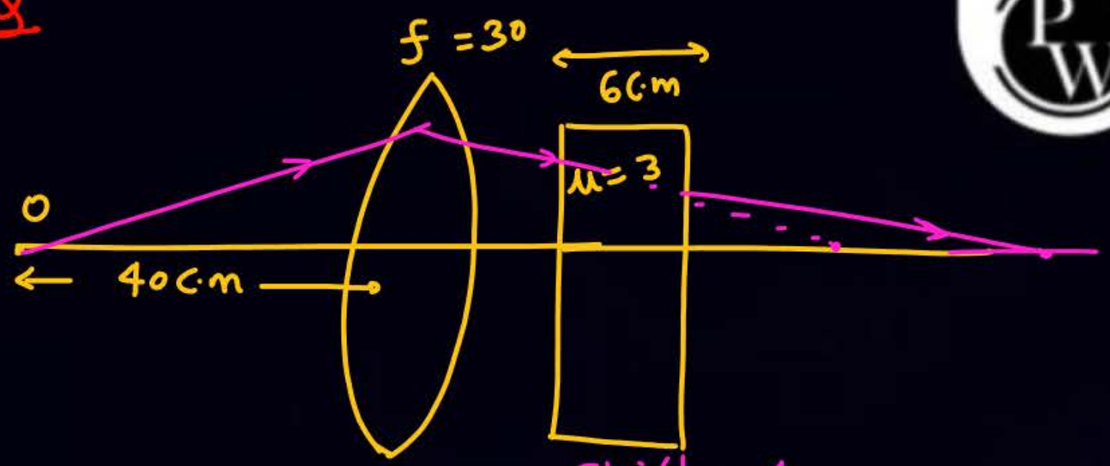
Shift = 4cm

for lens $u = -(44-4) = -40$

$f = +30$

$v = +120$

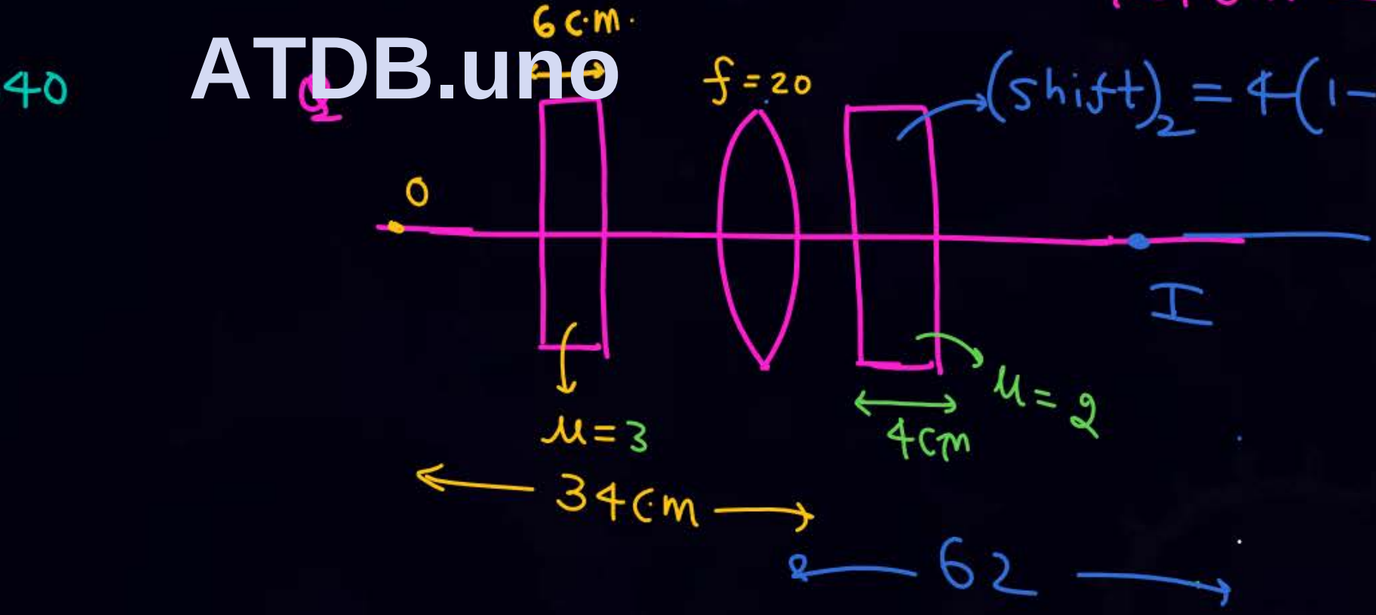
Q



Shift = 4cm

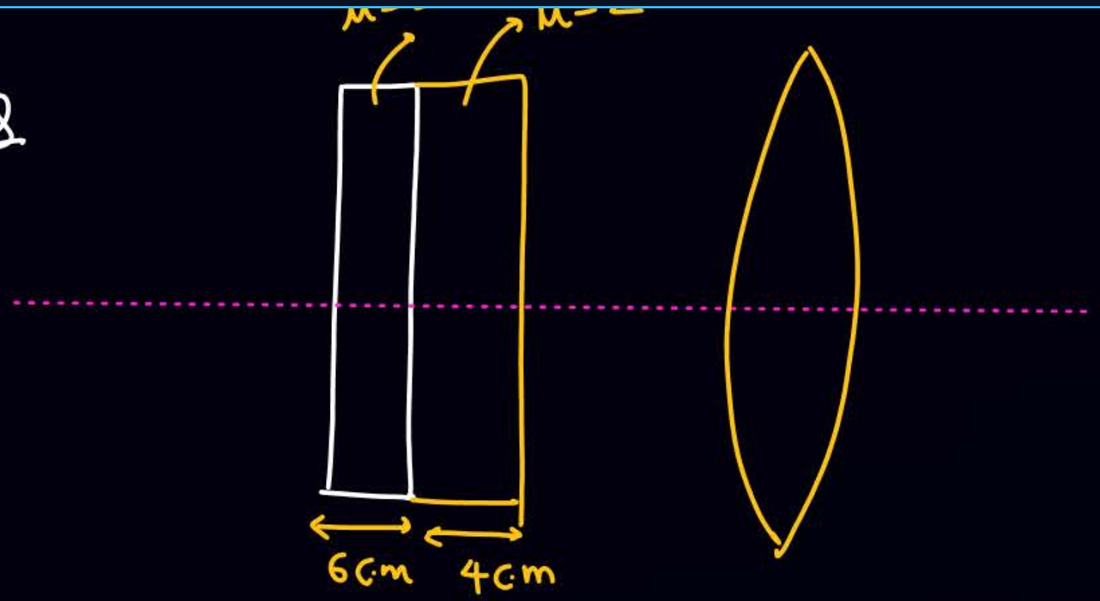
124cm

Q



$(shift)_2 = 4\left(1-\frac{1}{2}\right) = 2$

Q

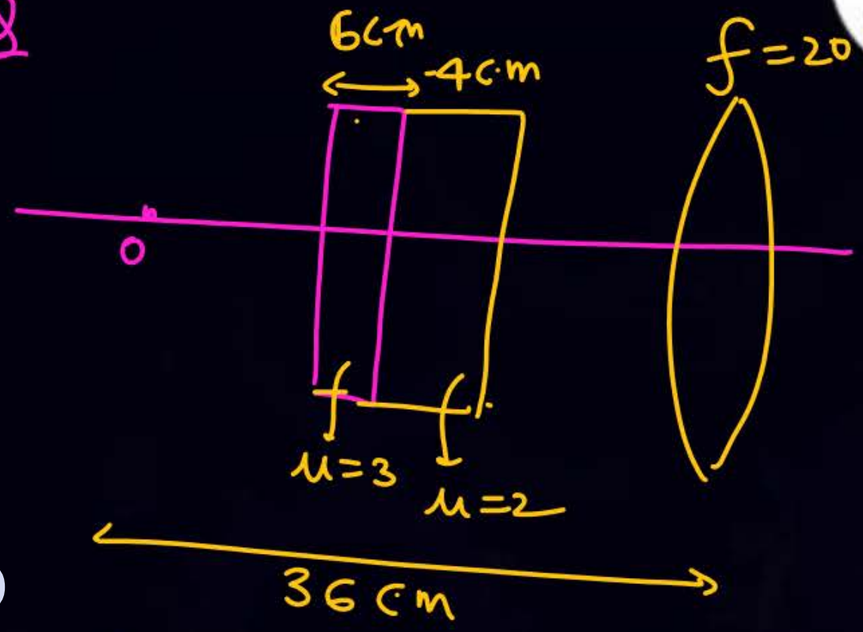


$$(\text{Shift})_{net} = (\text{Shift})_1 + (\text{shift})_2$$

$$= 6\left(1-\frac{1}{3}\right) + 4\left(1-\frac{1}{2}\right)$$

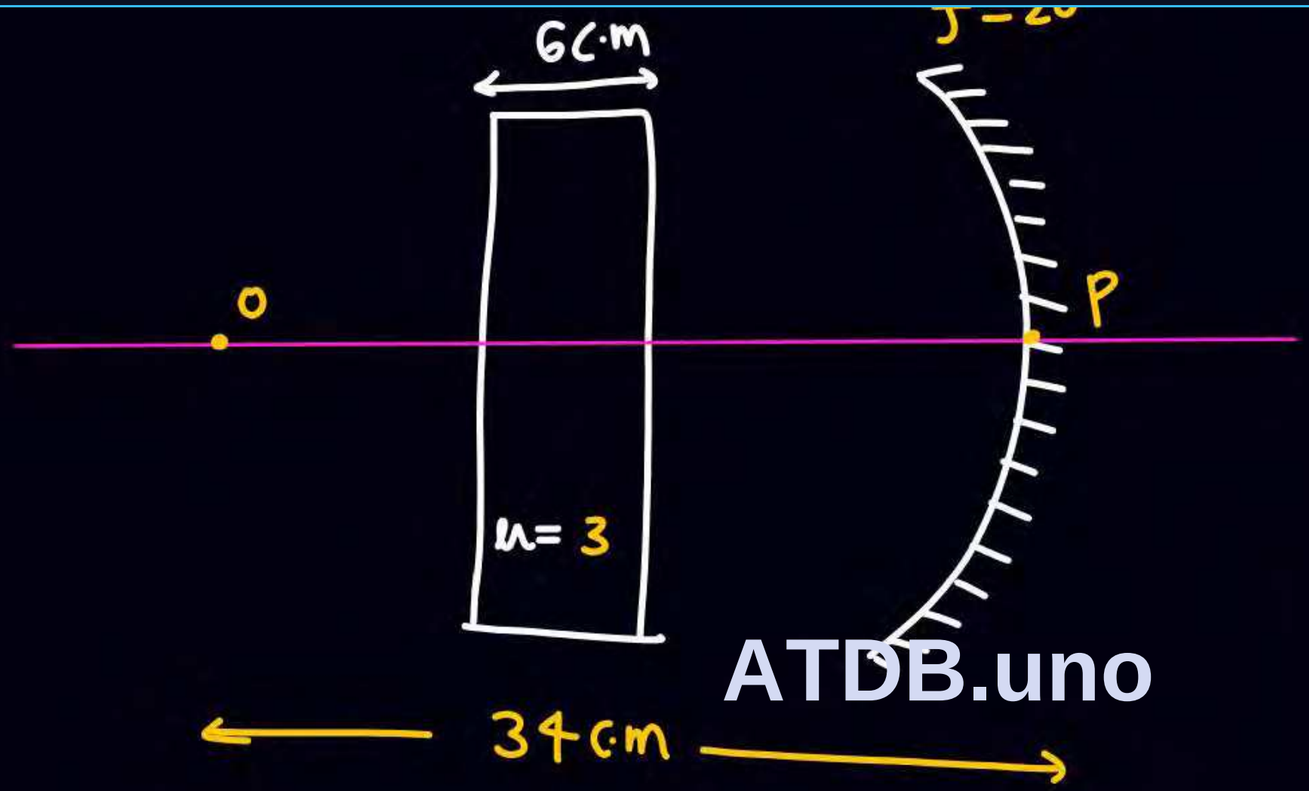
$$= 4+2 = 6\ \text{cm}$$

Q



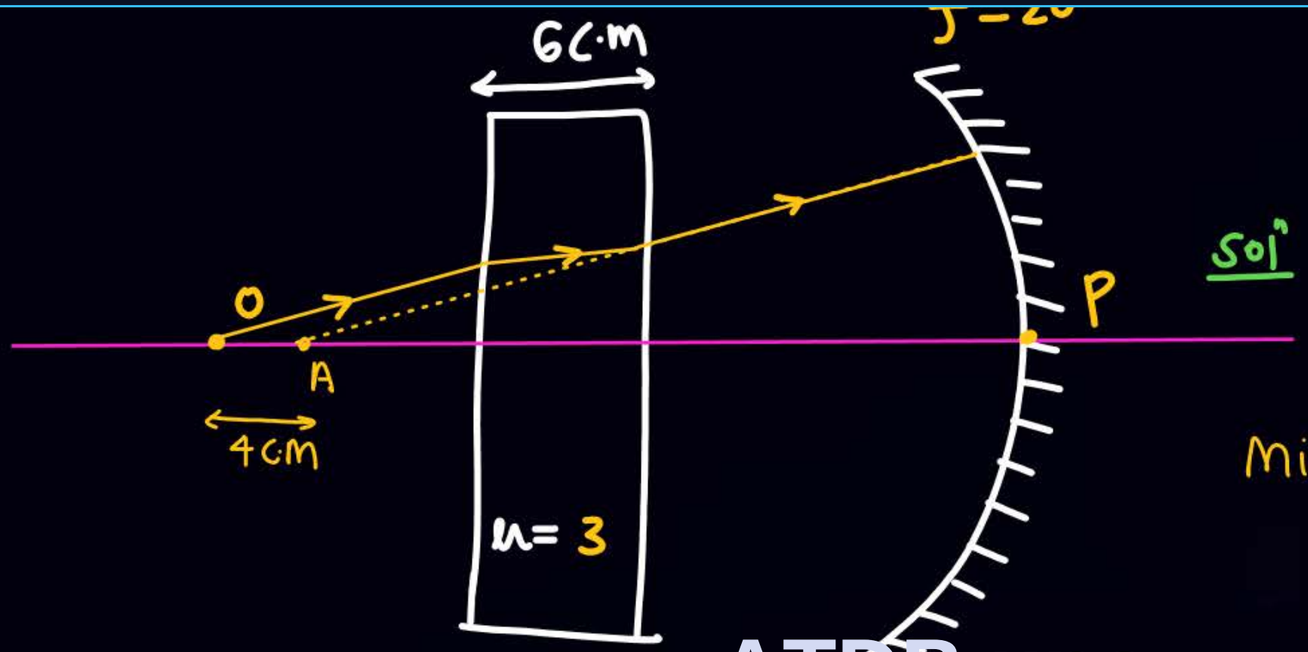
$$(\text{Shift})_{net} = 4+2 = 6$$

$$\left.\begin{aligned} u &= -30 \\ f &= +20 \end{aligned}\right\} \quad v = +60$$



final image location from p' will be

Q



final image location from p' will be

Shift = $6\left(1-\frac{1}{3}\right) = 4$ c·m

Mirror

$u = -30$
$f = -20$

34 c·m