JEE Main Physics

Short Notes

Ray Optics

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Ray Optics is an important topic from JEE Main / JEE Advanced Exam Point of view. Every year there are 1-3 questions asked from this topic. This short notes on Ray Optics will help you in revising the topic before the JEE Main & IIT JEE Advanced Exam.

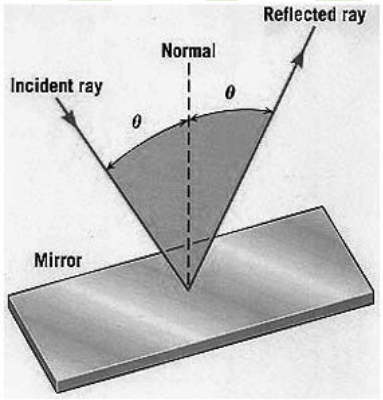
Ray Optics

Ray Optics is the branch of optics that is based on rectilinear propagation of light. It is valid only if the wavelength of Light << Size of obstacle and it only deals with image formation, reflection, and refraction.

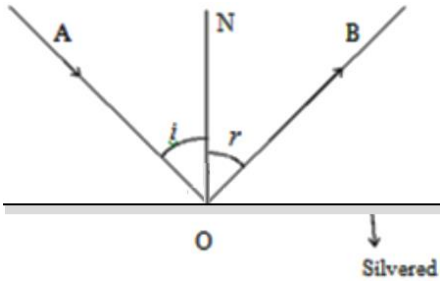
Fermat's principle: Light take the shortest possible route for propagation or where it takes the least time for propagation.

Reflection

When most of the incident light bounces off from the surface of an object if the light is striking on a smooth and shiny surface of the object.



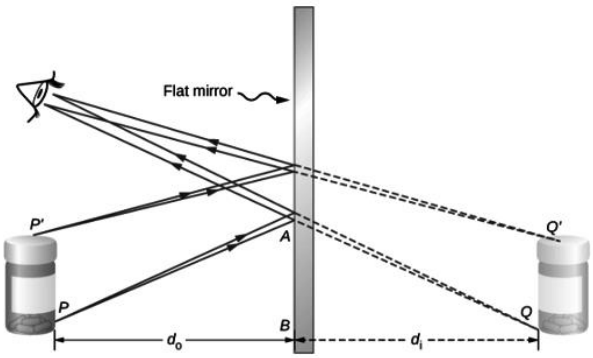
Laws of Refraction- Consider AO is an incident ray on a shiny surface or a mirror, the laws that govern the reflection phenomena are:



(i) The incident ray (AO), the reflected ray (OB) and the normal (ON) drawn to the reflecting surface at the point of incidence, all lie in the same plane.

(ii) The angle of incidence (∠i) is equal to the angle of reflection (∠r). ∠i = ∠r

Images formed by Plane Mirror



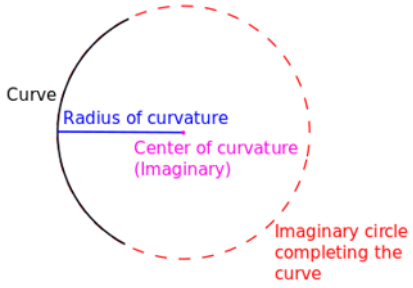
1. The image is always formed at the back of the mirror.
2. The image distance is always the same as the object distance from the mirror.
3. The minimum height of the mirror required for a full image of an object is $h_{mirror} = \frac{H_{object}}{2}$
4. The formed image by the plane mirror is always laterally inverted.

Real and Virtual Images

S.No	Real Images	Virtual Images
1.	Images are formed where the rays meet after reflection form mirror.	The image is formed where the rays tend to meet after reflection.
2.	Images are inverted.	Images are erect.
3.	The real image is captured on the screen.	The image is not captured on screen.

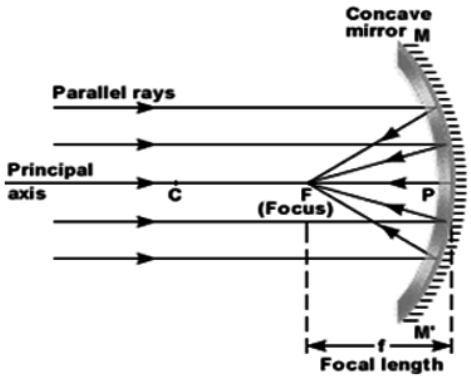
Spherical Mirror

A spherical mirror is a mirror whose surface is part of a sphere.

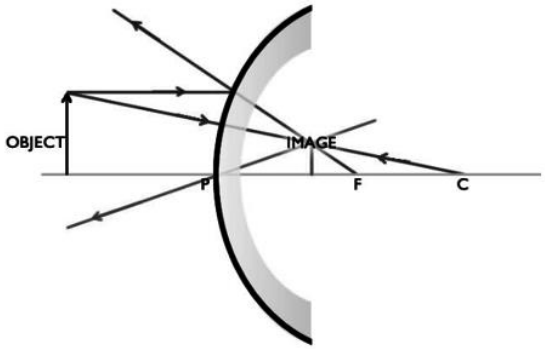


Types of Spherical Mirror

1. Concave mirror: It is curved towards an inward direction. In a concave mirror, light rays converge at a point after they strike and are reflected back from the reflecting surface of the mirror. It usually forms a real and inverted image.



2. Convex Mirror: It is curved outwards and light rays diverge after reflection thus also known as a diverging mirror. It usually forms a virtual and erect image.



The term used in Ray optics

1. Centre of Curvature (C): Centre of curvature is the point at the center of the mirror.

2. The radius of Curvature (R): The radius of curvature is the linear distance between the Pole and the Centre of curvature.

3. Pole (P): It is the midpoint of the mirror.

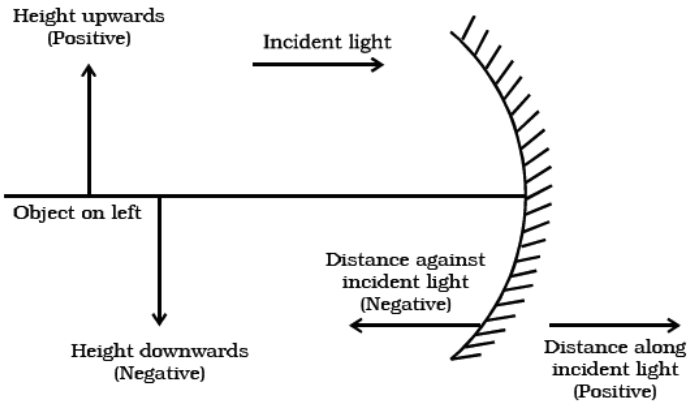
4. Principal Axis: It is the imaginary axis passing through the optical centre, focus and the centre of the curvature of the mirror.

5. Focus (f): Focus is the point, at which light rays parallel to the principal axis and will converge after getting reflected from the mirror. The focal length is the half of the radius of the curvature. $f = \frac{R}{2}$

6. Magnification (M): The ratio of the image height to the object height is known as the magnification.

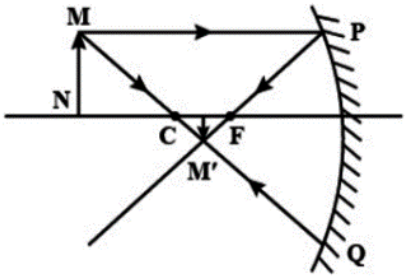
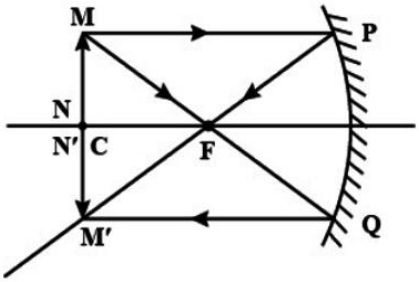
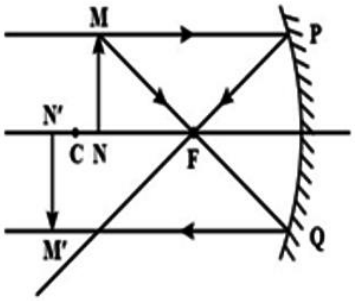
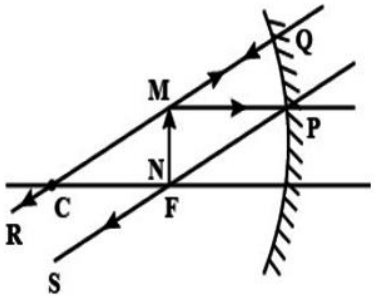
$$M = -\frac{q}{p} = \frac{h_{image}}{h_{object}}$$

The sign convention for the spherical mirror



Quantity	Positive (+)	Negative (-)
Object distance (u)	The object is in front of the mirror (real object)	The object is in the back of the mirror (virtual object)
Image distance (v)	The image is in front of the mirror (real image)	The image is in the back of the mirror (virtual image)
Focal length (f)	Centre of curvature is in front of the mirror (concave mirror)	Centre of curvature is in the back of the mirror (convex mirror)
The radius of curvature (R)	Centre of curvature is in front of the mirror (concave mirror)	Centre of curvature is in the back of the mirror (convex mirror)

Image characteristic for the concave mirror

S.No.	The position of the object (u)	Ray diagram	The position of the image (v)
1.	The object is located beyond the center of curvature (C)		The image will be an inverted image.
2.	The object is located at the center of curvature (C)		When the object is located at the center of curvature, the image will also be located at the center of curvature.
3.	The object is located between the center of curvature (C) and the focal point (F)		The image will be located beyond the center of curvature.
4.	The object is located at the focal point (F)		When the object is located at the focal point, no image is formed.

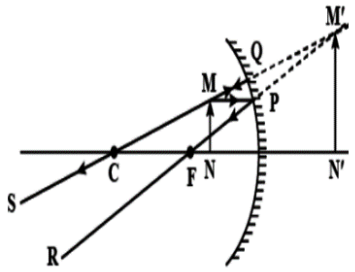
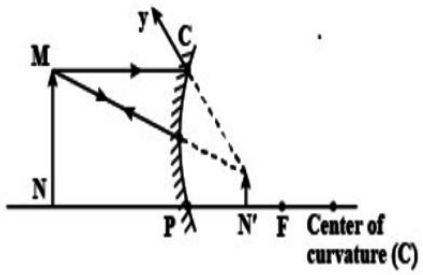
5.	The object is located in front of the focal point (F)		The image will be an upright image.

Image characteristic for the convex mirror

S.No.	The position of the object (u)	Ray diagram	The position of the image (v)
1.	The object is placed between pole (P) and principle focus (f)		The image will be located behind the convex mirror. The image will be virtual, upright and reduced in size.

Mirror Formula- If the object is placed *p* distance from the mirror of radius of curvature *R* the image distance can be calculated as using the mirror formula:

$$\frac{1}{p}+\frac{1}{q}=\frac{R}{2}$$

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{f} \qquad \ldots\left(f=\frac{R}{2}\right)$$

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