## Exercise-7(A)

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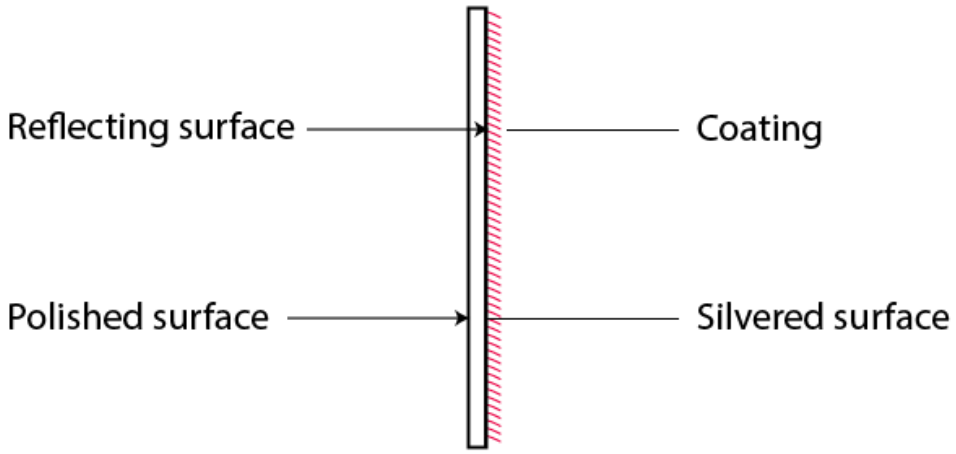
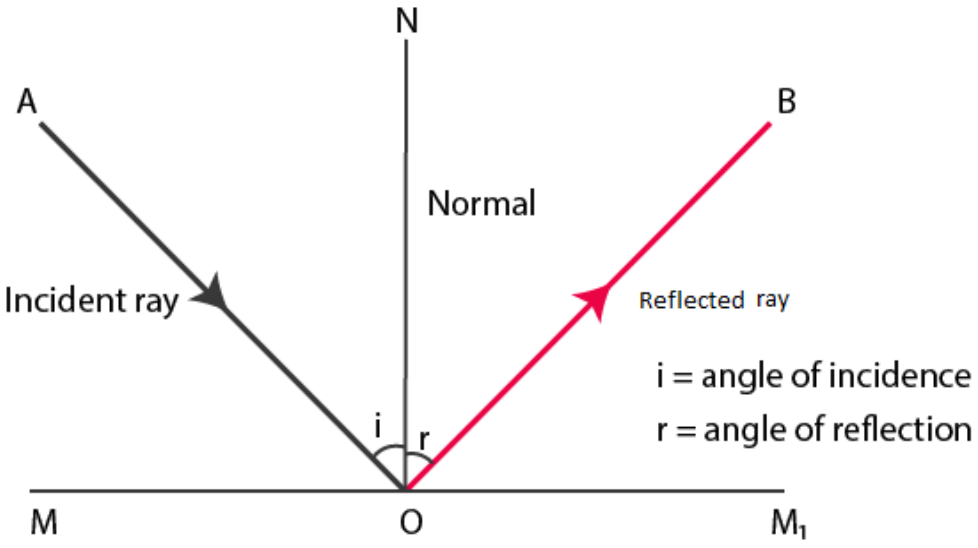
1. **What do you mean by reflection of light?**
   Solution:
   Reflection is when light reverts to the same medium after it strikes a surface.

2. **State which surface of plane mirror reflects most of the light incident on it : the front smooth surface or the back silvered surface.**
   Solution:
   The surface of the plane mirror that reflects most of the light incident on it is the back silvered surface.

3. **Explain the following terms:**
   **(a) Plane mirror**
   **(b) Incident ray**
   **(c) Reflected ray**
   **(d) Angle of incidence and**
   **(e) Angle of reflection**
   Solution:

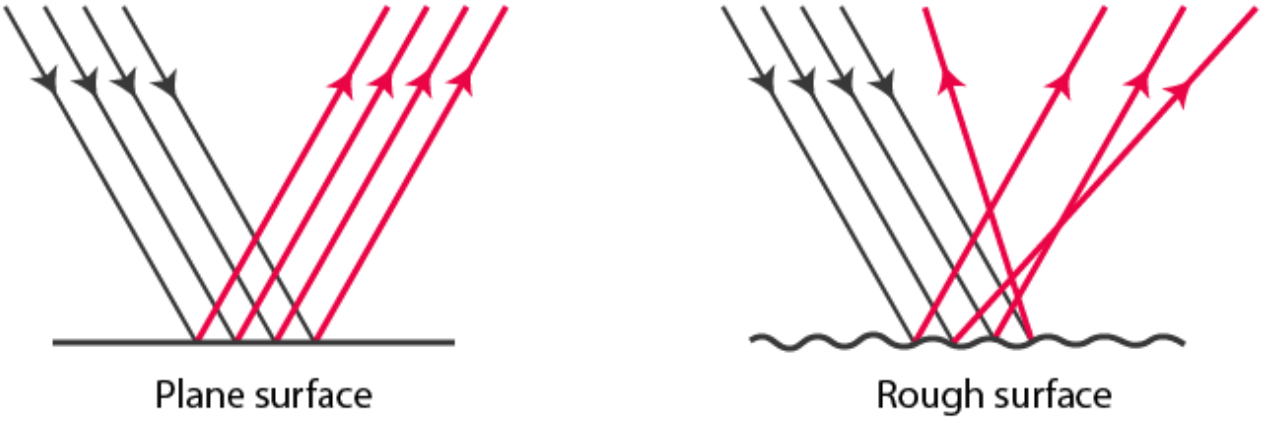



(a) Plane mirror – It is highly polished and a smooth reflecting surface that is prepared from a clear plane glass sheet, which are usually thin and silvered with appropriate reflecting abrasive on one of the sides. After pasting, the glass turns opaque but because of the reflecting property of the abrasive, the plane glass sheet turns into a plane glass mirror or plane glass reflector
(b) Incident ray – it is the light ray that strikes a reflecting surface
(c) Reflected ray – it is the light ray that is obtained after reflection from the surface in the same medium in which the incident ray is travelling
(d) Angle of incidence – it is the angle which the incident ray makes with the normal at the point of incidence. It is denoted by ‘i’
(e) Angle of reflection – it is the angle made by the reflected ray with the normal at the point of incidence. It is denoted by ‘r’




**4. With the help of diagrams, explain the difference between regular and irregular reflection.**

Solution:




When a ray or beam of light falls on a smooth and polished surface an irregular reflection is observed when the light falls on a rough surface. As the surface is uneven, light rays from several points gets reflected in different directions, producing irregular reflections.

**5. Differentiate between reflection of light from a plane mirror and that from a plane sheet of paper.**

Solution:

The differences are as follows:

| Reflection of light from a plane mirror | Reflection of light from s plane sheet of paper |
|---|---|
| It is regular reflection | It is an irregular reflection |

**6. State the two laws of reflection of light.**

Solution:

The two laws of reflection of light are as follows:

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

**7. State the laws of reflection and describe an experiment to verify them.**

Solution:

The two laws of reflection of light are as follows:

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

Experiment to verify laws of reflection:

- Fix a sheet of white paper on a drawing board and draw a line $MM_1$ as seen in the figure
- Take a point O at the mid of the line and draw a line OA such that ∠MOA is lesser than 90 °, say 60 °
- Draw a normal ON on $MM_1$ at the point O, placing a small plane mirror vertically with the help of a stand with its silvered surface on the line $MM_1$
- Fix two pins P and Q at some distance vertically on line OA, on the board
- Observe the other side of the normal, on the same side of the mirror, to see the images clearly $P^1$ and $Q^1$ of pins P and Q
- Fix pin R in line with images $P^1$ and $Q^1$ as seen in the mirror
- Fix one more pin S such that S is also in line with pin R as well the images $P^1$ and $Q^1$ of pins P and Q
- Sketch small circles on the paper around the position of pins as observed in the figure
- Remove the pins and draw a line OB joining the point O to the pin points S and R
- AO is the incident ray, OB is the reflected ray, ∠AON = i, is the angle of incidence, ∠BON is the angle of reflection 'r'. ∠AON and ∠BON are measured and recorded in the observation table
- The experiment is repeated for different angles such as 50°, 40°, 30° for ∠MOA
- From the observation it is observed that in each case, angle of incidence is equal to the angle of reflection, verifying the first law of reflection
- Since the experiment is carried out on a plane paper, the lower tips of all the four pins lie on the same plane, hence the incident ray, reflected ray, and the normal at the point of incidence, all lie in the same plane. This verifies the second law of reflection.

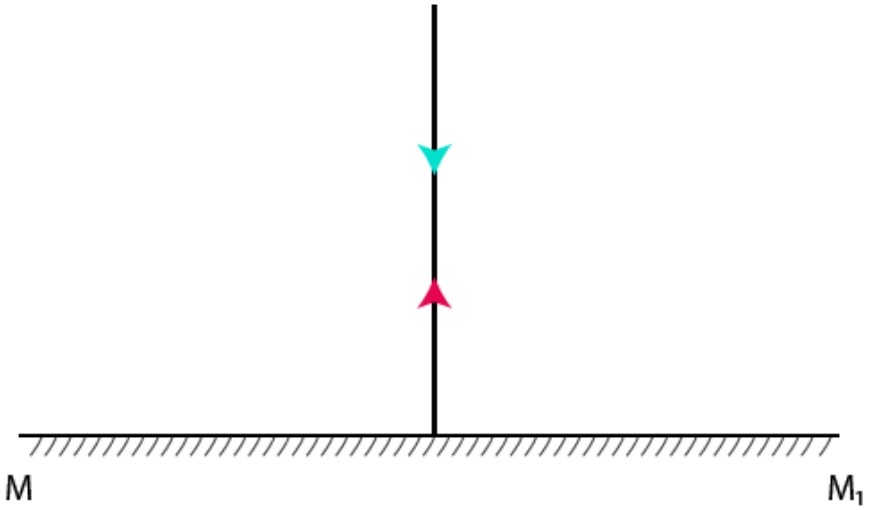
**8. A light ray is incident normally on a plane mirror.**

**(a) What is its angle of incidence?**

**(b) What is the direction of the reflected ray? Show it on a diagram.**

Solution:

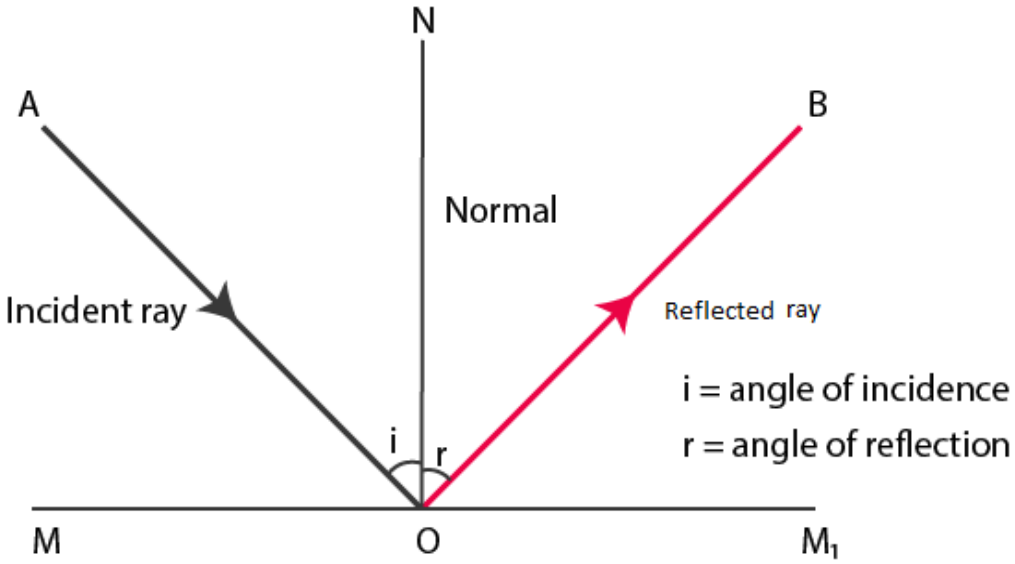
(a) The angle of incidence is 0 °
(b) The direction of the reflected ray is in the same direction as the incident ray.



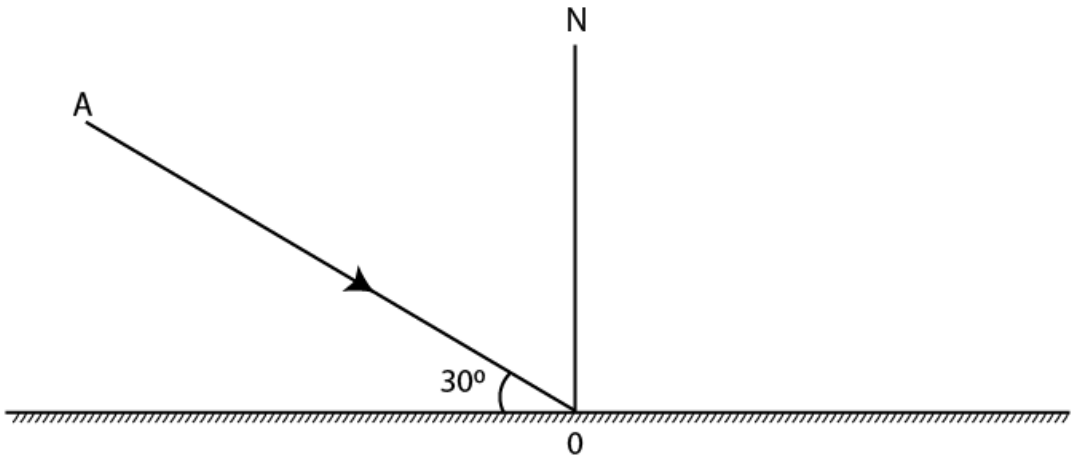

**9. Draw a diagram to show the reflection of a ray of light by a plane mirror. In the diagram, label the incident ray, the reflected ray, the normal, the angle of incidence and the angle of reflection.**

Solution:

The diagram is as follows:



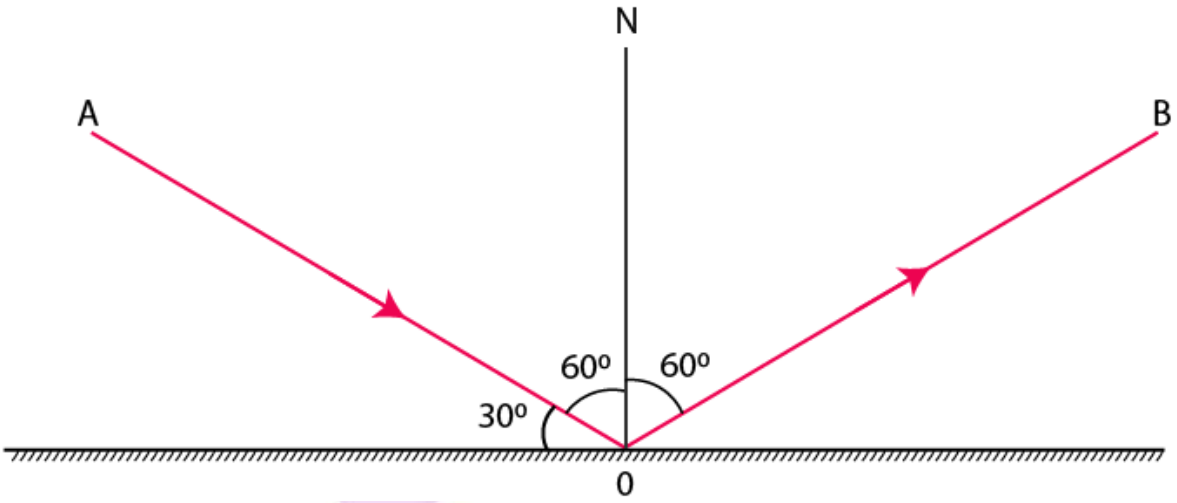

**10. Figure shows an incident ray AO and the normal ON on a plane mirror. The angle which the incident ray AO makes with the mirror is 30°.**
**(a)Find the angle of incidence.**
**(b)Draw the reflected ray and then find the angle between the incident and reflected rays.**




Solution:

(a) The angle of incidence = 90° - 30° = 60°

(b) The angle between the incident and reflected ray= angle of incidence + angle of reflection
Since angle of incidence = angle of reflection
Therefore, angle between the reflected ray and the incident ray = 60° + 60° = 120°

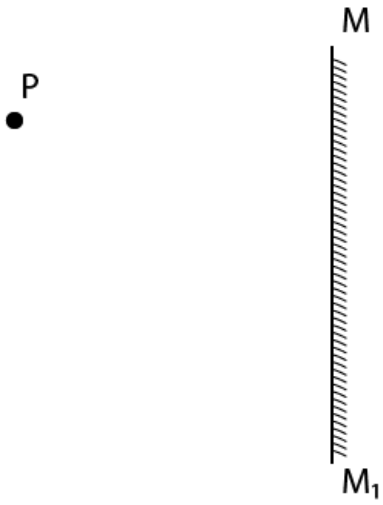



**11. The diagram shows a point object P in front of a plane mirror $MM_1$.**

**(a) Complete the diagram by taking two rays from the point P to show the formation of its image.**

**(b) In the diagram, mark the position of eye to see the image.**

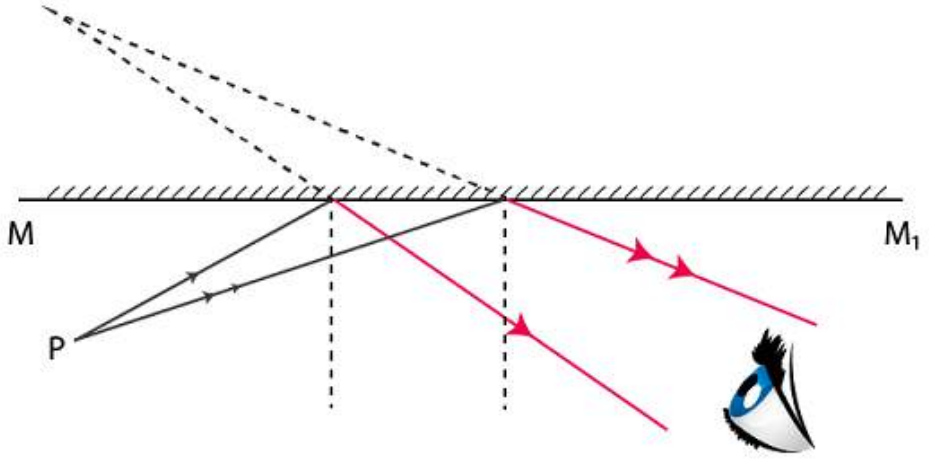
**(c) Is the image formed real or virtual? Explain why.**




Solution:

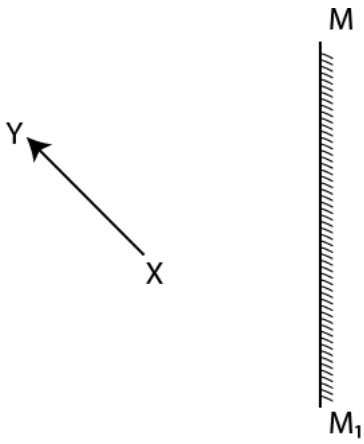
(a) & (b)

The diagram is completed by taking two rays and the position has been marked.



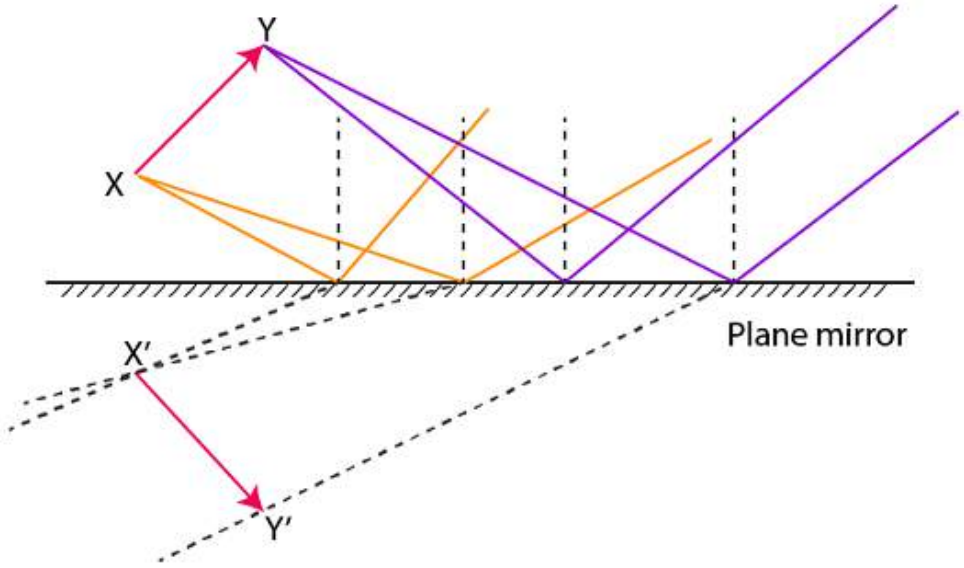

(c) The image formed is virtual because the reflected rays meet only when they are produced backwards.

**12. The diagram below shows an object XY in front of a plane mirror $MM_1$. Draw the diagram, path of two rays from each point X and Y of the object to show the formation of its image.**




Solution:

The required diagram is as shown below:




**13. (a) Write three characteristics of image formed by a plane mirror?**
**(b) How is the position of the image related to the position of the object?**

Solution:

(a) The three characteristics of image formed by a plane mirror:

- Images formed are upright or erect
- Images formed are virtual
- Images formed are of the same size as the object

(b) Both the positions are related such that the image is positioned at the same perpendicular distance behind the mirror as the object in front of it.

**14. Differentiate between a real and a virtual image.**

Solution:

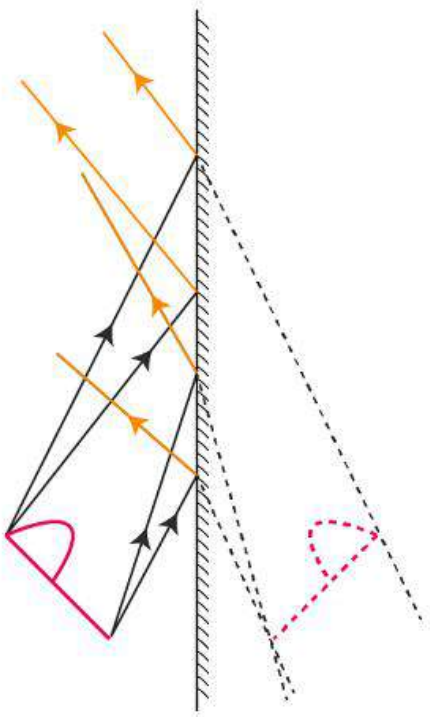
The differences between a real and a virtual image are as follows:

| Real image | Virtual image |
|---|---|
| It is formed due to actual intersection of the reflected rays | It is formed when the reflected rays meet if they are produced backwards |
| It can be obtained on a screen | It cannot be obtained on a screen |
| It is inverted with respect to the object | The image is upright with respect to the object |
| Example- the image formed of a distant object by a concave mirror | Example – the image formed of an object by a plane mirror or by a convex mirror |

**15. What is meant by a lateral inversion of an image in a plane mirror? Explain it with the help of a ray diagram.**

Solution:

Lateral inversion is the interchange of the left and right sides in the image of an object in a plane mirror.



The above diagram indicates the image formation of a letter P in a plane mirror, where the letter appears laterally inversed.

**16. The letters on the front of an ambulance are written laterally inverted like ƎɔИAJUꓭMA. Give reason.**

Solution:

It is written inverted because AMBULANCE, if seen through rear mirror in vehicles that are ahead of the driver, appears as AMBULANCE without any inversion, allowing the ambulance to pass.

**17. Why is it difficult to read the image of the text of a page formed due to reflection by a plane mirror?**

Solution:

It is difficult to read the image of the text of a page formed due to reflection by a plane mirror due to lateral inversion.

**Multiple Choice Type:**

1. **According to the law of reflection :**
   **(a) i/r = Constant**
   **(b) sin i/sin r = Constant**
   **(c) i + r = Constant**
   **(d) i = r**
   Solution:
   (d) i=r
   The first law of reflection states that angle of incidence is equal to the angel of reflection

2. **The image formed by a plane mirror is :**
   **(a) Erect and diminished**
   **(b) Erect and enlarged**
   **(c) Inverted and of same size**
   **(d) Erect and of same size**
   Solution:
   (d) Erect and of same size
   Images formed by a plane mirror are erect and laterally inverted.

3. **The image formed by a plane mirror is :**
   **(a) Real**
   **(b) Virtual**
   **(c) Virtual with lateral inversion**
   **(d) Real with lateral inversion**
   Solution:
   (c) Virtual with lateral inversion
   Images formed by a plane mirror are erect, virtual and laterally inversed.

**Numericals:**

1. **A ray is incident on a plane mirror. Its reflected ray is perpendicular to the incident ray. Find the angle of incidence.**
   Solution:
   Given: reflected ray is perpendicular to incident ray
   That is to say, i + r = 90°
   We know from the law of reflection that i=r (angle of incidence = angle of reflection)
   i+i=90° => 2i=90°
   ⇨ i=r=45°

2. **A man standing in front of a plane mirror finds his image at a distance 6 metre from himself. What is the distance of a man from the mirror?**
   Solution:

Given:
Distance between the man and his image is 6m
That is to say,
Distance between the man and mirror and the distance between mirror and image =6m
We know that the object distance = image distance
i.e., distance between the man and the mirror = distance between mirror and image
hence, the distance of the man and the mirror = 6/2 = 3m

3. **An insect is sitting in front of a plane mirror at a distance 1 m from it.**
**(a)Where is the image of the insect formed?**
**(b) What is the distance between the insect and its image?**
Solution:
(a) The image of the insect is formed 1m behind the mirror
The image is situated on the normal drawn from the object on the mirror and it is as far behind the mirror as the object is in front of it.
(b) The distance between the insect and its image, 1 +1 = 2m

4. **An object is kept at 60 cm in front of a plane mirror. If the mirror is now moved by 25 cm away from the object, how does the image shift from its previous position?**
Solution:
Given:
Image formed of the object at the beginning is at a distance 60cm
We know that, the image is situated on the normal drawn from the object on the mirror and it is as far behind the mirror as the object is in front of it.
Hence the image is formed behind the mirror at a distance of 60cm
The distance between the image and the object initially is 60 cm+ 60 cm=120cm
Now, as per the question, if the mirror is moved 25cm away from the object,
The new distance of the object from the mirror is given by:
60cm+25cm=85cm,
∴ The new distance is now formed 85cm from the mirror behind it
Hence, the current distance of the image from the object is 85cm + 85cm=170cm

Let the reference point be the position of the object,

∴ the new distance of the image from the object - the distance of the image from the object initially = distance between the two positions of the image
That is to say,
170cm – 120cm = 50cm
Therefore, the image shifts from its previous position 50cm away.

5. **An optician while testing the eyes of a patient keeps a chart of letters 3 m behind the patient and asks him to see the letters on the image of chart formed in a plane mirror kept at distance 2 m in front of him. At what distance is the chart seen by the patient?**
Solution:
Given:
The distance between the man and the mirror = 2m

The distance between the man and the chart = 3m
∴ the distance between the chart and the mirror = distance between the man and the mirror + distance between the man and the chart = 3m + 2m = 5m
The new image formed on the mirror, 2m apart from the man is 5m + 2m = 7m
∴ the chart seen by the patient is 7m away from him

## Exercise-7(B)

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1. **Two plane mirrors are placed making an angle Θ in between them. Write an expression for the number of images formed if an object is placed in between the mirrors. State the condition, if any.**

   Solution:

   The expression is as follows:

   (n-1) if 'n' is even or odd, the object placed is symmetrically
   If n=360 °/ Θ°, n is odd and the object is placed asymmetrically

2. **Two plane mirrors are placed making an angle Θ° in between them. For an object placed in between the mirrors, if angle is gradually increased from 0° to 180°, how will the number of images change: increase, decrease or remain unchanged?**

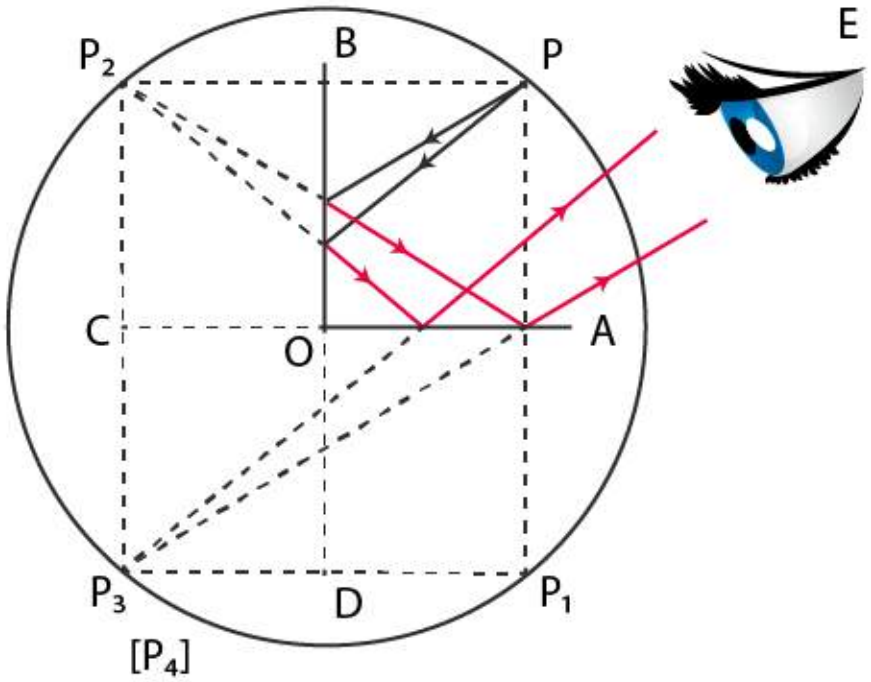
   Solution:

   The number of images decreases.

3. **How many images are formed for a point object kept in between the two plane mirrors at right angles to each other? Show them by drawing a ray diagram.**

   Solution:

   If a point object is placed between two plane mirrors that are at right angles to each other, then 3 images are formed for it.
   The ray diagram is as follows:

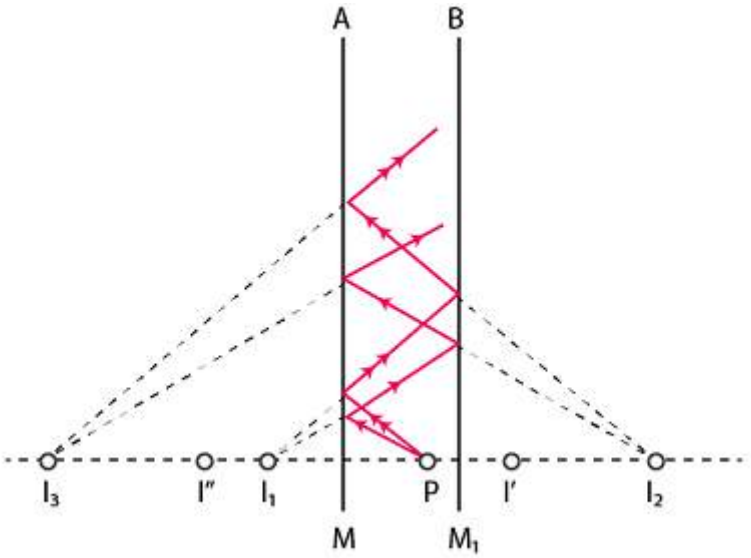


4. **Two plane mirrors are arranged parallel and facing each other at some separation. How many images are formed for a point object kept in between them? Show the formation of images with the help of a ray diagram.**

Solution:

The number of images formed for a point object placed between two plane mirrors that are arranged parallelly, facing each other at some distance is infinite.

The ray diagram is as follows:




5. **State two uses of a plane mirror.**

Solution:

The two uses of a plane mirror are:

- In the optician's room to increase the effective length of the room, achieved by placing a plane mirror on the front wall and the sign board on the opposite wall, just behind the patient. For the patient, the sign board is at nearly double the length of the room
- The two parallel plane mirrors each inclined 45° in a periscope with vertical walls are placed facing each other.

**Multiple Choice type:**

1. **Two plane mirrors are placed making an angle of 60° in between them. For an object placed in between the mirrors, the number of images formed will be :**

**(a) 3**
**(b) 6**
**(c) 5**
**(d) Infinite**

Solution:

(c) 5

If the angle between two mirrors is 60°, n=360°/60° = 6, number of images = n-1 = 6-1 = 5

2. **In a barber's shop, two plane mirrors are placed:**
   **(a) Perpendicular to each other**
   **(b) Parallel to each other**
   **(c) At an angle of 60° between them**
   **(d) At an angle of 45° between them**

   Solution:

   (b) Parallel to each other

   In order to see the hair at the back of the head, the two plane mirrors are placed parallel at the front and at the back of the viewer.

**Numericals:**

1. **State the number of images of an object placed between the two plane mirrors, formed in each case when the mirrors are inclined to each other at**
   **(a) 90° and**
   **(b) 60°**

   Solution:

**(a)** The number of images formed when an object is placed between the two plane mirrors at an angle of 90°, is 3. Three images are formed.

We know that, two mirrors kept perpendicular to each other, produces three images for an object that is placed in between them.

i.e, the angle between two mirrors is 60°, n=360°/90° = 4, number of images = n-1 = 4-1 = 3.

(b) The number of images formed if an object is placed between two plane mirrors with an angle of 60°, is five. Five images are formed:

i.e, the angle between two mirrors is 60°, n=360°/60° = 6, number of images = n-1 = 6-1 = 5.

2. **An object is placed**

**(i) asymmetrically**

**(ii) symmetrically, between two plane mirrors inclined at an angle of 50°. Find the number of images formed.**

Solution:

Given:

Angle between the two mirrors = 50°

n=360°/50°=> 7.2, can be rounded off to 7, which is an odd number.

(i) The number of images that will be formed when the image is placed asymmetrically is n, which is 7.

(ii) The number of images that will be formed when the images is placed symmetrically is n-1, i.e., 7-1=6. 6 images are formed.

## Exercise-7(C) Page: 170

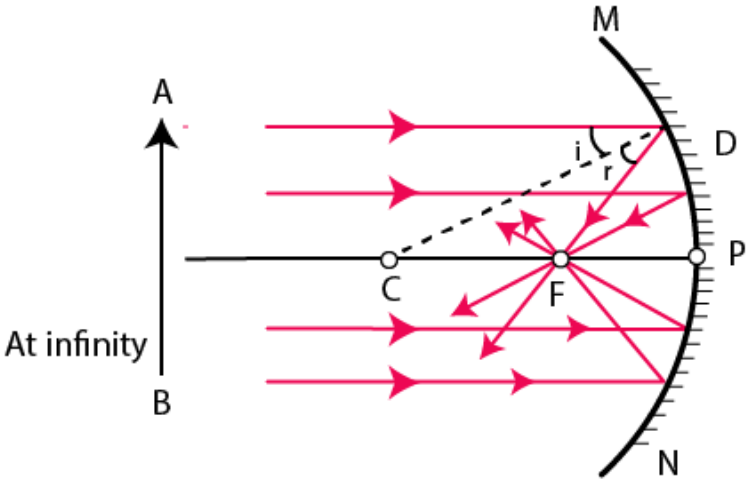
1. **What is a spherical mirror?**
   Solution:
   A spherical mirror is a reflecting surface that is part of a sphere.

2. **Name the two kinds of spherical mirrors and distinguish between them.**
   Solution:
   The two kinds of spherical mirrors depending upon whether the inner or outer surface of the sphere is silvered or spherical, are:
   - Concave mirror
   - Convex mirror

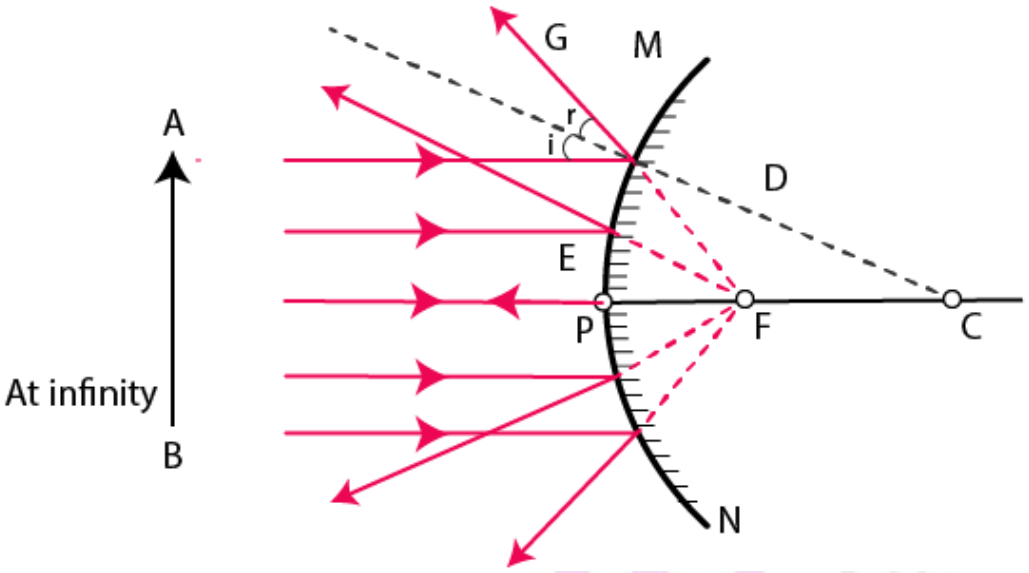
| Concave mirror | Convex mirror |
|---|---|
| Bulging surface is silvered | Inner surface is silvered |
| Reflection takes place from the hollow surface | Reflection takes place from bulging surface |

3. **Define the terms pole, principal axis and center of curvature with reference to a spherical mirror.**
   Solution:
   Pole – of a mirror is the geometric center of the spherical surface of the mirror
   Principal axis – is the straight line that joins the pole of the mirror to its center of curvature
   Centre of curvature – with reference to a spherical mirror is the center of the sphere of which the mirror is part of.

4. **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.**
   Solution:
   (i) Concave mirror



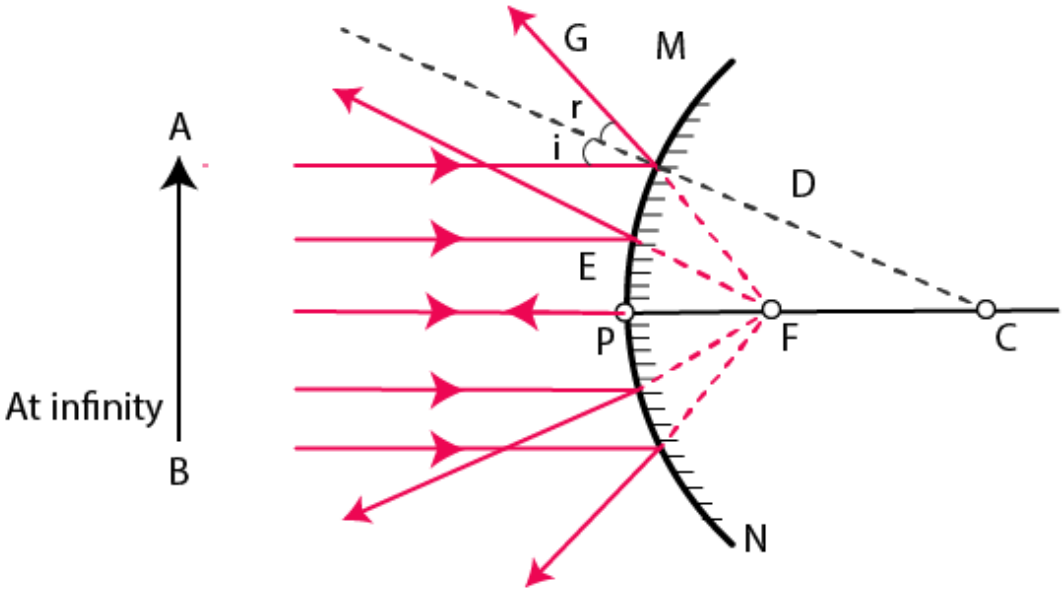
(ii) Convex mirror



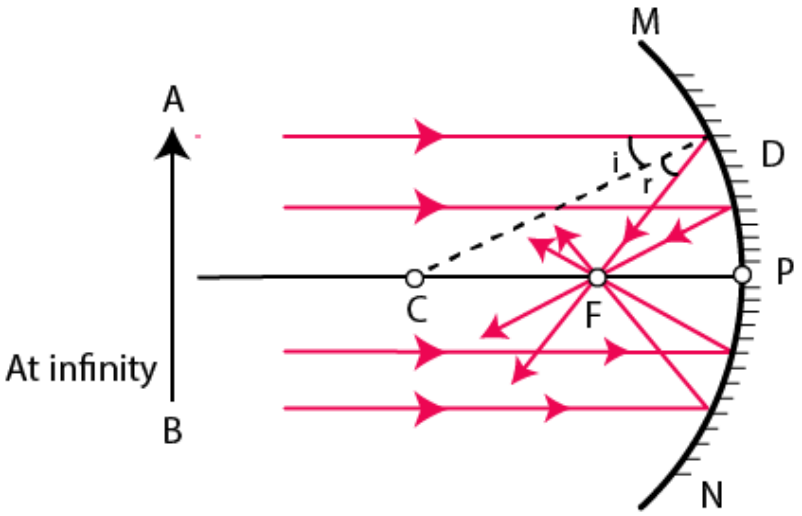

**5. Name the spherical mirror which (i) diverges (ii) converges the beam of light incident on it. Justify your answer by drawing a ray diagram in each case.**

Solution:

(i) The spherical mirror which diverges a beam of light falling on it is the convex mirror



(ii) The spherical mirror that converges a beam of light incident on it is the concave mirror

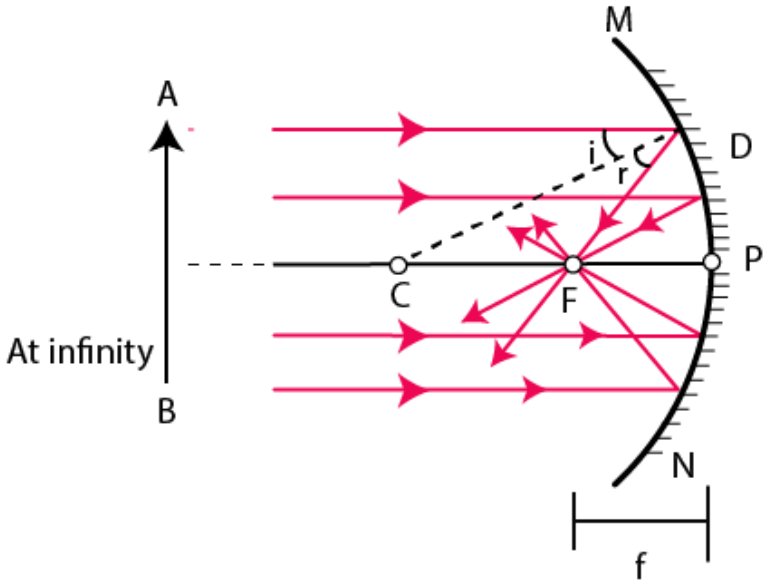



**6. Define the terms focus and focal length of a concave mirror. Draw diagram to illustrate your answer.**

Solution:

Focus of a concave mirror – it is a point on the principal axis through which the light rays that are incident parallel to the principal axis, pass once the light is reflected from the mirror

Focal length of a concave mirror – it is the distance of the focus from the pole of the concave mirror

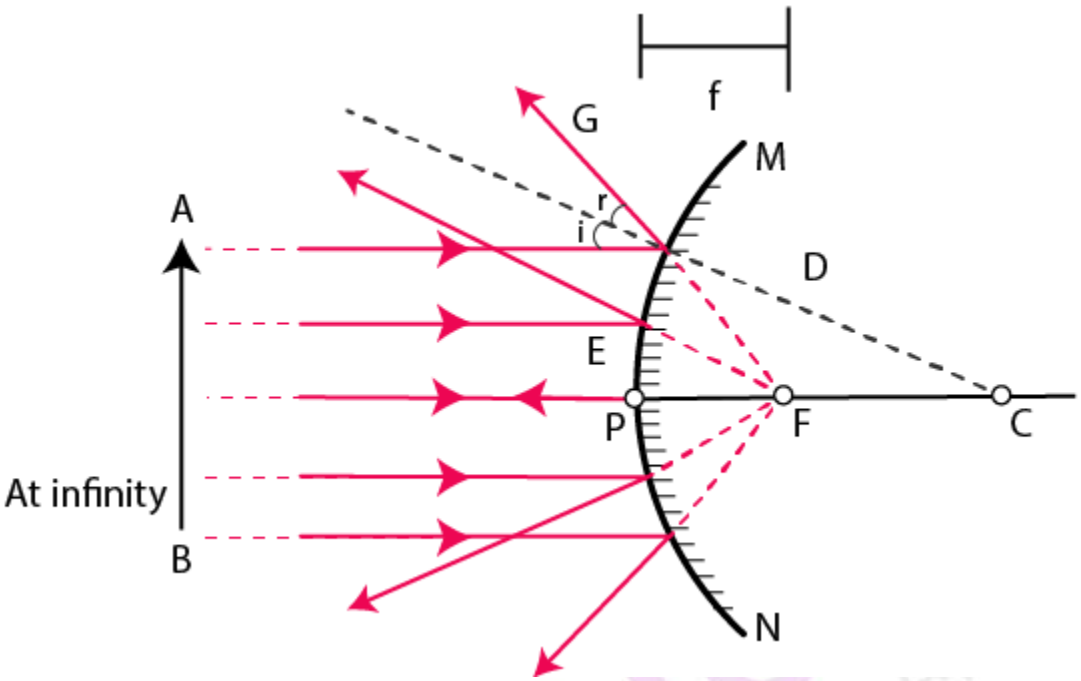



**7. Explain the meaning of the terms focus and focal length in case of a convex mirror, with the help of a suitable ray diagram.**

Solution:

Focus of a convex mirror – it is a point on the principal axis from where the light rays that are incident, parallel to the principal axis, appear to arrive after reflection from the mirror

Focal length of a convex mirror – it is the distance of the focus from the pole of the convex mirror




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

Solution:

The incident ray is directed towards the centre of curvature.

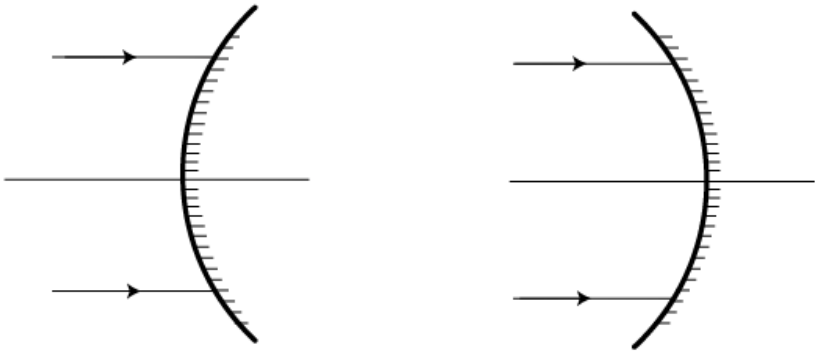
It is because the ray is normal to the spherical mirror,

Hence ∠i=0, i.e., the angle of incidence is 0

Therefore, the angle of reflection ∠r=0

**9. (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.**



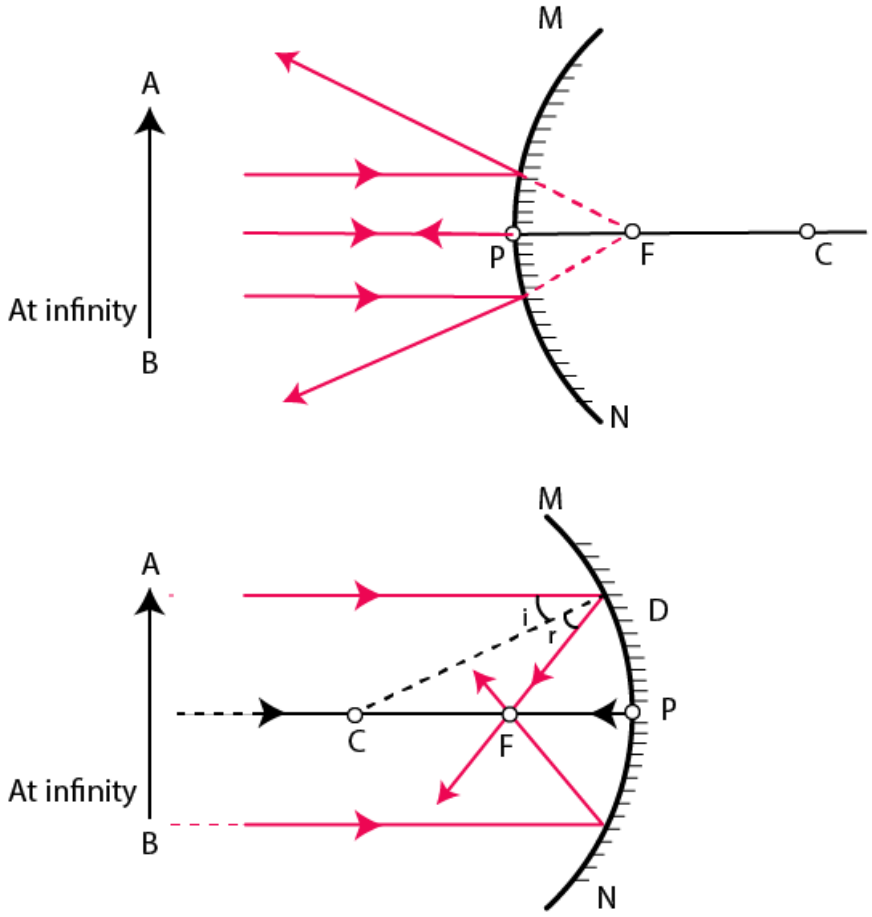
(a) (b)

Solution:

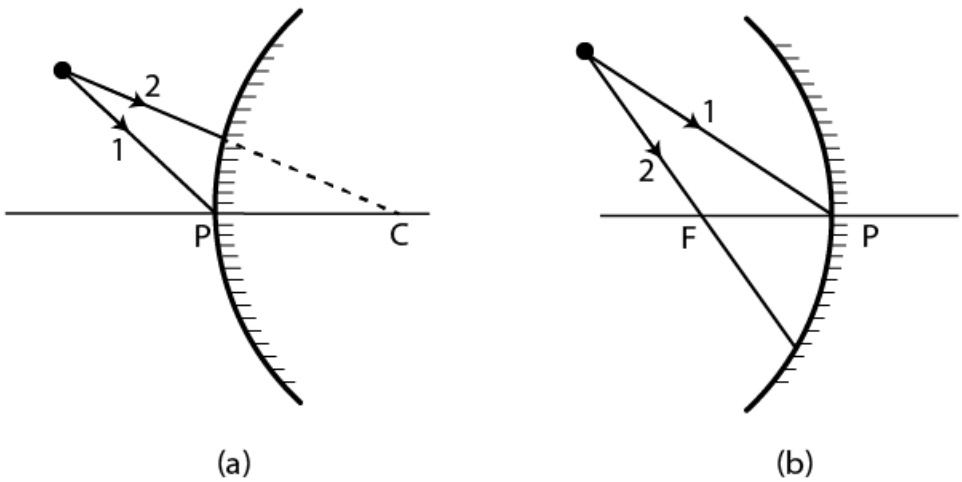
(i) Figure (a) shows a convex mirror

Figure (b) shows a concave mirror

(ii) The diagram is as shown:

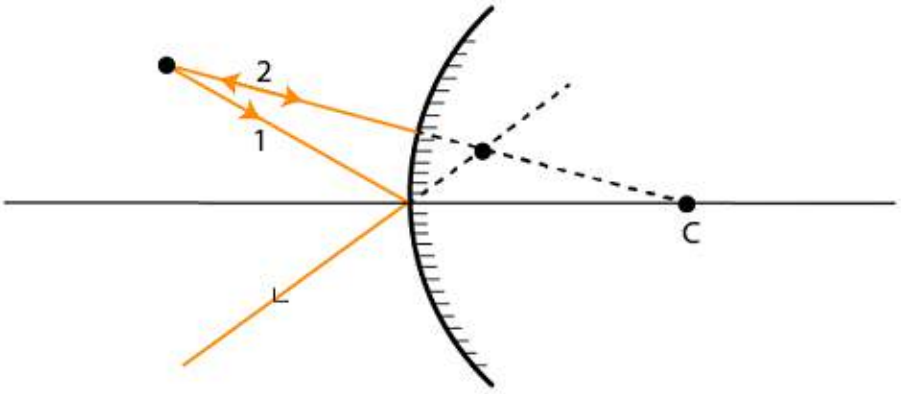


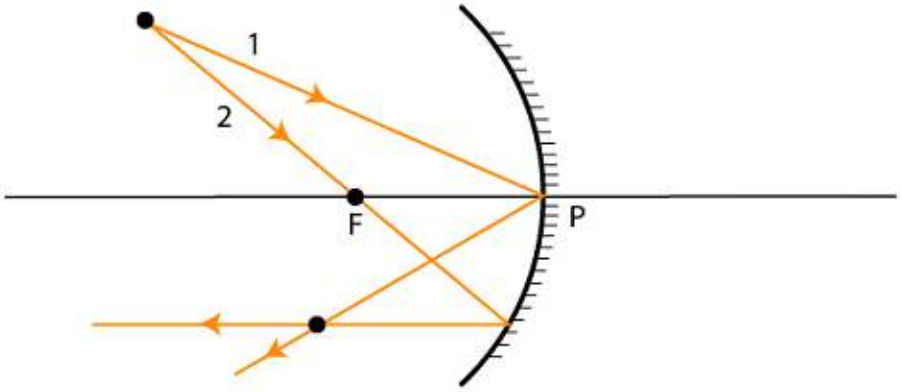

**10. Complete the following diagrams in figure by drawing the reflected rays for the incident rays 1 and 2.**



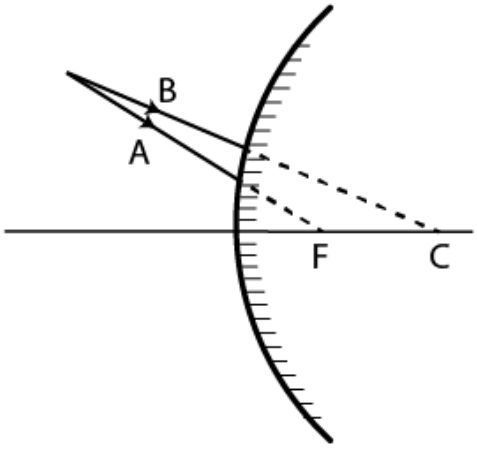

(a) (b)

Solution:
The diagrams are as shown below:

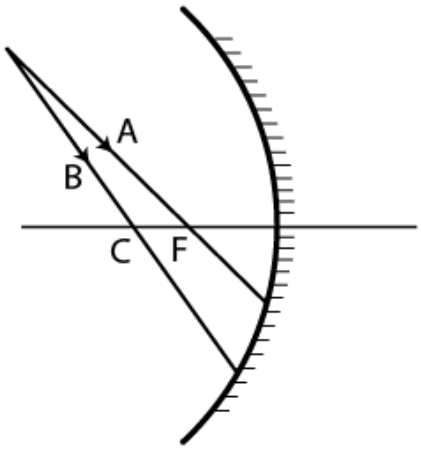



**11. Complete the following diagrams shown in figure by drawing the reflected ray for each of the incident ray A and B.**

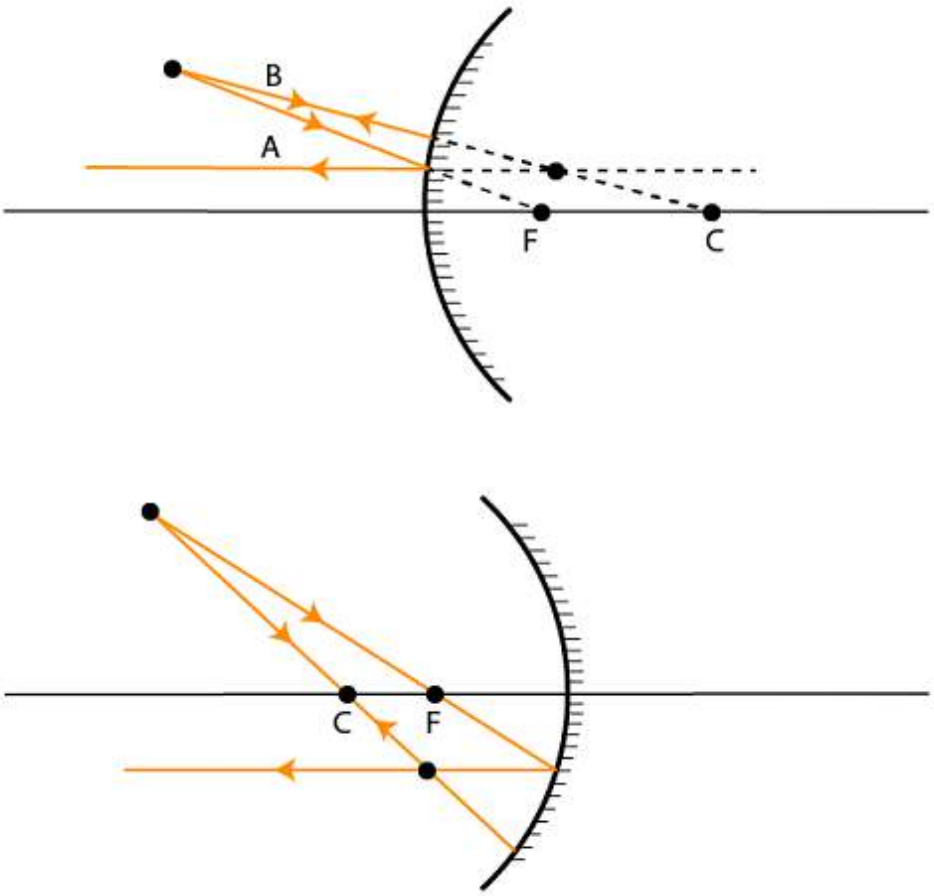



(a)




(b)

Solution:
The diagram is as shown

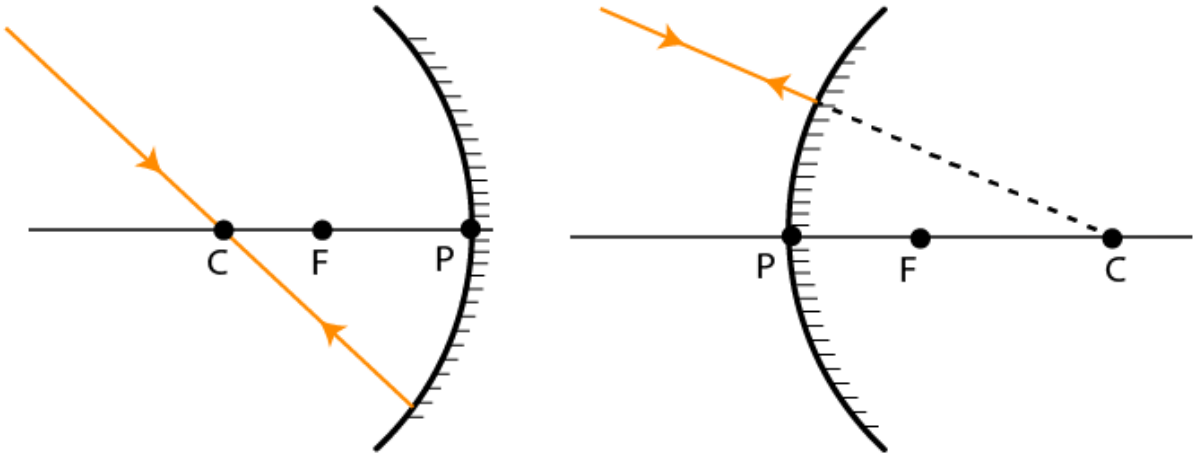



**12. State the two consecutive rays that are chosen to construct the image by a spherical mirror for a given object? Explain your answer with the help of suitable ray diagrams.**

Solution:
The two convenient rays, chosen to construct the image by a spherical mirror are as follows:

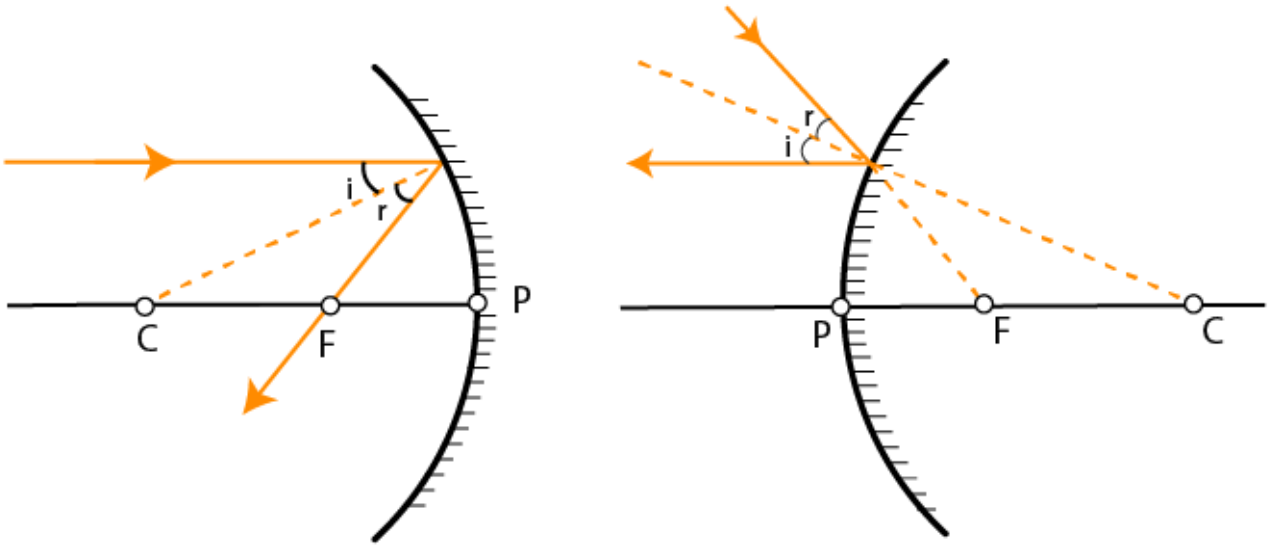
- A ray that passes through the center of curvature

A ray passing through (for concave mirror) or directed towards (for convex mirror) the center of curvature of a spherical mirror is reflected back along its own path.

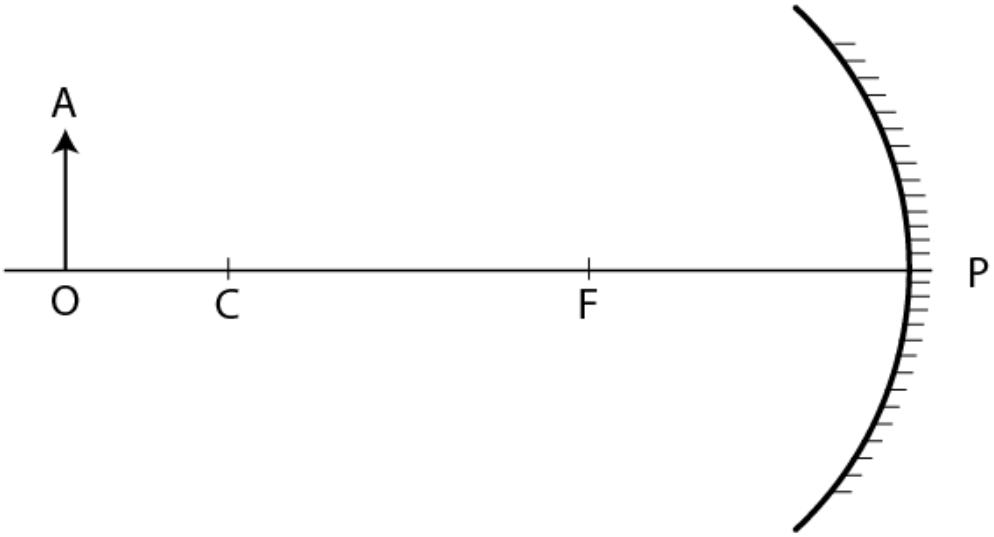



- A ray that is parallel to the principal axis

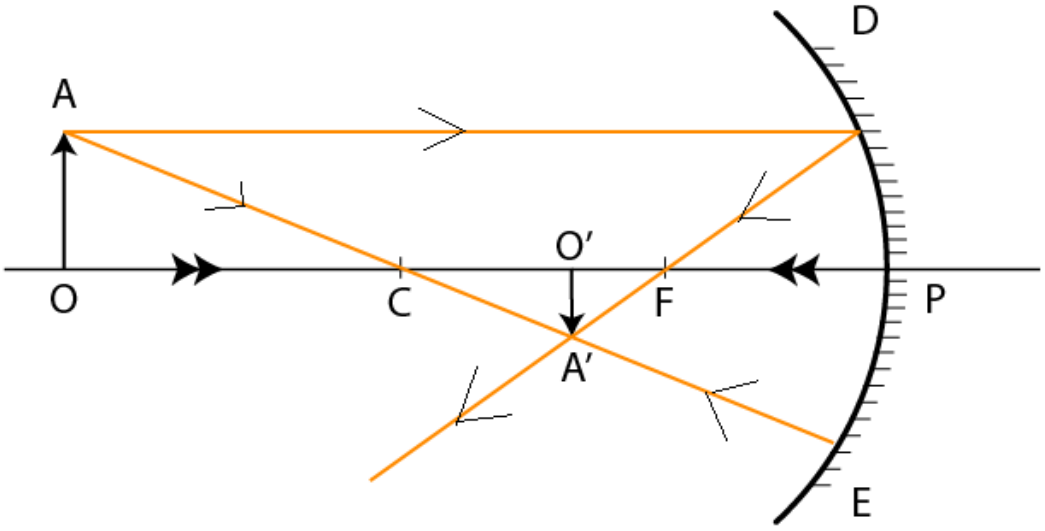
A ray incident parallel to the principal axis, once it is reflected from a spherical mirror, either passes(concave mirror) or appears to be coming (convex mirror) from the focus.



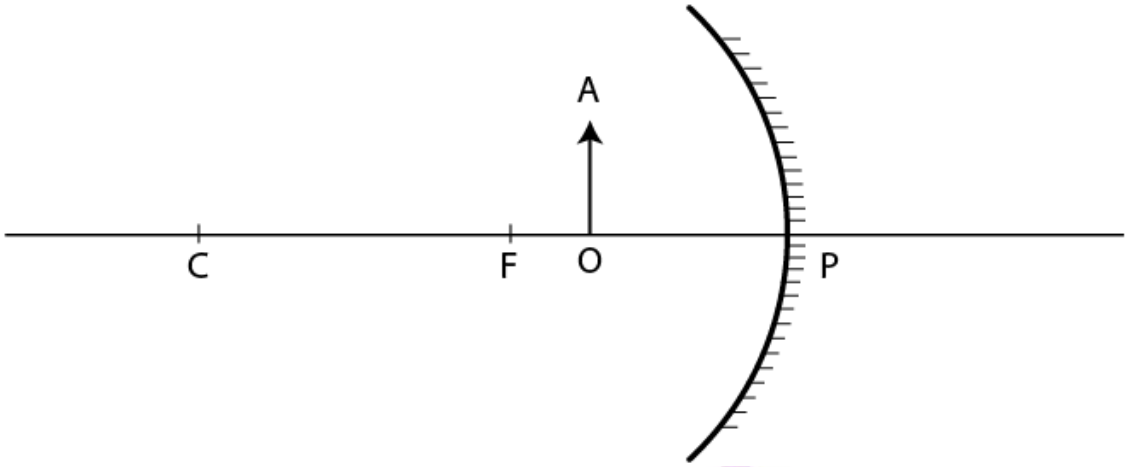

**13. Figure shows a concave mirror with its pole at P, focus F and center of curvature C. Draw ray diagram to show the formation of image of an object OA.**



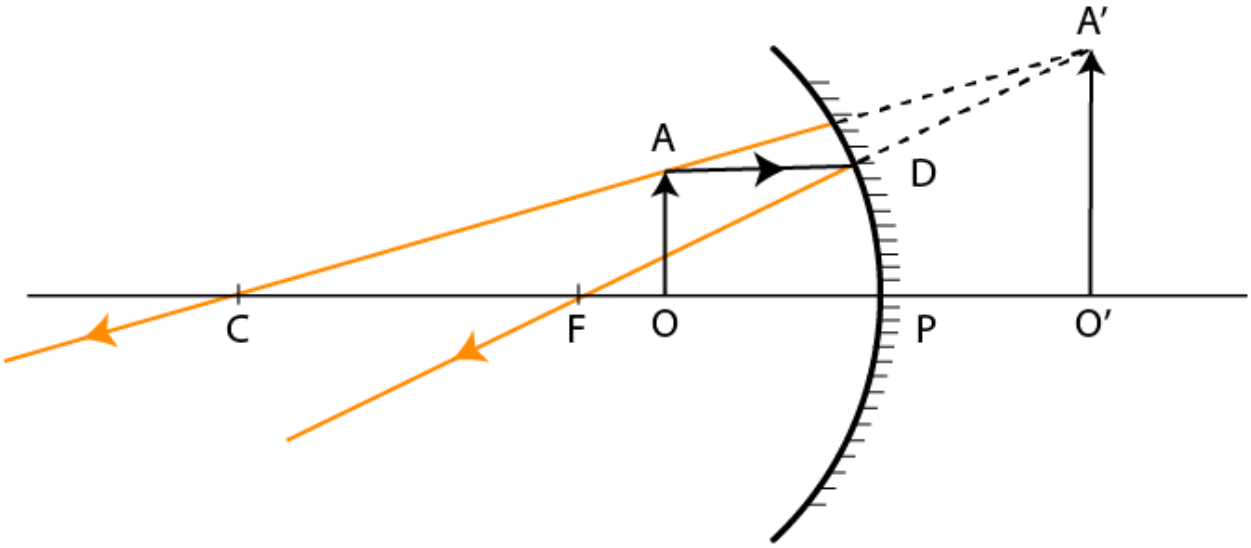

Solution:
The required diagram is as shown:



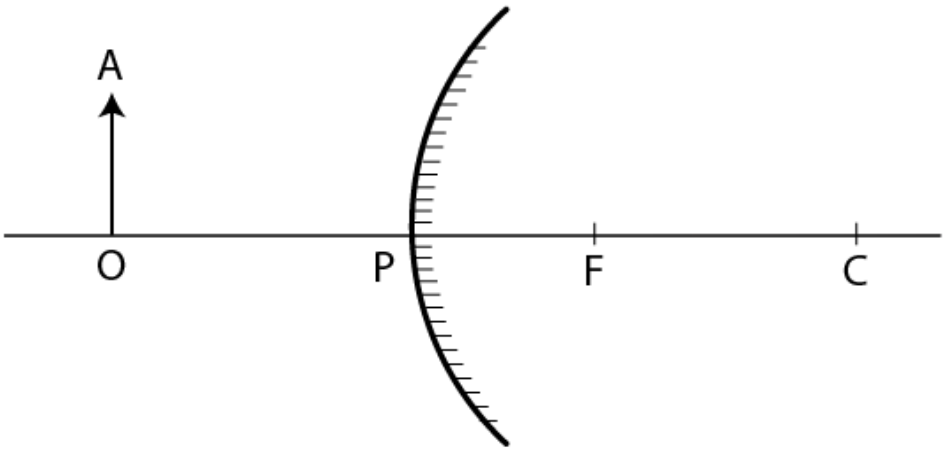

**14. Figure shows a concave mirror with its pole at P, focus F and center of curvature C. Draw ray diagram to show the formation of image of an object OA.**




Solution:
The figure is as shown below:

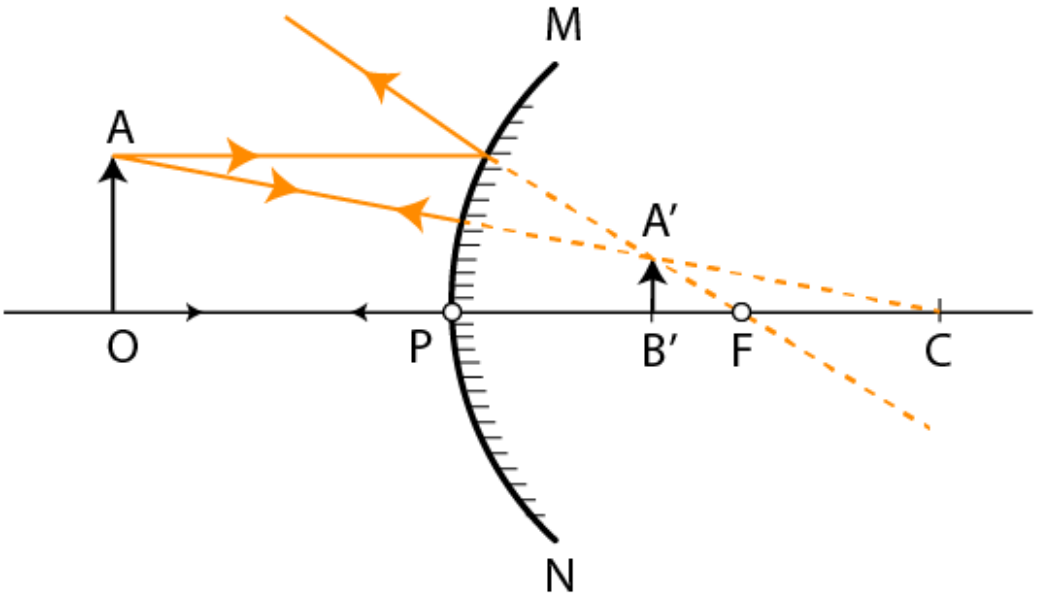



**15. The diagram below in figure shows a convex mirror. C is its center of curvature and F is its focus. (i) Draw two rays from A and hence locate the position of image of object OA. Label the image IB.(ii) State three characteristics of the image.**




Solution:

(i) The diagram is as shown:



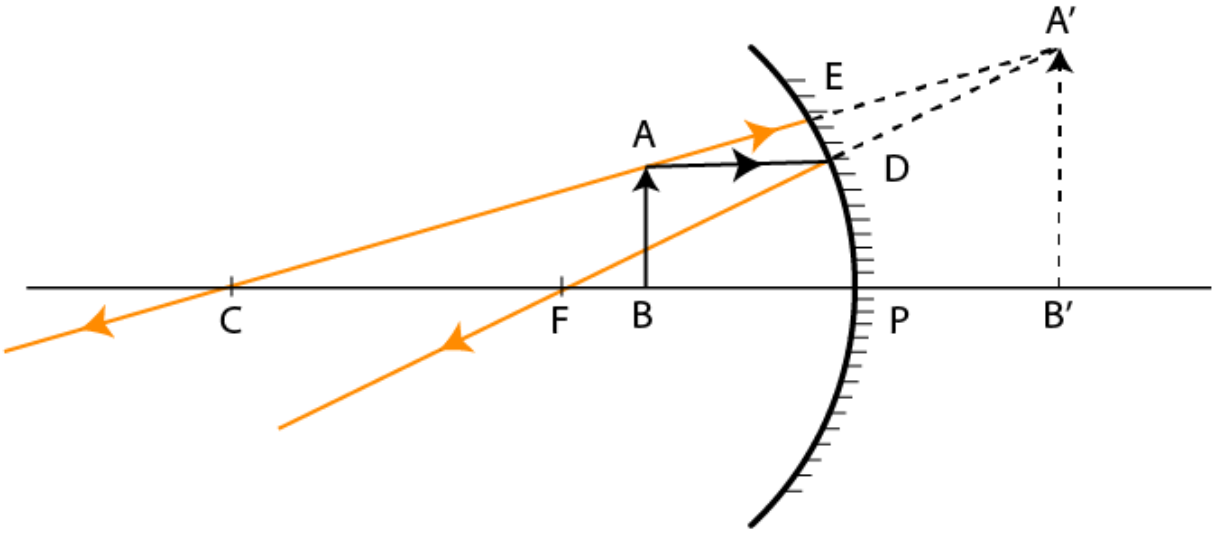

(ii) The three characteristics of the image are:

- Erect
- Virtual
- Diminished

**16. 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.**

Solution:

The following ray diagram shows the formation of image by a concave mirror for an object placed between its pole and focus.



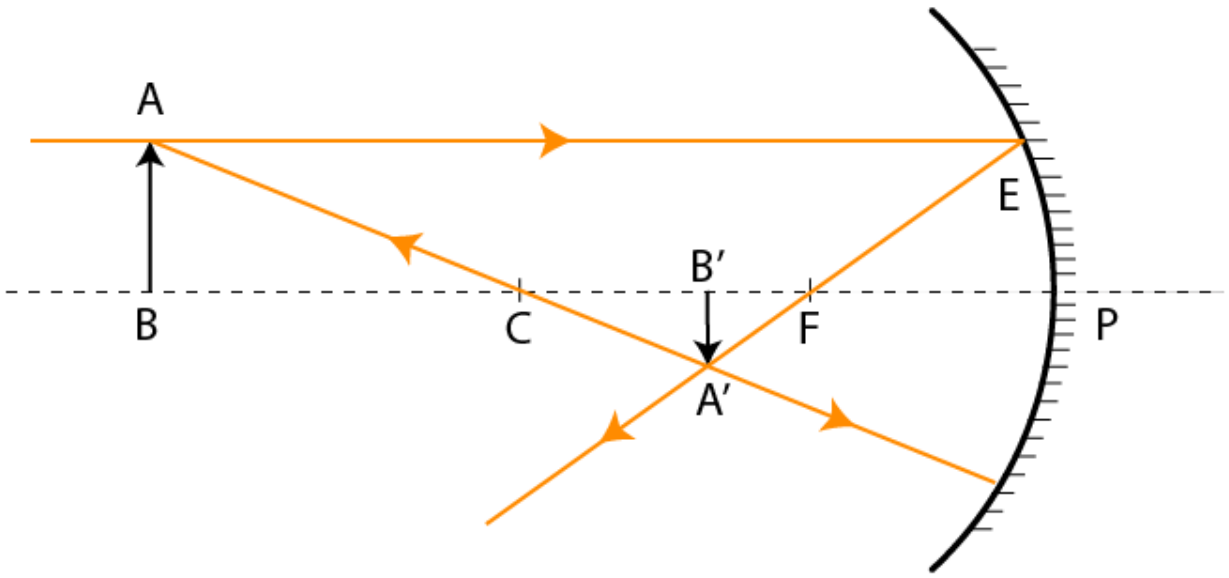

The image is formed behind the mirror when an object is placed between the focus F and the pole P
The three characteristics of the image are as follows:

- The images are virtual
- The images are upright
- The images are magnified

**17. 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.**

Solution:

The following diagram shows the formation of image by a concave mirror for an object beyond its center of curvature.



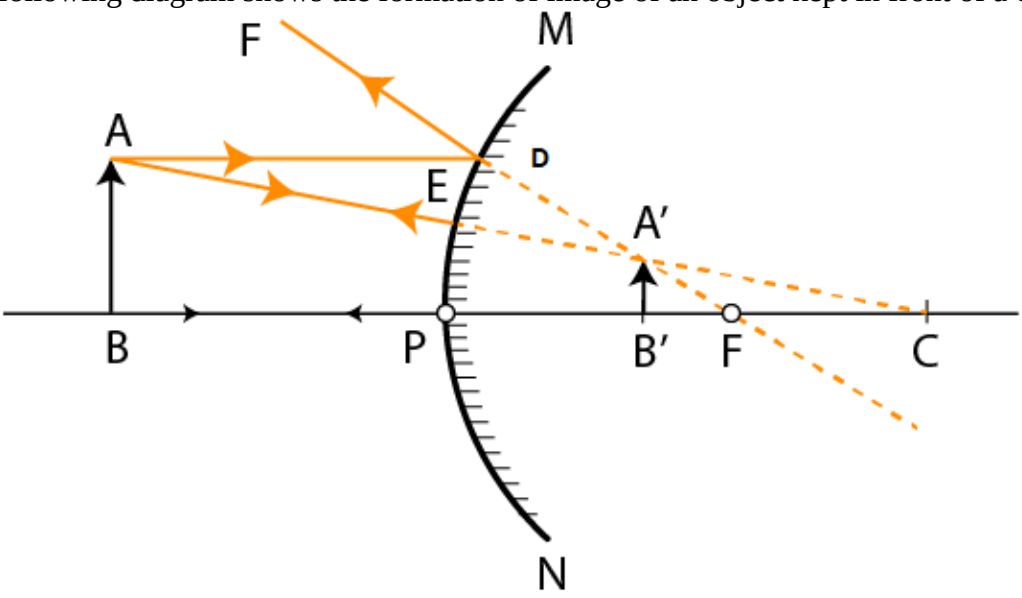
The image is formed between the center of curvature C and the focus F, when an object is placed beyond the center of curvature C.
The three characteristics of the image are as follows:

- The images are real
- The images are diminished
- The images are inverted

**18. 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.**

Solution:

The following diagram shows the formation of image of an object kept in front of a convex mirror.




The three characteristics of the image are as follows:

- The images are erect
- The images are virtual
- The images are diminished

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

Solution:

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

**20. (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?**

Solution:

(a) The image formed by a concave mirror is magnified and erect if the object is placed between the pole and focus of concave mirror.
(b) The image formed of an object when placed between the pole and the focus of a concave mirror is virtual.

**21. (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.**

Solution:

(a) The position of object for which the image is formed by a concave mirror is of the same size is at the center of curvature.

(b) The images so formed have the following two characteristics in addition, they are:

- The images formed are real
- The images formed are inverted

**22. (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?**

Solution:

(a) An image that can be obtained on screen is a real image

(b) To obtain a real image of an object, concave mirror can be used

(c) No, concave mirror cannot form real image for all the locations of the object.

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

Solution:

The image formed moves away from the mirror when an object is moved from infinity towards the pole of mirror. In addition, the image formed is real and inverted.

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

Solution:

The images formed by a convex mirror are

- Upright
- Virtual
- Diminished

The image of the object is always located between the pole and the focus of the convex mirror, regardless of the distance of the object when placed in front of the mirror.

**25. 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.**

Solution:

The types of mirrors used to obtain the following are:

(a) A real and enlarged image – concave mirror

(b) A virtual and enlarged image - concave mirror

(c) A virtual and diminished image – convex mirror

(d) A real and diminished image - concave mirror

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

Solution:

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

$$f = \frac{1}{2} R$$

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

Solution:

The spherical mirror's formula is as follows:

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

where 'u' is the distance of the object
'v' is the distance of the image
'f' focal length for the spherical mirror

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

Solution:

Linear magnification is the ratio of the length of the image to the length of the object.

Magnification 'm' can be given by;

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

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

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

Solution:

The maximum distance from the pole, at which the image in a convex mirror can be obtained is the focal length, as the image formed of an object by a convex mirror is always between the pole and the focus. The object would be located at infinity then.

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

Solution:

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

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

Solution:

In order to distinguish between a plane mirror, a concave mirror and a convex mirror, the chosen mirror is held close to the face and the image obtained is observed.

One of the following three cases can be observed depending upon the type of mirror chosen:

| Type of mirror | Position of the mirror | Change in size of image when moved away or towards |
|---|---|---|
| Plane | Upright | Size remains the same |
| Concave | Upright | Size increases when the mirror is moved away |
| Convex | Upright | Size decreases when the mirror is moved away |

**32. State two uses of a concave mirror.**

Solution:

The two uses of a concave mirror are as follows:

- It can be used as a shaving mirror – when it is held closer to the face, produces an upright, magnified image hence even tiny hair on the face can be seen easily. Hence, a concave mirror with a large focal length and large aperture is used
- It can be used as a reflector – in search light, torch, head light of automobiles, cycles etc. A polished metallic surface of the concave is used as a reflector to get a parallel beam of light. Source of light is placed at the focus of concave reflector. Rays of light are incident on the concave reflector from the bulb which form a parallel beam after reflection.

**33. State the kind of mirror used**

**(a) By a dentist**

**(b) As a search- light reflector**

Solution:

(a) By a dentist – concave mirror

(b) As a search- light reflector – concave mirror

**34. (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)**

Solution:

(a) The person's face in relation to the focus of the mirror is between the pole and the focus

(b) The three characteristics of the image so formed are as follows:

- The images are erect
- The images are virtual
- The images are magnified

**35. Which mirror will you prefer to use as a rear view mirror in a car: plane mirror or convex mirror? Give one reason.**

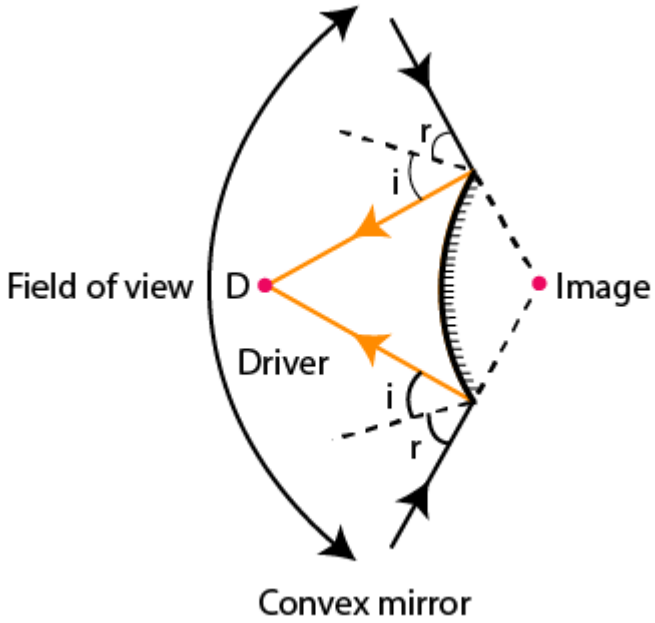
Solution:

A convex mirror would be preferred. It is because convex mirrors offer a wider field of view in comparison to the plane mirror of the same size.

**36. 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.**

Solution:

It is the property of a convex mirror to diverge the incident beam, forming images that are virtual, erect, and small forming between focus and pole. Hence the driver can see the traffic that is behind him, which enables the driver to use it as a rear view in vehicles to see all the traffic that approaches from behind.




**Multiple choice type:**

1. **For an incident ray directed towards center of curvature of a spherical mirror, the reflected ray:**
   **(a) Retraces its path**
   **(b) Passes through the focus**
   **(c) Passes through the pole**
   **(d) Becomes parallel to the principal axis**

   Solution:

   (a) Retraces its path

2. **The image formed by a convex mirror is:**
   **(a) Erect and diminished**
   **(b) Erect and enlarged**
   **(c) Inverted and diminished**
   **(d) Inverted and enlarged**

   Solution:

   (a) Erect and diminished

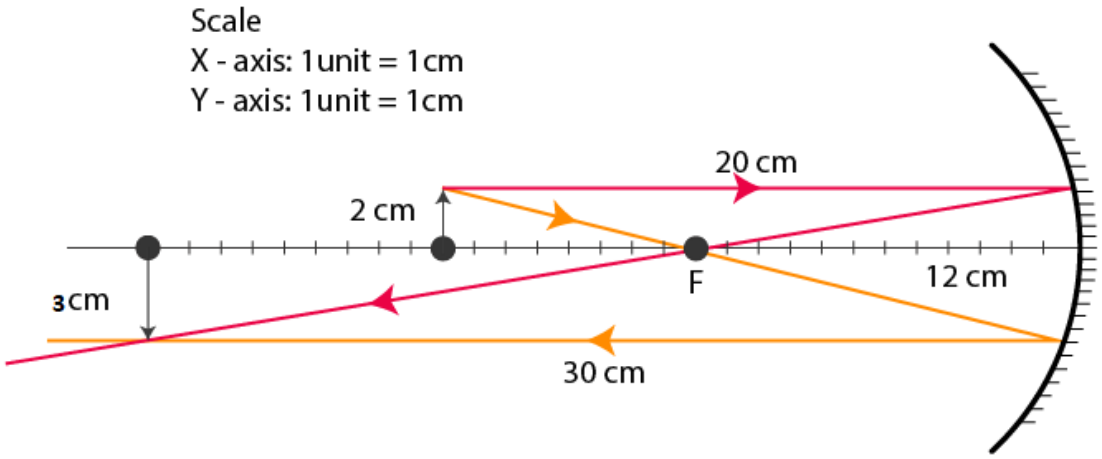
3. **A real and enlarged image can be obtained by using a:**
   **(a) Convex mirror**
   **(b) Plane mirror**
   **(c) Concave mirror**
   **(d) Either convex**
   Solution:
   (c) Concave mirror

**Numericals:**

1. **The radius of curvature of a convex mirror is 40cm. find its focal length.**
   Solution:
   Given:
   R = 40cm
   We know that, $f = \frac{1}{2} R$
   $= ½ \times 40 = 20cm$

2. **The focal length of a concave mirror is 10cm. find its radius of curvature.**
   Solution:
   Given:
   F=10cm, R =?
   We know that, $f = \frac{1}{2} R$
   $10 = \frac{1}{2} R$
   R=20cm

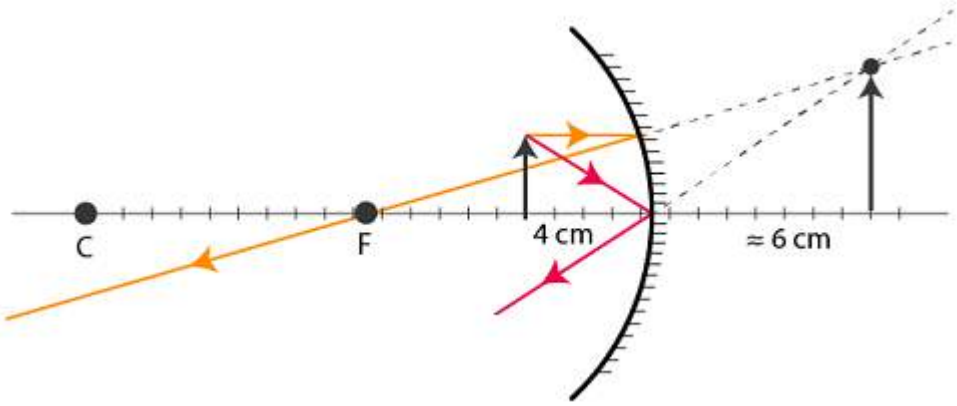
3. **An object of height 2cm is placed at a distance 20cm in front of a concave mirror of focal length 12cm. Find the position, size and nature of the image.**
   Solution:
   Given:




The image is 30cm in front of the mirror.
The image is 3cm high with the following characteristics:

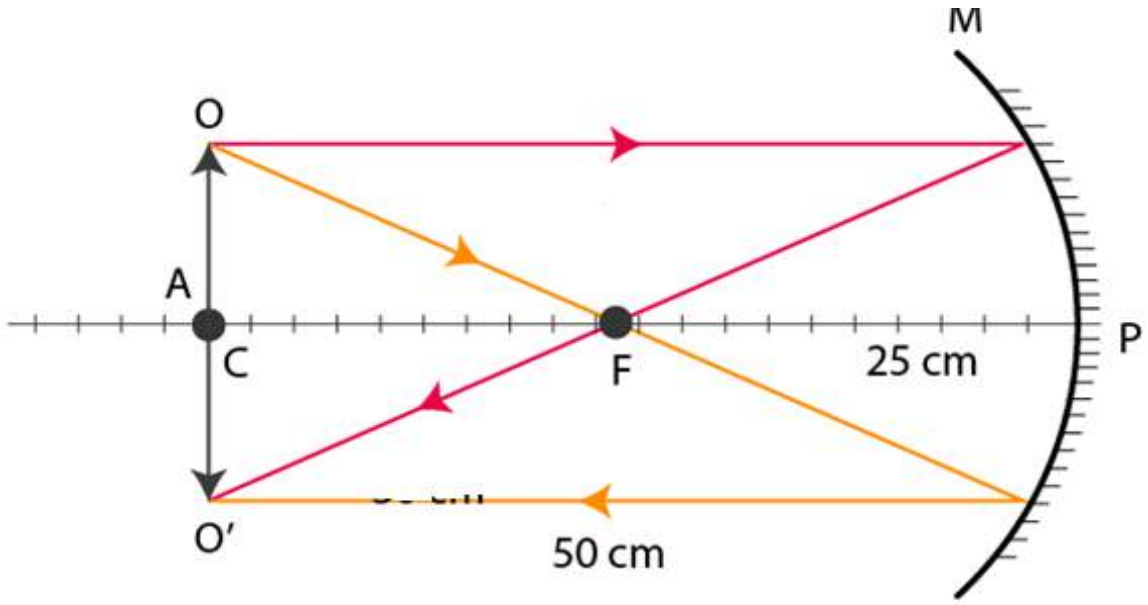
- Real
- Inverted
- Magnified

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




The image is formed 6cm behind the mirror.
Yes, the image is magnified.

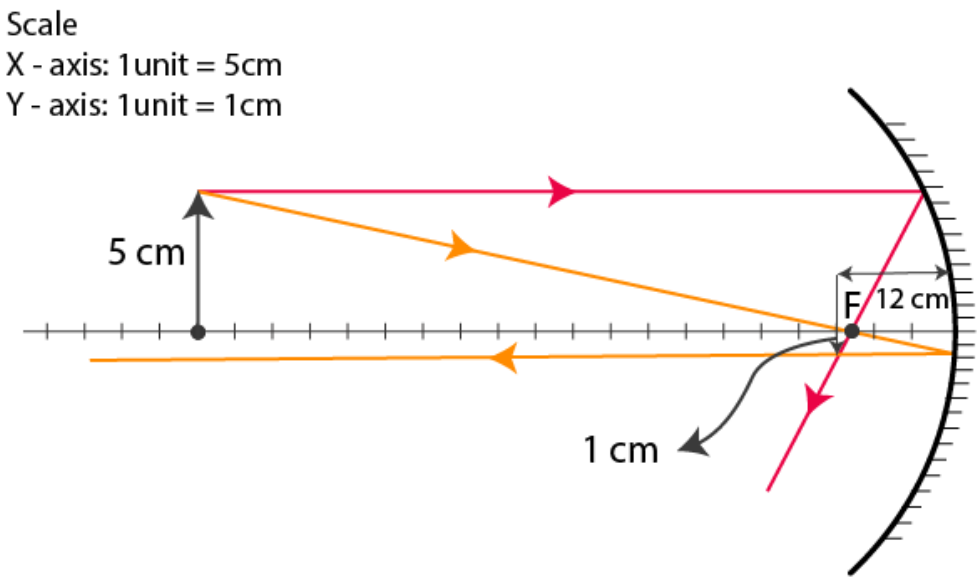
5. **At what distance from a concave mirror of focal length 25cm should an object be placed so that the size of image is equal to the size of the object. Draw a ray diagram to show this.**
Solution:
If the object is placed at the center of the curvature of a concave mirror, the size of the image is equal to the size of the object.




Therefore, the object should be kept at 50cm.

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

Solution:

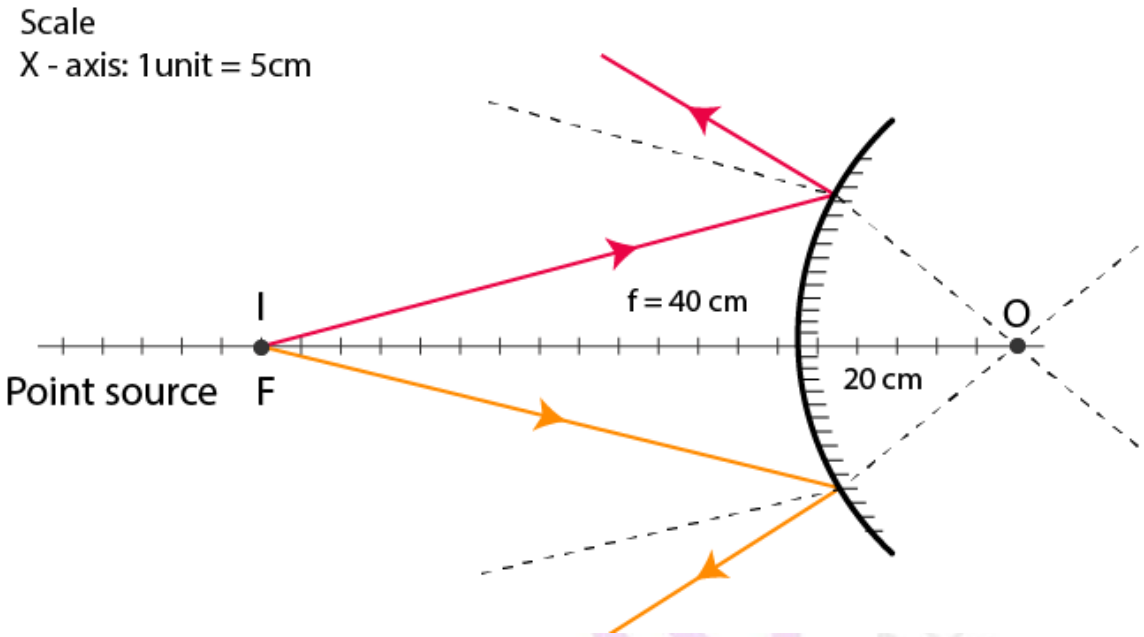



(i) The position of the object is 12cm in front of the mirror
(ii) The size of the image is 1cm

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

Solution:

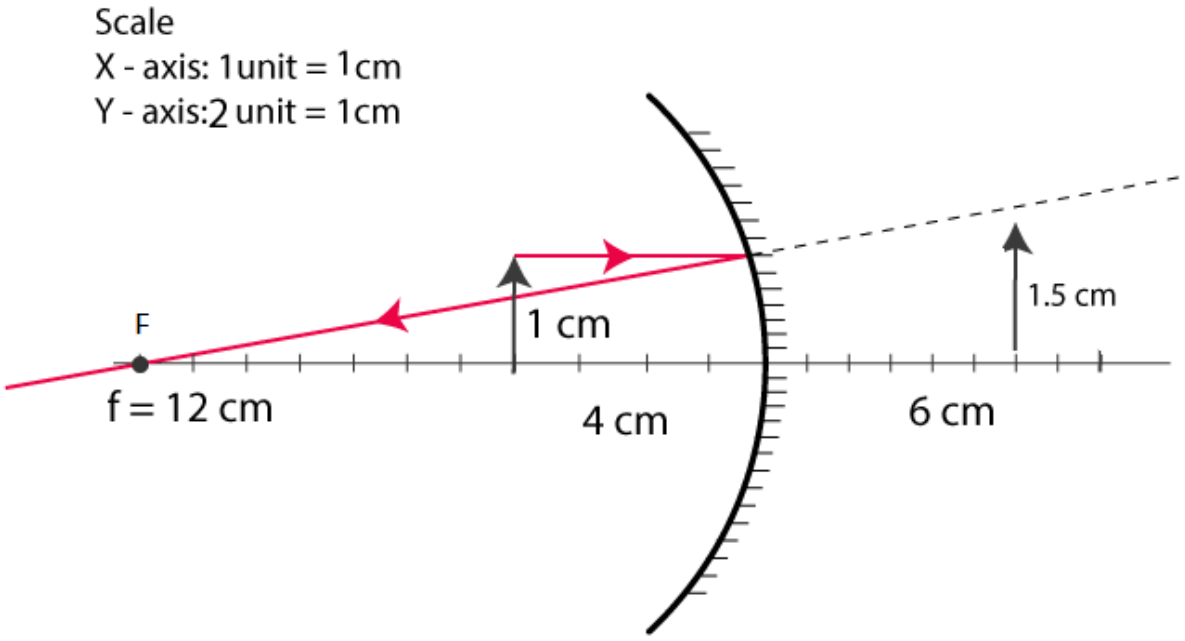
The image is positioned behind the mirror at a distance of 20cm.




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

Solution:

After reflection, a ray that passes parallel to the principal axis through the focal point. Therefore, the focal length is 12cm.




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

Solution:
Given:
Distance of the object (u) = 30cm (negative)
Focal length = 15cm (negative)
(a)
We know that mirror formula,

$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$$
$$\Rightarrow \frac{1}{v}=\frac{1}{f}-\frac{1}{u}$$
$$\Rightarrow \frac{1}{v}=\frac{1}{-15}-\frac{1}{-30}$$
$$\Rightarrow \frac{1}{v}=\frac{1}{30}-\frac{1}{15}$$
$$\Rightarrow \frac{1}{v}=-\frac{1}{30}$$
$$\Rightarrow v = -30cm$$

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

(a) To find the length of the image

We know that,

$$m=\frac{I}{O}=-\frac{v}{u}$$
$$I=-\frac{OV}{u}=\frac{-4\ x-30}{-30}=-4cm$$

Negative sign represents that the image is inverted.

$$\therefore I = 4cm$$

Length of the image is 4cm

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

Solution:
Given:
(a)Distance of the object (u) = 30cm (negative)
We know that,

$$m=\frac{I}{O}=\frac{30}{O}=3$$

For a real object, the value of 'm' is negative
m = -3

As, $m=-\frac{v}{u}$

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

=> v = 3u
=> v = 3 x 30 = 90 cm

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

Mirror formula can be given by:

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

⇨ $\frac{1}{f}=\frac{1}{30}+\frac{1}{90}=-\frac{4}{90}$

⇨ f = -22.5cm

The focal length of the mirror is 22.5cm

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

Solution:

Given:

Distance of the object (u) = 5 (negative), m = 2, focal length = ?

We know that,

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

⇨ $2=-\frac{v}{u}$

⇨ v = -10

The image is formed 10cm behind the mirror.

To find the focal length;

We know that,

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

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

=> f = -10cm

Therefore, the focal length of the mirror is 10cm

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

Solution:

We know that, magnification ‘m’ can be given by:

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

As the images formed by a convex images are always upright and virtual,

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

⇨ $\frac{1}{3}=-\frac{v}{u}$

⇨ $v=-\frac{1}{3}u$

⇨ Since $'u'$is always negative, u = 3v

This is the relation between u and v.

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

Solution:

Magnification can be given by:

$m = \frac{I}{O} = \frac{20}{O} = 2$

We know that:

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

Therefore, $-\frac{v}{u} = 2$

$v = -2u$

Since 'u' is always negative

$v = 2u$

The above equation shows how u and v are related.

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

Solution:

We know that,

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

Given: $m = -3$

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

$v = 3u$

Since 'u' is always negative

$v = -3u$

The above equation shows how u and v are related.