RAY OPTICS_WORK SHEET_1_3

Solved examples

1. A candle 5 cm in size is places at 30 cm in front of a concave mirror of radius of curvature 40 cm. At what distance from the mirror should a screen be placed in order to obtain a sharp image? Describe the nature and size of the image. If the candle is moved towards the mirror, how would the screen have to be moved?

Solution:

Size of the candle= h=5cm; Object distance=u=-30 cm

Image size=h'

Radius of curvature of the concave mirror =R=-40 cm

Focal length of the concave mirror, f= R/2= -20 cm

Image distance =v

From the mirror formula, $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}\Rightarrow\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$

$$\Rightarrow \frac{1}{v}\therefore v=8.57cm$$

$\Rightarrow$ v= - 60 cm

The screen must be placed 60 cm away from the mirror to obtain sharp image.

Magnification of the image is $m=\frac{h'}{h}=-\frac{v}{u}$

$$\therefore h'=-\frac{v}{u}\times h=-\left(\frac{-60}{-30}\right)\times 5=-10cm$$

The height of the image of candle is 10 cm.The negative sign indicates that the image is inverted and real.

If the candle is moved closer to the mirror, then the screen will have to be moved away from the mirror in order to obtain the image.

2. An object of height 5 cm is placed 15 cm away from a convex mirror of focal length 20 cm. Find out the location of the image and magnification produced. What happens to the image if the object is moved farther from the mirror?

Solution:

Height of the object, h = 5 cm; Object distance = u = -15 cm

Focal length of the convex mirror = f= 20 cm
Image distance = v

Using mirror formula $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}\Rightarrow\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$

$$\Rightarrow\frac{1}{20}-\frac{1}{-15}=\frac{1}{20}+\frac{1}{15}=\frac{35}{300}=\frac{7}{60}$$

$$\therefore v=8.57cm$$

Image of the object is formed on the other side of the mirror.

Magnification of the image is given by, $m=\frac{h'}{h}=-\frac{v}{u}$

$$\therefore h'=-\frac{v}{u}\times h=-\left(\frac{8.57}{-15}\right)\times 5=+2.86cm$$

The positive sign indicates that the image is erect, virtual and the image is diminished

If the object is moved farther from the mirror, the image will also move away from the mirror and the size of the image reduces gradually.

Solve the following questions

1. Explain why a ray of light passing through the center of curvature of a concave mirror, get s reflected along the same path

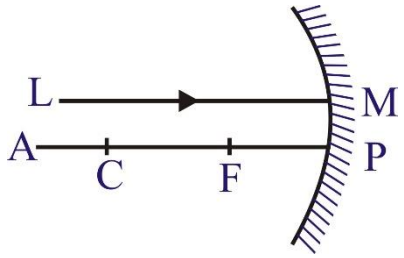
2. What is the nature of the image formed by a concave mirror if the magnification produced by the mirror is + 3?

3. Between which two points of a concave mirror should an object be placed to obtain a magnification of – 3?

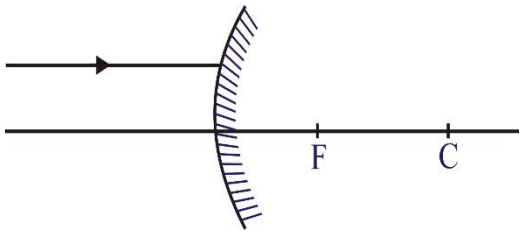
4. The outer surface of a hollow sphere of aluminum of radius 50 cm is to be used as a mirror. What will be the focal length of this mirror? Which type of spherical mirror will it provide?

5. Between which two points related to a concave mirror should an object be placed to obtain on a screen an image twice the size of the object?

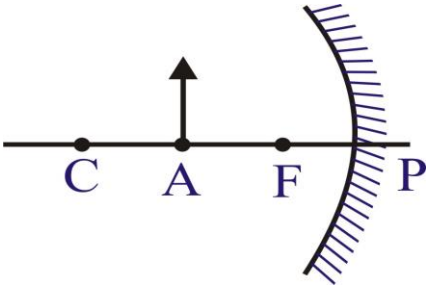
6. A ray of light LM is incident on a mirror as shown in the figure. The angle of incidence for this ray is the angle between it and the line joining two other points in the figure. Name these two points.



7. Redraw the diagram given below in your answer book and show the direction of the light ray after reflection from the mirror



8. Draw the following diagram in your answer book and show the formation of image of the object AB with the help of suitable rays



9. Which kind of mirrors are used in the headlights of a motor- car and why?

10."A concave mirror of focal length ‘f’ can form a magnified, erect as well as an inverted image of an object placed in front of it." Justify this statement stating the position of the object with respect to the mirror in each case for obtaining these images.

11. List four properties of the image formed by a concave mirror, when object is placed between focus and pole of the mirror.

12. Define the focus of a concave mirror. If the radius of curvature of a convex mirror is 30 cm, what would be its focal length?

13. What is the minimum number of rays required for locating the image formed by a concave mirror for an object? Draw a ray diagram to show the formation of a virtual image by a concave mirror.

14. Draw a ray diagram to show the (i) position and (ii) nature of the image formed when an object is placed between focus F and pole P of a concave mirror.

15. An object is placed at a distance of 12 cm in front of a concave mirror. It forms a real image four times larger than the object. Calculate the distance of the image from the mirror.

16. An object 2 cm in size is placed 30 cm in front of a concave mirror of focal length 15 cm. At what distance from the mirror should a screen be placed in order to obtain a sharp image? What will be the nature and the size of the image fanned? Draw a ray diagram to show the formation of the image in this case.

17. (a) To construct a ray diagram, we use two light rays which are so chosen that it is easy to know their directions after reflection from the mirror. List these two rays and state the path of these rays after reflection. Use these rays to locate the image of an object placed between center of curvature and focus of a concave mirror.

(b) Draw a ray diagram to show the formation of image of an object placed between the pole and principal focus of a concave mirror. How will the nature and size of the image formed change, if the mirror is replaced by converging lens of same focal length?

18. List the sign conventions for reflection of light by spherical mirrors. Draw a diagram and apply these conventions in the determination of focal length of a spherical mirror which forms a three times magnified real image of an object placed 16 cm in front of it.

19. List the new Cartesian sign convention for reflection of light by spherical mirrors. Draw a diagram and apply these conventions for calculating the focal length and nature of a spherical mirror which forms a 1/3 times magnified virtual image of an object placed 18 cm in front of it.

20.Draw the ray diagram in each case to show the position and nature of the image formed when the object is placed : (i) At the center of curvature of a concave minor
(ii) Between the pole P and focus F of a concave mirror
(iii) In front of a convex mirror

Acknowledgement

The questions in this work sheet have been taken from NCERT text book and based on previous years CBSE Board Exam question papers