UNIT 6

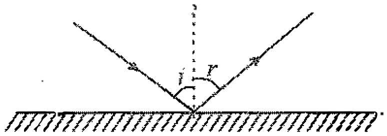
OPTICS

REFLECTION OF LIGHT

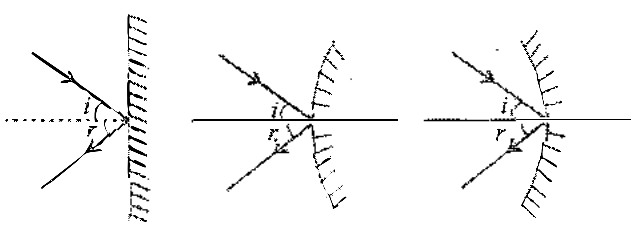
- Reflection is the phenomenon by virtue of which a light beam after interacting with a surface separating the two different media bounces back into the same medium.

Laws of Reflection

- First law of reflection states that the incident ray, reflected ray and normal to the surface lie in the same plane.

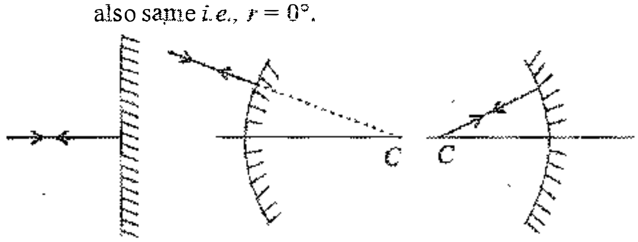


- Second law of reflection states that angle of reflection is equal to angle of incidence.
    - These laws of reflection hold true for regular reflection at all kind of surfaces *i.e.*, plane or curved.



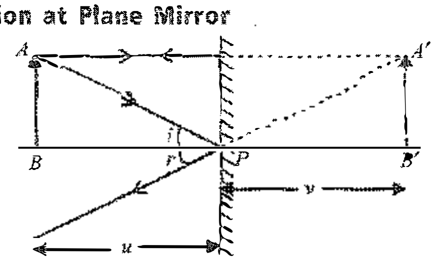
Plane mirror Convex mirror Concave mirror

- For angle of incidence $i = 0°$, angle of reflection r is also same *i.e.*, $r = 0°$.

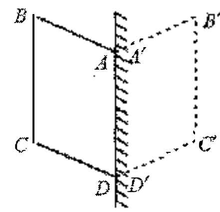


Plane mirror Convex mirror Concave mirror

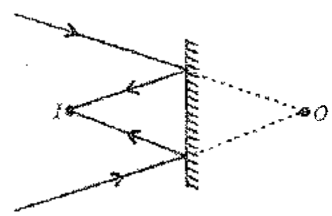
Reflection at Plane Mirror



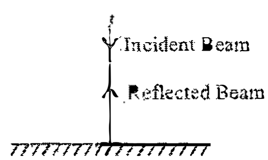
- Image formed by plane mirror is virtual, erect, of same size and is formed at same distance from the mirror as is the object *i.e.*, $u = v$.
- Image formed by plane mirror is laterally inverted, *i.e.*, right side of the object appears as the left side of the image and vice-versa.

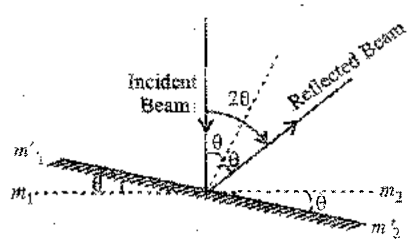


- A plane mirror can form a real image only when a convergent beam of light falls on the plane mirror.

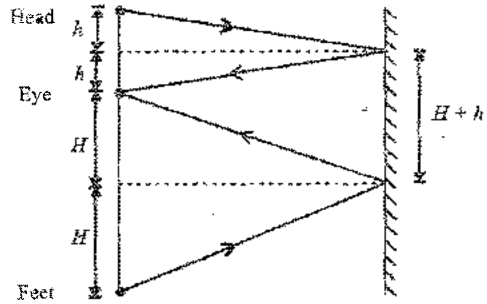


- On keeping the incident ray fixed, if the mirror is turned through an angle θ, then the reflected ray turns by an angle 2θ from its initial path.



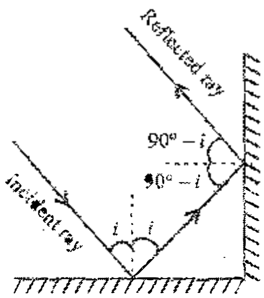


- To view full image, a person needs a plane mirror of length equal to half the height of person.

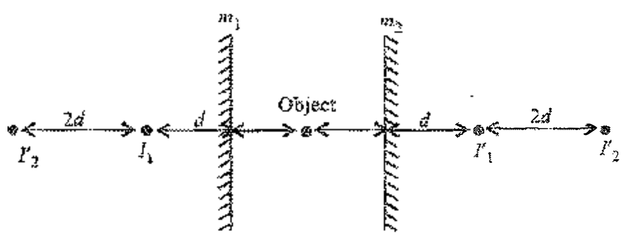


So, to observe the complete image of a person of height $2(H + h)$ the minimum height of mirror required is $(H + h)$.

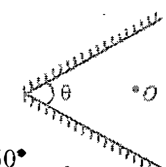
- If there are two plane mirrors perpendicular to each other, then the ray of light after suffering reflection from both the mirrors become antiparallel.



- If two plane mirrors are parallel to each other, then infinite images of an object placed between them are formed. If the first image is d distance behind the mirror, then all other consecutive images are $2d$ distance apart.



- If there are two plane mirrors inclined at angle θ with each other, then the number of possible images of a point object are :



(a) $n = m - 1$

if $m = \frac{360°}{\theta}$ is even number.

For example, if $\theta = 60°$ then $m = \frac{360°}{60°} = 6$

and $n = 6 - 1 = 5$

(b) $n = m$

if $m = \frac{360°}{\theta}$ is odd number.

For example, if $\theta = 72°$ then $m = \frac{360°}{72°} = 5$

and $n = 5$

(c) $n = \text{Int}[m]$

if $m = \frac{360°}{\theta}$ is a fractional number.

For example, if $\theta = 75°$ then $m = \frac{360°}{75°} = 4.8$

and $n = \text{Int}[4.8] = 4$

- If the reflecting surface is smooth, then the regular reflection take place and images can be formed, but if the surface is rough, diffused reflection take place where the reflected rays scatter in different directions so, the image cannot be formed by such reflection. This is why we can see our image while looking into a steel container but we do not observe the image while reading a news paper.

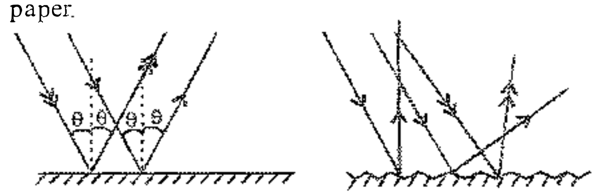
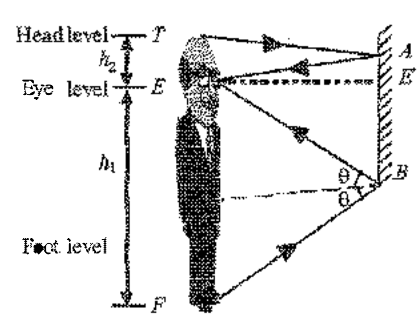


Illustration 1

What is the minimum length of a plane mirror required for a person to see his or her full image?

Soln.:



The total height of the person from top of the head T to bottom of the feet F is TF. E' is exactly appropriate to E, the eye level of the person.

From the foot F, the incident ray is reflected at B, the level end of the mirror to reach the eye level of the person at E. Due to incident ray equal to reflected ray, as shown by θ.

$$E'B = \frac{1}{2}EF = \frac{h_1}{2}$$

A similar argument proves $AE' = \frac{1}{2}TE = \frac{h_2}{2}$

Here height of the mirror to show a full-sized image of the person is only half sized *i.e.*,

$$AB = AE' + E'B = \frac{h_1}{2} + \frac{h_2}{2} = \frac{(h_1 + h_2)}{2}$$

Illustration 2

Two adjacent walls of a room perpendicular to each other are covered fully by mirror, how many images of yourself, will you see if you stand in that room.

Soln.: $\theta = 90°$

$$\frac{360}{\theta} = \frac{360}{90} = 4 \text{ is even,}$$