19. The shiny outer surface of a hollow sphere of aluminium of radius 50 cm is to be used as a mirror:

(a) What will be the focal length of this mirror?

(b) Which type of spherical mirror will it provide?

(c) State whether this spherical mirror will diverge or converge light rays.

Ans:

a) Given that,
Radius of curvature R= 50cm
We know that, R = 2f
Hence, focal length f = R/2 = 50/2 = 25cm
Thus, the focal length of this mirror is 25cm.

b) The convex mirror type of spherical mirror will it provide.

c) The spherical mirror which is a convex mirror is the diverging mirror as it diverges all the ray incident.

20. What is the advantage of using a convex mirror as a rear-view mirror in vehicles as compared to a plane mirror? Illustrate your answer with the help of labelled diagrams.

Ans:

- A convex mirror always produces an erect image of the object
- The image which is formed in the convex mirror is highly diminished due to which it helps in seeing a wide field of view.
- The convex mirror allows the driver to see the large area of traffic behind him which is not possible with the plane mirror.
- Also, plane mirror gives a narrow field of view. And if the plane mirror is used as rear-view mirror in vehicles, then it may give the smaller view of the road and traffic behind the him. Hence, to see the traffic or vehicles coming from behind in order to get safe driving drivers prefers to use a convex mirror as a real-view mirror in a vehicle.
- The following figure shows the field of view produced by concave and convex mirror.

a) (Convex mirror gives a wide-field of view)

b) (A plane mirror gives a narrow field of view)
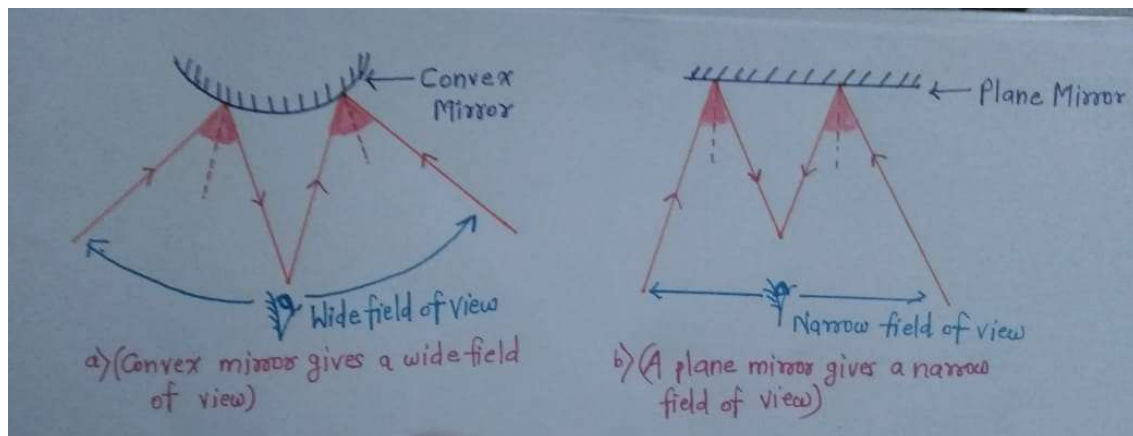
21. Give two uses of a convex mirror. Explain why you would choose convex mirror for these uses.

Following are the uses of convex mirror:

1) Convex mirror is used as rear-view mirror in vehicles to see traffic at rear side.

- A convex mirror always produces an erect image of the object
- The image which is formed in the convex mirror is highly diminished due to which it helps in seeing a wide field of view.
- The convex mirror allows the driver to see the large area of traffic behind him which is not possible with the plane mirror.
- Also, plane mirror gives a narrow field of view. And if the plane mirror is used as rear-view mirror in

vehicles, then it may give the smaller view of the road and traffic behind the him. Hence, to see the traffic or vehicles coming from behind in order to get safe driving drivers prefers to use a convex mirror as a real-view mirror in a vehicle.

2) Big convex mirror is used as shop security mirror.
Big convex mirror is installed at a strategic point in the shop, so that the shop owner can keep his attention on the customers in order to look thieves and also shoplifter among them.

22. What would your image look like if you stood close to a large:
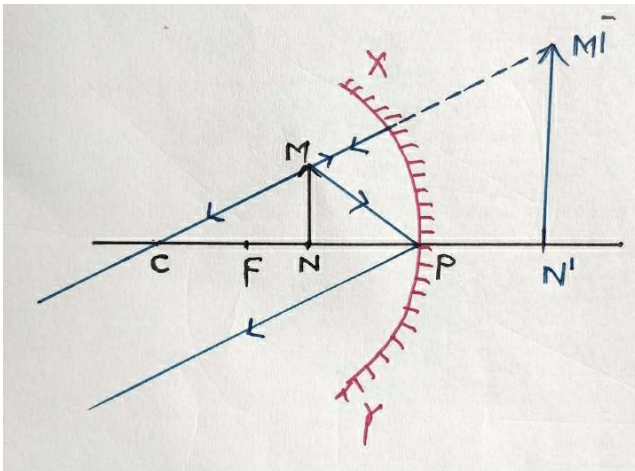
(a) convex mirror?

(b) concave mirror? Give reasons for your answer.

Ans:

a) When we stood close to a large convex mirror our image formed will be virtual, erect and diminished. Because in case of convex mirror when the object is in between pole P and infinity then the image formed will be always virtual, erect and diminished as shown in figure below.
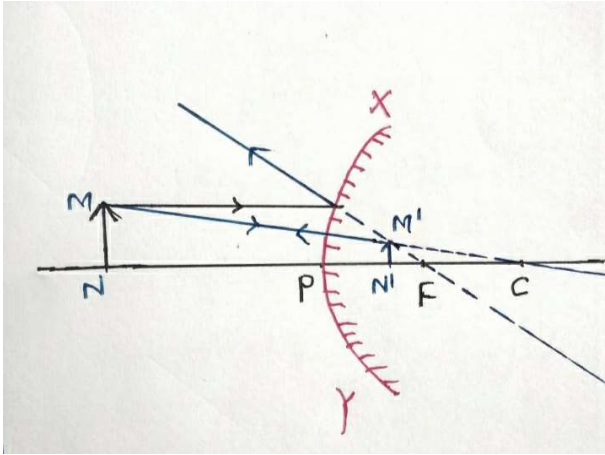
b) When we stood close to a large concave mirror, then the image formed will be virtual, erect and enlarged because in case of concave mirror when the object is between pole P and focus F of the concave mirror then the image formed will be always virtual, erect and magnified as shown in figure below.

23. Which of the following are concave mirrors and which convex mirrors? Shaving mirrors, Car headlight mirror, Searchlight mirror, Driving mirror, Dentist's inspection mirror, Torch mirror, Staircase mirror in a double-decker bus, Make-up mirror, Solar furnace mirror, Satellite TV dish, Shop security mirror.

Ans:

Concave mirrors:

Shaving mirrors, car headlight mirrors, searchlight mirrors, dentist inspection mirror, torch mirror, make up mirror, solar furnace mirror, satellite TV dish.

Convex mirrors:

Driving mirrors, staircase in a double decker bus, shop security mirror.

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

Ans:

- If the mirror we have chosen shows the upright image whose size is same as that of the object and after moving the mirror away and towards the object then also the size of the image is not changing that means the mirror chosen is the plane mirror only.

- If the mirror chosen shows upright and magnified image of the object and also on moving the mirror away from the object it shows more magnified image again that means the mirror chosen is the concave mirror only.

- If the mirror chosen shows the image of the object which is upright and smaller image of the object and also on moving the mirror away from the object gives the smaller and smaller image then it is the convex mirror only.

25. If a driver has one convex and one plane rear-view mirror, how would the images in each mirror appear different?

Ans:

- The convex mirror has large field of view due to which the image formed will be very small as compared to the object. Also, the image distance and object distance both are different.

- The plane mirror has small field of view and the size of the image is same as that of the object size. Also, the image distance and object distance are the same for the plane mirror.

Long Answer Type Questions

26. (a) Draw a labelled ray diagram to show the formation of image of an object by a convex mirror. Mark clearly the pole, focus and centre of curvature on the diagram.

(b) What happens to the image when the object is moved away from the mirror gradually?

(c) State three characteristics of the image formed by a convex mirror.

Ans:

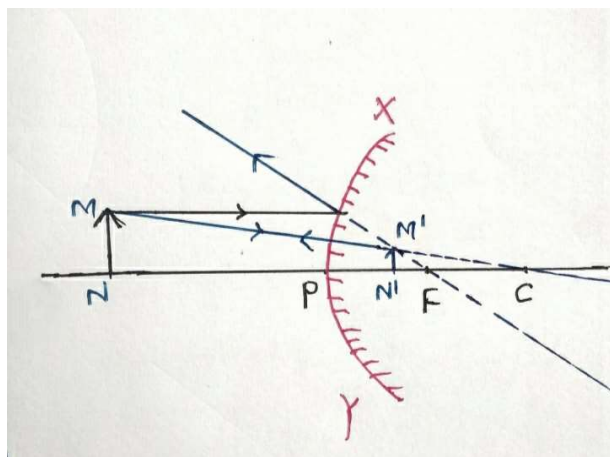a) The following figure shows the formation of image of an object by a convex mirror.
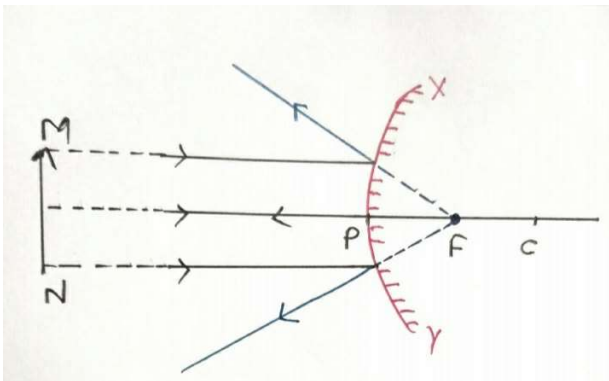
When the object is placed at infinity from the convex mirror then the image will be formed behind the mirror at the focus F.

The image formed will be virtual, erect and highly diminished as shown in figure above.

When the object is placed between pole P and infinity of a convex mirror then the image will be formed behind the mirror between pole P and focus F.

The image formed will be virtual, erect and diminished as shown in figure below.

b) When the object is moved away from the mirror gradually then the image size goes on decreasing and hence it becomes smaller and smaller.

c) The image formed by the convex mirror is always diminished, virtual and erect.

27. (a) Draw a labelled ray diagram to show the formation of image in a convex mirror when the object is at infinity. Mark clearly the pole and focus of the mirror in the diagram.

(b) State three characteristics of the image formed in this case.

(c) Draw diagram to show how a convex mirror can be used to give a large field of view.
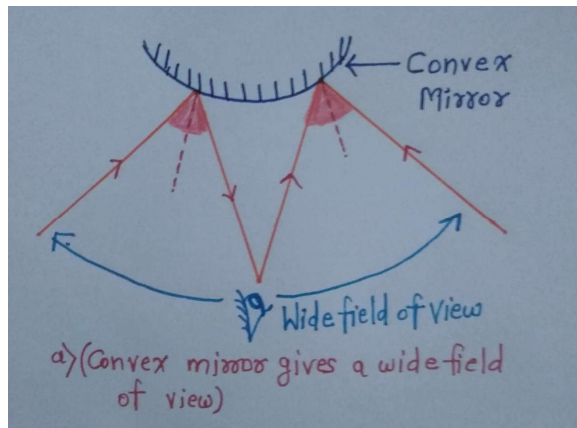
Ans:

a) The following figure shows the formation of image in a convex mirror when the object is at infinity.
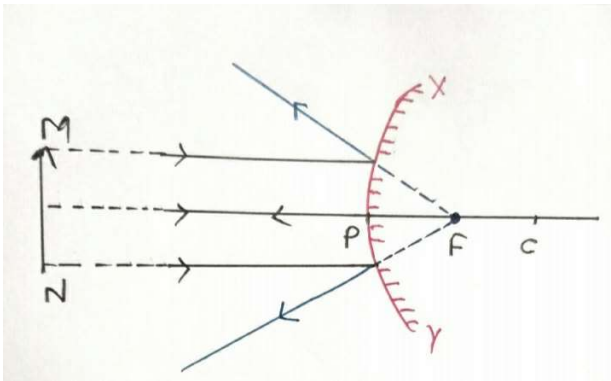
b) The image formed in this case is behind the mirror at the focus F and it is virtual, erect and highly diminished.

c) The following diagram shows how a convex mirror can be used to give a large field of view.

a) (Convex mirror gives a wide-field of view)

Numerical Problems Based on Convex Mirrors:

Short Answer Type Questions

1. An object is kept at a distance of 5 cm in front of a convex mirror of focal length 10 cm. Calculate the position and magnification of the image and state its nature.

Ans:

Given that,

Object distance u = -5cm

Focal length f = 10cm

We know that,

1/f = 1/u + 1/v

$1/v = 1/f - 1/u = 1/10 + 1/5 = 3/10$

Thus, $v = 10/3 = 3.33cm$

Thus, the image is formed behind the convex mirror at a distance of 3.33cm.

Also, magnification m = -v/u = -3.33/-5= 10/(5*3)= 2/3 = 0.66

Hence the image formed is virtual and erect.

2. An object is placed at a distance of 10 cm from a convex mirror of focal length 5 cm.

(i) Draw a ray-diagram showing the formation of image.

(ii) State two characteristics of the image formed. (iii) Calculate the distance of the image from mirror.

Ans:

a) The following diagram shows an object is placed at a distance of 10cm from a convex mirror of focal length 5cm. That means the object is at centre of curvature of the convex mirror.
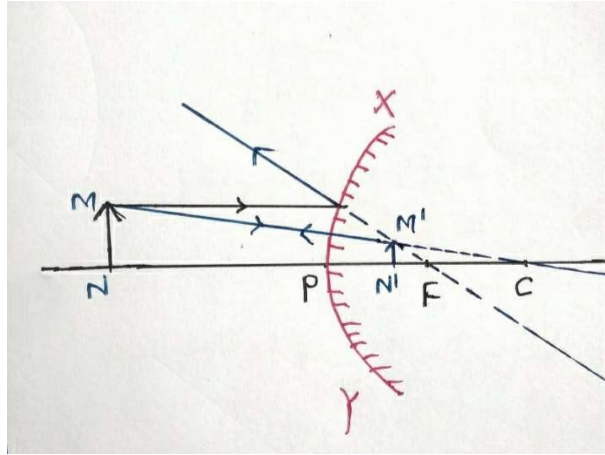
b) The image formed is the virtual, erect and diminished also.

c) Given that,
   Object distance u = - 10cm
   Focal length f = 5cm
   We know that,
   $1/f = 1/u + 1/v$
   $1/v = 1/f - 1/u$
   $1/v = 1/5 + 1/10 = 3/10$
   Thus, v = 10/3 = 3.33cm
   Thus, the image is formed at a distance of 3.33cm behind the convex mirror.

3. An object is placed at a distance of 6 cm from a convex mirror of focal length 12 cm. Find the position and nature of the image.

Ans:

Given that,

Object distance u= -6cm

Focal length f= 12cm

We know that,

1/f = 1/v + 1/u

1/v = 1/f – 1/u

1/v = 1/12+ 1/6= 3/12= ¼

Thus, v = 4cm

Thus, the image formed is behind the mirror at a distance of 4cm.

Magnification m = -v/u = 4/6= 2/3= 0.66

Thus, the image formed is virtual and erect.

4. An object placed 20 cm in front of a mirror is found to have an image 15 cm (a) in front of it, (b) behind the mirror. Find the focal length of the mirror and the kind of mirror in each case.

Ans:

a)

Given that,

Object distance u= -20cm

Image distance v= -15cm

We know that,

$1/f = 1/u + 1/v = -1/20 - 1/15$

$5/f = -1/4 - 1/3 = -7/12$

Thus, $f/5 = -12/7$

And F = -60/7 cm

As the focal length is negative and hence the mirror is the concave mirror whose focal length is 60/7cm.

b)

Given that,

Object distance u= -20cm

Image distance v = 15cm

We know that,

$1/f = 1/u + 1/v$

$1/f = -1/20 + 1/15$

$5/f = -1/4 + 1/3 = 1/12$

Thus, $f/5 = 12$

And F = 60cm

As the focal length is positive and hence the mirror is the convex mirror of focal length 60cm.

5. An arrow 2.5 cm high is placed at a distance of 25 cm from a diverging mirror of focal length 20 cm. Find the nature, position and size of the image formed.

Ans:

Given that,

Object height h1= 2.5cm

Object distance u= -25cm

Focal length f= 20cm

We know that,

1/f = 1/u + 1/v

1/v = 1/f – 1/u

1/v = 1/20 + 1/25

5/v = ¼ + 1/5

5/v = 9/20

Thus, v/5 = 20/9

And V = 100/9 = 11.1cm

Thus, the image will be formed at a distance o 11.1cm behind the convex mirror.

Now, magnification m = -v/u = 100/(9*25)= 4/9

Also, m= h2/h1 = 4/9

Thus, h2 = 4/9*2.5= 1.1cm

Thus, the image formed is virtual, erect and having height 1.1cm

6. A convex mirror used as a rear-view mirror in a car has a radius of curvature of 3 m. If a bus is located at a distance of 5 m from this mirror, find the position of image. What is the nature of the image?

Ans:

Given that,

R= 3m

Object distance u= -5m

We know that, R= 2f

Hence, f = R/2 = 3/2= 1.5m

We know that,

1/f = 1/u + 1/v

1/v = 1/f – 1/u = 2/3 + 1/5 = 13/15

Thus, v = 15/13= 1.15m

Thus, the image of the bus is formed at a distance of 1.15m behind the mirror.

Magnification m = -v/u = 15/ (13*5) = 3/13= 0.223

Thus, the image formed is virtual, erect and diminished.

7. A diverging mirror of radius of curvature 40 cm forms an image which is half the height of the object. Find the object and image positions.

Ans:

Given that,

R= 40cm hence, f =20cm

Magnification m = ½

We know that, m= -v/u = ½

Thus, v = -u/2

We have,

1/f = 1/u + 1/v

1/f = 1/u – 2/u

1/f = -1/u

Thus, u = -f = -20cm

Thus, u = -20cm

And V = -u/2 = 20/2 = 10cm

Thus, the image will be formed at a distance of 10cm behind the mirror.

8. The radius of curvature of a convex mirror used as a rear-view mirror in a moving car is 2.0 m. A truck is coming from behind it at a distance of 3.5 m. Calculate (a) position, and (b) size, of the image relative to the size of the truck. What will be the nature of the image?

Ans:

Given that,

R= 2m

Object distance u= -3.5m

And F = 1m

We know that,

1/f = 1/u + 1/v

1/f = -1/3.5 +1/v

1/v = 1 +1/3.5

1/v = 4.5/3.5= 9/7

Thus, v = 7/9= 0.77m

Thus, the image of truck is formed at a distance of 0.77m behind the mirror.

Also, magnification m = -v/u = 7/ (9*3.5) = 1/ (4.5)

As the magnification is positive, the image formed is virtual and erect.

Long Answer Type Question

9. (a) Draw a diagram to represent a convex mirror. On this diagram mark principal axis, principal focus F and the centre of curvature C if the focal length of convex mirror is 3 cm.

(b) An object 1 cm tall is placed 30 cm in front of a convex mirror of focal length 20 cm. Find the size and position of the image formed by the convex mirror.

Ans:

a) The following diagram shows the convex mirror having focal length 3cm.
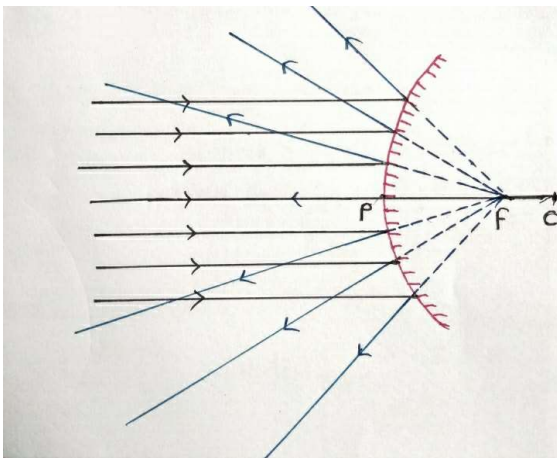
b) Given that,
   Object height h1= 1cm
   Object distance u= -30cm

Focal length f= 20cm

We know that,

$1/f = 1/v + 1/u$

$1/v = 1/f - 1/u$

$1/v = 1/20 + 1/30 = 50/600 = 5/60 = 1/12$

Thus, v = 12cm

Thus, the image formed will be at a distance of 12cm behind the mirror.

Also, magnification $m = -v/u = h_2/h_1$

Thus, $12/30 = h_2/1$

Thus, $h_2 = 4/10 = 2/5 = 0.4$cm

Thus, the height of the image will be 0.4cm