

Chapter 10 (CBSE) Reflection in Mirror

Exercise — Multiple Choice (MCQ)

Question 1

A spherical mirror is made by silvering a part of a:

- a) solid metal sphere
- b) hollow metal sphere
- c) hollow glass sphere
- d) None of the above

Answer

b) hollow glass sphere

Reason — A spherical mirror is made by silvering a part of a hollow glass sphere .

Question 2

A mirror is made by silvering the surface of a piece of a hollow sphere.

- a) convex, outer
- b) plane, outer
- c) concave, outer
- d) concave, inner

Answer

c) concave, outer

Reason — A concave mirror is made by silvering the outer (or bulging) surface of a piece of a hollow sphere such that the reflection takes place from the hollow (or concave) surface.

Question 3

A mirror is made by silvering the surface of a piece of a hollow sphere.

- a) concave, inner
- b) convex, inner
- c) convex, outer
- d) None of the above

Answer

b) convex, inner

Reason — A convex mirror is made by silvering the inner surface of a piece of a hollow sphere such that the reflection takes place from the outer (or bulging) surface.

Question 4

The correct statement(s) is/are :

- (i) The radius of a sphere of which the spherical mirror is a part is called the radius of curvature.
- (ii) The geometric centre of the spherical surface of a mirror is called the centre of curvature.
- (iii) Principal axis is the straight line joining the pole of the mirror to its aperture.

- a) (i)
- b) (ii)
- c) (iii)

None of the above

Answer

- a) (i)



Reason — The radius of a sphere of which the spherical mirror is a part is called the radius of curvature.

The geometric centre of the spherical surface of a mirror is called the pole of the mirror.

Principal axis is the straight line joining the pole of the mirror to its centre of curvature.

Question 5

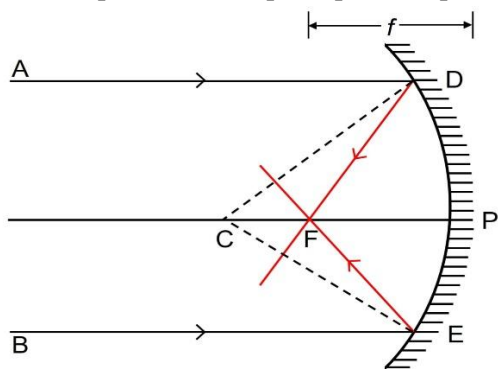
The focus of a concave mirror is a point on the through which the light rays incident to the principal axis pass after reflection from the mirror.

- a) centre of curvature, perpendicular
- b) principal axis, parallel
- c) principal axis, perpendicular
- d) aperture, parallel

Answer

- b) principal axis, parallel

Reason — The focus of a concave mirror is a point on the principal axis through which the light rays incident parallel to the principal axis, pass after reflection from the mirror.



Question 6

A concave mirror has a focus, whereas a convex mirror has a focus.

- a) real and virtual, real
- b) real, virtual
- c) virtual, real
- d) virtual, real and virtual

Answer

- b) real, virtual

Reason — A concave mirror has a real focus because the light rays incident parallel to the principal axis, after reflection actually pass through the focus.

A convex mirror has a virtual focus because the light rays incident parallel to the principal axis, appear to come from the focus after reflection from the mirror.

Question 7

A focal plane passes through the focus and is to the principal axis.

- a) Parallel
- b) Inclined
- c) Normal
- d) none of the above

Answer

- c) normal



Reason — A plane passing through the focus and normal to the principal axis of the mirror, is called the focal plane.

Question 8

For an incident ray directed towards center of curvature of a spherical mirror, the reflected ray:

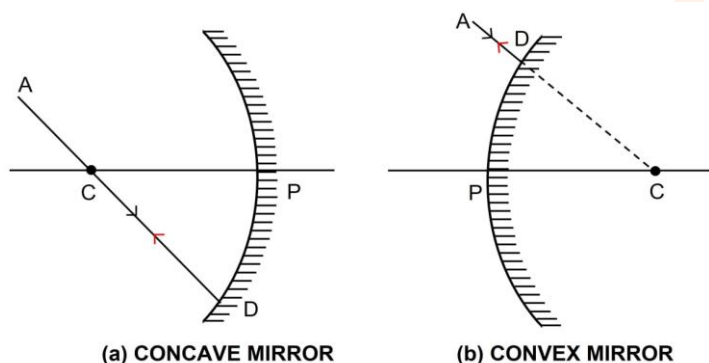
- a) retraces it's path
- b) passes through the focus
- c) passes through the pole
- d) becomes parallel to the principal axis

Answer

- a) retraces it's path

Reason — A line joining the centre of curvature to any point on the surface of mirror is normal to the mirror at that point, so a ray AD passing through the center of curvature C (or appearing to pass through through the centre of curvature C) is incident normally on the spherical mirror.

Since it's angle of incidence is zero, therefore the angle of reflection will also be zero and the ray AD gets reflected along it's own path DA as shown below.



Question 9

A ray either incident from the focus (or converging at the focus), after reflection from a spherical mirror:

- a) becomes perpendicular to the principal axis
- b) becomes parallel to the principal axis
- c) becomes normal to the focus
- d) passes through the centre of curvature

Answer

- b) becomes parallel to the principal axis

Reason — A ray either incident from the focus (or converging at the focus), after reflection from a spherical mirror becomes parallel to the principal axis.

Question 10

For a concave mirror, when the object is at infinity, the nature of the image formed at focus is

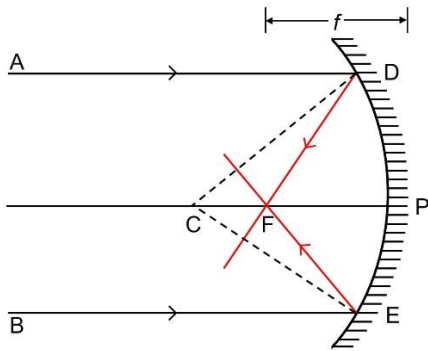
- a) virtual, inverted
- b) virtual, diminished to a point
- c) real, enlarged, inverted
- d) real, inverted, diminished to a point

Answer

- d) real, inverted, diminished to a point

Reason — For a concave mirror, when the object is at infinity, the nature of the image formed at focus is real, inverted, diminished to a point.





Question 11

For a concave mirror, when the object is at the centre of curvature, the place and nature of the image formed is:

- a) at focus, real, inverted
- b) at focus, virtual, inverted
- c) at centre of curvature, real, inverted, diminished
- d) at centre of curvature, real, same size as that of the object

Answer

d) at centre of curvature, real, same size as that of the object

Reason — For a concave mirror, when the object is at the centre of curvature, the image is also at the centre of curvature. It is real and same size as that of the object.

Question 12

For a concave mirror, when the object is at focus, the size of the image formed is:

- a) magnified
- b) highly magnified
- c) diminished
- d) of the same size

Answer

b) highly magnified

Reason — For a concave mirror, when the object is at focus, the image is at infinity. It is real, inverted and highly magnified.

Question 13

The image formed by a convex mirror is:

- a) erect and diminished
- b) erect and enlarged
- c) inverted and diminished
- d) inverted and enlarged

Answer

a) erect and diminished

Reason — In a convex mirror, the image formed is always virtual, erect and diminished. It is always situated between its pole and focus irrespective of the distance of object in front of the mirror.

Question 14

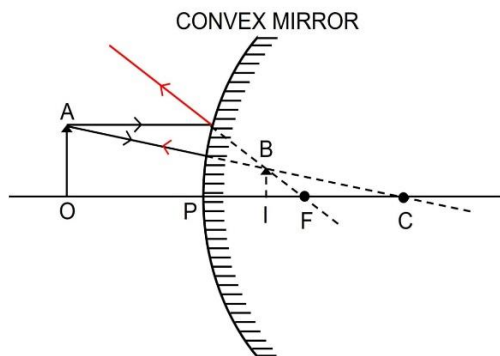
For a convex mirror, when the object is in front of the mirror, the image formed is :

- a) real, upright and magnified
- b) real, inverted and diminished
- c) virtual, upright and magnified
- d) virtual, upright and diminished

Answer

d) virtual, upright and diminished

Reason — For a convex mirror, when the object is in front of the mirror, the image is between the pole and the focus. It is virtual, upright and diminished.



Question 15

For a spherical mirror, the focal length is its radius of curvature.

- a) equal to
- b) half of
- c) twice of
- d) one-third of

Answer

- b) half of

Reason — The focal length of a spherical mirror is equal to half of its radius of curvature i.e., $f = \frac{1}{2}R$

Question 16

The wrong rule of sign convention is :

- (i) All distances are measured from the centre of curvature of the mirror taken as origin.
- (ii) The distances measured along the principal axis in the direction of incident light are positive.
- (iii) The distances above the principal axis are taken positive.

- a) (i)
- b) (ii)
- c) (iii)
- d) both (i) and (ii)

Answer

- a) (i)

Reason — The rules of sign convention are:

- (i) All distances are measured from the pole of the mirror taken as origin.
- (ii) The distances measured along the principal axis in the direction of incident light are positive while those opposite to the incident light are negative.
- (iii) The distances above the principal axis are taken positive and those below the principal axis are taken negative.

Question 17

For a convex mirror, the value of u is always and the value of v is

- a) positive, positive
- b) positive, negative
- c) negative, negative



d) negative, positive

Answer

d) negative, positive

Reason — For a convex mirror, the value of u is always negative and the value of v is always positive.

Question 18

A real and enlarged image can be obtained by using a:

- a) convex mirror
- b) plane mirror
- c) concave mirror
- d) either convex or plane mirror

Answer

c) concave mirror

Reason — The image formed by a concave mirror is real and enlarged, when the object is between centre of curvature and focus or at focus.

Question 19

The type of mirror used as a reflector in the street lights is :

- a) plane mirror
- b) convex mirror
- c) concave mirror
- d) parabolic mirror

Answer

b) convex mirror

Reason — A convex polished metallic surface is used in street lamps as a reflector so as to diverge light over a larger area.

Question 20

The type of mirror used as a shaving mirror in daily life is :

- a) plane mirror
- b) convex mirror
- c) concave mirror
- d) parabolic mirror

Answer

c) concave mirror

Reason — When a concave mirror is held near the face (such that the face is between pole and focus of the mirror), it gives an upright and magnified image. Hence even tiny hair can be seen. For this concave mirror of large focal length and large aperture is used.

Question 21

Which mirror always forms a diminished image for all positions of the object placed in front of it ?

- a) plane mirror
- b) convex mirror
- c) concave mirror
- d) parabolic mirror

Answer

b) convex mirror

Reason — A convex mirror always forms a diminished image for all positions of the object placed in front of it.



Exercise — Very Short Answer

Question 1

What is a spherical mirror?

Answer

A reflecting surface which is a part of a sphere is called a spherical mirror.

Question 2

Define centre of curvature of a spherical mirror.

Answer

The centre of curvature of a mirror is the centre of the sphere of which the mirror is a part.

Question 3

Define radius of curvature of a spherical mirror.

Answer

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

Question 4

What is the aperture of a spherical mirror?

Answer

The plane surface area of the mirror through which light rays enter and fall on the mirror is called its aperture.

Question 5

Define the pole of a spherical mirror.

Answer

The geometric centre of the spherical surface of mirror is called the pole of the mirror.

Question 6

Name the spherical mirror which always produces an erect and virtual image. How is the size of image related to the size of object?

Answer

A convex mirror always produces an erect and virtual image. The size of the image is shorter than the size of the object.

Question 7

(a) For what position of object, the image formed by a concave mirror is magnified and erect?

(b) State whether the image in part (a) is real or virtual?

Answer

(a) When the object is between the pole and focus of a concave mirror then the image formed is magnified and erect

(b) The image is virtual.

Question 8

(a) State the position of object for which the image formed by a concave mirror is of same size.

(b) Write two more characteristics of the image.

Answer

(a) When the object is at the centre of curvature of a concave mirror, the image is of the same size as the object.

(b) The images thus formed is real and inverted.

Question 9

(a) What is a real image?

(b) What type of mirror can be used to obtain a real image of an object?



(c) Does the mirror mentioned in part (b) form real image for all locations of the object?

Answer

- (a) A real image is one that can be obtained on a screen.
- (b) A concave mirror can be used to obtain a real image of an object.
- (c) No, concave mirror does not form real image for all the locations of the object.

Question 10

Name the kind of mirror used to obtain —

- (a) a real and enlarged image,
- (b) a virtual and enlarged image,
- (c) a virtual and diminished image,
- (d) a real and diminished image.

Answer

- (a) Concave mirror is used to obtain a real and enlarged image.
- (b) Concave mirror is used to obtain a virtual and enlarged image.
- (c) Convex mirror is used to obtain a virtual and diminished image.
- (d) Concave mirror is used to obtain a real and diminished image.

Question 11

How is the focal length of a spherical mirror related to its radius of curvature?

Answer

The focal length 'f' is related to the radius of curvature 'R' in the following way —

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

Question 12

Write the spherical mirror's formula and explain the meaning of each symbol used in it.

Answer

The formula for the spherical mirror is —

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

u = distance of object

v = distance of image

f = focal length

Question 13

State the kind of mirror used —

- (a) by a dentist,
- (b) as a search-light reflector.

Answer

- (a) Concave mirror is used by a dentist.
- (b) Concave mirror is used as a search-light reflector.

Question 14

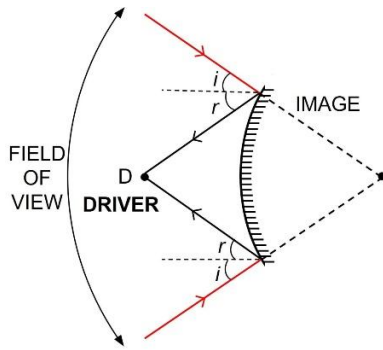
Which mirror will you prefer to use as a rear view mirror in a car — plane mirror or convex mirror?

Give one reason.

Answer

A convex mirror would be preferred in comparison to a plane mirror for use as a rear view mirror in a car because it provides a much wider field view as compared to a plane mirror of the same size. The below ray diagram shows this:





Question 15

How is magnification (m) related to the distance of the object (u) and the distance of the image (v) ?

Answer

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = - \frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = - \frac{v}{u}$$

where

- 'I' is the length of the image,
- 'O' is the length of the object,
- 'v' is the distance of the image,
- 'u' is the distance of the object.

Exercise — Short Answer

Question 1

Name the two kinds of spherical mirrors and distinguish between them.

Answer

Depending on whether the inner or outer surface of the sphere is silvered, spherical mirrors are of two types —

Concave mirror

Convex mirror

Difference between the two mirrors are —

Concave mirror	Convex mirror
It is made by silvering the outer surface of a part of the hollow sphere, so reflection takes place from the inner surface.	It is made by silvering the inner surface of a part of the hollow sphere, so reflection takes place from the bulging surface.
The light rays incident on it converge after reflection.	The light rays incident on it diverge after reflection.
The image formed by it is real as well as virtual. For all positions of the object at or beyond the focus, the image is real, while for positions of the object between the focus and the pole, the image is virtual.	The image formed by it is always virtual for all positions of the object in front of it.



Concave mirror	Convex mirror
For object away from the centre of curvature, the image is diminished, for object at the centre of curvature, image is of same size and for object within the centre of curvature, image is diminished.	The image is always diminished for all positions of the object in front of it.

Question 2

Define the terms pole, principal axis and center of curvature with reference to a spherical mirror.

Answer

Pole — The geometric centre of the spherical surface of mirror is called the pole of the mirror.

Principal axis — It is the straight line joining the pole of the mirror to its centre of curvature.

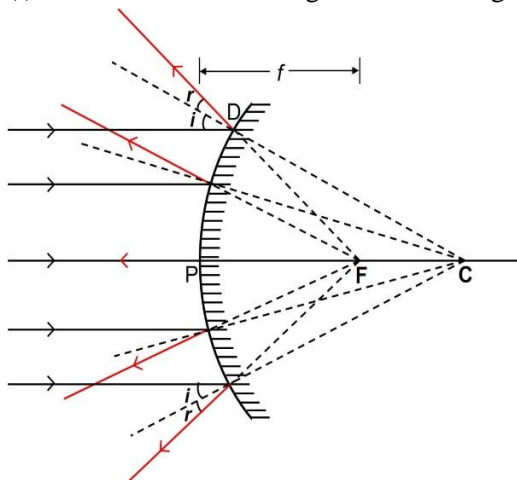
Centre of curvature — The centre of curvature of a mirror is the centre of sphere of which the mirror is a part.

Question 3

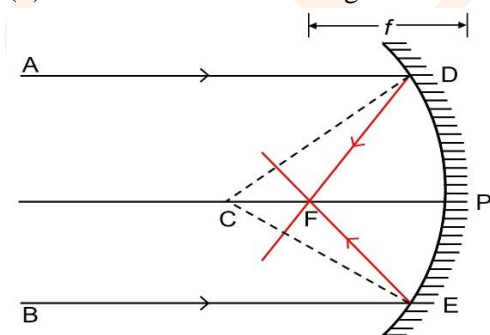
Name the spherical mirror which (i) diverges (ii) converges the beam of light incident on it. Justify your answer by drawing a ray diagram in each case.

Answer

(i) A convex mirror diverges a beam of light incident on it.



(ii) A concave mirror converges a beam of light incident on it.

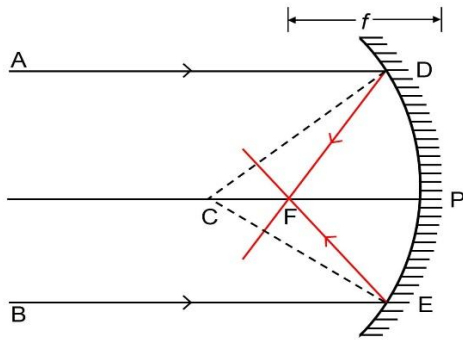


Question 4

Define the terms focus and focal length of a concave mirror. Draw diagram to illustrate your answer.

Answer

Focus of a concave mirror — The focus of a concave mirror is a point on the principal axis through which the light rays incident parallel to the principal axis, pass after reflection from the mirror.



Focal length of a concave mirror — The distance of focus F from the pole P of the mirror is called the focal length of the mirror.

i.e., focal length $f = PF$.

Question 5

State the direction of incident ray which after reflection from a spherical mirror retraces its path. Give a reason to your answer.

Answer

When the incident ray is directed towards the centre of curvature, after reflection from a spherical mirror, it retraces its path.

It is because the ray is normal to the spherical mirror, so $\angle i$ (angle of incidence) = 0, therefore, $\angle r$ (angle of reflection) = 0.

Question 6

What is meant by magnification? Write its expression. What is its sign for the (a) real (b) virtual, image?

Answer

The ratio of length of the image to the length of object, is called linear magnification.

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = - \frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = - \frac{v}{u}$$

Where

'I' is the length of the image,

'O' is the length of the object,

'v' is the distance of the image,

'u' is the distance of the object.

(a) For a real image, linear magnification m is negative.

(b) For a virtual image, linear magnification m is positive.

Question 7

Upto what maximum distance from the pole, the image in a convex mirror can be obtained? What will be the location of object then?

Answer

The maximum distance from the pole, in a convex mirror where the image can be obtained is till the focal length of the mirror. The object would then have to be at infinity.

Question 8

Upto what maximum distance from a concave mirror, the image can be obtained? What will be the location of object for it?



Answer

The maximum distance from the concave mirror, where the image can be obtained is infinity. The object would then be at focus.

Question 9

How will you distinguish between a plane mirror, a concave mirror and a convex mirror, without touching them?

Answer

In order to distinguish between a plane mirror, a concave mirror and a convex mirror, the given mirror is held near the face and the image obtained is seen.

There can be the following three cases —

Case 1 — If image is upright, of same size and it does not change in size by moving the mirror towards or away from the face, then the mirror is plane.

Case 2 — If image is upright, magnified and increases in size on small movement of the mirror away from the face then the mirror is concave.

Case 3 — If image is upright, diminished and decreases in size on small movement of the mirror away from the face then the mirror is convex.

Question 10

State two uses of a concave mirror.

Answer

Uses of a concave mirror are as follows —

As a shaving mirror — When a concave mirror is held near the face (such that the face is between pole and focus of the mirror), it gives an upright and magnified image. Hence even tiny hair can be seen.

As a reflector — In torch, searchlight and head light of automobiles, cycles etc., a concave polished metallic surface is used to obtain a parallel beam of light.

Question 11

(a) When a concave mirror is used as a shaving mirror, where is the person's face in relation to the focus of mirror?

(b) State three characteristics of the image seen in part (a)

Answer

(a) When a concave mirror is used as a shaving mirror, the person's face should be between the pole and the focus.

(b) The image formed is erect, virtual and magnified.

Exercise — Long Answer

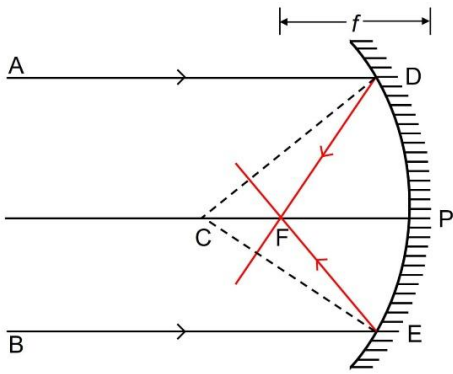
Question 1

Draw suitable diagrams to illustrate the action of (i) concave mirror, and (ii) convex mirror, on a beam of light incident parallel to the principal axis.

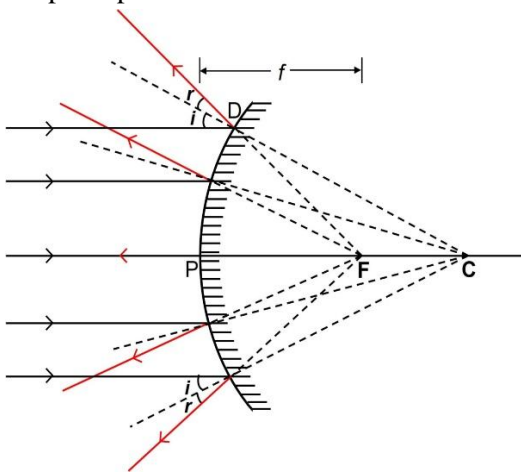
Answer

(i) Below ray diagram illustrates the action of concave mirror on a beam of light incident parallel to the principal axis:





(ii) Below ray diagram illustrates the action of convex mirror on a beam of light incident parallel to the principal axis:

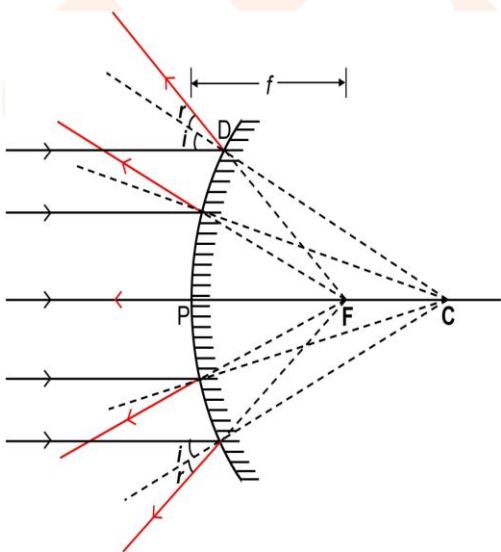


Question 2

Explain the meaning of the terms focus and focal length in case of a convex mirror, with the help of a suitable ray diagram.

Answer

Focus of a convex mirror — The focus of a convex mirror is a point on the principal axis from which, the light rays that are incident parallel to the principal axis, appear to come, after reflection from the mirror.



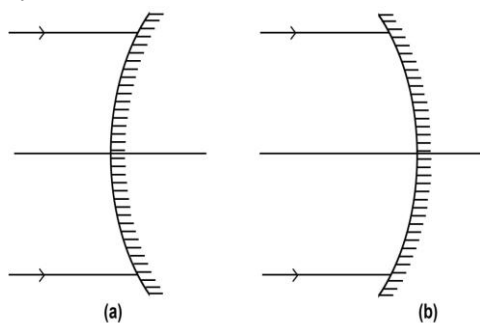
Focal length of a concave mirror — The distance of focus F from the pole P of the mirror is called the focal length of the mirror.

i.e., focal length $f = PF$.

Question 3

(i) Name the mirrors shown in figure (a) and (b).

(ii) In each case (a) and (b), draw the reflected rays for the given incident rays and mark focus by the symbol F.

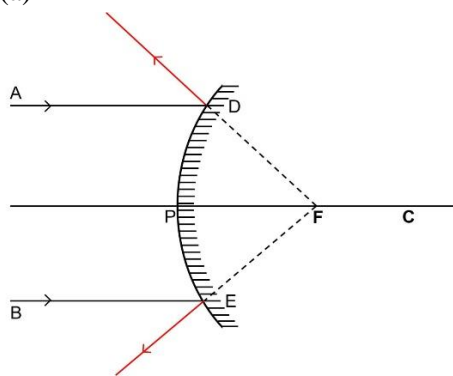


Answer

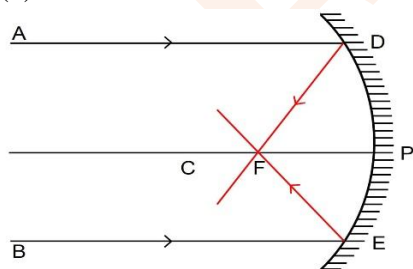
(i) The figure (a) shows convex mirror and figure (b) shows concave mirror.

(ii) Diagrams showing reflected rays are shown below:

(a)

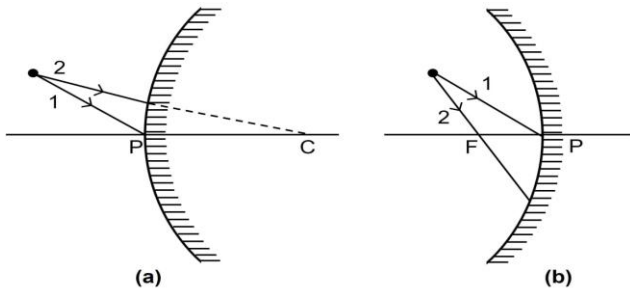


(b)



Question 4

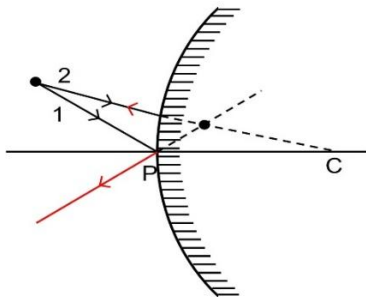
Complete the following diagrams in figure by drawing the reflected rays for the incident rays 1 and 2.



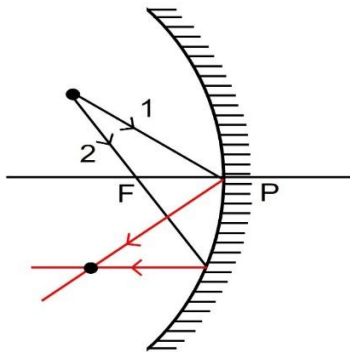
Answer

Below are the completed diagrams showing the reflected rays for the incident rays 1 and 2:

(a)

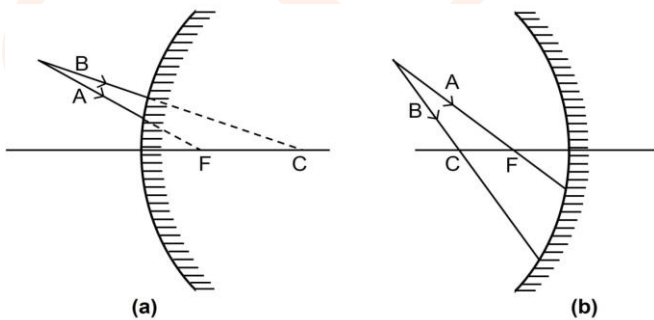


(b)



Question 5

Complete the following diagrams shown in figure by drawing the reflected ray for each of the incident ray A and B.

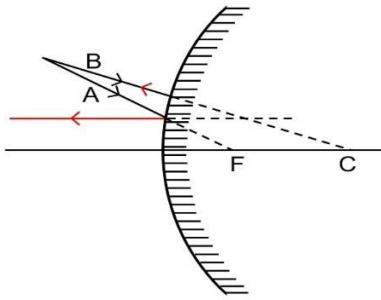


Answer

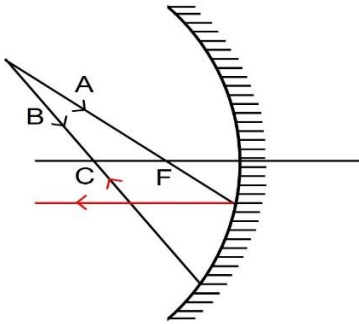
Below are the completed diagrams showing the reflected rays for the incident rays A and B:

(a)





(b)



Question 6

State the two convenient rays that are chosen to construct the image by a spherical mirror for a given object? Explain your answer with the help of suitable ray diagrams.

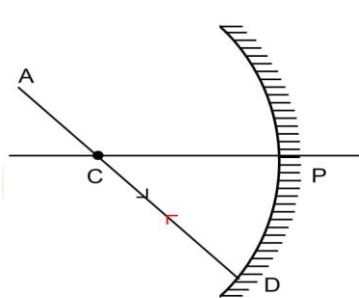
Answer

The two convenient rays, chosen to construct the image by a spherical mirror are —

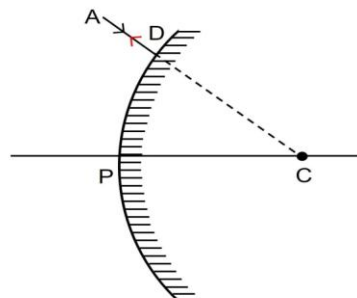
(i) A ray that passes through the center of curvature.

A line joining the centre of curvature to any point on the surface of mirror is normal to the mirror at that point, therefore a ray AD passing through the center of curvature C (or appearing to pass through through the centre of curvature C) is incident normally on the spherical mirror.

Since it's angle of incidence is zero, therefore the angle of reflection will also be zero and the ray AD gets reflected along it's own path DA as shown below:



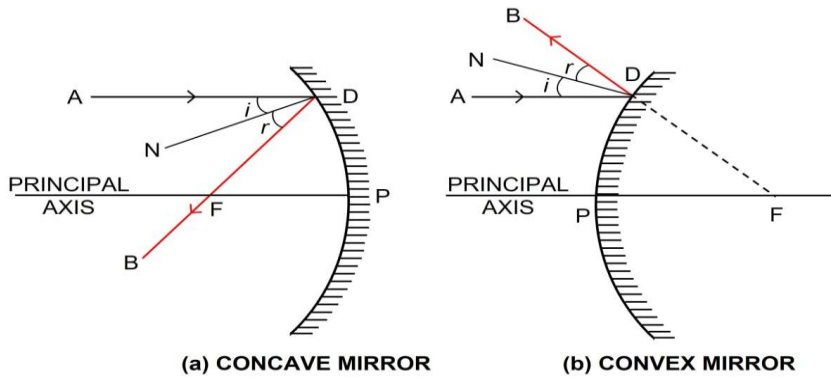
(a) CONCAVE MIRROR



(b) CONVEX MIRROR

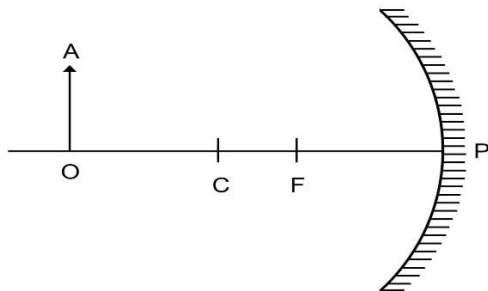
(ii) A ray parallel to the principal axis.

A ray of light AD incident parallel to the principal axis, after reflection passes either through the focus F (in a concave mirror) or will appear to come from the focus F (in a convex mirror) along DB as shown below:



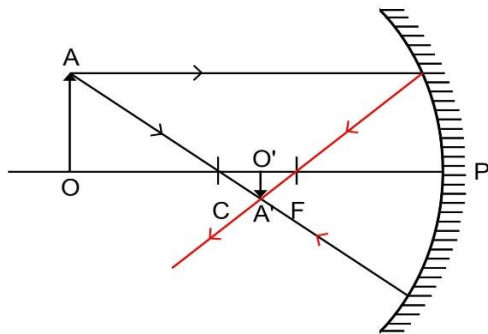
Question 7

Figure shows a concave mirror with its pole at P, focus F and center of curvature C. Draw ray diagram to show the formation of image of an object OA.



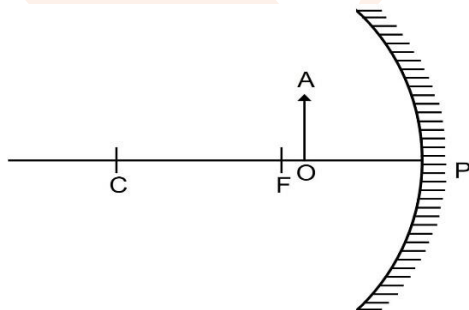
Answer

Ray diagram showing the formation of the image is given below:



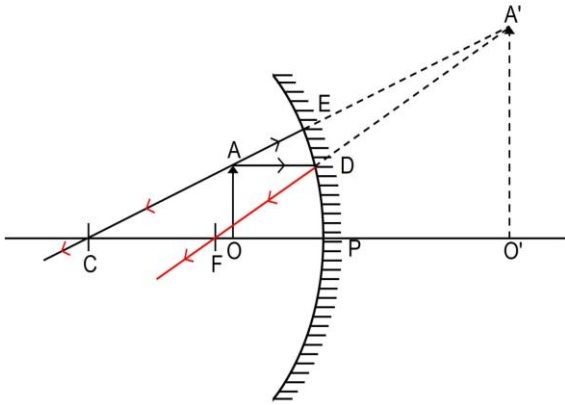
Question 8

Figure shows a concave mirror with its pole at P, focus F and center of curvature C. Draw ray diagram to show the formation of image of an object OA.



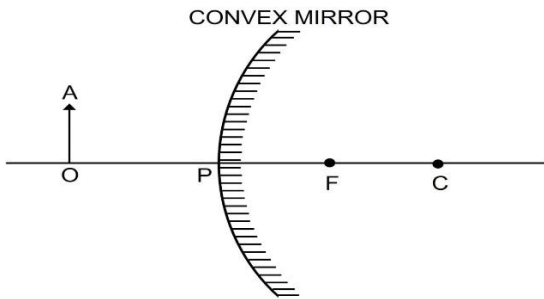
Answer

Ray diagram showing the formation of the image is given below:



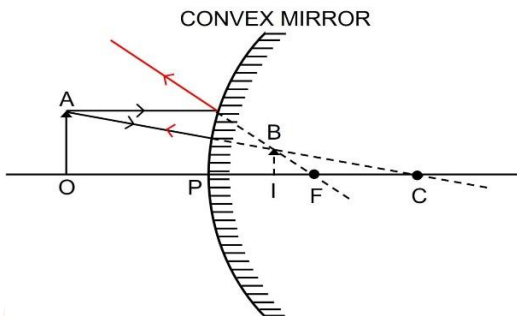
Question 9

The diagram below in figure shows a convex mirror. C is its center of curvature and F is its focus. (i) Draw two rays from A and hence locate the position of image of object OA. Label the image IB. (ii) State three characteristics of the image.



Answer

(i) Below completed ray diagram shows the position of the image of object OA:



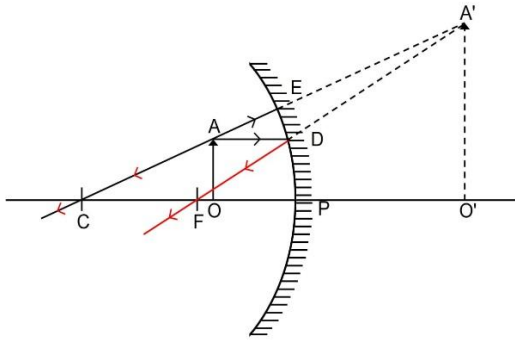
(ii) The three characteristics of the image are virtual, upright and diminished.

Question 10

Draw a ray diagram to show the formation of image by a concave mirror for an object placed between its pole and focus. State three characteristics of the image.

Answer

Below is the ray diagram showing the formation of image by a concave mirror for an object placed between its pole and focus:



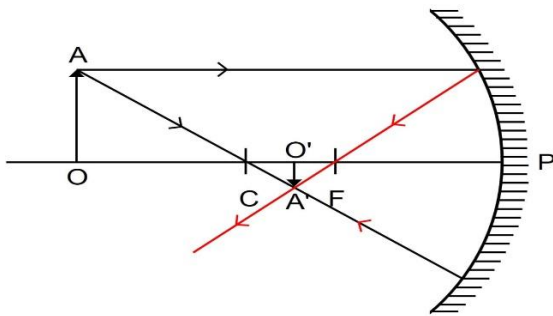
When the object is between the focus F and the pole P, the image is formed behind the mirror. It is virtual, upright and magnified.

Question 11

Draw a ray diagram to show the formation of image by a concave mirror for an object beyond its center of curvature. State three characteristics of the image.

Answer

The image by a concave mirror for an object beyond its center of curvature is shown below:



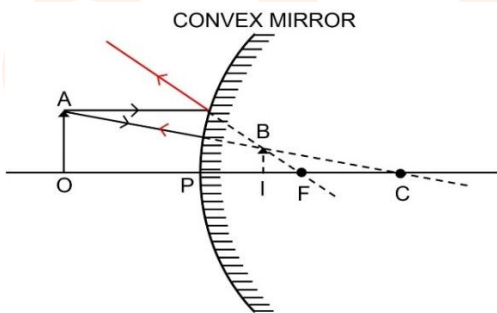
When object is beyond the centre of curvature C, the image is between the focus F and the centre of curvature C. It is real, inverted and diminished.

Question 12

Draw a ray diagram to show the formation of image of an object kept in front of a convex mirror. State three characteristics of the image.

Answer

The diagram below shows the formation of image when the object is kept in front of a convex mirror.



When the object is in front of the convex mirror, the image is between the pole P and focus F on the other side of the mirror.

The image formed is virtual, upright and diminished.

Question 13

Discuss the position and nature of image formed by a concave mirror when an object is moved from infinity towards the pole of mirror.

Answer

The image formed moves away from the concave mirror when an object is moved from infinity towards the pole of mirror.

The image is diminished when the object is beyond centre of curvature, but it becomes magnified as the object comes within the centre of curvature. The image is of the same size of the object when the object is at the centre of curvature.

For the object situated beyond focus, the image is always real and inverted, whereas for the object situated between the focus and pole the image is upright and virtual.

The table below shows the position, size and nature of the image formed by a concave mirror for different positions of the object.

No.	Position of the object	Position of the image	Size of the image	Nature of the image
1	At infinity	At the focus	Diminished to a point	Real and inverted
2	At very far distance	In focal plane	Highly diminished	Real and inverted
3	Beyond the centre of curvature	Between the centre of curvature and focus	Diminished	Real and inverted
4	At the centre of curvature	At the centre of curvature	Same size	Real and inverted
5	Between the centre of curvature and focus	Beyond the centre of curvature	Magnified	Real and inverted
6	At focus	At infinity	Highly magnified	Real and inverted
7	Between the focus and the pole	Behind the mirror	Magnified	Virtual and upright

Question 14

Discuss the position and nature of image formed by a convex mirror when an object is moved from infinity towards the pole of mirror.

Answer

In a convex mirror, the image formed is always virtual, upright and diminished. It is always situated between its pole and focus irrespective of the distance of object in front of the mirror.

As the object comes closer to the mirror from infinity towards the pole, its image shifts from focus towards the pole and increase in size.

The table below shows the position, size and nature of the image formed by a convex mirror

No.	Position of the object	Position of the image	Size of the image	Nature of the image
1.	At infinity	At focus	Diminished to a point	Virtual and upright



No.	Position of the object	Position of the image	Size of the image	Nature of the image
2.	At any other point	Between focus and the pole	Diminished	Virtual and upright

Question 15

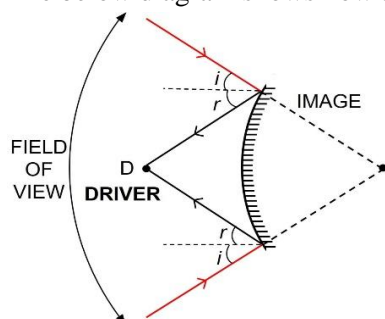
Why does a driver use a convex mirror instead of a plane mirror as a rear view mirror? Illustrate your answer with the help of a ray diagram.

Answer

A convex mirror diverges the incident light beam and always forms a virtual, small and erect image behind the mirror between its pole and focus. This fact enables the driver to use it as a rear view mirror in vehicles to see all the traffic approaching from behind.

Although a plane mirror can also be used as a rear view mirror, but a convex mirror provides a much wider field view as compared to a plane mirror of the same size.

The below diagram shows how a convex mirror provides a better field view than a plane mirror.



Exercise — Numerical

Question 1

The radius of curvature of a convex mirror is 40 cm. find its focal length.

Answer

Focal length, $f = \frac{1}{2} \times \text{Radius of curvature (R)}$

Given,

$R = 40 \text{ cm}$

Substituting the values in the formula above we get,

Focal length $= \frac{1}{2} \times R = \frac{1}{2} \times 40 = 20 \text{ cm}$

Hence, focal length of the convex mirror = 20 cm.

Question 2

The focal length of a concave mirror is 10 cm. Find its radius of curvature.

Answer

Focal length, $f = \frac{1}{2} \times \text{Radius of curvature (R)}$

$\Rightarrow \text{Radius of curvature (R)} = 2 \times \text{Focal length (f)}$

Given,

$f = 10 \text{ cm}$

Substituting the values in the formula above we get,

$$R = 2 \times 10 = 20 \text{ cm,}$$

Hence, radius of curvature of concave mirror = 20 cm.

Question 3

An object of height 2 cm is placed at a distance 20 cm in front of a concave mirror of focal length 12 cm. Find the position, size and nature of the image.

Answer

Given,

$$\text{Object height (O)} = 2 \text{ cm}$$

$$\text{Focal length (f)} = 12 \text{ cm (negative)}$$

$$\text{Object distance (u)} = 20 \text{ cm (negative)}$$

Mirror formula:

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

Substituting the values in the formula above we get,

$$\frac{1}{v} + \frac{1}{-20} = \frac{1}{-12}$$

$$\frac{1}{v} - \frac{1}{20} = -\frac{1}{12}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{12} = \frac{3-5}{60} = \frac{-2}{60} = -\frac{1}{30}$$

$$v = -\frac{30}{1} = -30 \text{ cm}$$

Hence, the image is formed at a distance of 30 cm in front of the mirror.

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = -\frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = -\frac{v}{u} = -\frac{-30}{-20} = -\frac{3}{2}$$

$$I = -\frac{3}{2} \times O = -\frac{3}{2} \times 2 = -3 \text{ cm}$$

Hence, length of image = 3 cm

Image will be real, inverted and magnified.

Question 4

An object is placed at 4 cm distance in front of a concave mirror of radius of curvature 24 cm. Find the position of image. Is the image magnified?

Answer

Given,

$$\text{Radius of curvature (R)} = 24 \text{ cm (negative)}$$

$$\text{Object distance (u)} = 4 \text{ cm (negative)}$$

$$\text{Focal length, f} = \frac{1}{2} \times (-24) = -12 \text{ cm}$$

Hence, focal length of the concave mirror = -12 cm.

Mirror formula:

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

Substituting the values in the formula above we get,

$$\frac{1}{v} + \frac{1}{-4} = \frac{1}{-12}$$



$$\frac{1}{v} - \frac{1}{4} = -\frac{1}{12}$$

$$\frac{1}{v} = \frac{1}{4} - \frac{1}{12} = \frac{3-1}{12} = \frac{2}{12} = \frac{1}{6}$$

$$v = \frac{6}{1} = 6 \text{ cm}$$

The image is formed 6 cm behind the mirror.

Computing linear magnification:

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = -\frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = -\frac{v}{u} = -\frac{6}{-4} = \frac{3}{2} = 1.5$$

As, the length of image is 1.5 times the image of object, hence, the image is magnified.

Question 5

At what distance from a concave mirror of focal length 25 cm should an object be placed so that the size of image is equal to the size of the object.

Answer

To get an image of same size the object should be placed at the center of the curvature of a concave mirror.

Given,

focal length = 25 cm

As, centre of curvature = 2 × focal length

Therefore,

centre of curvature = 2 × 25 = 50 cm

Hence, the object should be kept at 50 cm so that the size of image is equal to the size of object.

Question 6

An object 5 cm high is placed at a distance 60 cm in front of a concave mirror of focal length 10 cm. Find (i) the position and (ii) size, of the image.

Answer

Given,

Object height (O) = 5 cm

focal length (f) = 10 cm (negative)

Object distance (u) = 60 cm (negative)

Mirror formula:

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

Substituting the values in the formula above we get,

$$\frac{1}{v} + \frac{1}{-60} = \frac{1}{-10}$$

$$\frac{1}{v} - \frac{1}{60} = -\frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{60} - \frac{1}{10} = \frac{1-6}{60} = -\frac{5}{60} = -\frac{1}{12}$$

$$v = -\frac{12}{1} = -12 \text{ cm}$$



The image distance (v) = 12 cm in front of the mirror.

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = - \frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = - \frac{v}{u} = - \frac{-12}{-60} = - \frac{1}{5}$$

$$I = - \frac{1}{5} \times O = - \frac{1}{5} \times 5 = -1$$

Hence, length of image = 1 cm

Negative sign shows that the image will be inverted.

Question 7

A point light source is kept in front of a convex mirror at a distance of 40 cm. The focal length of the mirror is 40 cm. Find the position of image.

Answer

Given,

$$u = 40 \text{ cm (negative)}$$

$$f = 40 \text{ cm (positive)}$$

Mirror formula:

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

Substituting the values in the formula above we get,

$$\frac{1}{v} + \frac{1}{-40} = \frac{1}{40}$$

$$\frac{1}{v} - \frac{1}{40} = \frac{1}{40}$$

$$\frac{1}{v} = \frac{1}{40} + \frac{1}{40} = \frac{1+1}{40} = \frac{2}{40} = \frac{1}{20}$$

$$v = \frac{20}{1} = 20 \text{ cm}$$

Hence, the image is formed 20 cm behind the mirror.

Question 8

When an object of height 1 cm is kept at a distance 4 cm from a concave mirror, its erect image of height 1.5 cm is formed at a distance 6 cm behind the mirror. Find the focal length of the mirror.

Answer

Given,

$$u = 4 \text{ cm (negative)}$$

$$v = 6 \text{ cm (positive)}$$

Mirror formula:

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

Substituting the values in the formula above we get,

$$\frac{1}{6} + \frac{1}{-4} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{1}{6} - \frac{1}{4} = \frac{2-3}{12} = \frac{-1}{12}$$



$$f = -\frac{12}{1} = -12 \text{ cm}$$

Hence, the focal length of concave mirror = 12 cm

Question 9

An object of length 4 cm is placed in front of a concave mirror at a distance 30 cm. The focal length of mirror is 15 cm. (a) Where will the image form? (b) What will be the length of image?

Answer

(a) Given,

$$u = 30 \text{ cm (negative)}$$

$$f = 15 \text{ cm (negative)}$$

Mirror formula:

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

Substituting the values in the formula above we get,

$$\frac{1}{v} + \frac{1}{-30} = \frac{1}{-15}$$

$$\frac{1}{v} = \frac{1}{30} - \frac{1}{15} = \frac{1-2}{30} = \frac{-1}{30}$$

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

Hence, the image is formed at 30 cm in front of the mirror

(b) Magnification

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = -\frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = -\frac{v}{u} = -\frac{-30}{-30} = -1$$

$$I = -1 \times O = -1 \times 4 = -4$$

Hence, length of image = 4 cm

Negative sign represents that the image is inverted.

Question 10

A concave mirror forms a real image of an object placed in front of it at a distance 30 cm, of size three times the size of object. Find (a) the focal length of mirror (b) position of image.

Answer

Given,

(a) Distance of the object (u) = 30 cm (negative)

Image height = 3 times the height of object

So, magnification (m) = 3 (negative for the real image)

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = -\frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = -\frac{v}{u}$$

$$-\frac{v}{-30} = m = 3$$

$$\frac{v}{30} = m = -3$$

$$v = -3 \times 30 = -90 \text{ cm}$$



$$I = -\frac{1}{5} \times O = -\frac{1}{5} \times 5 = -1$$

Hence, the image is formed 90 cm in front of the mirror.

Mirror formula:

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

Substituting the values in the formula above we get,

$$\frac{1}{-90} + \frac{1}{-30} = \frac{1}{f}$$

$$\frac{1}{f} = -\frac{1}{90} - \frac{1}{30} = \frac{-1-3}{90} = \frac{-4}{90} = -\frac{2}{45}$$

$$f = -\frac{45}{2} = 22.5 \text{ cm}$$

Hence, focal length of the mirror = 22.5 cm

(b) The image is formed 90 cm in front of the mirror

Question 11

A concave mirror forms a virtual image of size twice that of the object placed at a distance 5 cm from it. Find (a) the focal length of the mirror (b) position of the image.

Answer

(a) Given,

Distance of the object (u) = 5 cm (negative)

Magnification (m) = 2 (positive for the virtual image)

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = -\frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = -\frac{v}{u}$$

$$2 = -\frac{v}{-5}$$

$$2 = \frac{v}{5}$$

$$v = 2 \times 5 = 10 \text{ cm}$$

Hence, the image is formed 10 cm behind the mirror.

Mirror formula:

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

Substituting the values in the mirror formula, we get,

$$\frac{1}{-5} + \frac{1}{10} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{1}{10} - \frac{1}{5} = \frac{1-2}{10} = \frac{-1}{10}$$

$$f = -\frac{10}{1} = -10 \text{ cm}$$

Hence, focal length of the mirror = 10 cm

(b) The position of the image is 10 cm behind the mirror



Question 12

The image formed by a convex mirror is of size one-third the size of object. How are u and v related?

Answer

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = - \frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = - \frac{v}{u}$$

As per question, the image formed by a convex mirror is of size one-third the size of object

$$\therefore I = \frac{1}{3} \times O$$

$$\frac{I}{O} = \frac{1}{3}$$

$$\therefore - \frac{v}{u} = \frac{I}{O} = \frac{1}{3}$$

$$v = - \frac{1}{3} \times u$$

$$u = -3v$$

Question 13

The erect image formed by a concave mirror is of size double the size of object. How are u and v related?

Answer

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = - \frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = - \frac{v}{u}$$

Now, given

$$\frac{I}{O} = 2$$

$$\therefore - \frac{v}{u} = \frac{I}{O} = 2$$

$$v = -2u$$

Question 14

The magnification for a mirror is -3. How are u and v related?

Answer

$$\text{Magnification (m)} = \frac{\text{Length of image (I)}}{\text{Length of object (O)}} = - \frac{\text{Distance of image (v)}}{\text{Distance of object (u)}}$$

$$m = \frac{I}{O} = - \frac{v}{u}$$

Now, Given

$$\frac{I}{O} = -3$$

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

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

$$v = 3u$$

Hence, $v = 3u$

