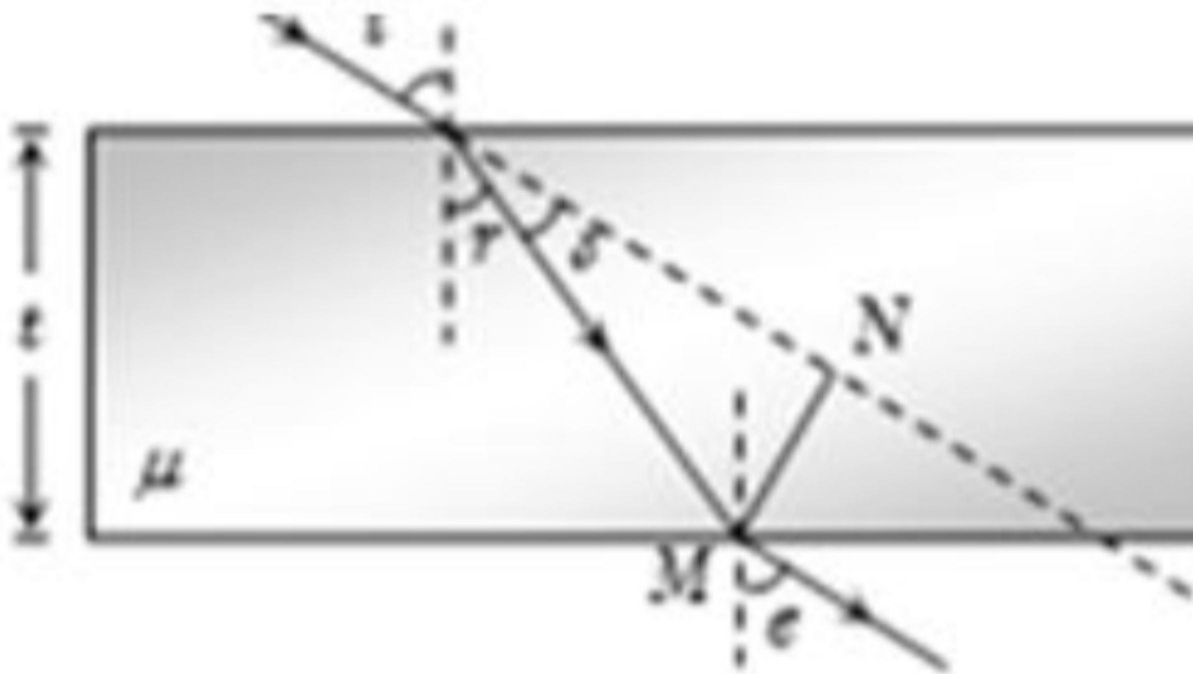
Refraction through a glass slab

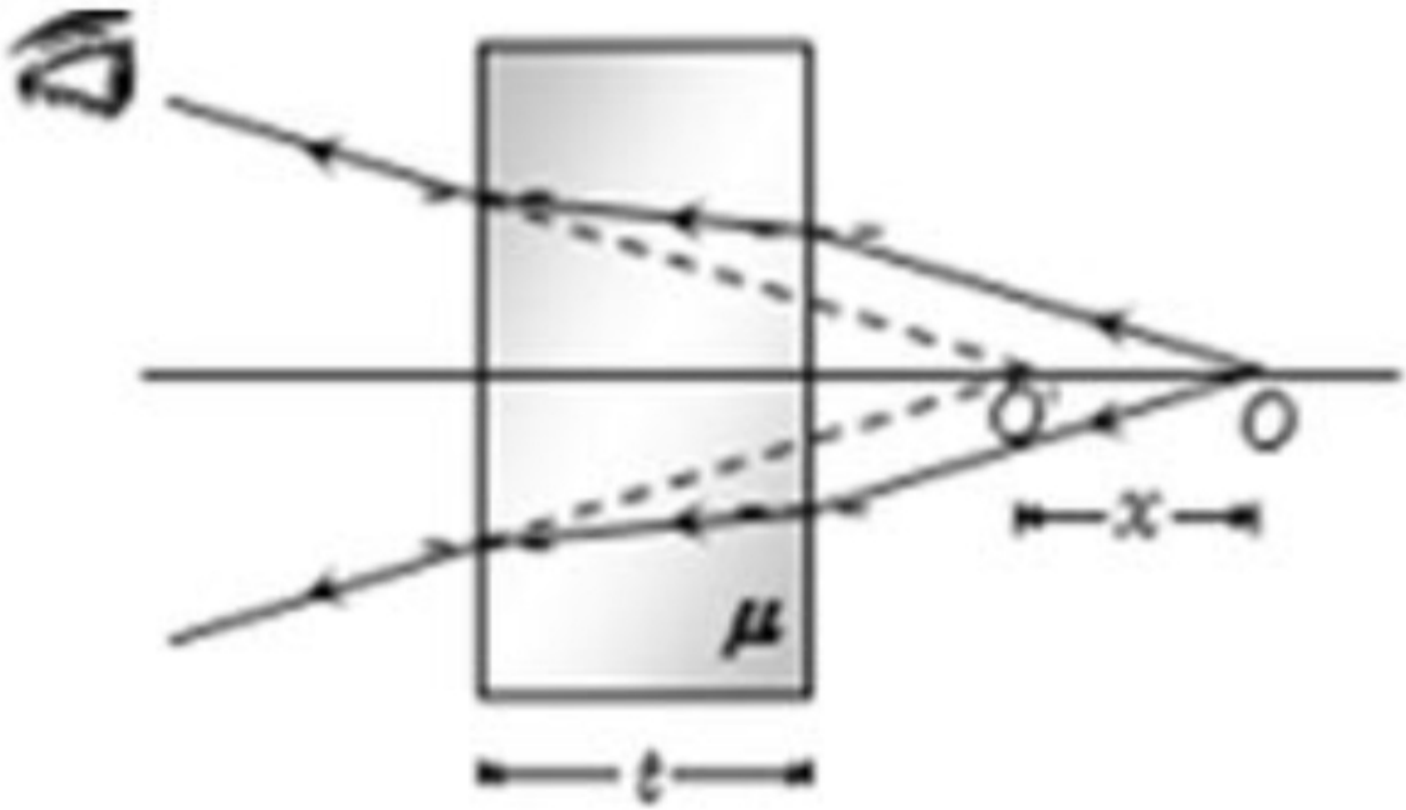
(1) Lateral Shift: The refracting surfaces of a glass slab are parallel to each other. When a light ray passes through a glass slab it is refracted twice at the two parallel faces and finally emerges out parallel to it's incident direction i.e. the ray undergoes no deviation $\delta = 0$. The angle of emergence (e) is equal to the angle of incidence (i)



The Lateral shift of the ray is the perpendicular distance between the incident and the emergent ray, and the given by

(2) Normal shift: If a glass slab is placed in the path of a converging or diverging beam of light then point of convergence or point of divergence appears to be shifted shown

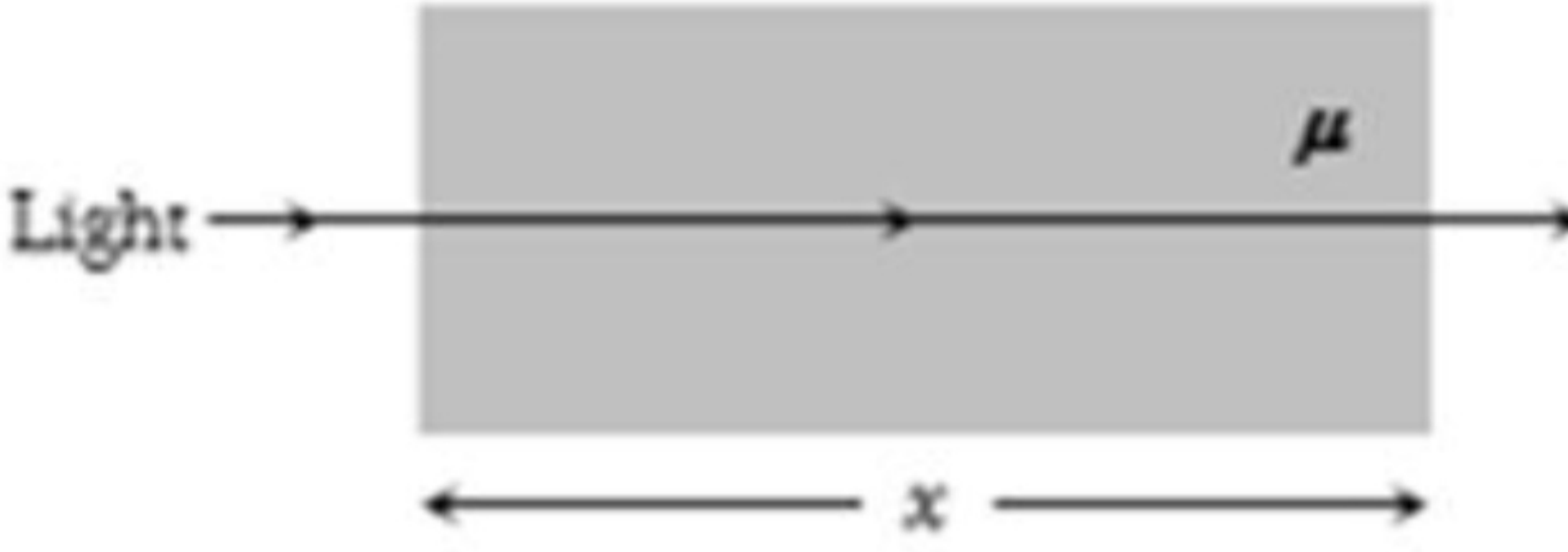
Normal shift:



$$OO' = x = \left(1 - \frac{1}{\mu}\right) t$$

(3) Optical path: It is defined as distance travelled by light in vacuum in the same time in which travels a given path length in a medium.

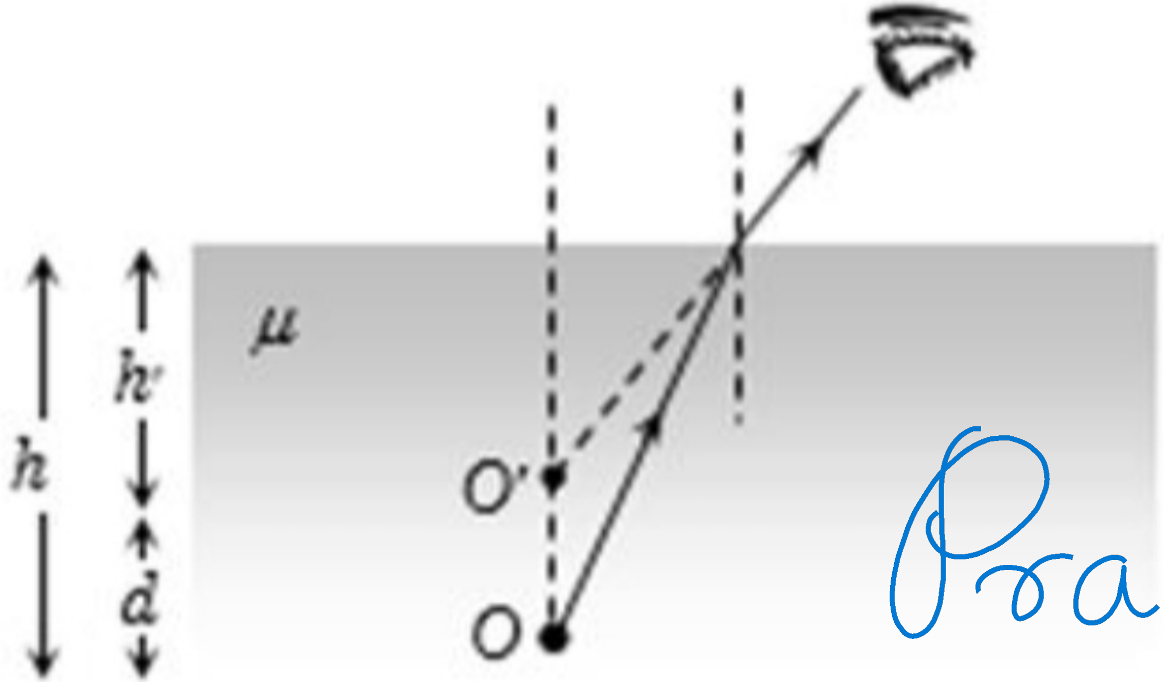
Time taken by light ray to pass through the medium $= \frac{\mu x}{c}$; where x = geometrical path and μx = optical path



Real and Apparent Depth

If object and observer are situated in different medium then due to refraction, object appears to be displaced from it’s real position.

(1) When object is in denser medium and observer is in rarer medium



Pravith

(i) $\mu = \dfrac{Real\ depth}{Apparent\ depth} = \dfrac{h}{h^1}$

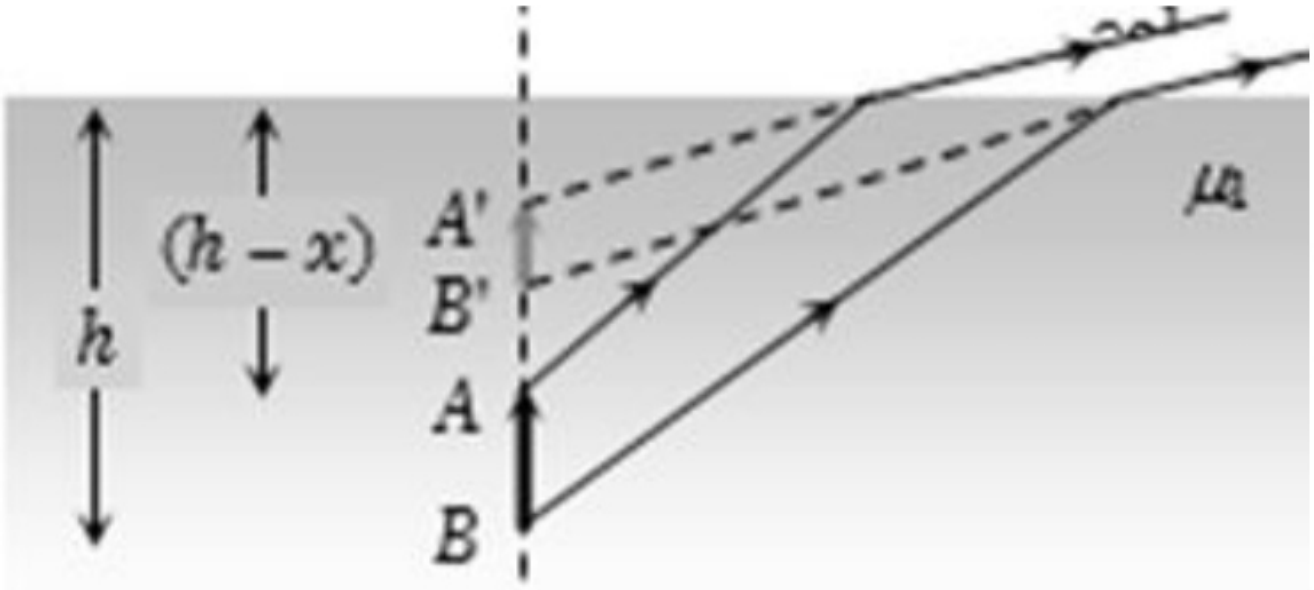
(ii) Real depth > Apparent depth

(iii) Shift $d = h - h = \left(1 - \frac{1}{\mu}\right)h.$

For water $\mu = \frac{4}{3} \Rightarrow d = \frac{h}{4};$
For Glass $\mu = \frac{3}{2} \Rightarrow d = \frac{h}{3}$

(iv) Lateral magnification :
consider an object of height x placed vertically in a medium μ such that the lower end (B) is a distance h from the interface and

the upper end (A) at a distance (h-x) from the interface.



Distance of image of B (i.e. B') from the interface $= \frac{\mu_2}{\mu_1} h$

Distance of image of A (i.e. A') from the interface $= \frac{\mu_2}{\mu_1}\left(h - x\right)$

Therefore, length of the images

$$= \frac{\mu_2}{\mu_1}x$$

Or the lateral magnification of the object $m = \frac{\mu_2}{\mu_1} = \frac{1}{\mu}$

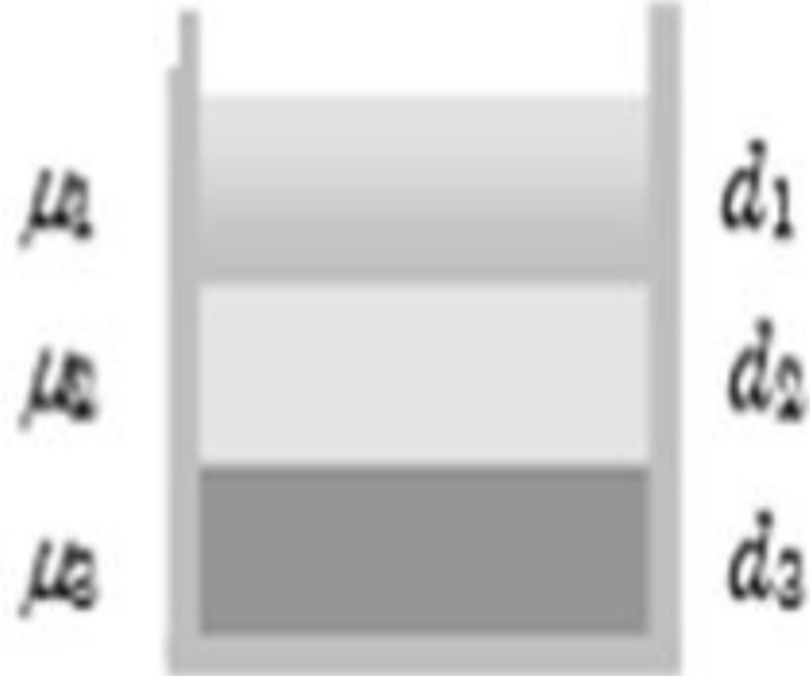
(v) If a breaker contains various

immiscible liquid as shown then

Apparent depth of bottom

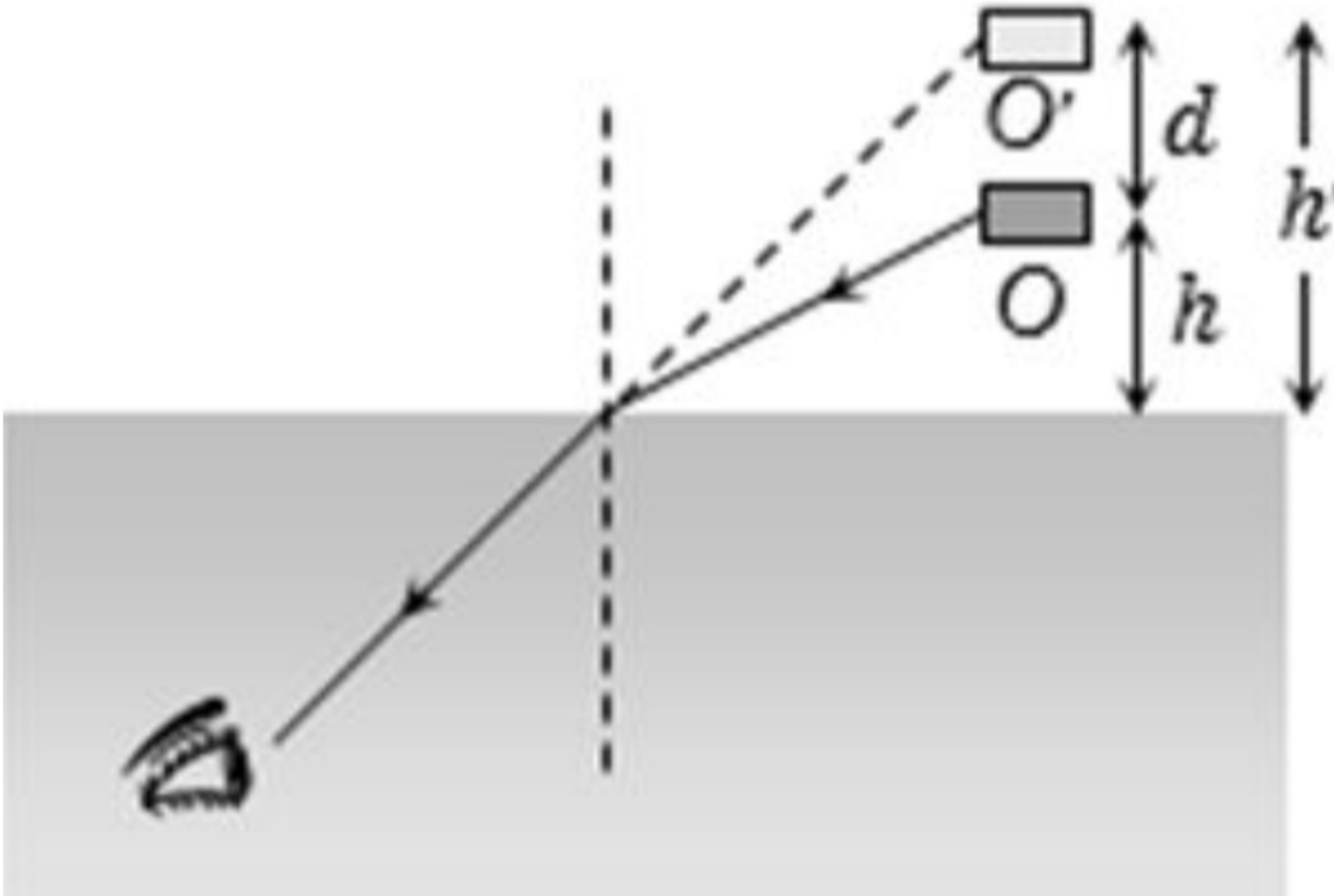
$$= \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} + \frac{d_3}{\mu_3}$$

$$\mu\, compention = \frac{d_{AC}}{d_{APP.}} = \frac{d_1 + d_2 + \dots}{\frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} + \dots}$$



(In case of two liquids if $d_1 = d_2 than\ \mu = \frac{2\mu_1\mu_2}{\mu_1+\mu_2}$)

(2) Object is in rarer medium and observer is in denser medium



(i) $\mu = \frac{h}{h}$

(ii) Real depth < Apparent depth

(iii) $+d = (\mu - 1)h$

(iv) Shift for water $d_w = \frac{h}{3}$; Shift for glass $d_g = \frac{h}{2}$