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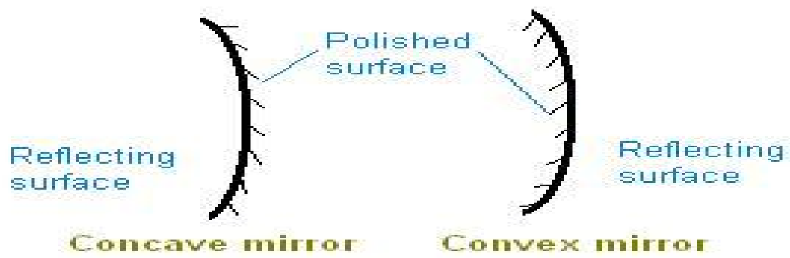
P U N J A B I   C O L O N Y   G A L I   0 1

LIGHT - REFLECTION AND REFRACTION

Class 8th Extra score Physics (Science) Notes

Spherical Mirror

Mirrors having curved surfaces are known as Spherical Mirrors. There are two types of spherical mirrors – Concave Mirror and Convex Mirror



Concave Mirror

A concave mirror is a type of spherical mirror in which the reflecting surface is curved inwards.

Convex Mirror

A convex mirror is a type of spherical mirror in which the reflecting surface is curved outwards. In a convex mirror light gets reflected from its outer surface.

Use of Concave Mirror

1. A concave mirror forms image according to the position of the object. If an object is placed very close to a concave mirror i.e. between the focus and the pole, then the image formed is virtual, erect and highly magnified. Because of this property concave mirrors are used as:

(a) As a dentist's mirror (to see a larger image of teeth),

(b) For examining eyes, ears, nose and throat by Doctors

(c) Shaving mirror.

2. When a light emitting object is placed at the focus of a concave mirror, then all the reflected rays become parallel to the principal axis. This property of a concave mirror is used in;

(a) A torch (b) Behind the headlights of vehicles and light posts etc.

3. Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

Use of Convex Mirror

A convex mirror forms virtual, erect and diminished image of objects which subsequently increases the field of view. Because f this property of convex mirrors they are used in –

(a) Rear-view mirrors of vehicles

(b) Safety mirrors in stores.

Pole of a Spherical Mirror

The geometrical centre of the central point of a mirror is called pole. It lies on the mirror and is denoted by the letter P (as shown in the adjacent figure).

Center of Curvature

It is the geometrical center of the sphere from which the given spherical mirror is obtained. It is denoted by the letter C.

Aperture

The width of the reflecting surface is called aperture (AB in the figure).

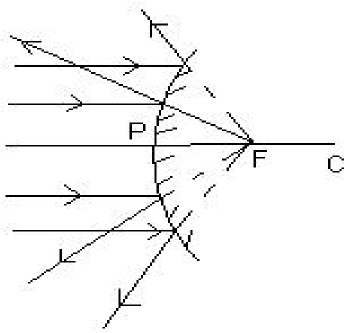
Radius of Curvature

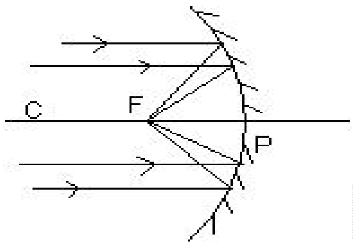
The radius of the curvature is the radius of the sphere from which the spherical mirror is obtained. It is denoted by R which is equal to the distance between the center of curvature (C) and pole (P). .

Principal Axis

The imaginary line passing through the Pole and the Center of Curvature is called the Principal Axis (PC).

Focus





The focus (F) is the point on the principal axis of a spherical mirror where incident rays parallel to the principal axis either meet or appear to be meeting after reflection. A concave mirror has got a real focus which lies on the same side of reflecting surface whereas a convex mirror has got a virtual focus which is obtained on the opposite side of the reflecting surface by extrapolating the rays reflected from the mirror surface. F is the distance between the focus and the pole of the mirror. Radius of curvature (R) and the focal length (F) of a spherical mirror are related as:

R = 2F

Focal Length

The distance between the focus (F) and the pole (P) is called the focal length. It is generally denoted by f.

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

Light Wave

Light is a form of energy which brings the sensation of sight. Light waves travel with a speed of 3×10^8 ms^{-1} in free space. Its speed depends on the medium. Light wave is a transverse wave and does not require any medium to propagate.

Ray and Beam

Light travels in a straight line. An arrow which represents the direction of propagation of light is called the ray of light.

A bundle of rays originating from the same source of light in a particular direction is called a beam of light.

Rectilinear Propagation of Light

The property of light of travelling in a straight line is called the Rectilinear Propagation of Light.

Reflection of Light The scattering back of the light by any shining and smooth surface is known as reflection of light.

Real and Virtual Image

If light after reflection converges to a point to form an image of its own, it's called a real image. If they are diverging (appear to be meeting at a point), then it forms a virtual image.

Real image can be obtained on a screen but it is not possible in case of virtual image.

Plane Mirror

- Image formed by a plane mirror is - virtual, erect, size equal to that of the object, at the distance behind the mirror as the object is in front of the mirror, and laterally inverted.
- When a plane mirror is turned by an angle 1^{O}, the reflected ray will turn by an angle of 2^{O}.
- When the light falls normally on a plane mirror, it will retrace its path.
- To see full size image of a person he needs a mirror of length equal to half of his height.
- The radius of curvature of a plane mirror is infinity, so its R = f = α (infinity).
- The magnification of the image formed by a plane mirror is +1.

Image Formation by a Concave Mirror

(Table followed by figures showing respective positions)

	Position of Object	Position of Image	Size of Image	Type of Image
1	At infinity	At the focus F	Highly diminished, point sized	Real, inverted
2	Beyond C	Between C and F	Diminished	Real, inverted
3	At C	At C	Same size	Real, inverted
4	Between C and F	Beyond C	Enlarged	Real, inverted
5	At F	At infinity	Highly enlarged	Real, inverted
6	Between P and F	Behind the mirror	Enlarged	Virtual, erect

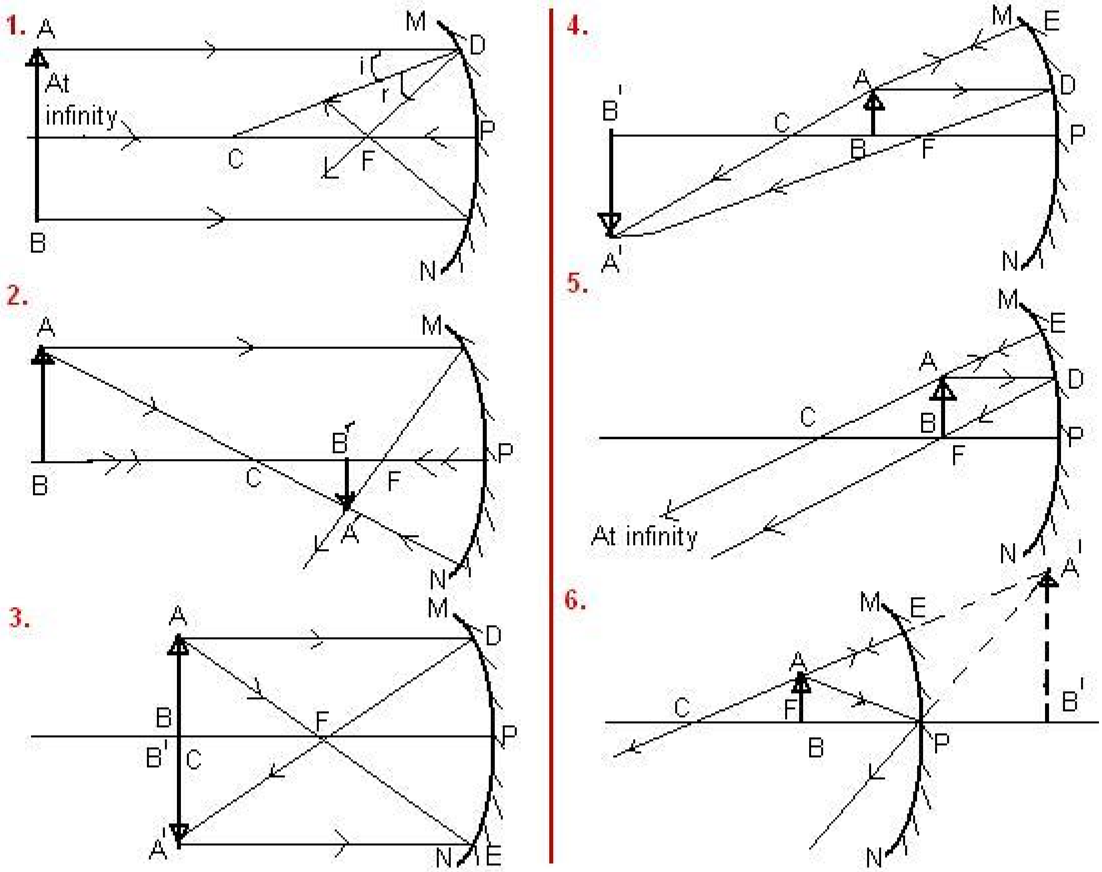
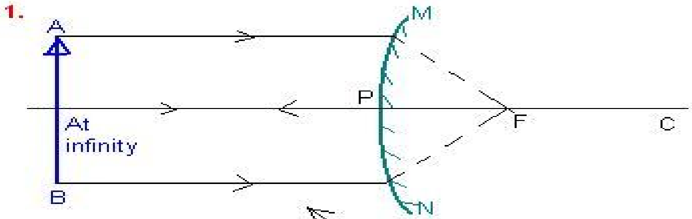
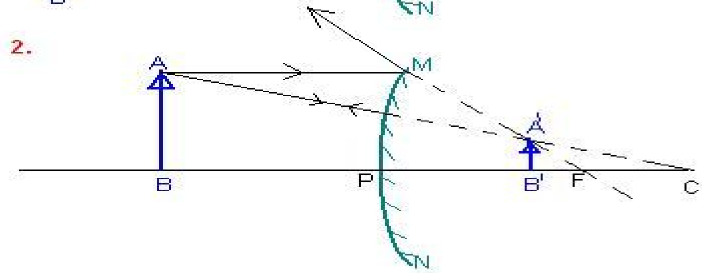


Image Formation by a Convex Mirror (Table followed by figures showing respective positions)

	Position of Object	Position of Image	Size of Image	Nature of Image
1.	At infinity	At focus F, behind the mirror	Highly diminished, point sized	Virtual and erect
2.	Between infinity and Pole of the mirror	Between P and F, behind mirror	Diminished	Virtual and erect





Sign Convention (Spherical Mirrors)

The following table summarizes the new Cartesian Sign Convention for Spherical Mirrors:

Type of Mirrors	Distance of Object (u)	Distance of Image (v)		Focal length (f)	Height of object	Height of image	
		Real image	Virtual Image			Real image	Virtual image
Convex	- ve	Image is not formed	+ ve	+ ve	+ ve	Image is not formed	+ ve
Concave	- ve	- ve	+ ve	- ve	+ ve	- ve	+ ve

Mirrors Formula

There is a relationship between the distance of image (v), distance of object (u) and the focal length of a spherical mirror (f) which is given by the Mirror Formula. The mirror formula is

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

Magnification

The magnification of a spherical mirror gives the relative extent to which the image of an object is magnified with respect to the object size. It is expressed as the ratio of the height of image to the height of object.

Magnification (m) = Image height / Object height = h_i / h_o

Magnification (m) = - image distance (V) / Object distance(u)

The equation holds true for both concave and convex mirror. M is –ve for inverted image and +ve for erect image. So, magnification is always positive for a convex mirror, while it depends on the position of the position of the object with respect to concave mirror.

Refraction: The phenomenon of bending of light as it travels from one medium to another medium is called refraction of light.

When light enters from a rarer medium into a denser medium it will bend towards the normal. Similarly when light gets into a rarer medium from a denser medium it will bend away fro the normal.

Refraction or change in the direction in the light ray (bending) takes place on account of a change in the speed of light on entering the second media. (Why does the phenomenon of refraction takes place? or, Why does the ray of light change the direction when entering from one medium to another medium?)

Laws of Refraction : There are two laws of refraction:

(i) The incident ray, the refracted ray and the normal to the interface of the two media at the point of incidence - all lie in the same plane.

(ii) The ratio of the sine of the angle of refraction for a given pair of media is constant. This is known as Snell's Law. Mathematically this can be represented as:

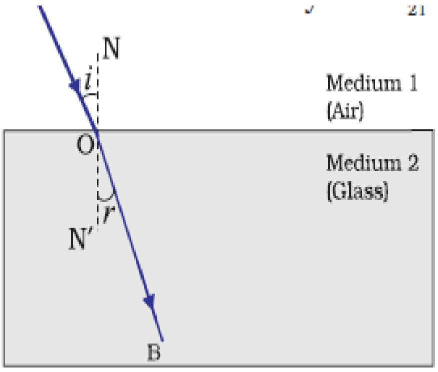
$$\frac{Sin\ i}{\sin r} = \text{constant} = {}^{1}\mu_2$$

Where i = Angle of incident and r = angle of refraction and

${}^{1}\mu_2$ = refractive index of medium 2 with medium 1

Refractive Index

It is the ratio of the angle of incidence to the sine of the angle of refraction when light is refracted from one medium to another medium. Refractive index is also linked to an important physical quantity i.e. the relative speed of propagation of light in different media.



Consider a ray o light travelling from medium 1 (air) into medium 2 (glass) as shown in the above figure. Let v_1 be the speed of light in the medium 1and v_2 in medium 2. The refractive index of medium 2 with respect to medium 1 can be expressed as n_{21} = (Sin i ÷ Sin r) = ($v_1 \div v_2$)

If c is the speed of light in air and v is the speed of light in the medium, then, the refractive index of the medium n_m is given by

$$n_m = \frac{\text{Speed of light in air}}{\text{Speed of light in the medium}} = \frac{c}{v}$$

Spherical Lens

A lens is a curved piece of glass or any other transparent material bound by two surfaces of which one or both surfaces are spherical, through which light can pass. There are two types of lenses: Concave Lens and Convex Lens.

Concave Lens

A concave or bi-concave lens is made by joining two curved surfaces in such a way that the thickness is lesser in the center while it gradually increases as we move towards edge.

Convex Lens

A convex or bi-convex lens is made by joining two curved surfaces in such a way that the thickness is more in the center while it gradually reduces as we move towards the edge.

Optical Center

Optical center is a point located at the center inside the lens. Optical center is usually represented by the letter O (as shown in the figures). A ray of the light through the optical center of a lens always passes without suffering any deviation.

Center of Curvature of a Lens

It is the center point of arcs of the two spherical surfaces of the lens is made. Since a lens constitutes two spherical surfaces, it has two centers of curvature.

Radius of Curvature of a Lens

The distance between the optical center and either of the center of curvatures is termed as radius of curvature.

Principal Axis of a Lens

An imaginary straight line passing through the two centers of curvature of a lens is called its principal axis.

Power of a Lens

The degree of convergence or divergence of light rays achieved by a lens is expressed in terms of its power (P). The power of a lens is defined as the reciprocal of its focal length.

$P = \frac{1}{f(in\ metere)}$. The SI unit of power of lens is D (Diopter)

Image Formation by a Convex Lens

(Table followed by figures)

	Position of the object	Position of the image	Size of image	Nature of image
1	At infinity	At focus F_2	Highly diminished, point sized	Real, inverted
2	Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real, inverted
3	At $2F_1$	At $2F_2$	Same size	Real, inverted
4	Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real, inverted
5	At focus F_1	At infinity	Infinitely large or highly enlarged	Real, inverted
6	Between focus F_1 and optic center O	On the same side of the lens as the object	Enlarged	Virtual, erect

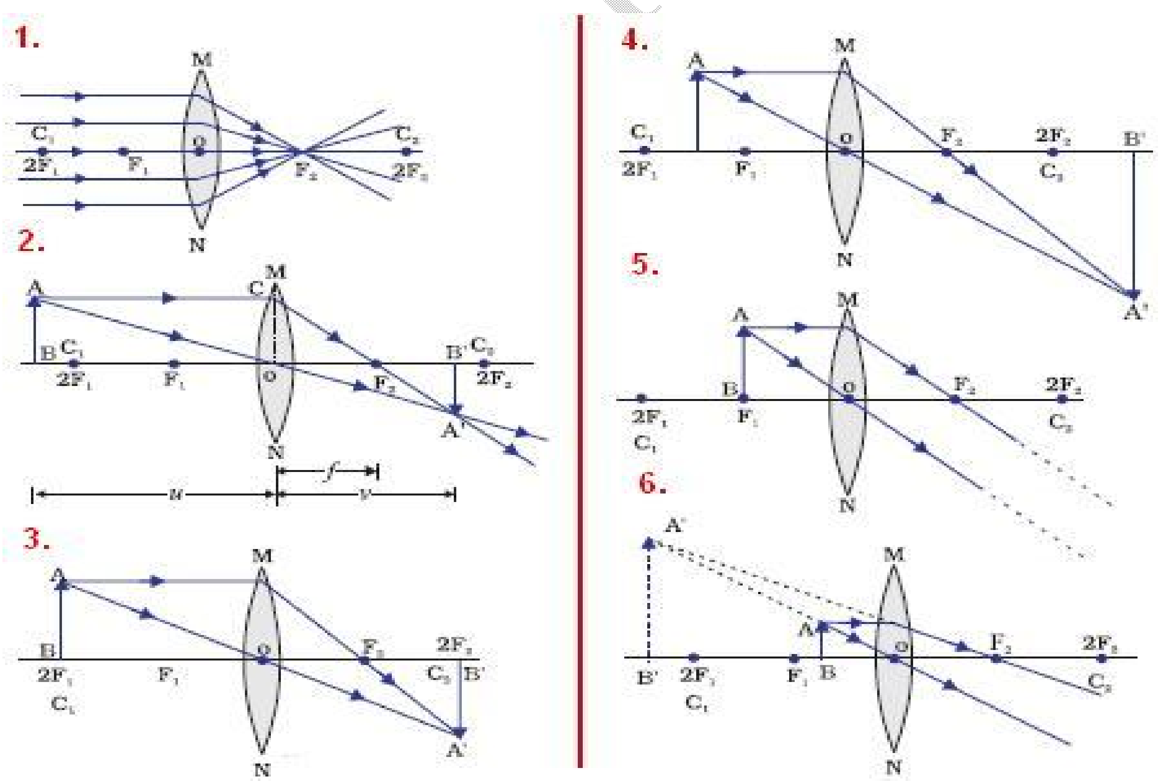
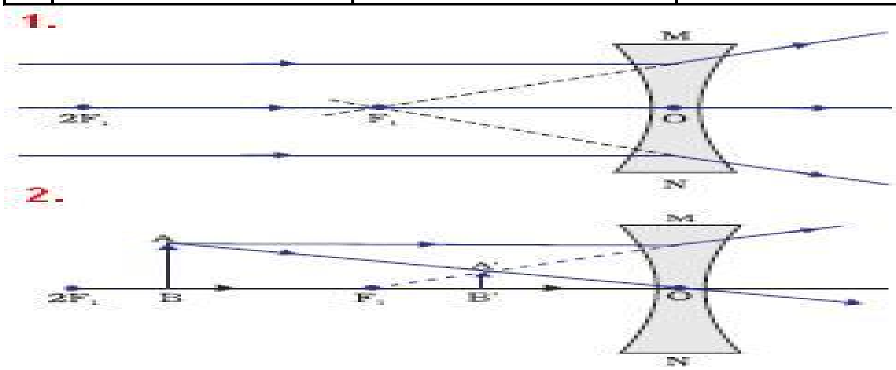


Image Formation by a Concave Lens
(Table followed by figures)

	Position of object	Position of image	Size of image	Nature of image
1	At the infinity	At focus F_1	Highly diminished, point-sized	Virtual, erect.
2	Between infinity and optical center of the lens	Between focus F_1 and optical center O.	Diminished	Virtual, erect.



Sign Convention (Spherical Lenses)

The following table summarizes the New Cartesian Sign Convention for spherical lenses:

Lens	Distance of object (u)	Distance of image (v)		Focal length (f)	Height of object	Height of image	
		Real image	Virtual image			Real image	Virtual image
Convex	– ve	+ ve	– ve	+ ve	+ ve	– ve	+ ve
Concave	– ve		– ve	– ve	+ ve		+ ve

The lens formula
Expressed as Object distance (u), image-distance (v) and the focal length (f). The lens formula is expressed as

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

Magnification

The magnification produced by a lens, similar to that for spherical mirrors, is defined as the ratio of the height of the image and the height of the object. It is represented by the letter *m*. If *h* is the height of the object and *h'* is the height of the image given by a lens

$$m = \frac{\text{height of image}}{\text{height of object}} = \frac{v}{u}$$