Ray Optics 01 : Introduction

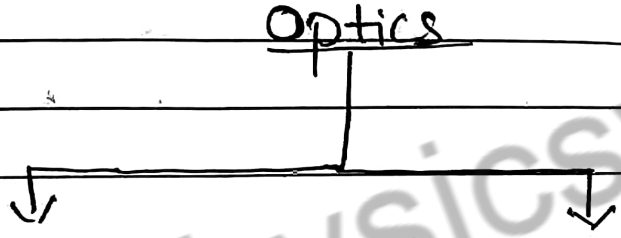
Reflection in a Plane Mirror

⇒ Study of light is called as optics

⇒ Light is that part of ElectroMagnetic Spectrum which helps us to see Objects

4000A° – 7800A°

Gamma Rays	X rays	U V rays	visible (Light)	I.R	M.W	Radio waves

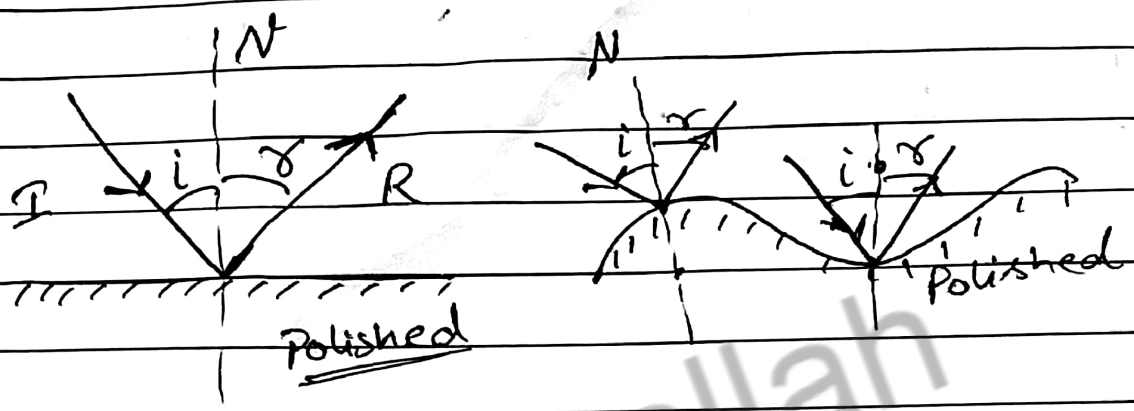


Geometrical optics (Ray optics)	wave optics
dimensions of Object very large compared to wavelength of light → Mirrors / Lenses / Prism / Telescope etc	dimensions of Object comparable to wavelength of light. → small aperture Interference / Diffraction / Polarisation, etc

Light always travel in Straight Line

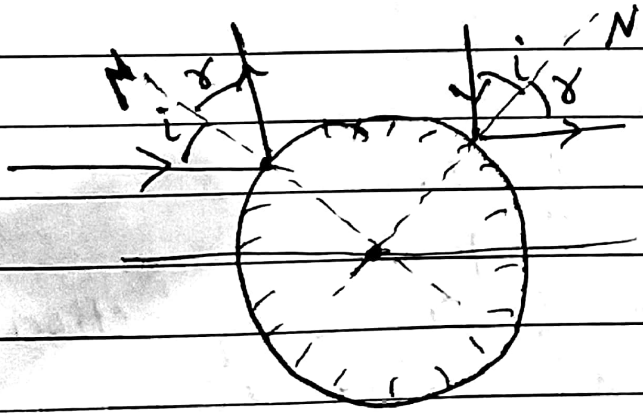
The path of light is called Ray & bundle of rays are called beam of light.

Reflection:



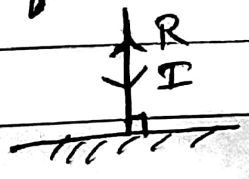
Laws of Reflection:

1. $\angle i = \angle r$
2. Incident ray, Normal & reflected ray lie in same plane at the point of incidence.



$\angle i = \angle r$ for reflection at any surface.

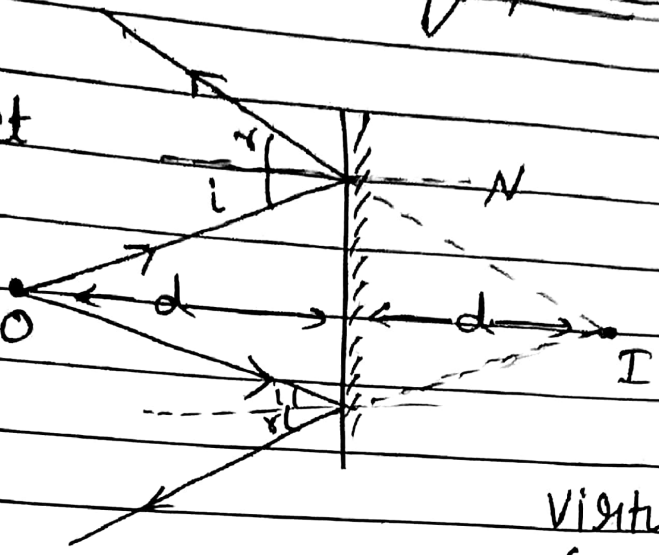
Note: for normal incidence $\angle i = \angle r = 0$



$\angle i = 0, \angle r = 0$

Image formation by plane Mirror

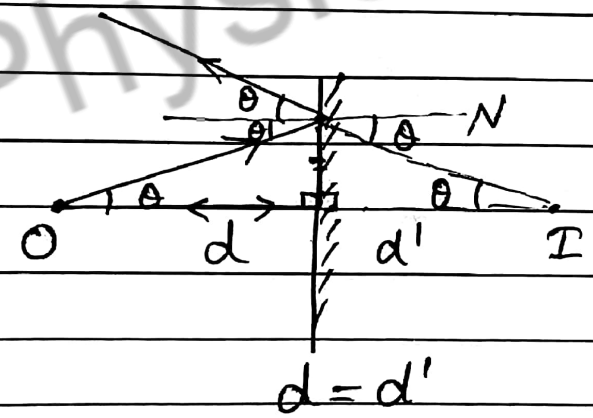
① Point object



Virtual image
(as rays appear to meet)

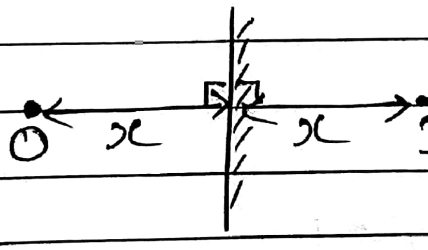
Note: For plane mirror, image is formed as far behind the mirror as the object is infront of it.

Proof:

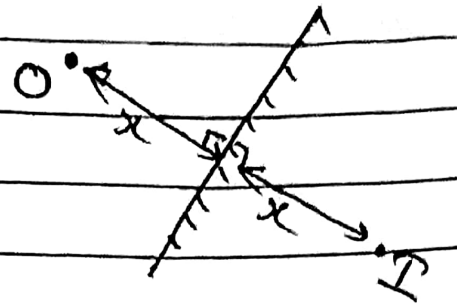


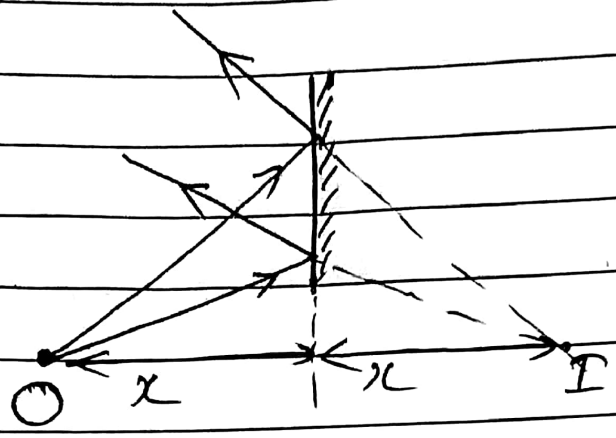
$d = d'$

To draw image for Plane mirror:

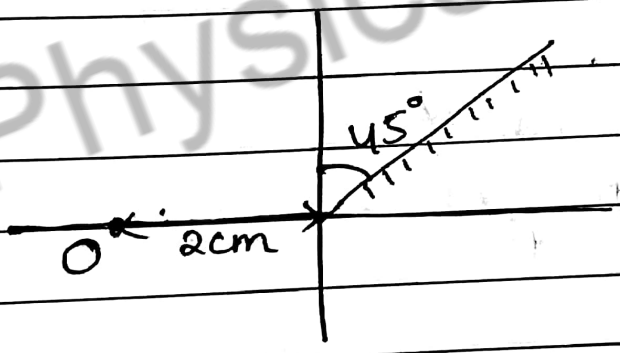


Object se Mirror pe Perpendicular gira kar utne hi distance pe Image bana do

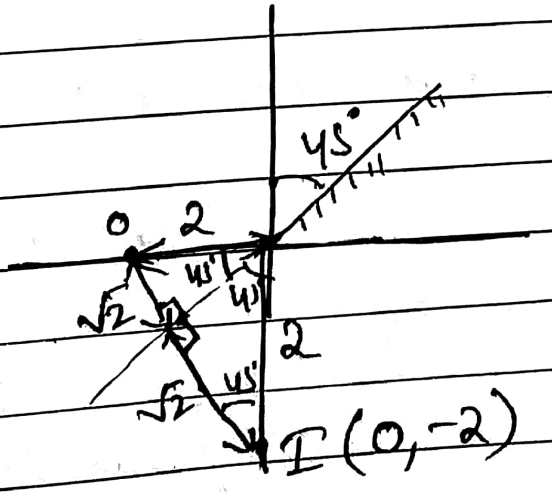




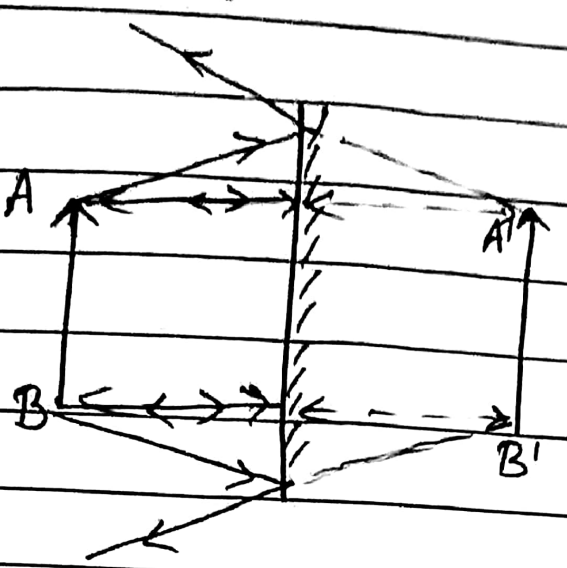
Q) Find the co-ordinates of image



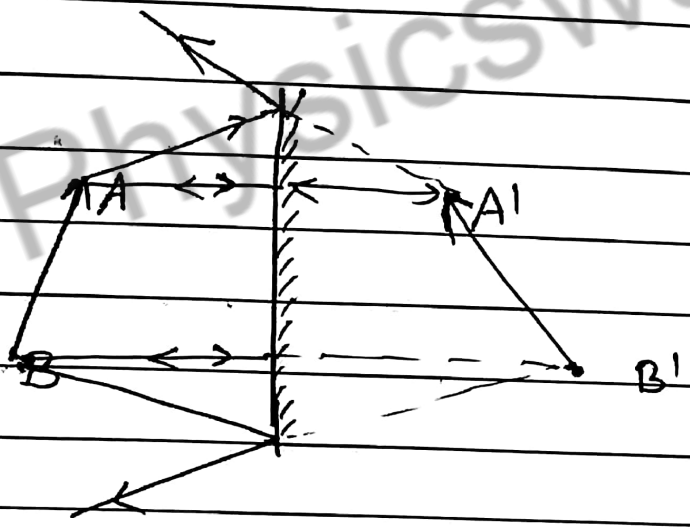
Solution



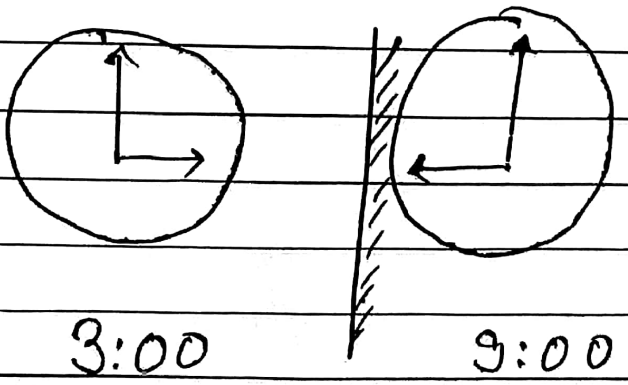
② Extended Object.



- Image is of same size
- Image is Upright o Erect.



Clock Problems

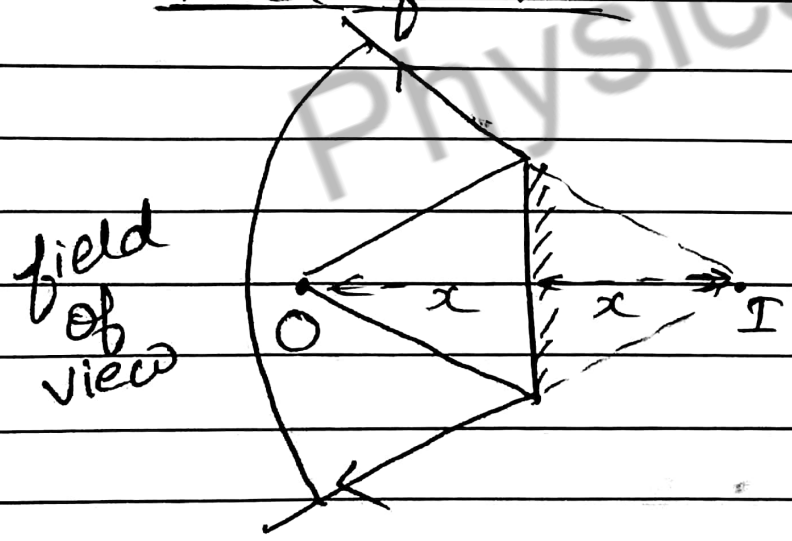


Trick: subtract given time from 12:00:00

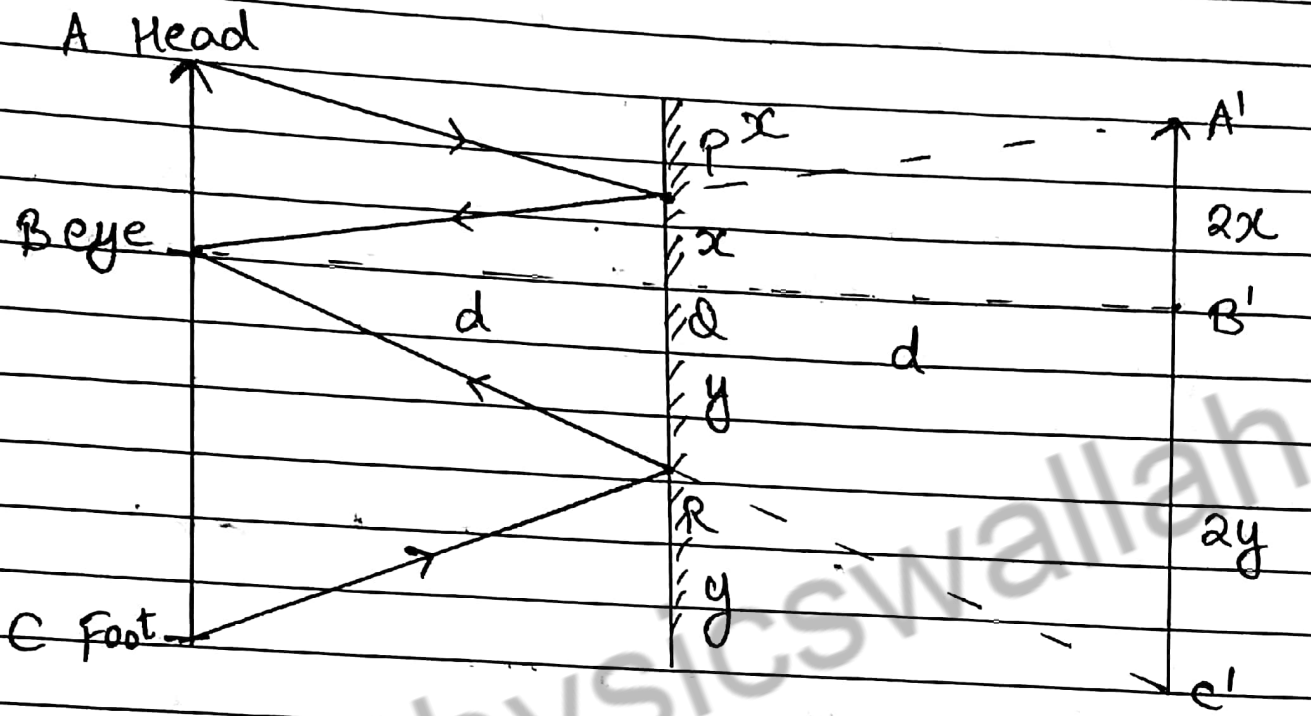
Q) Find the time shown in mirror by a clock which reads 2:35:15

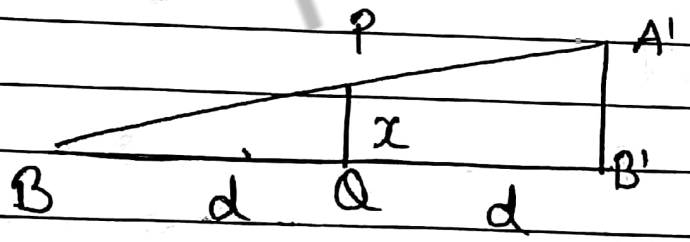
Ans
$$\begin{array}{r} 12:00:00 \\ - \quad 2:35:15 \\ \hline 9:24:45 \end{array}$$

Field of View



Q1) A boy of height 'H' wants to see his complete image in a mirror. Find the minimum length of mirror required

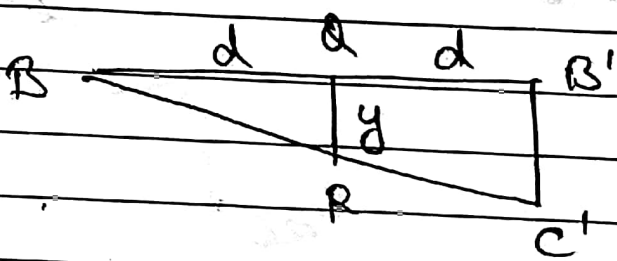




$$\frac{A'B'}{PQ} = \frac{BB'}{BQ}$$

$$\frac{A'B'}{x} = \frac{2d}{d}$$

$$A'B' = 2x$$



$$\frac{B'C'}{QR} = \frac{BB'}{BQ}$$

$$\frac{B'C'}{y} = \frac{2d}{d}$$

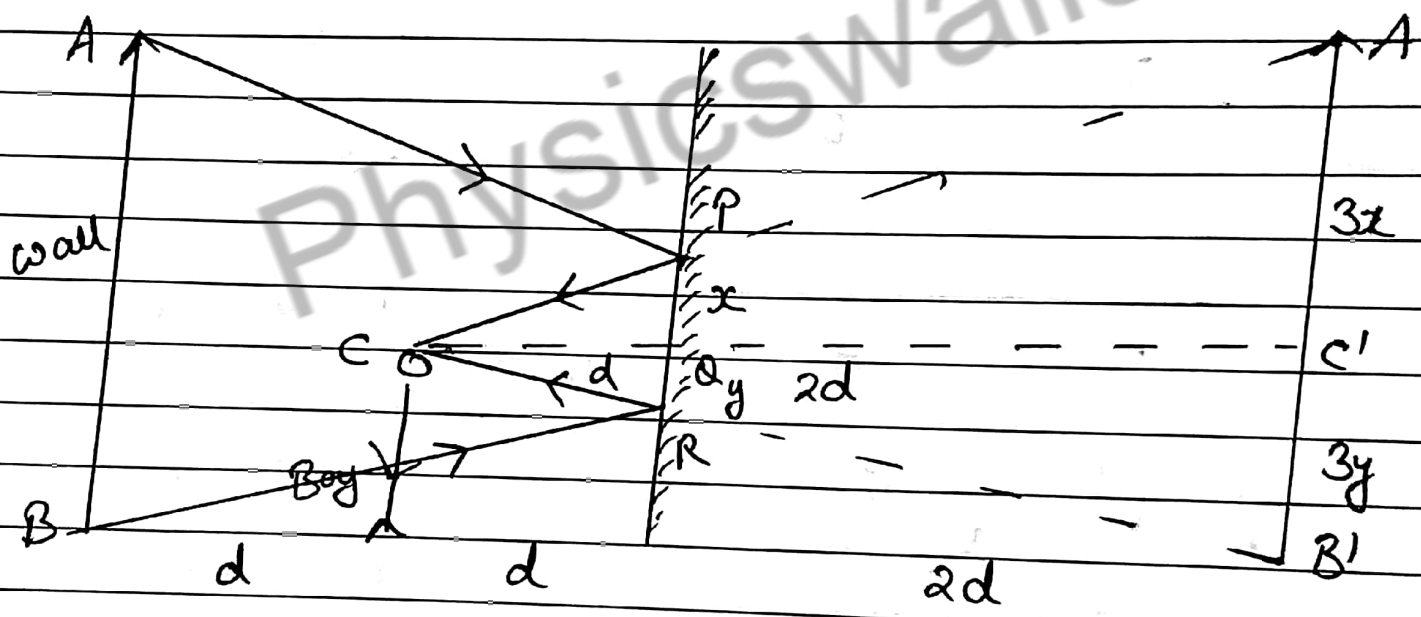
$$B'C' = 2y$$

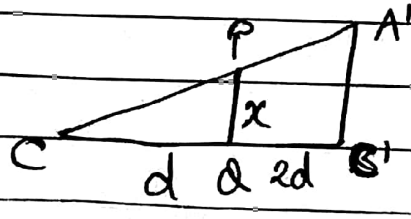
Height of boy = $AC = A'C' = 2x + 2y = H$

Height of mirror required = $PR = x + y = \frac{H}{2}$

At least half the height of boy

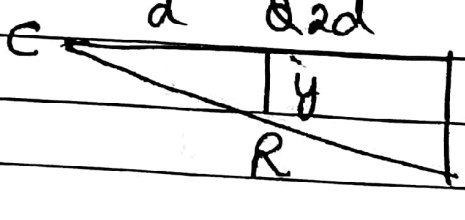
(Q2) A boy is standing midway between a wall of Height 'H' and a plane mirror. Find the minimum length of mirror required to see the complete image of wall.





$\frac{A'C'}{x} = \frac{3d}{d}$

$A'C' = 3x$



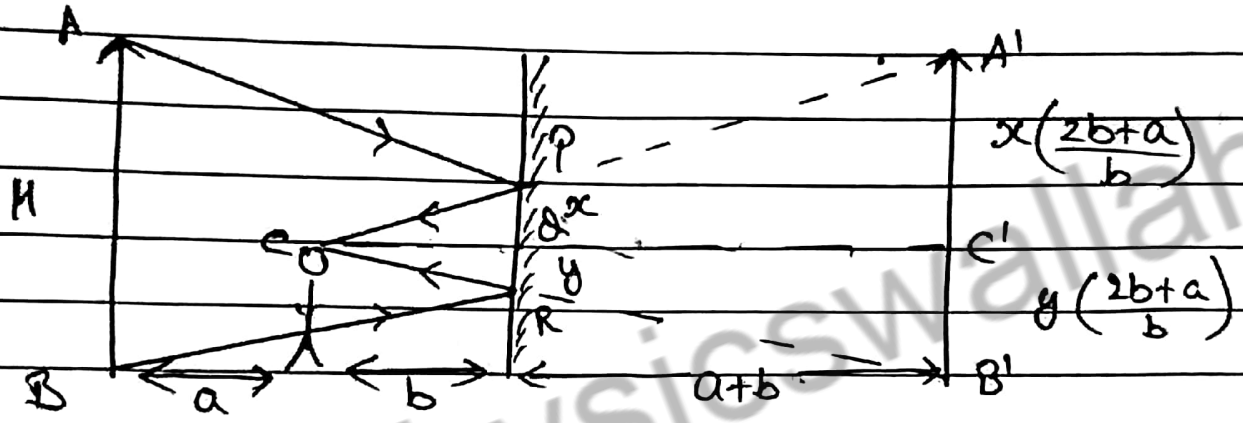
$\frac{C'B'}{y} = \frac{3d}{d}$

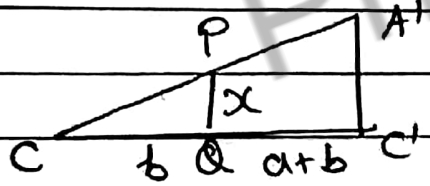
$C'B' = 3y$

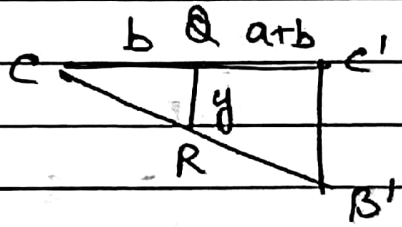
Height of wall = $AB = A'B' = 3x + 3y = H$

Height of mirror required = $x + y = \frac{H}{3}$

Q3) Find the minimum length of mirror required to see full image of wall of height 'H'







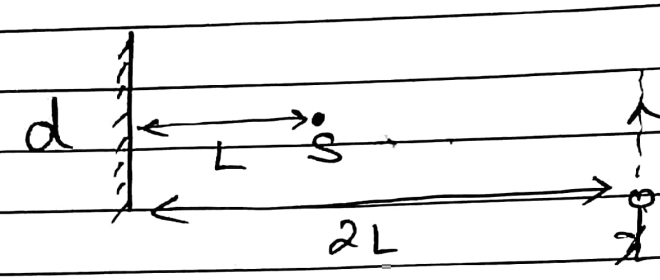
$$\frac{A'C'}{x} = \frac{2b+a}{b} \qquad \frac{C'B'}{y} = \frac{2b+a}{b}$$

$$A'C' = x\left(\frac{2b+a}{b}\right) \qquad C'B' = y\left(\frac{2b+a}{b}\right)$$

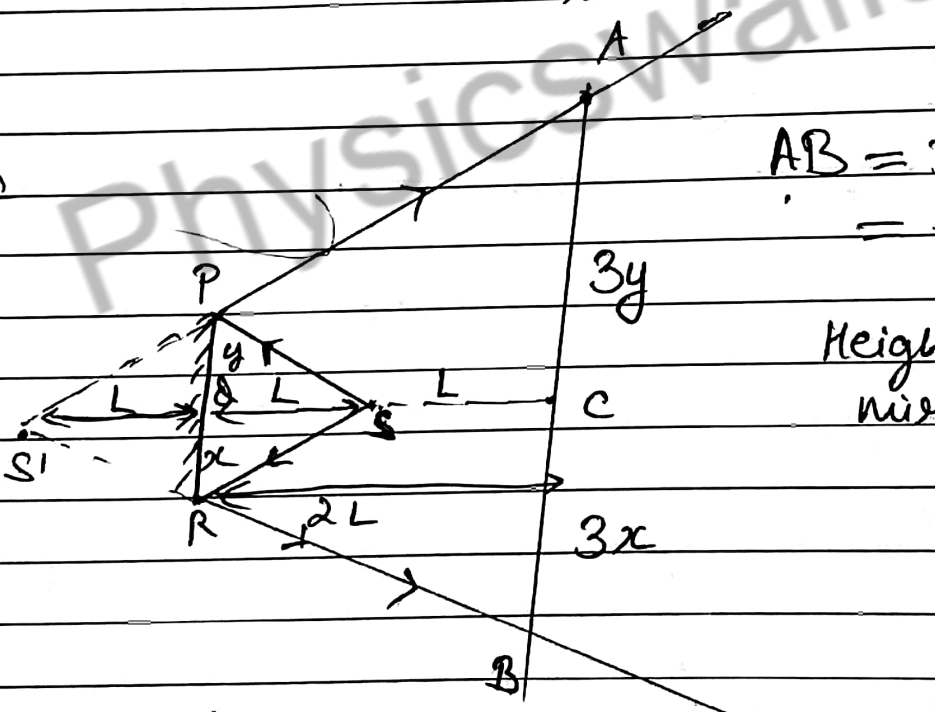
Height of wall = $(x+y)\left(\frac{2b+a}{b}\right) = H$

Height of mirror required = $x + y = \frac{Hb}{2b+a}$

Q4) S is a point source of light placed at centre of mirror at distance 'L' from mirror. A man walks infront of the mirror along a line parallel to the mirror at a distance '2L' from it as shown. The greatest distance over which he can see the image of light source in the mirror is



Solution



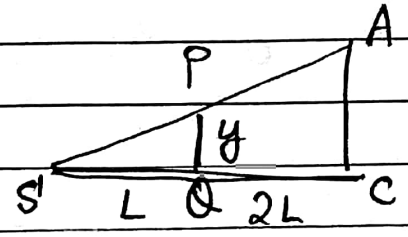
$AB = 3x + 3y$

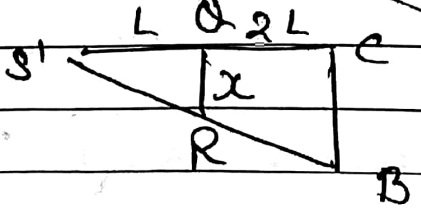
$= \frac{3d}{2} + \frac{3d}{2} = 3d$

Height of mirror $= y + x$

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

$= d$





$\frac{AC}{y} = \frac{3L}{L}$

$AC = 3y$

$\frac{CB}{x} = \frac{3x}{L}$

$CB = 3x$