11. Reflection of Light

EXTRA QUESTIONS

Q.1 The magnification produced by a concave mirror is positive or negative depending on the object distance. Is the following statement true or false?

Ans.- The following statement is true.

Q.2 The magnification produced by a convex mirror is positive or negative depending on the object distance. Is the following statement true or false?

Ans.- False. The magnification produced by a convex mirror is always positive.

Q.3 Match the pairs.

A	B
1) Plane mirror	- Image always smaller than the object.
2) Concave mirror	- Image always larger than the object.
3) Convex mirror	- The size of the image always equal to that object.
	- Magnification equal to 1 or less than 1 or greater than 1 (numerically).

Ans.-

A	B
1) Plane mirror	- The size of the image always equal to that object.
2) Concave mirror	- Magnification equal to 1 or less than 1 or greater than 1 (numerically).
3) Convex mirror	- Image always smaller than the object.

Q.4 Name the mirror which produces magnification always less than 1.

Ans. A convex mirror produces magnification always less than 1.

Q.5 Name the mirror for which the image distance always numerically equals the object distance, i.e. |v| = |u|.

Ans.- For a plane mirror, the image distance always numerically equals the object distance, i.e. i.e. |v| = |u|.

Q.6 An object is placed at 6cm in front of a concave mirror of radius of curvature 60cm state the nature and size of the image relative to that of the object.

Ans.- The image is real, inverted and of the same size as that of the object.

Q.7 An object is placed at 10cm in front of a concave mirror of focal length 25cm. state the nature and size of the image relative to that object.

Ans.- The image is virtual, erect and larger than the object.

Q.8 Why are many images obtained in a kaleidoscope?

Ans.- In a kaleidoscope, three plane mirrors are fixed at 60^0, with each other. Hence the rays of light starting from an object (reflected rays) are reflected many times by the mirrors, thereby forming many images.

Q.9 What is convergence of light? Where is it used?

Ans.- When light rays meet at a single point, it is called convergence of light.

A converging beam of light is used by doctors to examine teeth, ears, eyes, etc. It is also used in solar devices.

Q.10 What is divergence of light? Where is it used?

Ans.- When light rays from the same point source spread away from each other, it is called divergence of light

A diverging beam of light is used in streetlight and table lamps.

Q.11 A virtual image cannot be obtained on a projected screen. Why?

Ans.- In the case of a virtual image, rays of light do not actually meet at that point. Hence, it cannot be obtained (or projected) on a screen.

Q.12 A boy is sitting in front of two plane mirrors inclined at an angle of 60^0 to each other. How many images does the boy see in the mirror?

Ans.- Angle between mirror A = 60^0

Number of images formed n = ?

Formula $n = \frac{360^0}{A} - 1$

$n = \frac{360^0}{60^0} - 1$

= 6 - 1

n = 5

The boy sees 5 images in the mirror.

Q.13 An image is formed 5cm behind a convex mirror of focal length 10cm. At that distance is the object placed from the mirror?

Ans.- Given - Image distance (v) = 5cm

Focal length (f) = 10cm.

Object distance (u) = ?

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

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

$\therefore \frac{1}{u} = \frac{1}{10} - \frac{1}{5}$

$\therefore \frac{1}{u} = \frac{1-2}{10}$

$\therefore \frac{1}{u} = \frac{-1}{10}$

$\therefore u = -10cm.$

The object is placed at a distance of 10cm in front of the mirror.

Q.14 What is - 1) Centre of curvature of mirror (c) and 2) radius of curvature (R).

Ans.- 1) The centre of the sphere of which the mirror is a part, is called the centre of curvature of the mirror.

2) The radius of the sphere of which the mirror is a part, is called the radius of curvature of the mirror.

Q.15 What is the principal axis of a mirror?

Ans.- The straight line passing through the pole and centre of curvature of the mirror is called its principle axis.

Q.16 What is Focal length of a mirror (f)?

Ans.- The distance (f) between the pole and the principle focus of the mirror is called the focal length. This distance is half of the radius of curvature of the mirror. $f = \frac{R}{2}$

Q.17 What is Real image and the virtual image?

Real Image	Virtual Image
1) A real image is formed only when the reflected rays actually meet at the point.	1) A virtual image is formed only when the reflected rays appear to meet at a point.
2) Real images can be obtained on a screen.	2) Virtual images cannot be obtained on a screen.
3) All real images are inverted.	3) All virtual images are erect.

Q.18 A dentist uses a concave mirror while examining teeth.

Ans.- 1) A concave mirror produces on erect, virtual an magnified image of an object placed between its pole and focus.

2) A dentist uses this principle to get a clear and distinct image of teeth, hence a dentist uses a concave mirror.

Q.19 A convex mirror has a focal length of 18cm. The image of an object kept in front of the mirror is half the height of the object. What is the distance of the object from the mirror?

Ans.- Image size $(h^2) = \frac{1}{2}h_1$.

Focal length (f)= 18cm.

Object distance (u) =?

Formulae -

(i) $M = \frac{h_2}{h_1} = -\frac{v}{u}$ (ii) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$M = \frac{h_2}{h_1}$

$\therefore M = \frac{1}{2} \times \frac{h_1}{h_1}$

$\therefore M = -\frac{v}{u}$

$\therefore -\frac{v}{u} = \frac{1}{2}$

$\therefore v = -\frac{1}{2}, u = -\frac{u}{2}$

$\therefore \frac{1}{v} = \frac{-2}{u}$

$\therefore \frac{1}{v} + \frac{1}{u} = \frac{1}{f} \quad \therefore \frac{-2}{u} + \frac{1}{u} = \frac{1}{f}$

$\frac{-2+1}{u} = \frac{1}{18} \quad \therefore \frac{-1}{u} = \frac{1}{18}$

$\therefore u = -18\ cm.$

The object is placed in front of the convex mirror at a distance of 18 cm.

Q.20 What is the focus of a convex mirror (f)?

Ans.- Incident rays parallel to the principal axis, after reflection, appear to come from a particular behind the mirror lying along the principle axis. This point is called the principle focus of the convex mirror.

Q.21 Draw a ray diagram for the cases of images obtained in concave mirrors?

a) A ray diagram for object between pole and focus for a concave mirror.

Ans.-

Image position	Nature of image
Behind the mirror	Virtual, erect and magnified.

Q.22 Explain the images formed by concave mirrors with respect to position of the image and object and also the Nature and size of the image.

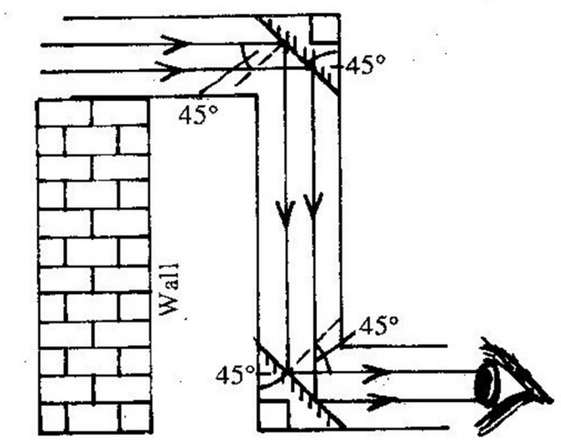
Ans.-

No	Position of the object	Position of image	Nature of image	Size of image
1)	Between pole and focus	Behind the mirror	Erect, virtual	Magnified
2)	At focus	At infinity	Inverted, real	Very large

3)	Between focus and centre of curvature	Beyond the centre of curvature	Inverted, real	Magnified
4)	At the centre of curvature	At the centre of curvature	Inverted, real	Same as object
5)	Beyond the centre of curvature	Between the centre of curvature and focus	Inverted, real	Diminished.
6)	At a very large distance	At focus	Inverted, real	Point image.

Q.23 What is a Reflecting periscope?

Ans.- It consists of a wooden or a cardboard tube bent twice at right angles. The inner side of the tube is blackened to prevent reflection. Two plane mirrors M_1 and M_2 are placed at the bent portion of the tube. The mirrors are placed such that the light rays are incident at an angle of 45^0. The light rays are incident on the plane mirror M_1 and the reflected rays from this mirror are incident on the second mirror M_2 at the same angle of incidence. Thus, the light rays undergo a reflection for a second time at an angle of 45^0, and emerge from the lower tube, where the image of the object is viewed.



Reflecting peri-scope

Uses of a Reflecting Periscope -

1) It is used by soldiers to view the enemy movements during wars.

2) It is used in submarines, to see the objects above the water surface.

Disadvantages of a Reflecting Periscope -

1) The periscope cannot be used in places of dust and fog. The deposition of the dust does not give rise to proper reflection.
2) The final image is not bright due to successive reflections.

Q.24 What do you mean by Fluorescence?

Ans.- Some dolls look brighter or shine in the dark. This is due to fluorescence.

Certain materials or substances like zinc sulphide, Barium platino cyride, etc. absorb shorter wavelengths of light and emit light in the longer wavelength region. This property of the substance is called Fluorescence.

Q.25 What is the reason that sky is blue in colour?

Ans.- Suspended particles present in the atmosphere are responsible for scattering of light. Since violet, blue and indigo have shorter wavelength these colors are scattered most and in all directions, hence, the sky appears blue.

Q.26 The sun appears Red at sunrise and sunset. Explain this statement.

Ans.- At sunrise and at sunset, the sun is at horizon and the light from the sun traverses a greater distance than at other times. Hence, most of the light of shorter wavelength is scattered and the colors corresponding to these wavelengths, do not reach us. The longer wavelength like red, orange and yellow reach the Earth from the rising sun, making the sun and sky appear of those colors.

Q.27 A convex mirror is made by cutting a hollow sphere of radius of curvature 40cm, find the focal length of the mirror.

Ans.- Solution - In the given problem, R = 40cm

Focal length of the mirror = $\frac{Radius\ of\ curvature}{2}$

$\therefore$ focal length, f = $\frac{40}{2}$ = 20cm.

Q.28 An object is placed at 20cm from the pole of a concave mirror. It forms real image at a distance of 20 cm from the pole. Find the focal length of the concave mirror.

Ans.- Solution - In the given problem,

Object distance, u = - 20cm (Using Cartesian sign convention)
Image distance, v = - 20cm (Using Cartesian sign convention for real image)

Focal length of the mirror - $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $\therefore \frac{1}{f} = \frac{-1}{20} + \frac{-1}{20}$

$\therefore \frac{1}{f} = \frac{-(20+20)}{20\times20} = \frac{-40}{400}$ $\therefore f = \frac{-400}{40} = -10\ cm.$

The focal length of the given concave mirror is $= -10cm.$

Q.29 What is Magnification?

Ans.- Magnification is the ratio of the height of the image to that of the object.

$\therefore$ Magnification, m = $\frac{height\ of\ the\ image\ (h_1)}{height\ of\ the\ object\ (h_0)}$

$= \frac{A^1B^1}{AB}$

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

m is negative for a real image and positive for a virtual image.

Q.30 State the uses of a concave mirror.

Ans.- 1) A concave mirror is used in a barber's shop, and by the dentist. If the object is placed between the pole and the focus of the mirror, an erect, virtual and magnified image is obtained.

2) A concave mirror is used in a torch and head lamps of vehicles. The source of the light is kept at the focus of the mirror. Hence, a parallel beam of light is obtained.

3) A concave mirror is used in flood lights. If the source of light is placed a little beyond the centre of curvature of the mirror, it gives a bright beam of light.

4) A concave mirror is used in various equipments using solar energy as sunrays reflected by concave mirror converge in the focal plane.

Q.31 A concave mirror is used for shaving.

Ans.- When a object is placed within the focal length of a concave mirror, its erect and magnified image is formed behind the mirror. When a man holds a concave mirror such that his

face lies within the focal length of the mirror, he gets a clear and magnified view of his face and thus can shave easily. Hence a concave mirror is used for shaving.

Q.32 An object is placed at 6cm in front of a concave mirror of focal length 10cm. Find the position and nature of the image. What is the magnification produced by the mirror?

Ans.- For a concave mirror,

$u = -6cm$, $f = -10cm$, v = ?, M = ?

According to the mirror formula,

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

$$\frac{1}{v} = \frac{1}{-10} - \left(\frac{1}{-6}\right)$$

$$= \frac{1}{-10} + \frac{1}{6} \qquad = \frac{1}{-10} - \left(\frac{-1}{6}\right)$$

$$= \frac{1}{6} - \frac{1}{10} = \frac{2}{30}$$

$$\frac{1}{v} = \frac{1}{15cm}$$

$$\therefore v = 15cm$$

The image is formed behind the mirror at 15cm from the mirror. It is a virtual and erect image.

Q.33 A concave mirror produces three times magnified (enlarged) real image of object placed at 10cm in front of it. Where is the image located?

Ans.- Object distance $u = -10cm$.

Image distance (v)

Magnification, $M = \frac{h_2}{h_1} = -\frac{v}{u}$

Height of the image, $h_2 = -3h_1$

$$\therefore \frac{-3h_1}{h_1} = -\frac{v}{u}$$

$$\therefore -\frac{v}{u} = -3$$

$$\therefore -v = -3 \times (-10)$$

$$\therefore -v = 30$$

$$\therefore v = -30\text{cm}.$$

Q.34 An object is placed at a distance of 10cm from a convex mirror of focal length 15cm. Find the position and nature of the image.

Ans.- Given Focal length of convex mirror,

(f) = +15cm, object distance $(u) = -10cm.$

By the mirror formula,

$$\frac{1}{v} = \frac{1}{u} + \frac{1}{v} \qquad \therefore \frac{1}{15} = \frac{1}{-10} + \frac{1}{v}$$

$$\therefore \frac{1}{v} = \frac{1}{15} + \frac{1}{10}$$

$$\therefore \frac{1}{v} = \frac{10+15}{150}$$

$$\therefore \frac{1}{v} = \frac{25}{150}$$

$$\therefore \frac{1}{v} = \frac{5}{30}$$

$$\therefore \frac{1}{v} = \frac{1}{6}$$

$$\therefore v = 6cm.$$

Magnification $M = \frac{-v}{u} = \frac{-6}{-10} = 0.6$

∴ The image is located at a distance of 6cm from the mirror on the other side of the mirror. The positive value, less than 1, of magnification indicates that the image formed is virtual, erect and diminished.

Q.35 When a person stands in front of a plane mirror, how is the image formed? What is the nature of the image?

Ans.- 1) When a person stands in front of a plane mirror, rays from his body fall on the mirror and get reflected following laws of reflection.

2) The image of every point on the body of the person is formed behind the mirror at the same distance from the mirror as the point itself.

3) Thus, the image formed is erect and laterally inverted. The size of the image is same as that of the person.

Q.36 What is a concave mirror?

Ans.- If the inner surface of the spherical mirror is the reflecting surface, then it is called a concave mirror.

Q.37 What is a convex mirror?

Ans.- If the outer surface of the spherical mirror is the reflecting surface then it is called a convex mirror.

Q.38 What is a spherical mirror? Explain the two types of a spherical mirror?

Ans.- A spherical mirror is the part of a hollow glass sphere. The inner or outer surface of this part is coated with a shiny substance to produce a spherical mirror.

There are two types of spherical mirror -

1) Concave mirror 2) Convex mirror.

1) Concave mirror - When the inner surface of the spherical mirror is the reflecting surface, then it is called a convex mirror.

2) Convex mirror - When the outer surface of the spherical mirror is the reflecting surface, then it is called a convex mirror.

Q.39 What is the principal focus of the concave mirror?

Ans.- Incident rays which are parallel to the principal axis of a concave mirror, after reflection from the mirror, meet at a particular point in front of the mirror on the principal axis. This point is called the principal focus of the concave mirror.

Q.40 What is the nature of the image formed by a convex mirror?

Ans.- The images formed by a convex mirror are always virtual, smaller than the object and situated behind the mirror.

Q.41 An object of size 7cm is placed at 25cm in front of a concave mirror of focal length 15cm. At what distance from the mirror should a screen be placed so that we can get a sharp and clear image? Find the nature and size of the image.

Ans.- Given, for concave mirror, $h_1 = 7cm$

$u = -25cm, \quad f = -15cm$

Image distance (v), Image size (h_2)

According to mirror formula,

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

$$\therefore \frac{1}{v} = \frac{1}{f} - \frac{1}{u} \qquad = \frac{1}{(-15)} - \frac{1}{(-25)}$$

$= -\left(\frac{1}{15} - \frac{1}{25}\right) = -\frac{1}{15} + \frac{1}{25}$

$\therefore \frac{1}{v} = \frac{-2}{75}$ $\therefore v = -37.5cm$

The screen should be placed at 37.5cm in front of the mirror.

The image formed is real.

Magnification - $M = \frac{h_2}{h_1} = -\frac{v}{u}$

$\therefore h_2 = -h_1 \frac{v}{u}$

$\therefore h_2 = -7 \times \left(\frac{-37.5}{25}\right)$

$h_2 = -7 \times 1.5$

$h_2 = -10.5cm$

$\therefore$ The size of image $= -10.5cm$.

The image is inverted and real.

Q.42 Differentiate between convex mirror and concave mirror.

Convex mirror	Concave mirror
1) When outer surface of a spherical mirror is reflecting, it is called a convex mirror.	1) When inner surface of a spherical mirror is reflecting, it is called a concave mirror.
2) It can form only a virtual image.	2) It can form a real image as well as virtual image.
3) It can form only a diminished image.	3) It can form a magnified diminished or same size image depending on the position of the object.
4) Its focus is behind the mirror.	4) Its focus is in front of the mirror.

Q.43 When an object is kept as 6cmin front of a concave mirror, its image is obtained at 24cm behind the mirror. Find the focal length and radius of curvature of the mirror.

Ans.- For concave mirror, object distance $(u) = -6cm$,

Image distance $(v) = 24cm$. Focal length (f), Radius of curvature (R).

According to mirror formula,

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ $= \frac{1}{24} + \frac{1}{-6}$

$\frac{1}{f} = \frac{1}{24} - \frac{1}{6}$ $= \frac{6-24}{144}$

$\therefore \frac{1}{f} = \frac{18}{144}$

$\therefore \frac{1}{f} = \frac{-1}{8}$

$\therefore f = -8cm.$

$\therefore$ The focal length of the mirror $= -8cm.$

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

$\therefore R = 2 \times f$

$= 2(-8)$

$\therefore$ Radius of curvature $= -16cm.$

i) Focal length $(f) = -8cm.$

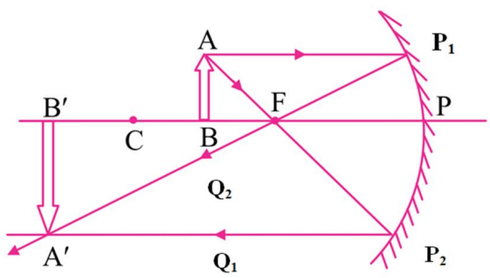
ii) Radius of curvature (R) $= -16cm.$

Q.44 Explain the formula verified experimentally regarding the images obtained in plane mirrors inclined with each other at some angle.

Ans.- Formula for number of images (n) obtained when an object is placed between two mirrors inclined at angle (A) with each other is given as - n = $\frac{360^0}{A} - 1$.

Q.45 Explain with diagram the formation of image in a convex mirror.

Ans.-



Object placed between focus and centre of curvature

1) Object AB is placed in front of a convex mirror.

2) Incident ray BD, starting from B passes through centre of curvature and traces its path backwards as reflected ray.

3) Incident ray BE, starting from B travelling parallel to principal axis, reflects such that it appears to have come from focus F as shown in diagram.
4) The two rays appear to meet at point 'B' forming image A'B'.
5) The image formed is virtual, diminished and lies behind the mirror.

Q.46 How will you find out if a mirror is concave or convex?
Ans.- 1) When held close to an object, the concave mirror forms an erect and enlarged image of the object. If the same mirror is taken farther, the image gets smaller and smaller and gets inverted in nature.
2) A convex mirror always forms erect and diminished image of an object.
3) It is necessary to understand the nature of the image produced, we can determine convex and the concave mirrors.

Q.47 What sign conventions are used for reflection from a spherical mirror?
Ans.- 1) The pole of the mirror is considered as origin and all the distances are measured from the pole.
2) Principal axis is taken as X-axis and all the distances parallel to the principal axis are measured from the pole of the mirror.
3) The object is always kept on the left of the mirror.
4) All the distances measured to the right of the origin (in the same direction of the incident ray) are taken as positive, while those measured to the left side of the origin are taken as negative.
5) All the distances measured vertically upwards from the principal axis are taken as positive and those measured in vertically downward direction, are taken as negative.

Q.48 State the relationship between object distance (u), image distance (v) and focal length (f) of a spherical mirror. What is this relationship known as?
Ans.- The object distance (u), image distance (v) and focal length (f) of a spherical mirror are related by the formula,

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

This relationship is known as mirror formula.

Q.49 Obtain the relation between magnifications (M), produced by spherical mirror in terms of focal length of mirror (f) when an object is placed at distance u forming image at distance v.

Ans.- Magnification,

$M = \frac{-v}{u}$ _____ (By definition)

$\therefore u = \frac{-v}{M}$ _____ i)

Using the mirror formula,

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

Using equation (i),

$\frac{1}{f} = \frac{1}{v} + \left(\frac{-M}{v}\right)$

$\therefore \frac{1}{f} = \frac{1-M}{v}$

$\therefore f = \frac{v}{1-M}$

$\therefore 1 - M = \frac{v}{f}$

$\therefore M = 1 - \frac{v}{f}$

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

This equation gives relation between magnification and focal length of spherical mirror.

Q.50 Sunita wants to get an inverted image of height 10cm of an object kept at a distance of 30cm form a concave mirror. The focal length of the mirror is 10cm. At what distance from the mirror should she place the screen? What will be the type of image, and what is the height of the object?

Ans.- Focal length $(f) = -10cm$

Object distance $(u) = -30cm$

Height of the image $h_2 = -10cm$

1) Image distance (v)

2) Height of object (h_1)

3) Type of image

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

2) $M = \frac{h_2}{h_1}$

From formula 1),

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

$\therefore \frac{1}{v} = \frac{1}{-10} - \frac{1}{-30}$

$= \frac{-3+1}{30} = \frac{-2}{30}$

$= \frac{-1}{15}$

$\therefore v = -15\text{cm}$

i.e. image is formed at a distance of 15cm from the mirror on left side. Hence, the image formed is real.

From formula ii)

$h_1 = -\frac{uh_2}{v} = \frac{(-30)(-10)}{-15}$

$= (-2)(-10)$

$\therefore h_1 = 20cm$

Ans.- Distance of image is 15cm. Height of the object is 20cm. Type of image is real and diminished.