Chapter 6 Light: Reflection of Light

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Solution 1:
Light may be defined as the radiant energy which produces in us the sensation of sight. Light itself is invisible but makes other objects visible.

Solution 2:
Yes, light is a form of energy that produces the sensation of vision in our eyes.

Solution 3:
The velocity of light in vacuum is 3×10^8 m/s.

Solution 4:
Two sources of light are

- Natural, for e.g. Sun
- Artificial, for e.g. Light bulb.

Solution 5:
Four characteristics of light are :-

- Light waves can travel through vacuum
- Light waves are transverse waves
- Wavelength of light waves is short so that their length is measured in centi-microns.
- The velocity of light in vacuum is 3×10^8 m/s.

Solution 6:
The Sun and the stars are the two luminous bodies.

Solution 7:
Two non -luminous bodies are moon, chair.

Solution 8:

Difference between convergent and divergent beam of light.

Convergent beam	Divergent beam
1. Rays of light converge to a point as the beam progresses	Rays of light diverge from each other as the beam progresses
2. The rays concentrate at a point	The rays emerge from a point source
3. A parallel beam of light converges on passing through a convex lens	A parallel beam of light diverges on passing through a concave lens

Solution 9:
A ray of light is the path along which light travels.

Solution 10:
Three distinctions between light and sound waves are

- Light waves can travel through vacuum while sound waves cannot.
- Light waves are transverse waves while sound waves are longitudinal waves.
- The velocity of light in air is 3 x 10^8 m/s while the speed of light in air is just about 330 m/s.

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Solution 11:

- A ray of light
- Divergent beam of light
- Divergent beam of light
- Parallel beam of light

Solution 12:
The substance through which light is made to pass is called medium.

Solution 13:
Rectilinear propagation of light is that the light travels along a straight line.

Solution 14:
No, glass is a transparent medium.

Solution 15:
No, no metal is transparent by nature.

Solution 16:

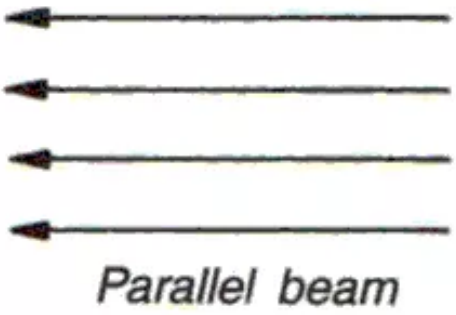
Difference between a ray of light and a beam of light

Ray of light	Beam of light
1. Ray of light is the path along which the light travels	Many rays of light form a beam of light
2. A ray of light can be emitted from any source in any direction	A beam of light can be emitted from a laser source
3. A ray of light contains only one photon	A beam of light contains multiple photons

Solution 17:
Waxed paper is the translucent medium among the given substances.

Solution 18:

Parallel beam of light is the beam in which rays of light travel parallel to each other.
Divergent beam of light is the beam of light in which rays of light diverge from each other as the beam progresses



Parallel beam

Divergent beam

Solution 19:
Two observations that proves that light travels in a straight line are :-

- Sunlight coming through a hole in a dark room, we can easily see that light travels in a straight line
- Light coming from a laser light, used for presentation, can also be seen to travel in straight line.

Solution 20:
When rays of light fall on a surface, they are turned back into the same medium in accordance with some definite laws. This process is known as reflection.

Solution 21:
A smooth and polished flat surface is the cause of regular surface.

Solution 22:
Reflection obeys following two laws

- The incident ray, the reflected ray, and the normal at the point of incidence, all lie in the same plane.
- The angle of incidence and the angle of reflection are always equal.

Solution 23:
The height of plane mirror should be half of the size of the object to get a full image of the object. So for a man of height 1.6 m tall should use a 0.8m tall plane mirror.

Solution 24:
Rectilinear propagation of light is that the light travels along a straight line.

Solution 25:
Lateral inversion is the reversal of image experienced in a plane mirror. The image is of the same size and equidistant from the object but the left and right sides are transposed.

Solution 26:
Formation of image is the phenomenon based on laws of reflection.

Solution 27:
The principle employed in a periscope is successive reflections from two plane mirrors.

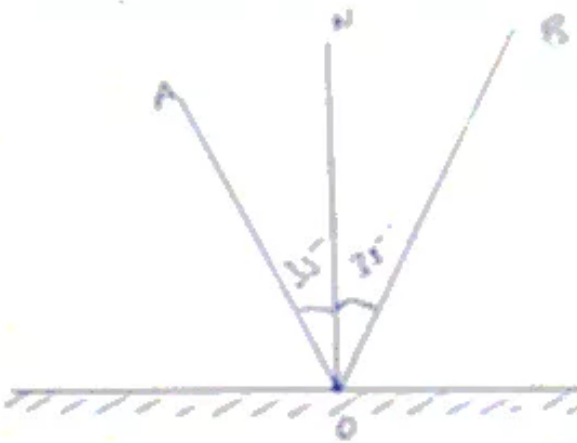
Solution 28:
The point at which the light is incident on the reflecting surface is called the point of incidence.

Solution 29:
Any smooth, highly polished reflecting surface is called mirror.

Solution 30:
A smooth, highly polished plane surface is called plane mirror.

Solution 31:
The angle between the incident ray and the normal to the surface at the point of incidence is called the angle of incidence.

Solution 32:
Angle of reflection to the normal = angle of incidence to the normal = 20°
So the angle between incident ray and reflected ray = Angle of incidence + Angle of reflection = 20 + 20 = 40°



Solution 33:
Given, angle between incident ray and mirror = 35°

- Angle of incidence = angle of mirror to the normal – angle between incident ray and mirror
  = 90 – 35 = 55°
- Angle of reflection = angle of incidence = 55°

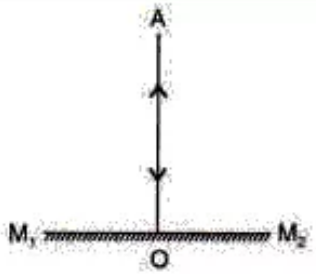
- Total angle turned = angle of incidence + angle of reflection
  = 55 + 55 = 110°
- The angle between incident ray and reflected ray = Angle of incidence + Angle of reflection
  = 55 + 55 = 110°

Solution 34:

Given, distance of boy from the mirror = 3 m

- Distance of image from mirror = distance of boy from the mirror = 3 m
  Distance between boy and his image = distance of boy from the mirror + distance of image from mirror = 3+3 = 6 m
- Now, distance of boy from the mirror = 4 m
  Distance of image from mirror = 4 m
  Distance between boy and his image = distance of boy from the mirror + distance of image from mirror = 4+4 = 8 m.

Solution 35:



The angle of incidence = angle of reflection = 0 ° because the image is perpendicular to the surface of the plane mirror.

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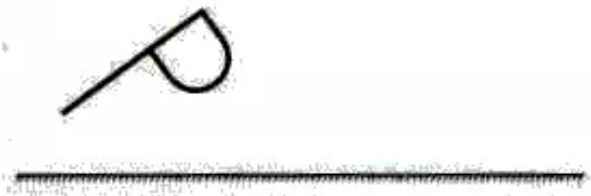
Solution 36:

Two characteristics of image formed by plane mirror are

- Image is erect and virtual
- Image and object are of same size.

Solution 37:

The answer diagram is:-

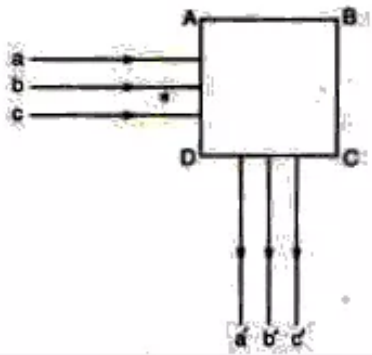


The reflection takes place at the surface of the plane mirror in accordance with the laws of reflection in which the angle of incidence is equal to angle of reflection.

The light coming from the letter P is reflected from the surface of plane mirror. When these reflected rays are produced backwards, they form an inverted virtual image of letter P which is same in size of letter P.

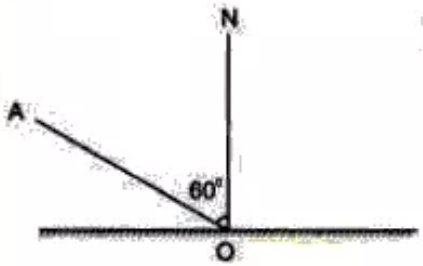
Solution 38:

The answer diagram is:-



Solution 39:

The answer diagram is:-



Since the angle of incidence = 60°

From the diagram, Angle of reflection to the normal = angle of incidence to the normal = 60°

So the angle between incident ray and reflected ray = Angle of incidence + Angle of reflection = 60 + 60 = 120°

Chapter 6. Light: Spherical Mirrors

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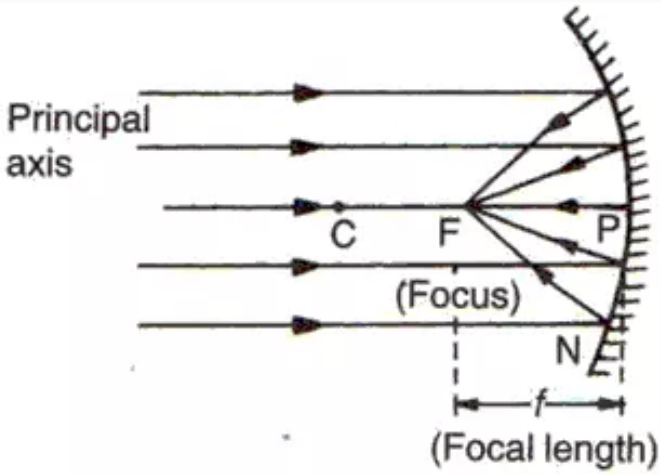
Solution 1:
A spherical mirror is a part of a hollow glass sphere silvered on one side.

Solution 2:



The parallel beam of light on reflection by a concave mirror converges at a point on the principal axis, midway between pole and the centre of curvature. This point is called principal focus

Solution 3:
Focal length = 1/2 of radius of curvature
= 1/2 x 30 = 15cm.

Solution 4:
Focal point is the principal focus of the mirror where a parallel beam of light meets(or appear to meet) after reflection from the mirror.

Solution 5:

difference between real and virtual images

Real images	Virtual images
it can be obtained on a screen	It can't be obtained on a screen
it is inverted(upside down with respect to the object)	It is erect with respect to the object
It is formed when two or more reflected rays intersect each other at a point in front of the mirror	It is formed when two or more reflected rays appear to intersect at a point behind the mirror

Solution 6:

- Pole is the centre of the reflecting surface, in this case spherical mirror.
- Centre of curvature is the centre of the imaginary sphere to which the mirror belongs

- Aperture is the distance between the extreme points on the periphery of the mirror.
- Principal axis is the straight line passing through the pole and the centre of curvature.
- The principle focus of a spherical mirror may be defined as a point on its principle axis where a beam of light parallel to the principle axis converges to or appears to diverge from after reflection from the spherical mirror.

Solution 7:
Convex mirror has a wider field of view.

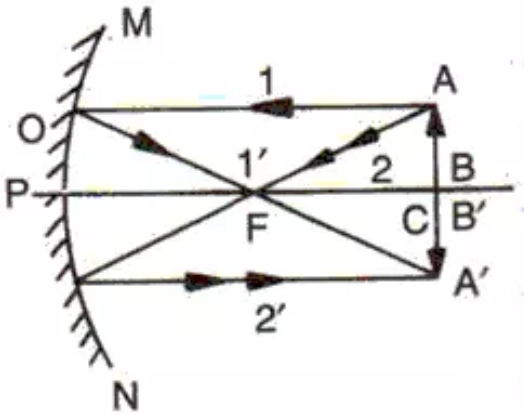
Solution 8:
Concave mirrors are used in reflecting microscope, in shaving and make up glasses and in ophthalmoscope.

Solution 9:
Convex mirrors are used as a rear view mirror in automobiles as it provides a wider view of following traffic.

Solution 10:
Convex mirror is used in vehicles to see the traffic following it.

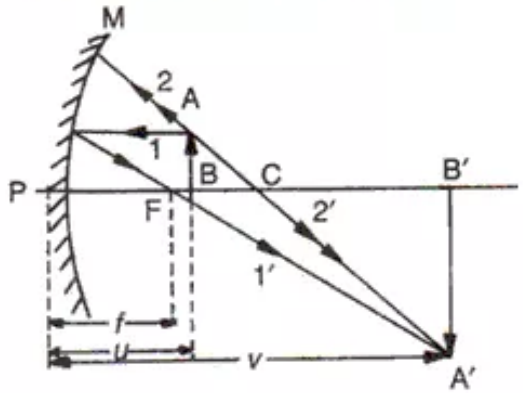
Solution 11:
The relationship between the focal length, f and radius of curvature, r is
f = 1/2 x r.

Solution 12:
A concave mirror forms a real image equal in size to the object when the object is kept at centre of curvature, C



Solution 13:

A concave mirror forms an enlarged virtual image when the object is kept between focus, F and pole, P



Solution 14:

Concave mirror can produce real and diminished image of the object.

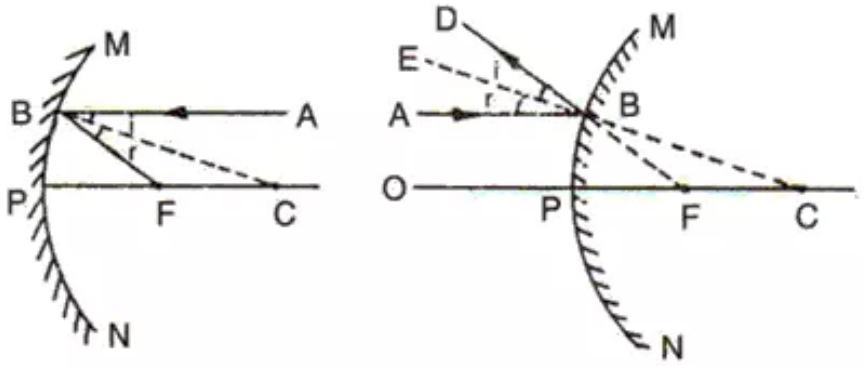
Solution 15:

The focal length of plane mirror is infinity.

Solution 16:

The object should be placed between F and P to obtain its magnified and erect image.

Solution 17:



Let's assume the aperture of the mirror to be very small. Let a ray AB of light parallel to the principal axis be incident on the concave mirror at B. the ray makes the angle of incidence, i with the normal BC at B, C being the centre of curvature of the mirror. The ray is reflected along BF with angle of reflection, r so that

$< i = < r$

In accordance with the laws of reflection. As the incident ray AB is parallel to the principal axis PC, so the reflected ray Bf passes through the principal focus, F. in figure (i)

$< ABC = < CBF$

But $< ABC$ = alternate $< BCF$

Therefore $< CBF = < BCF$

And the ΔFBC is isosceles

$BF = FC$ ...(i)

Since the aperture is assumed to be very small, so the point of incidence B is close to P

And BF =PF (approx.) ...(ii)

From (i) and (ii)

$PF = FC$

Adding PF to both sides

$PF + PF = PF + FC$

$2PF = PC$

Now since PF = f, the focal length of the mirror

And PC = R, the radius of curvature of the mirror

Therefore $2f = R$

From here we can determine the focal length of the concave mirror i.e. half of radius of curvature

Solution 18:

Linear magnification is defined as the ratio of the height of the image to the height of the

object. It is taken to be positive for an image to be virtual and erect and negative when image is real and inverted.
Magnification = height of image / height of object.

Solution 19:
SI unit of focal length is meter.

Solution 20:
The top mirror is convex mirror, the middle mirror is concave mirror and bottom mirror is a plane mirror.

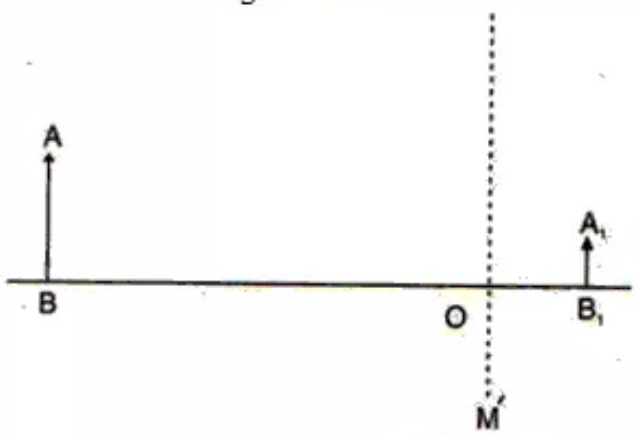
Solution 21:
The mirror having +15 cm as its focal length is a convex mirror because focal length is taken positive only in case of convex mirror.

Solution 22:
The mirror having -20 cm as its focal length is a concave mirror because focal length is taken negative only in case of concave mirror.

Solution 23:
When we look into a plane mirror, the image of our face is virtual because the image cannot be obtained on a screen.

Solution 24:
When an object is brought towards the concave mirror, the position of the image moves away from the mirror and the size increases and it remains inverted but at object position between F and P, the image is virtual, magnified and erect.

Solution 25:
The answer diagram is:-



A light ray coming from a point on object AB is reflected from the surface of the mirror. When this ray is produced backwards, it passes through the principal focus and the ray which traces its incident path after reflection, when produced backwards, passes through the centre of curvature. These two reflected rays coincide at a point where the image is formed. The image, A'B' is virtual, erect, and diminished in size
The focal length was found to be 24 mm

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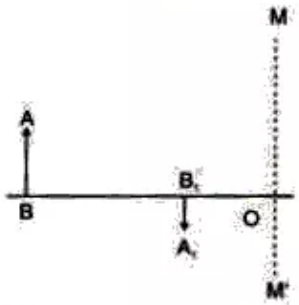
Solution 26:

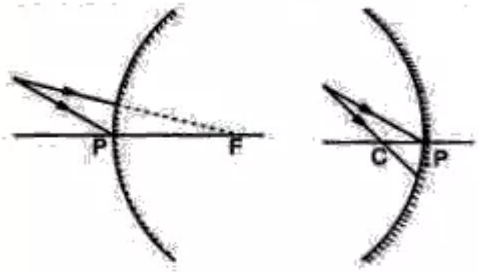
The answer diagram is:-



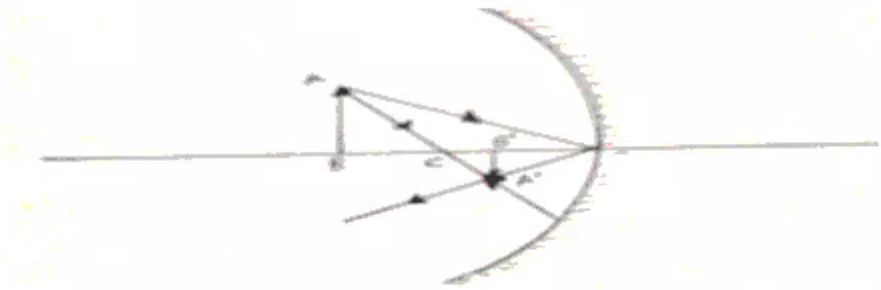
A light ray coming from a point on object AB is reflected from the surface of the mirror, it passes through the principal focus and the other ray passing through the centre of curvature strikes the mirror normally i.e. 90 degree. Hence it will reflect back. These two reflected rays coincide at a point where the image is formed. The image, A'B' is real, inverted, and diminished in size. The focal length was found to be 16 mm

Solution 27:

The answer diagram is:-



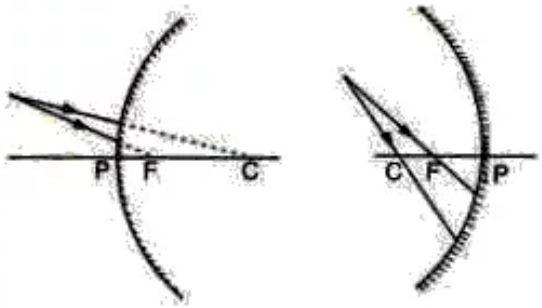
A light ray when produced backwards passes through principal focus as shown in the problem figure. We draw the normal through centre of curvature at the point of incidence and draw the reflected ray at an angle equal to the angle of incidence thus following the laws of reflection. The reflected ray is parallel to the principal axis. The other ray is reflected at the pole by an angle in accordance with the laws of reflection. These two reflected rays when produced backwards coincide at a point where the image is formed. The image, A'B' is virtual, erect, and diminished in size



A light ray coming from a point on object AB is reflected from the surface of the mirror, it passes through the principal focus and the other ray passing through the centre of curvature strikes the mirror normally i.e. 90 degree. Hence it will reflect back. These two reflected rays coincide at a point where the image is formed. The image, A'B' is real, inverted, and diminished in size.

Solution 28:

The answer diagram is:-

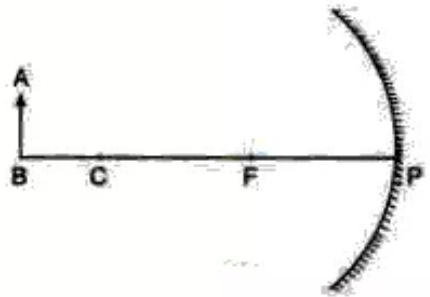


A light ray when produced backwards passes through principal focus as shown in the problem figure. We draw the normal through centre of curvature at the point of incidence and draw the reflected ray at an angle equal to the angle of incidence thus following the laws of reflection. The reflected ray is parallel to the principal axis. The other ray is passing through the centre of curvature as shown in problem figure. This ray retraces its incident path because it strikes the mirror normally i.e. 90 degrees. These two reflected rays when produced backwards coincide at a point where the image is formed. The image, A'B' is virtual, erect, and diminished in size

A light ray coming from a point on object AB passes through the principal focus and after reflection, it becomes parallel to the principal axis in accordance with laws of reflection and the other ray passing through the centre of curvature strikes the mirror normally i.e. 90 degree. Hence it will reflect back. These two reflected rays coincide at a point where the image is formed. The image, A'B' is real, inverted, and diminished in size.

Solution 29:

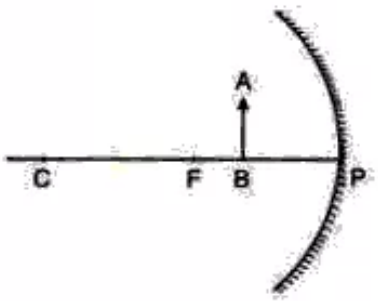
The answer diagram is:-



A light ray, parallel to the principal axis, coming from a point on object AB is reflected from the surface of the mirror, it passes through the principal focus and the other ray passing through the centre of curvature strikes the mirror normally i.e. 90 degree. Hence it will reflect back. These two reflected rays coincide at a point between F and C, where the image is formed. The image, A'B' is real, inverted, and diminished in size.

Solution 30:

The answer figure is:-



A light ray, parallel to the principal axis, coming from a point on object AB is reflected from the surface of the mirror, it passes through the principal focus and the other ray striking normally to the mirror reflects back and passes through the centre of curvature. These two reflected rays, when produced backwards, coincide at a point where the image is formed. The image, A'B' is virtual, erect, and magnified in size.

Chapter 6. Light

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Solution 1:
Convex mirror has a wider field of view.

Solution 2:
Convex mirror always produces an erect image of the object.

Solution 3:
Convex mirror is used in vehicles to see the traffic on rear side.

Solution 4:
We will use convex mirror to see an enlarged image of our face.

Solution 5:
Image of object placed at a long distance in front of a convex mirror is formed at principal focus. Radius of curvature of convex mirror is 20 cm.
Focal length of convex mirror = radius of curvature/2.
Focal length of convex mirror = 20/2 = 10 cm.
So image will form at principal focus 10 cm away from pole.

Solution 6:
Concave mirror can produce real and diminished image of the object.

Solution 7:
The distance of the principal focus from the pole of the mirror is called the focal length of the mirror.

Solution 8:
The mirror having +20 cm as its focal length is a convex mirror because focal length is taken positive only in case of convex mirror.

Solution 9:
The focal length of plane mirror is infinity.

Solution 10:
The mirror having -15 cm as its focal length is a concave mirror because focal length is taken negative only in case of concave mirror.

Solution 11:
Principal axis is the straight line passing through the pole and the centre of curvature.

Solution 12:
Linear magnification is defined as the ratio of the height of the image to the height of the object. It is taken to be positive for an image to be virtual and erect and negative when image is real and inverted.
Magnification = height of image / height of object.

Solution 13:
Pole is the centre of the reflecting surface, in this case spherical mirror.

Solution 14:
Centre of curvature is the centre of the imaginary sphere to which the mirror belongs.

Solution 15:
Three characteristics of light are:-

- Light waves can travel through vacuum.
- Light waves are transverse waves.
- The velocity of light in vacuum is 3×10^8 m/s.

Solution 16:
Three distinctions between light and sound waves are

- Light waves can travel through vacuum while sound waves cannot.
- Light waves are transverse waves while sound waves are longitudinal waves.
- The velocity of light in air is 3×10^8 m/s while the speed of light in air is just about 330 m/s.

Solution 17:

- When position of object is at infinity, concave mirror forms a point and Real image at Focus point.
- When position of object is beyond C, concave mirror forms a Diminished, Real and inverted image between F and C.
- When position of object is at C, concave mirror forms a Magnified, Real and inverted image at C.

Solution 18:
Image formed by a convex mirror is always Diminished, Virtual and Erect.

Solution 19:
Concave mirrors are used in reflecting microscope, in shaving and make up glasses and in ophthalmoscope.

Solution 20:

- The distance from the pole in the direction of incident ray is taken positive.
- The distance from the pole in the direction opposite to the incident ray is taken negative.

Solution 21:
Mirror formula is the relation between the focal length f of the mirror, the distance u of the object from the pole of the mirror, and the distance v of the image from the pole.
Mirror formula is
$1/v + 1/u = 1/f$.
Linear magnification is defined as the ratio of the height of the image to the height of the object. It is taken to be positive for an image to be virtual and erect and negative when image is real and inverted.
Magnification = height of image / height of object.

Solution 22:
Mirror formula is the relation between the focal length f of the mirror, the distance u of the object from the pole of the mirror, and the distance v of the image from the pole.
Mirror formula is
1/v +1/u = 1/f.
Size of body = 1.5 m.
Magnification of body = 1.5.
Magnification = height of image / height of object.
Height of image = magnification x height of object.
Height of image = 1.5 x 1.5= 2.25 m.

Solution 23:
Linear magnification is defined as the ratio of the height of the image to the height of the object. It is taken to be positive for an image to be virtual and erect and negative when image is real and inverted.
Magnification produced by concave mirror is:
Magnification = height of image / height of object.
It is a pure ratio and does not have any units.

Solution 24:

Real image	Virtual image
It is formed when two or more reflected rays intersect each other at a point in front of the mirror,	It is formed when two or more reflected rays appear to intersect at a point behind the mirror.
It is inverted	It is erect with respect to object.
It can be obtained on screen.	It can't be obtained on screen.

Solution 25:
A smooth and polished surface causes regular reflection while a rough and unpolished surface causes irregular reflection.

Solution 26:
When rays of light fall on a surface, they are turned back into the same medium in accordance with some definite laws. This process is known as reflection.
Reflection obeys following two laws

- The incident ray, the reflected ray, and the normal at the point of incidence, all lie in the same plane.
- The angle of incidence and the angle of reflection are always equal.

Solution 27:
You can distinguish between plane mirror, a concave mirror, and a convex mirror without touching them. When you look into these mirrors by bringing your face close to each mirror, they will produce an image of your face of different types.

- A plane mirror will produce an image of the same size as your face.
- A concave mirror will produce a magnified image of your face.
- A convex mirror will produce Diminished image of your face.

Solution 28:

You can distinguish between a concave mirror and a convex mirror without touching them. When you look into these mirrors by bringing your face close to each mirror, they will produce an image of your face of different types.

- A concave mirror will produce a magnified image of your face.
- A convex mirror will produce Diminished image of your face.

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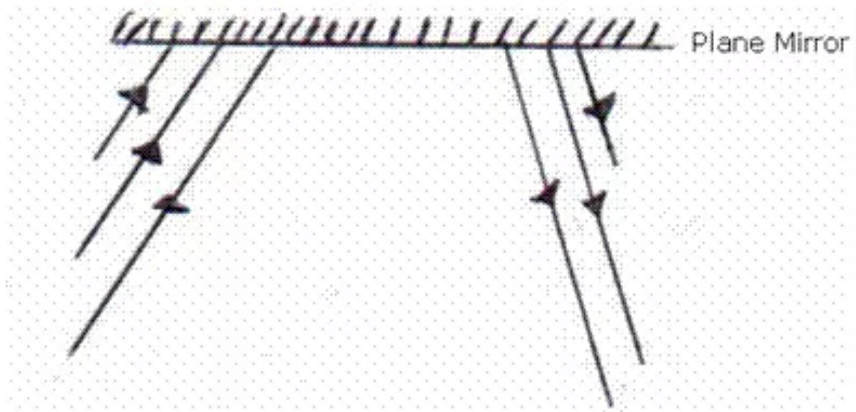
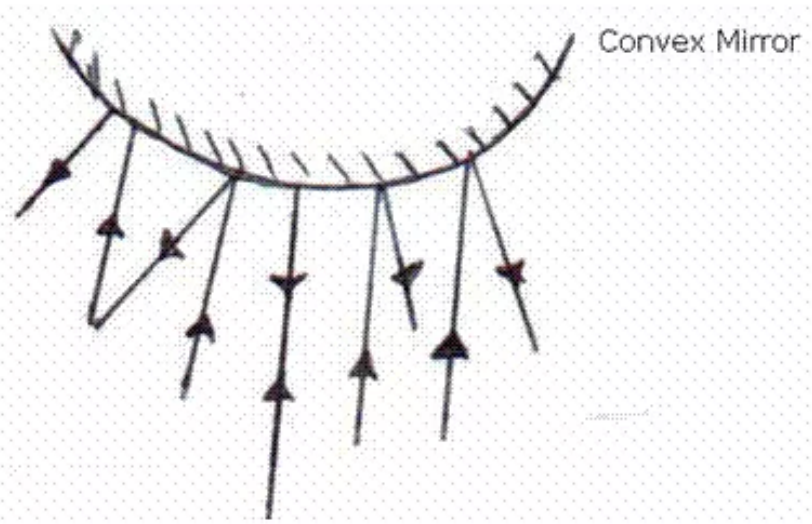
Solution 29:

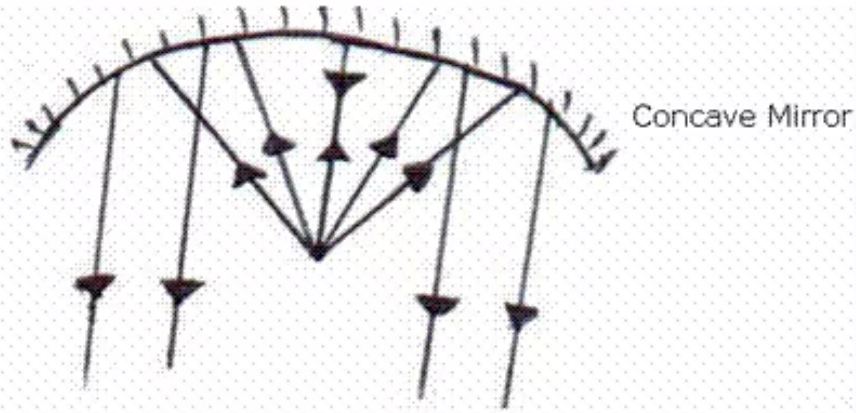
(i) PLANE MIRROR



(ii)CONVEX MIRROR



(iii)CONCAVE MIRROR



Solution 30:
Uses of concave mirror:

- Concave mirrors are used in reflecting microscope
- Concave mirrors are used in shaving and make up glasses.
  Uses of convex mirror: Convex mirrors are used as a rear view mirror in automobiles as it provides a wider view of following traffic.

Solution 31:
We can see the reflection of our face on a polished table top because a regular reflection occurs in case of a polished surface while on a unpolished table top irregular reflection occurs which make image of our face unclear.

Solution 32:

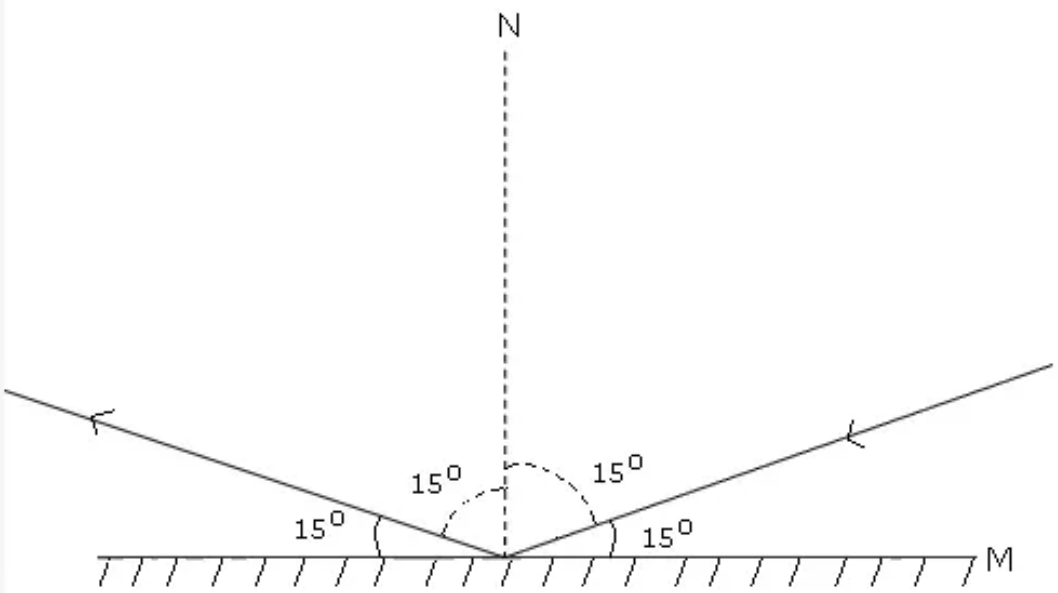
- The angle of incidence is the angle made by the incident ray with the plane mirror. **{FALSE}**
  Correct statement is the angle of incidence is the angle made by the incident ray with the normal to the surface of plane mirror.
- If a ray of light incident on a plane mirror is such that it makes an angle of 30° with the normal, then the angle of reflection is 60°.**{FALSE}**
  Correct statement is if a ray of light incident on a plane mirror is such that it makes an angle of 30° with the normal, then the angle of reflection is 30°.
- If the incident ray makes an angle of X° with the normal, then the angle between the incident ray and reflected ray is 2X°. **{TRUE}**
- The image formed in a plane mirror is real, erect and same size as that of the object. **{FALSE}**
  Correct statement is the image formed in a plane mirror is virtual, erect and same size as that of the object.

Solution 33:

Reflection obeys following two laws

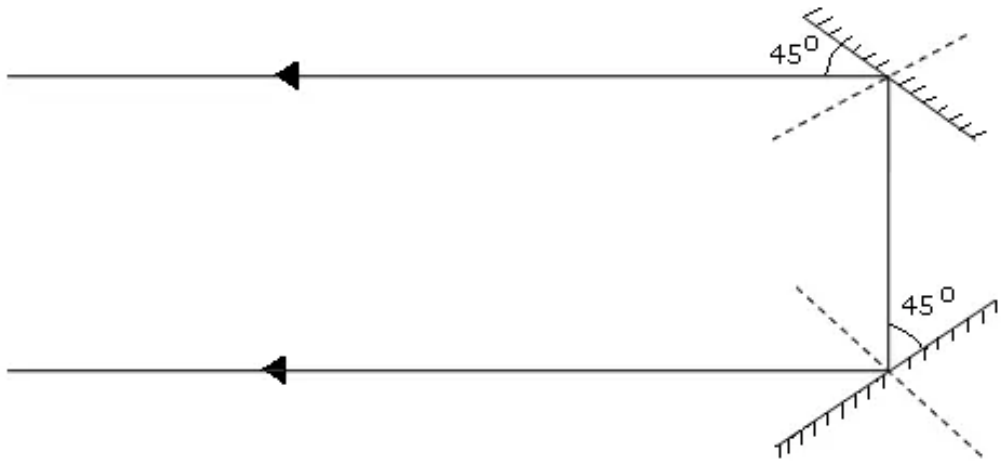
a. The incident ray, the reflected ray, and the normal at the point of incidence, all lie in the same plane.
b. The angle of incidence and the angle of reflection are always equal.

According to these two laws this ray will deviate like this:



Solution 34:

Two planes when put in this way then they will turn the incident ray by 180°.

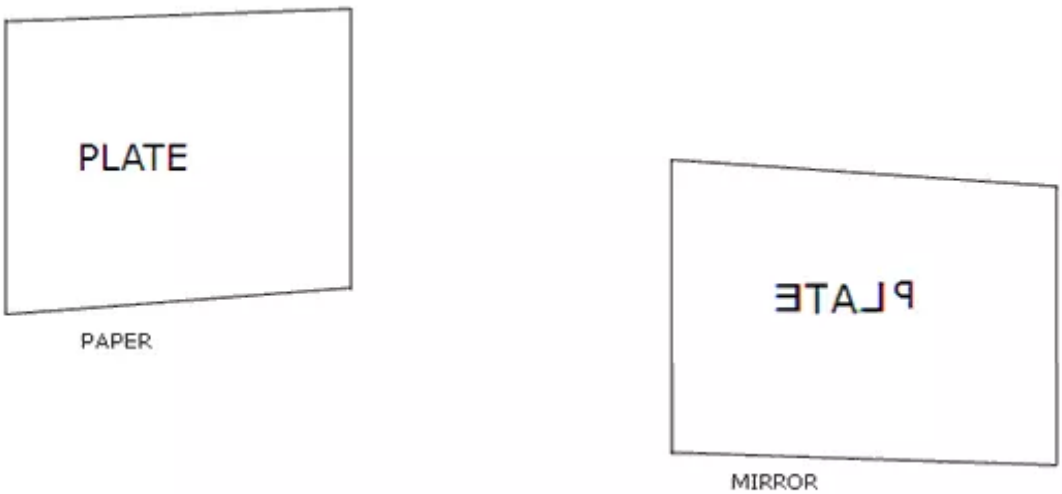


Solution 35:

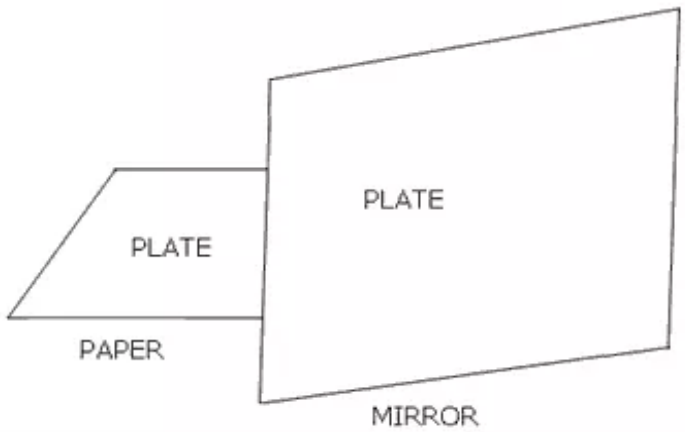
The image formed by a plane mirror is erect and virtual. It is a laterally inverted image. The image formed is of the same size as that of the object. Also, the image and the object are equidistant from the mirror.

Solution 36:

(i) When the paper is help parallel to the mirror.



(ii) When the Paper is held perpendicular to the mirror.



Solution 37:
Given, distance of boy from the mirror = 3 m

- Distance of image from mirror = distance of boy from the mirror = 3 m
  Distance between boy and his image = distance of boy from the mirror + distance of image from mirror = 3+3 = 6 m
- Now, distance of boy from the mirror = 4 m
  Distance of image from mirror = 4 m
  Distance between boy and his image = distance of boy from the mirror + distance of image from mirror = 4+4 = 8m.

Solution 38:
Periscope is used to see over the top of an obstacle. It is also used in submarines for observing for movement of ships. It can be used from the trenches for observing the movement on the surface of earth.

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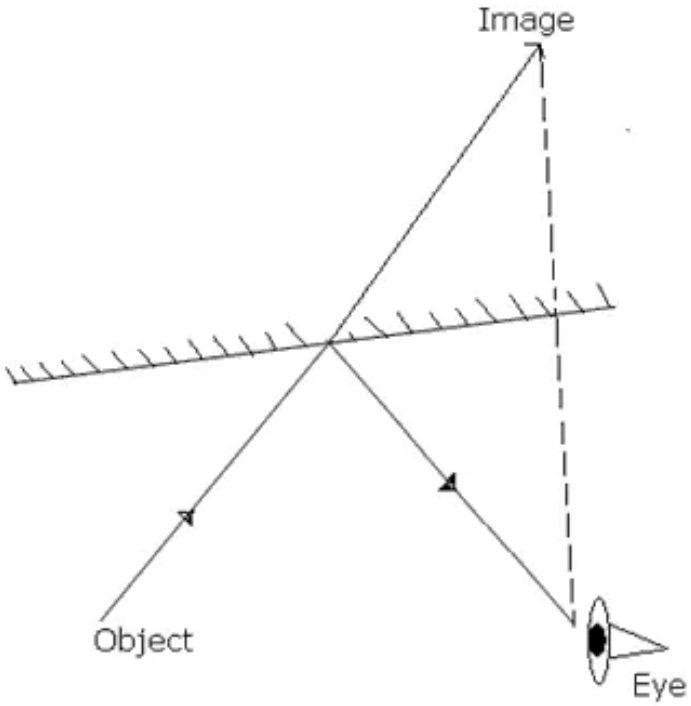
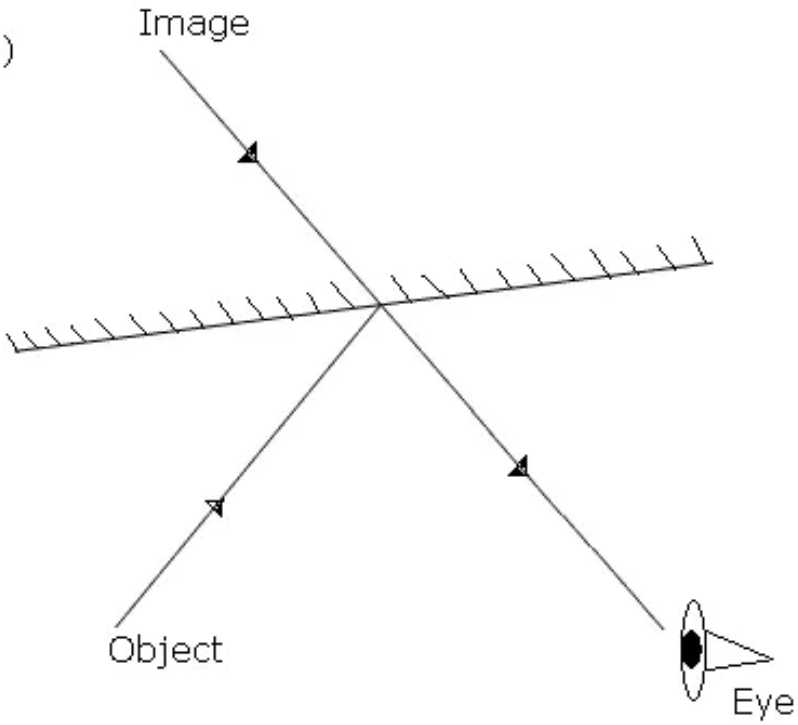
Solution 39:

The image observed by the eye after reflection from a plane mirror can be completed as follows:

(a)



(b)



Solution 40:

- Pole is the centre of the reflecting surface, in this case spherical mirror.
- Centre of curvature is the centre of the imaginary sphere to which the mirror belongs
- Principal focus of a spherical mirror is a point on the principal axis of the mirror, where all the rays travelling parallel to the principal axis and close to it after

reflection from the mirror, converge to or appear to diverge from.

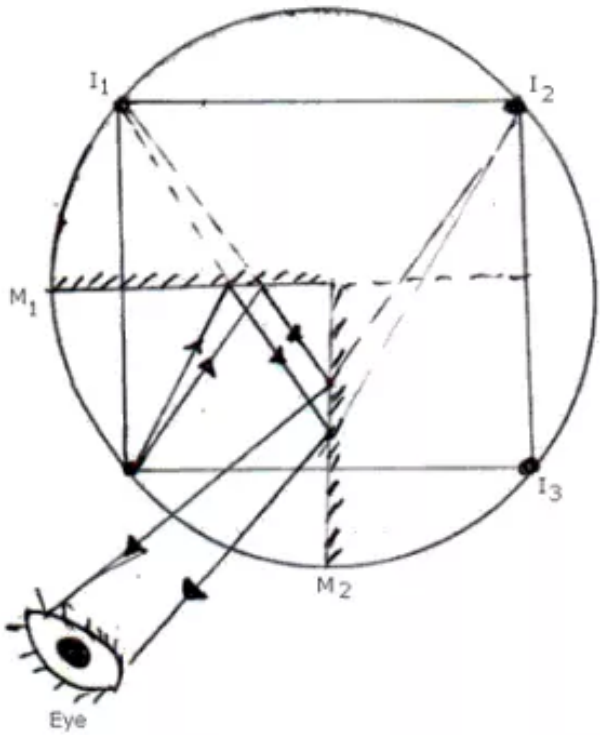
- Principal axis is the straight line passing through the pole and the centre of curvature.
- Focus of a concave mirror is a point on the principal axis of the mirror, where all the rays travelling parallel to the principal axis and close to it after reflection from the mirror converge to that point.
- Normal to the surface of a mirror at any point is the straight line at right angle to the tangent drawn at that point.

Solution 41:

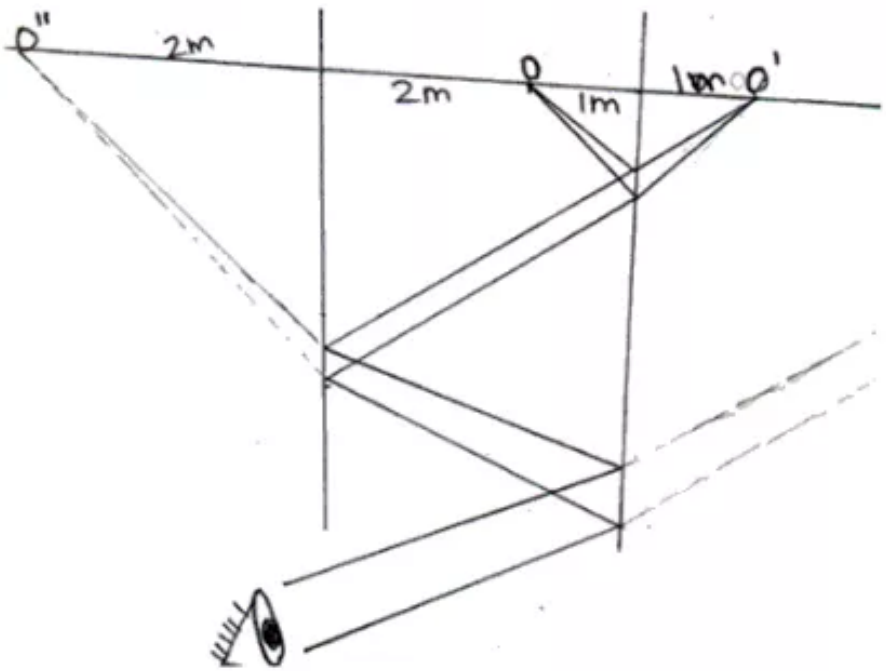
(i) When two mirrors are held perpendicular then number of images is 3 according to rule

Number of images = 360/X – 1 if 360/X is even

Number of images is 360/90 -1 = 4-1 = 3 images.



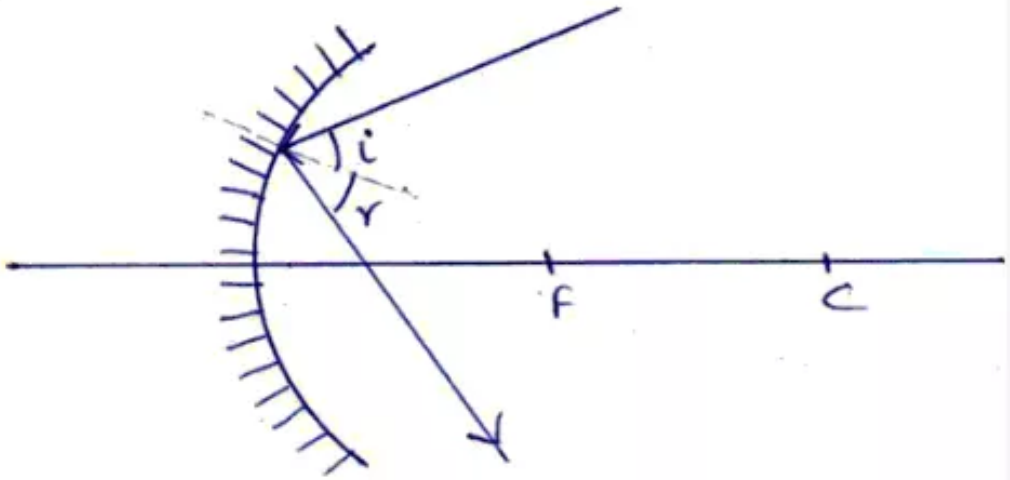
(ii) When two mirrors are held parallel to each other then, infinite numbers of image are formed and first two images are shown in this figure.



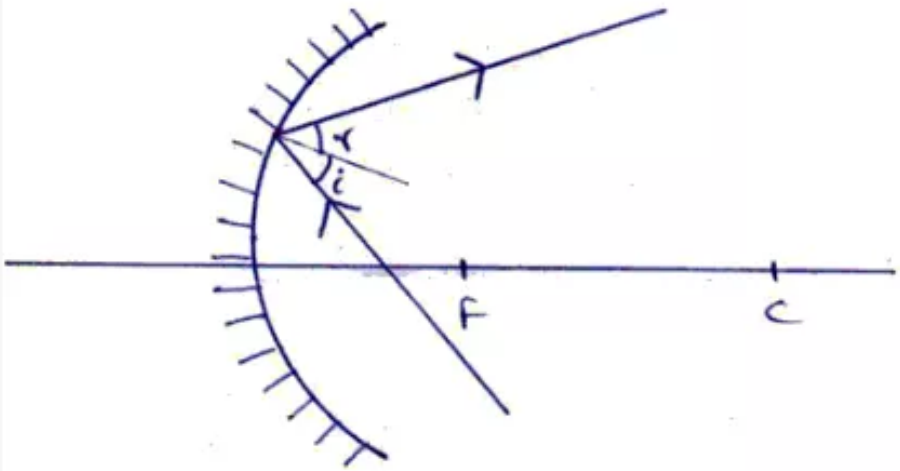
Solution 42:

Completed path of the incident ray in following cases are:

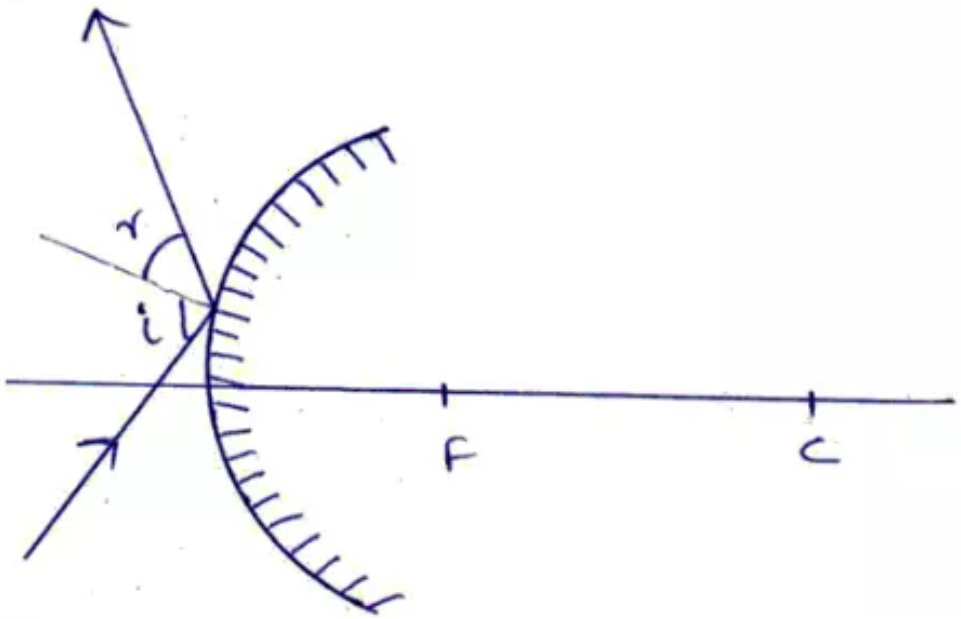
(i)



(ii)

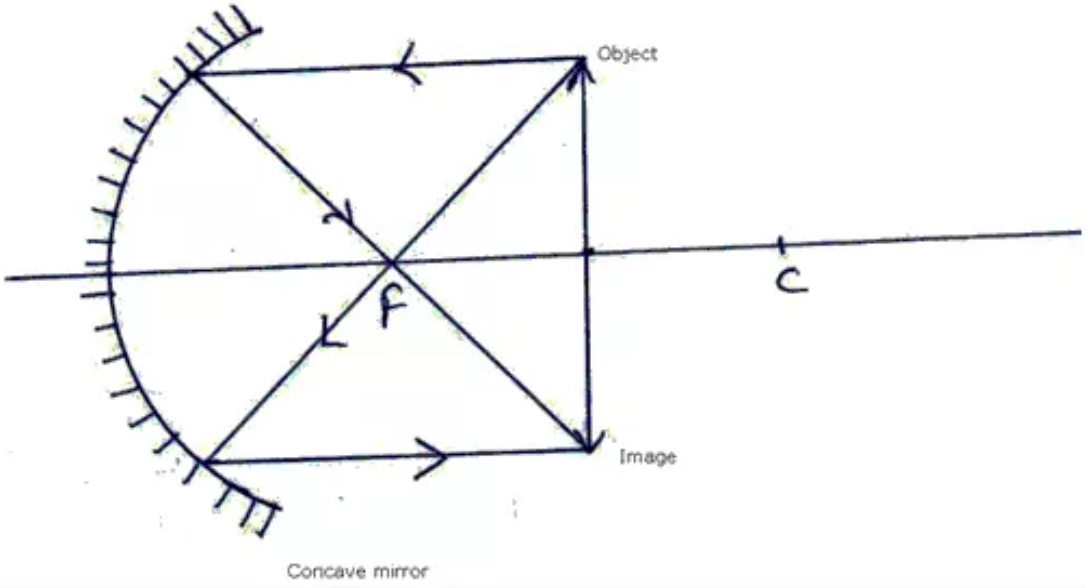


(iii)



Solution 43:

Position of image is exactly below the position of object as in this figure.



Concave mirror

Solution 44:

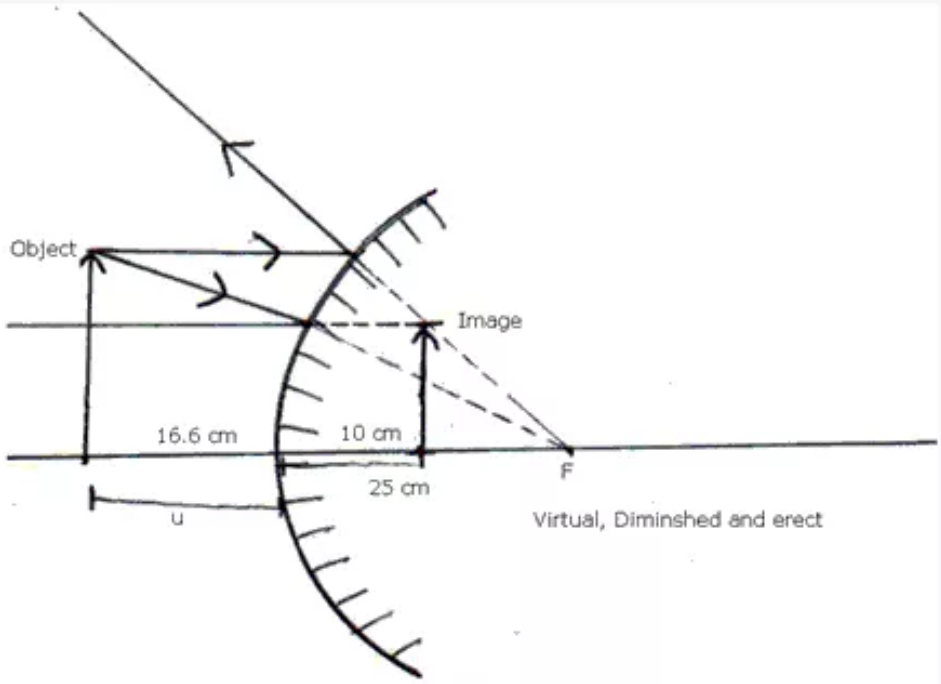
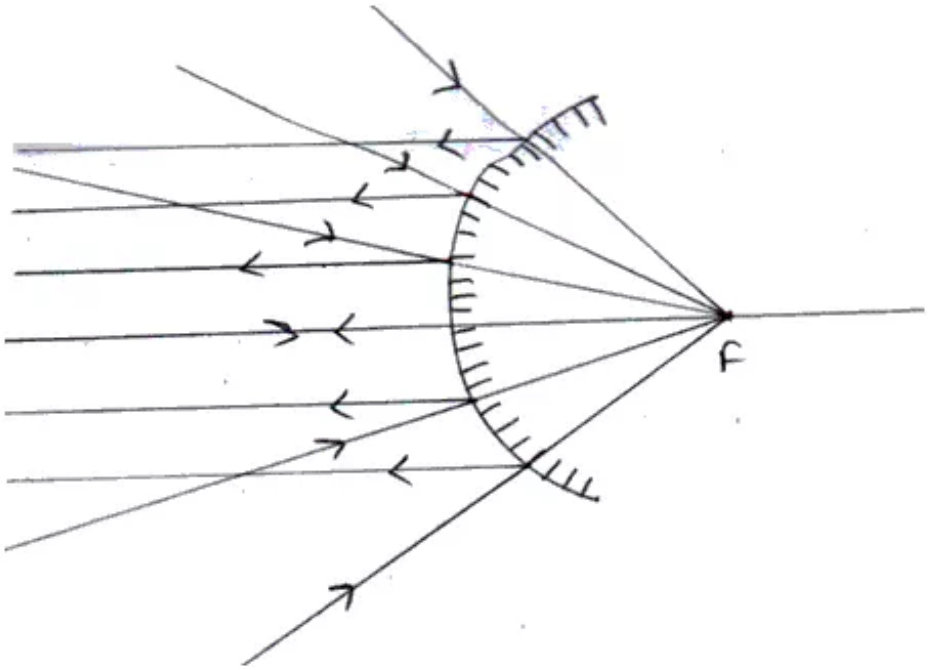


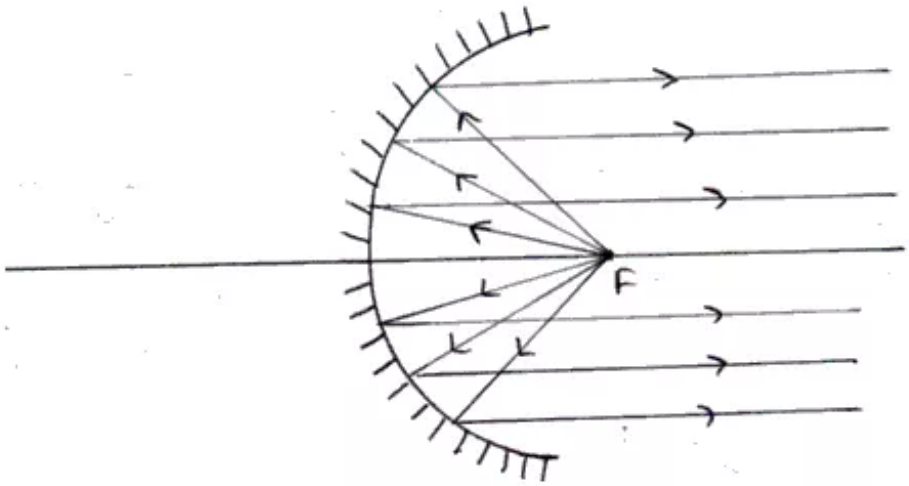
Image formed is virtual, Diminished and erect.

Solution 45:

(i) In case of convex mirror all rays incident parallel to principal axis appear to diverge from a Focal point. So it has a wider field of view as it converge all rays to a single point.



(ii) In case of concave mirror if object is placed at Focal point then ray emerging from it after reflecting from mirror would be parallel to principal axis.



Solution 46:

(i) Focal length =25 cm.

Object distance = 20 cm.

Height of object = 10 cm.

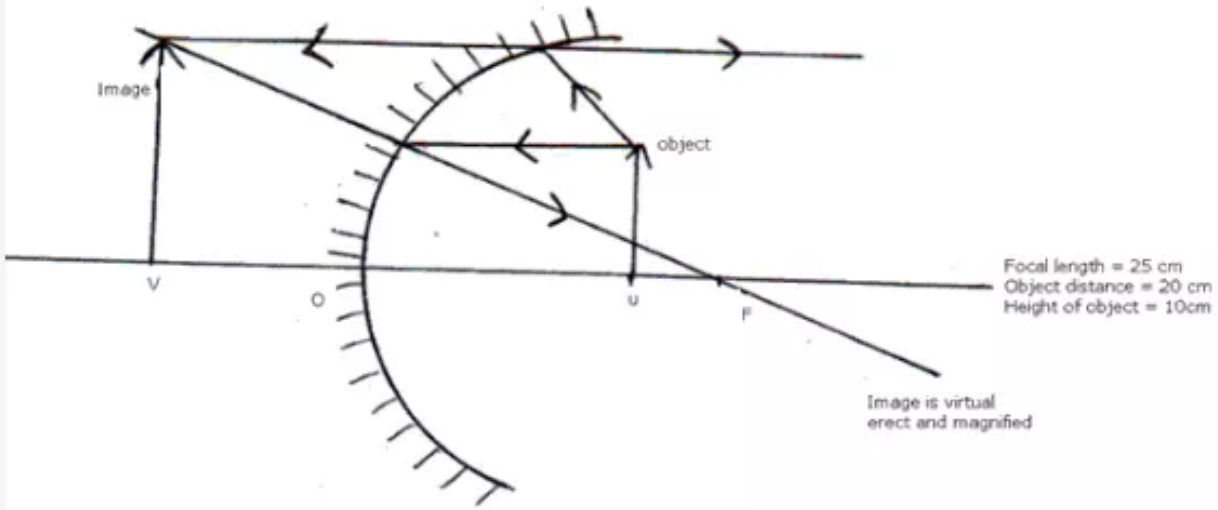


Image is VIRTUAL, ERECT and MAGNIFIED.

(ii) Focal length =25 cm.

Object distance = 20 cm.

Height of object = 10 cm.

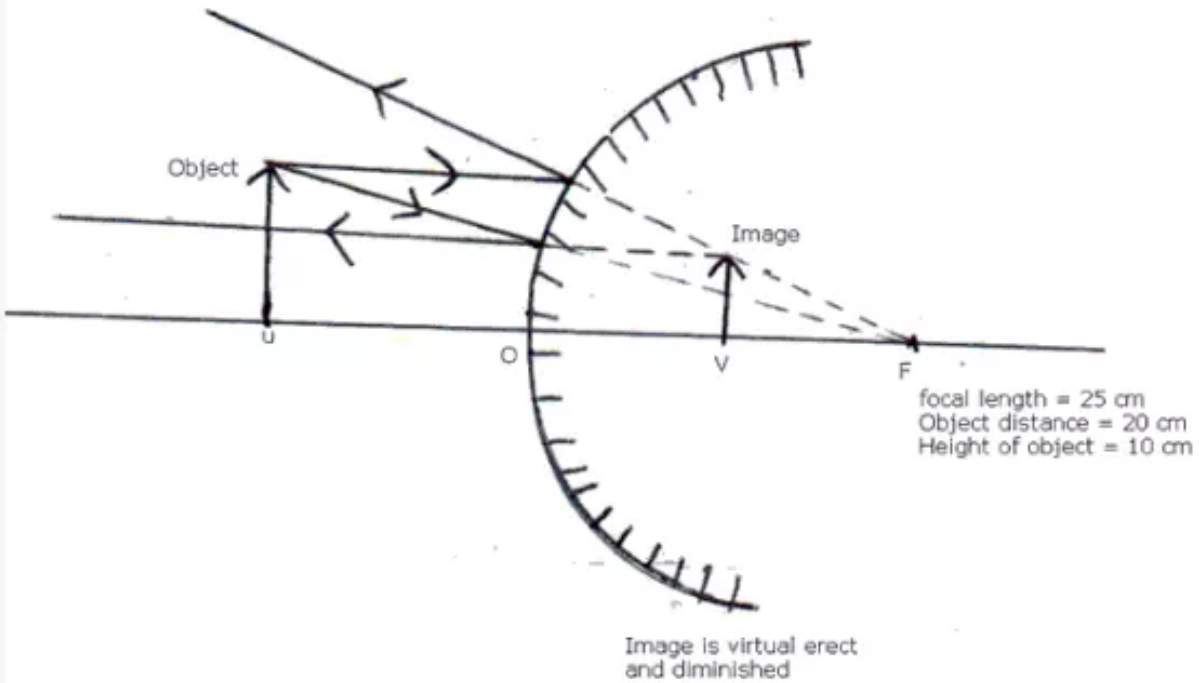


Image is VIRTUAL, ERECT and DIMINISHED.

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Solution 47:

Focal length of concave mirror= 10 cm.

Object distance = 30 cm.

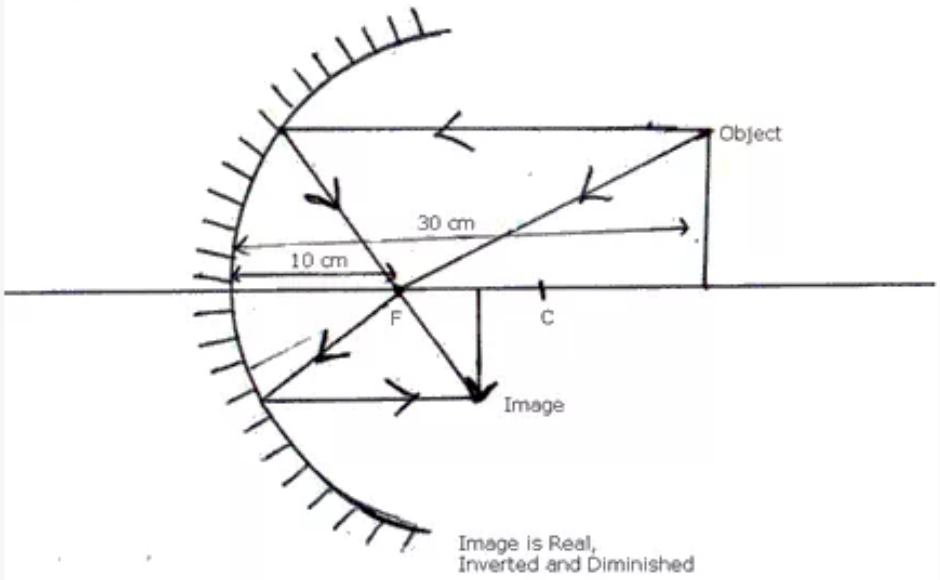


Image is real, inverted and diminished.

Solution 48:

Height of object = 5 cm.

Distance of object = 30 cm.

Focal length of mirror = 40 cm.

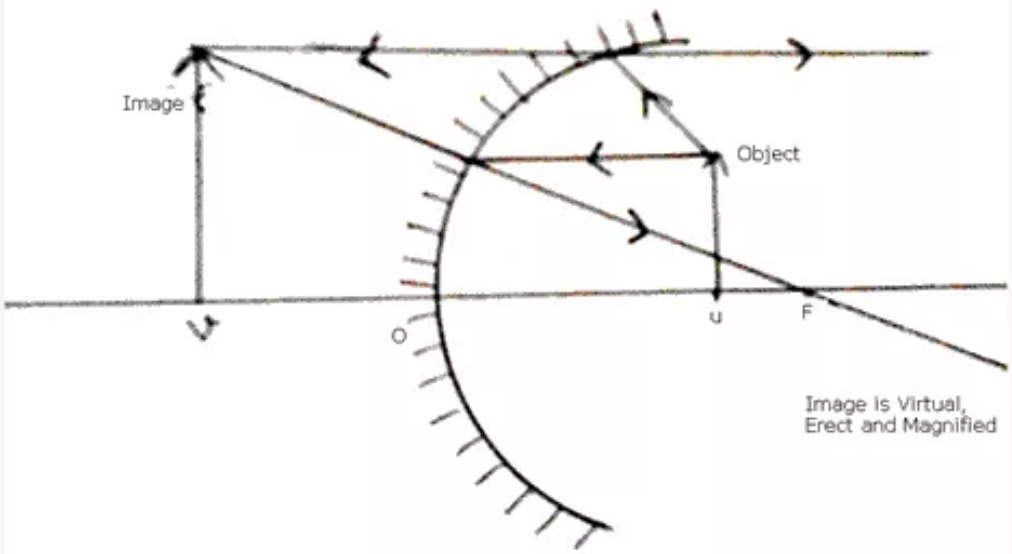


Image is virtual, erect and magnified.

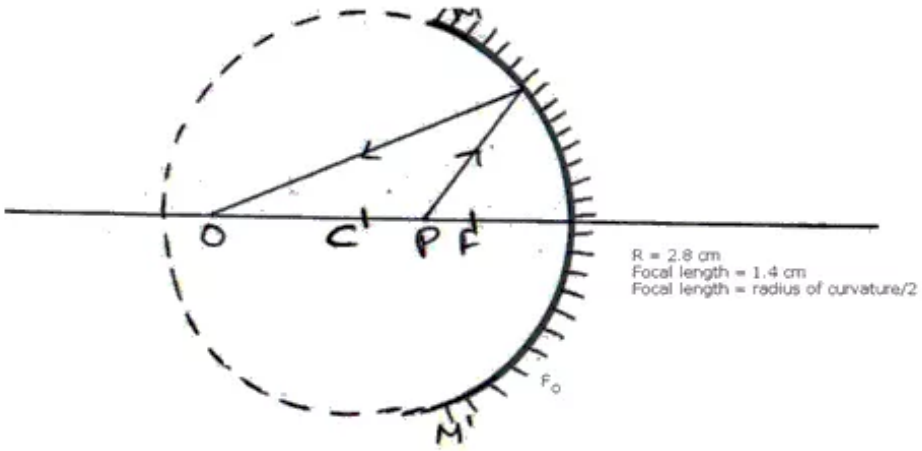
Solution 49:

(i) Centre of curvature can be determined by constructing the imaginary sphere to which lens belongs.

(ii) Value of radius of curvature can be found by measuring the radius of this imaginary sphere geometrically.

(iii)Focal length is the midpoint of pole and centre of curvature.

(iv)focal length of mirror = centre of curvature/2.

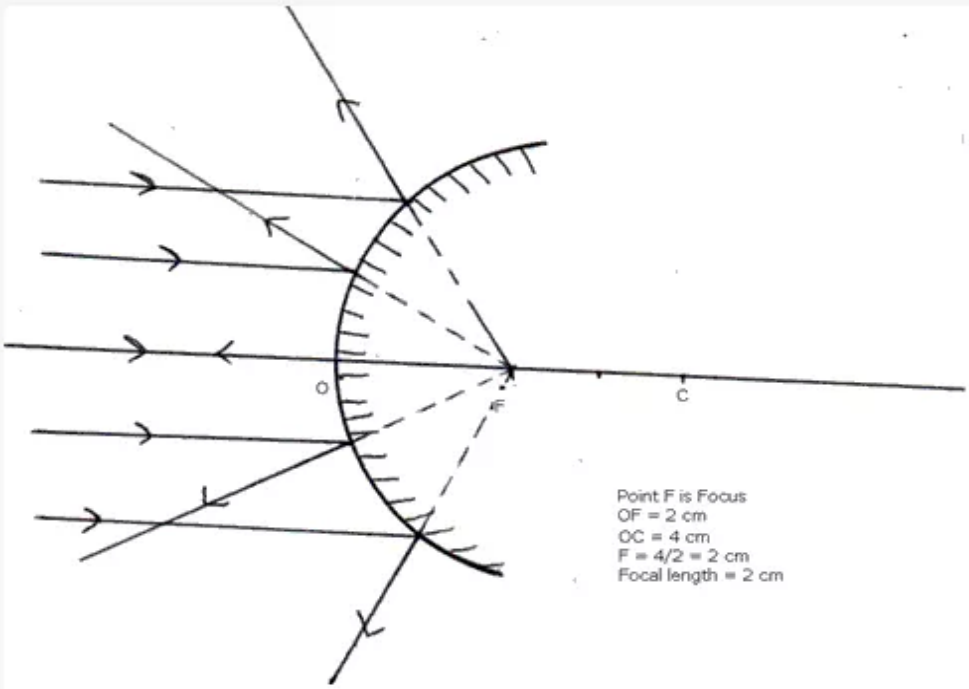


Centre of curvature = 2.8 cm.

Focal length of mirror = 1.4 cm.

Focal length = radius of curvature/2.

Solution 50:



We know when incident ray is parallel to principal axis then they appear to diverge from a point F.

Geometrically we can find this value and this comes to 2 cm.

Centre of curvature = 4 cm.

Focal length = centre of curvature/2.