VISUAL PHYSICS

SHORT NOTES

CHAPTER

Reflection

Available at:

9999021287

www.visualphysics.in

REFLECTION → bouncing back

Normal : perpendicular to the surface

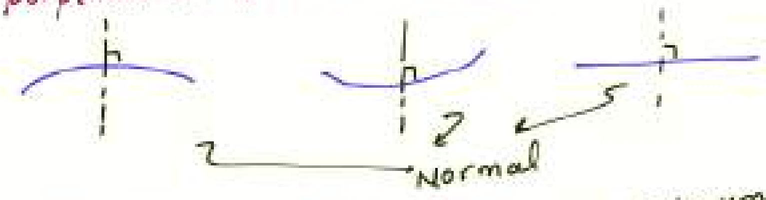
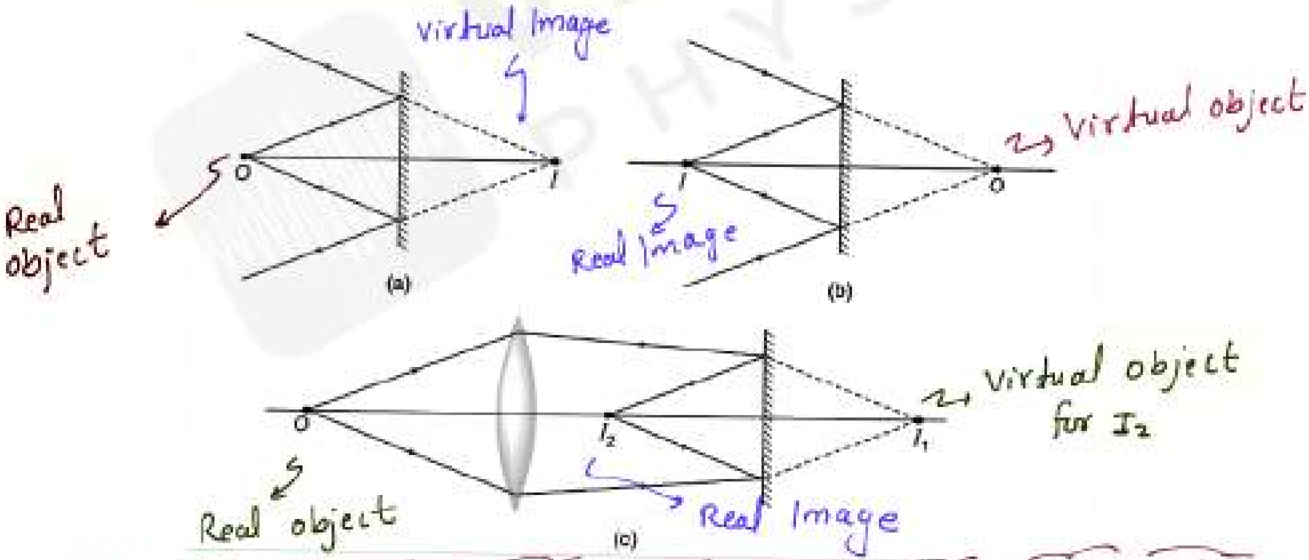


Image is formed → Reflection
or → Refraction
[minimum two rays are required by image formation]

Real object, virtual object, real image, virtual image

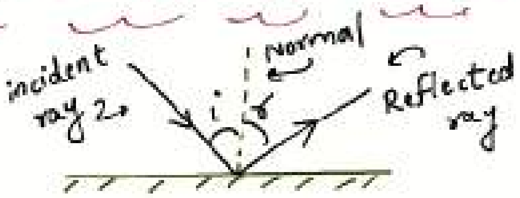
* The point where the rays meet (or appear to meet) before refraction or reflection is called object
* The point where the rays meet (or appear to meet) after reflection or refraction is called image

→ if rays actually meet → Real object, Real image
→ if rays appear to meet → virtual object, virtual Image



{ Virtual Images can not be taken on screen, but can be seen by eye }

Law of Reflection :



(i) $\angle i = \angle r$
(ii) Incident ray, reflected ray and normal lie on the same plane.

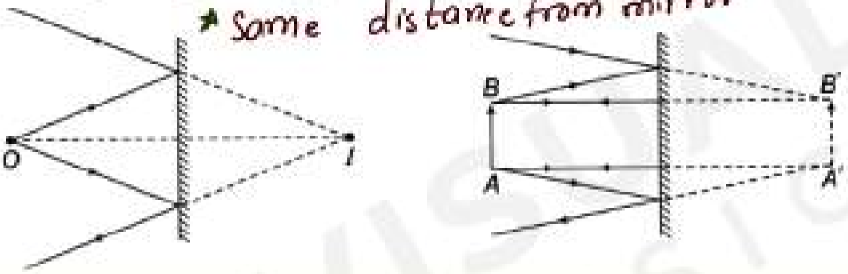
* Important points in Reflection laws:

(i) $\angle i = \angle r$ applied for any type of surface

(ii) If incident ray, reflected ray & normal are represented in form of vector, then these three should be coplanar

Reflection from a plane surface (plane mirror)

→ Real object :
* Virtual Image
* Erect Image
* Same Size
* Same distance from mirror



Sign Convention:

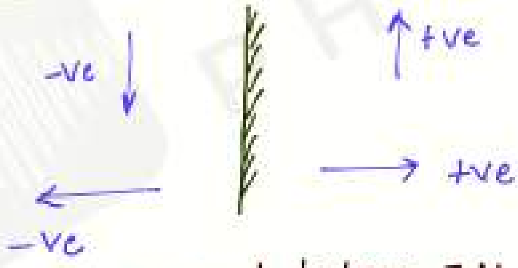


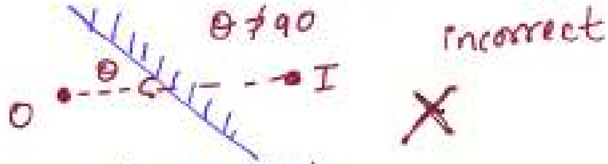
Image distance = v & object distance = u

* v & u are perpendicular distance from the mirror

* $\boxed{v = -u}$ → according to sign convention

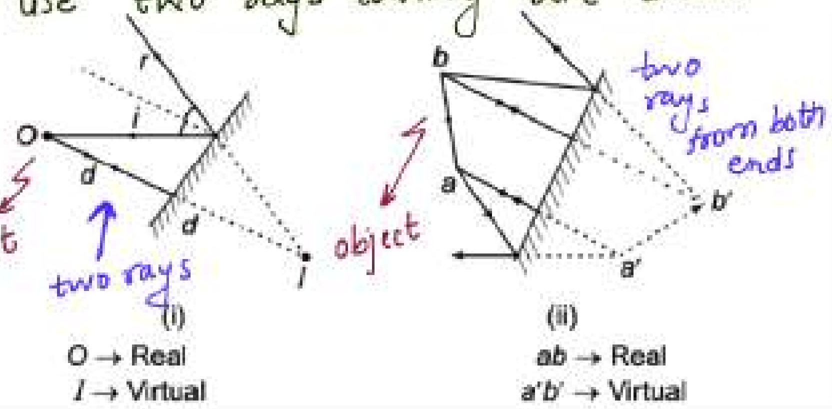
or $\boxed{|v| = |u|}$

$|v| = |u|$



$|v| = |u|$ → distance should be measured perpendicular

★ To draw Ray diagram use two rays coming out of each ends of the object



point object

two rays

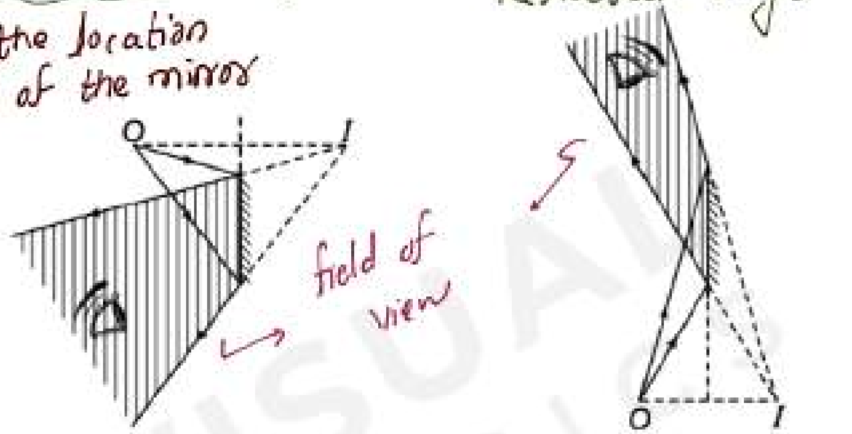
object

two rays from both ends

eye must lie in this region to see the image

★ {Field of view of an object :} Region between the extreme Reflected rays

↳ it depends on the location of object in front of the mirror

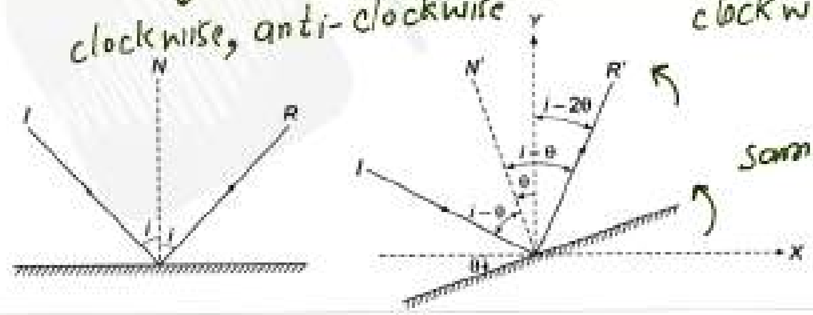


field of view

★ If mirror rotates by θ, reflected ray rotates 2θ in same direction

↓ clockwise, anti-clockwise

clockwise, anti-clockwise

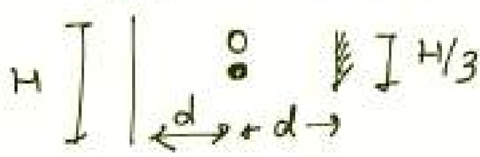


same direction

★ { H ↳ Height of object ⇒ $\frac{H}{2}$ ↳ length of mirror to see full image }

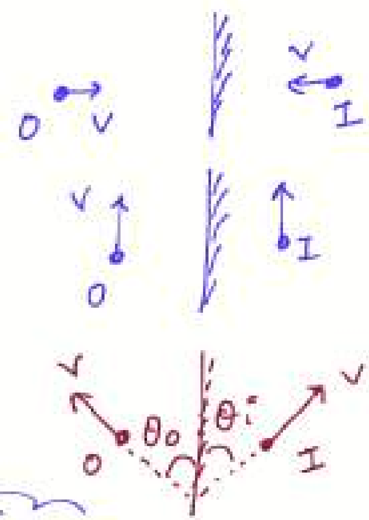
★ H = Height of wall

$\frac{H}{3}$ = length of mirror, if observe is exactly at midway between wall & mirror



* Object & Image velocity

- → Image speed = object speed
- → $\theta_i = \theta_o$ with mirror
- → velocities component along mirror are equal
- → velocities component perpendicular to mirror are equal & opposite

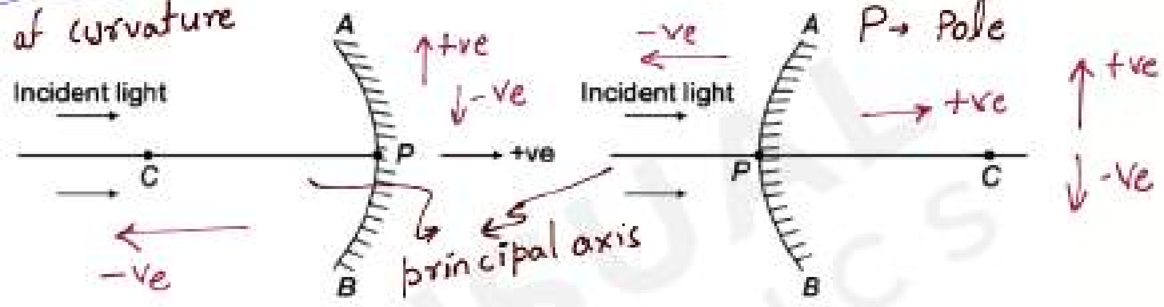


{ Reflection from spherical surface }

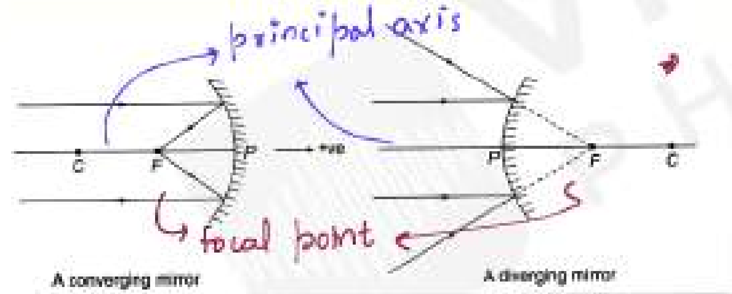
R → Radius of curvature = CP

C → Centre of curvature

P → Pole

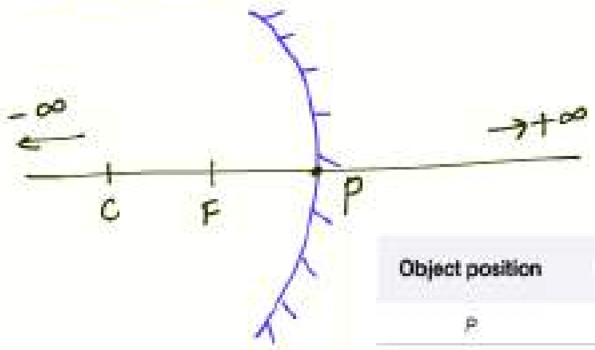


(a) Concave mirror (b) Convex mirror



* $PF = f = R/2$
* paraxial rays: Rays close to principal axis and nearly parallel to it.

Concave mirror :



Object position	Image position	Image nature	Object speed and image speed
P	P	–	–
F	$\pm\infty$	–	–
C	C	Real, inverted and same size	$v_i = v_O$
Between P and F	Between P and $+\infty$	Virtual, erect and magnified	$v_i > v_O$
Between F and C	Between $-\infty$ and C	Real, inverted and magnified	$v_i > v_O$
Between C and $-\infty$	Between C and F	Real, inverted and diminished	$v_O > v_i$

v_o

v_i

Convex mirror:

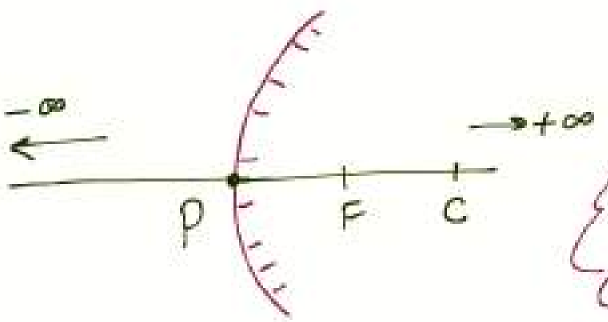
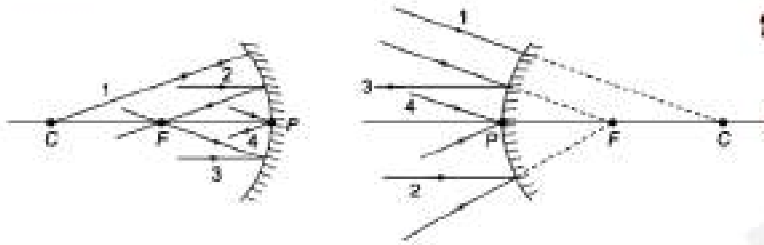


Image formed by convex mirror is always virtual, erect & diminished no matter where the object is

Convex mirror field of view > Concave mirror field of view

Ray diagrams:



Ray 1: A ray through C
Ray 2: A ray parallel to principal axis
Ray 3: Ray passing through focal length
Ray 4: A ray striking pole P.

using these 4 rays one can draw any ray diagrams

Image formation in Convex Mirror

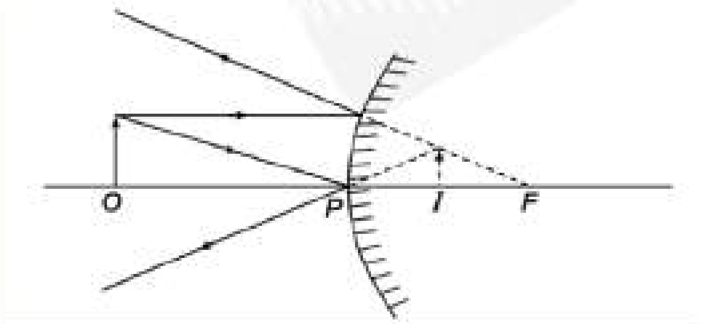
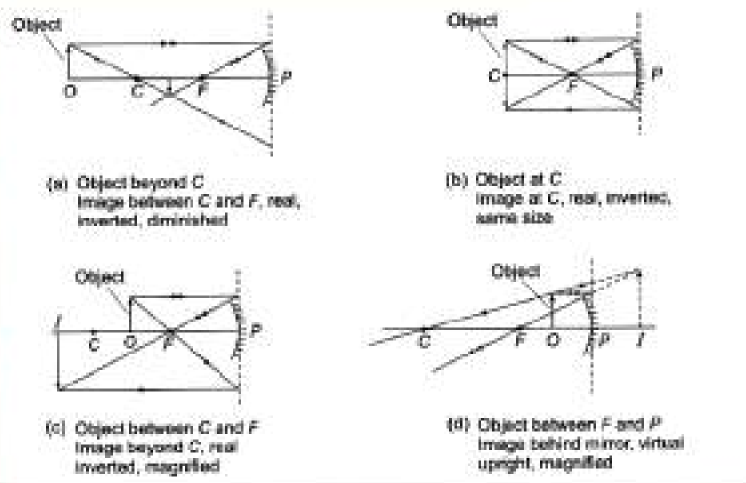


Image formation in Concave mirror



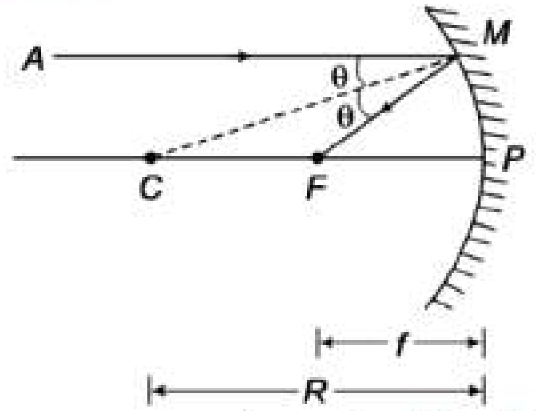
(a) Object beyond C
Image between C and F, real, inverted, diminished

(b) Object at C
Image at C, real, inverted, same size

(c) Object between C and F
Image beyond C, real inverted, magnified

(d) Object between F and P
Image behind mirror, virtual upright, magnified

Relation between f and R:



The rays are paraxial and so M is very close to P.

$\Rightarrow FM \approx FP$

$\therefore FC = FP$

$FP = \frac{1}{2} CP$

$\Rightarrow \boxed{f = \frac{R}{2}}$

$\angle i = \angle r$ (law of reflection)

$\angle AMC = \angle CMF = \theta$

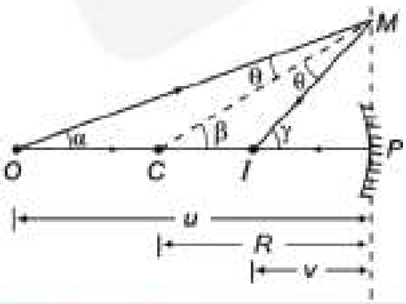
$\angle AMC = \angle MCF$ (alternate angles)

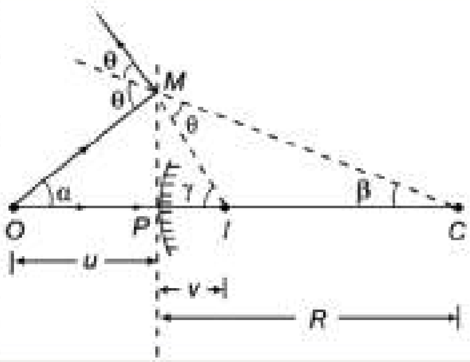
$\angle CMF = \angle MCF$

$\Rightarrow \Delta FCM$ is isosceles $[FC = FM]$

Mirror formula

$\alpha \simeq \tan\alpha = \frac{MP}{OP}$, $\beta = \frac{MP}{CP}$, $\gamma = \frac{MP}{IP}$





ΔCMO, $\beta = \alpha + \theta$ (exterior angle)

$\theta = \beta - \alpha$ —(i)

ΔCMI, $\gamma = \beta + \theta$

$\theta = \gamma - \beta$ —(ii)

from (i) & (ii)

$2\beta = \gamma + \alpha$ —(iii)

putting values of β, γ & α

$\frac{2}{CP} = \frac{1}{IP} + \frac{1}{OP}$

ΔCMO.

$\theta = \alpha + \beta$ —(i) [exterior angle]

ΔCMI, $\gamma = \theta + \beta$

$\theta = \gamma - \beta$ —(ii)

from (i) & (ii)

$2\beta = \gamma - \alpha$

$\frac{2}{CP} = \frac{1}{IP} - \frac{1}{OP}$

Now, $CP = -R$, $IP = -v$ & $OP = -u$

$$\frac{2}{R} = \frac{1}{v} + \frac{1}{u}$$

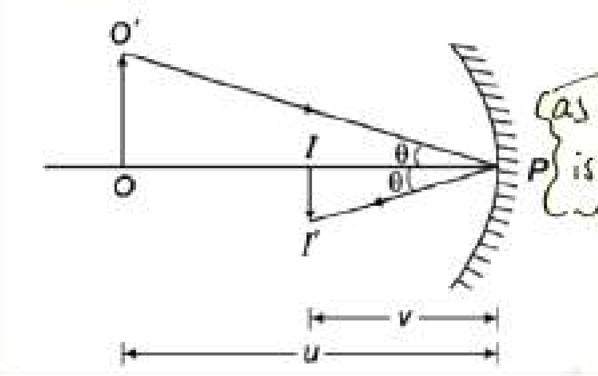
$$\left\{ \frac{1}{v} + \frac{1}{u} = \frac{1}{f} \right\}$$

$CP = +R$, $IP = +v$, $OP = -u$

$$\frac{2}{R} = \frac{1}{v} + \frac{1}{u}$$

$$\left\{ \frac{1}{f} = \frac{1}{v} + \frac{1}{u} \right\}$$

{Magnification}



$$m = \frac{\text{Height of image}}{\text{Height of object}} = \frac{II'}{O'O}$$

{as II' is negative}

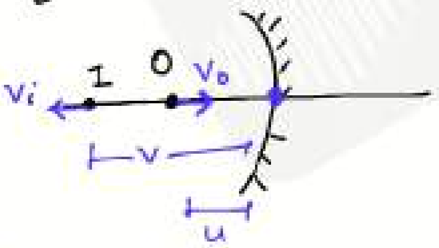
$$= -\frac{IP}{OP} \quad \{\text{similar triangles}\}$$

$\because IP = -v$ & $OP = -u$

$$\boxed{m = -\frac{v}{u}}$$

(Image velocity)

Along principal axis



$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

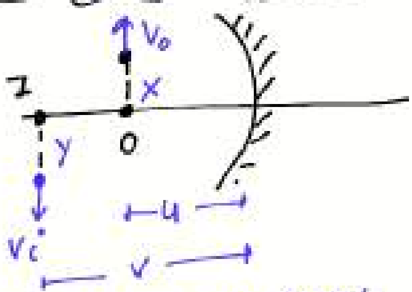
$$-v^{-2}\frac{dv}{dt} - u^{-2}\frac{du}{dt} = 0$$

image speed ↝ $\frac{dv}{dt} = -\left(\frac{v^2}{u^2}\right)\frac{du}{dt}$ ↜ object speed

$$m^2 = \frac{v^2}{u^2}$$

$$\Rightarrow \boxed{v_i = -m^2 v_o}$$

Along perpendicular to principal axis



as u & v = constant

$$m = \frac{I}{O} = \frac{y}{x}$$

$$\frac{dy}{dt} = m\frac{dx}{dt}$$

$$\boxed{v_i = m v_o}$$