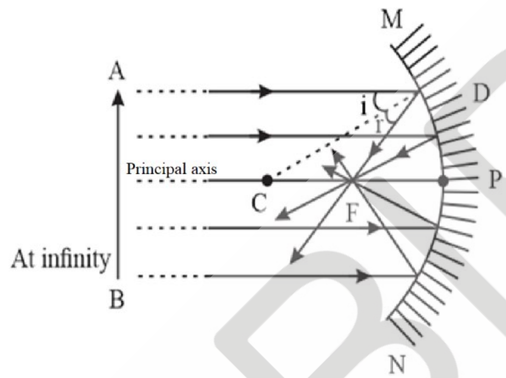
NCERT CBSE Solutions for Class 10 Science Chapter 10

Light: Reflection and Refraction

In Chapter Questions: (Page:168)

1. Define the principal focus of a concave mirror.

Solution:



The principal focus of a concave mirror is a point (F) on its principal axis to which all the light rays which are parallel and close to the axis, converge after reflection from the concave mirror.

2. The radius of curvature of a spherical mirror is 20 cm. What is its focal length?

Solution:

Given: radius of curvature (R) = 20 cm

The focal length of the mirror is $f = \frac{R}{2} = 10$ cm

3. Name a mirror that can give an erect and enlarged image of an object.

Solution:

The concave mirror can give erect and enlarged image when the object is placed between pole and focus.

4. Why do we prefer a convex mirror as a rear-view mirror in vehicles?

Solution:

Convex mirrors give an erect, virtual, full size diminished image of distant objects. Also, they have a wider field of view as they are curved outwards. Thus, convex mirrors enable the driver to view a much larger area than would be possible with a plane mirror.

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In Chapter Questions: (Page:171)

1. Find the focal length of a convex mirror whose radius of curvature is 32 cm.

Solution:

Given: radius of curvature (R) = 32 cm

The focal length of the convex mirror is $f = \frac{R}{2} = \frac{32}{2} = 16$ cm

2. A concave mirror produces three times magnified (enlarged) real image of an object placed at 10 cm in front of it. Where is the image located?

Solution:

Given: magnification (m) = -3

Object distance (u) = -10 cm

We know the magnification $m = -\frac{v}{u} = -3$

$\Rightarrow v = 3u = -30$ cm

This means the image is located at a distance of 30 cm in front of the mirror.

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In Chapter Questions: (Page:176)

1. A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal? Why?

Solution:

A ray of light travelling in air enters obliquely into water it bends towards the normal. Because when light ray enters from a rarer medium (air) to a denser medium (water) it bends towards the normal.

2. Light enters from air to glass having refractive index 1.50. What is the speed of light in the glass? The speed of light in a vacuum is 3×10^8 m s^{-1}.

Solution:

Given: Refractive index $n = 1.50$

Refractive index $n = \frac{\text{speed of light in vacuum}}{\text{speed of light in a medium}}$

$$\Rightarrow 1.50 = \frac{3 \times 10^8}{\text{speed of light in the glass}}$$

$$\Rightarrow \text{speed of light in glass} = 2 \times 10^8 \text{ m s}^{-1}$$

3. Find out, from the table, the medium having the highest optical density. Also, find the medium with the lowest optical density.

Material medium	Refractive index	Material medium	Refractive index
Air	1.0003	Crown glass	1.52
Ice	1.31	Canada Balsam	1.53
Water	1.33	Rock Salt	1.54
Alcohol	1.36	Carbon disulphide	1.63
Kerosene	1.44	Dense flint glass	1.65
Fused Quartz	1.46	Ruby	1.71
Turpentine oil	1.47	Sapphire	1.77
Benzene	1.50	Diamond	2.42

Solution:

Diamond has the highest optical density with refractive index 2.42.

Air has the lowest optical density of 1.0003.

4. You are given kerosene, turpentine, and water. In which of these does the light travel fastest? Use the information given in the table.

Material medium	Refractive index	Material medium	Refractive index
Air	1.0003	Crown glass	1.52
Ice	1.31	Canada Balsam	1.53
Water	1.33	Rock Salt	1.54
Alcohol	1.36	Carbon disulphide	1.63
Kerosene	1.44	Dense flint glass	1.65
Fused Quartz	1.46	Ruby	1.71
Turpentine oil	1.47	Sapphire	1.77
Benzene	1.50	Diamond	2.42

Solution:

In kerosene, turpentine and water the refractive index of water is lowest at 1.33. Hence, the light will travel fastest in the water when compared between these 3.

5. The refractive index of diamond is 2.42. What is the meaning of this statement?

Solution:

The refractive index 2.42 of the diamond means that the speed of light in the diamond will be 2.42 times smaller than the speed of light in vacuum.

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In Chapter Questions: (Page:202)

1. Define 1 diopter of power of a lens.

Solution:

One diopter is the power of a lens whose focal length is 1 meter.

2. A convex lens forms a real and inverted image of a needle at a distance of 50 cm from it. Where is the needle placed in front of the convex lens if the image is equal to the size of the object? Also, find the power of the lens.

Solution:

When the object is placed at a distance $2f$ in front of the convex lens, the image formed is at $2f$ on the other side of the lens, real and inverted and of the same size as the object.

$\Rightarrow 2f = 50$ cm

$\Rightarrow f = 25$ cm

$\therefore$ Power of lens, $P = \frac{1}{0.25} = 4$ D

3. Find the power of a concave lens of focal length 2 m.

Solution:

Given: focal length of lens $f = 2$ m

The power of the lens can be obtained as,

$P = \frac{1}{f} = \frac{1}{2} = 0.5$ D

NCERT Back of the Book Questions

1. Which one of the following materials cannot be used to make a lens?

(A) Water

(B) Glass

(C) Plastic

(D) Clay

Solution: (D)

Clay is opaque and does not allow visible light to pass through hence cannot be used to make the lens.

2. The image formed by a concave mirror is observed to be virtual, erect and larger than the object. Where should be the position of the object?

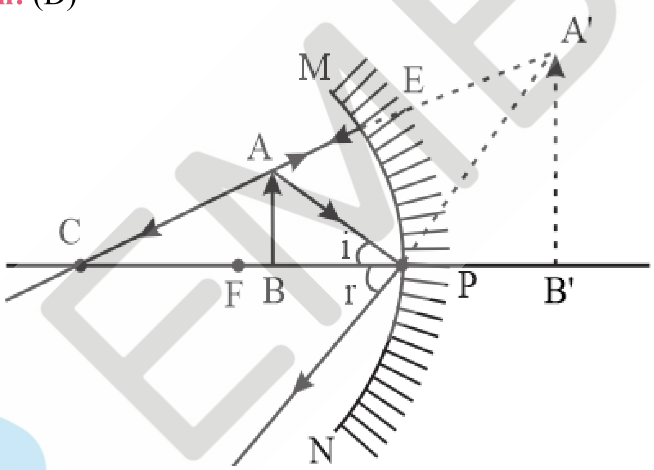
(A) Between the principal focus and the centre of curvature

(B) At the centre of curvature

(C) Beyond the centre of curvature

(D) Between the pole of the mirror and its principal focus.

Solution: (D)



When an object is placed between the pole(P) and focus(F) of a concave mirror, the image formed is

- behind the mirror
- virtual and erect and
- larger than the object (or magnified)

3. Where should an object be placed in front of a convex lens to get a real image of the size of the object?

(A) At the principal focus of the lens

(B) At twice the focal length

(C) At infinity

(D) Between the optical centre of the lens and its principal focus.

Solution: (B)

When the object is placed at a distance $2f$ in front of the convex lens, the image formed is

- at $2f$ on the other side of the lens,
- real and inverted, and
- of the same size as the object

4. A spherical mirror and a thin spherical lens have each a focal length of – 15 cm. The mirror and the lens are likely to be

(A) both concave.

(B) both convex.

(C) the mirror is concave, and the lens is convex.

(D) the mirror is convex, but the lens is concave.

Solution: (A)

For concave lens and mirror focal length is negative.

5. No matter how far you stand from a mirror, your image appears erect and smaller than you. The mirror is likely to be

(A) plane.

(B) concave.

(C) convex.

(D) either plane or convex

Solution: (C)

In the convex mirror, we have seen the image is always erect.

6. Which of the following lenses would you prefer to use while reading small letters found in a dictionary?

(A) A convex lens of focal length 50 cm.

(B) A concave lens of focal length 50 cm.

(C) A convex lens of focal length 5 cm.

(D) A concave lens of focal length 5 cm.

Solution: (C)

A convex lens gives a magnified image of an object when it is placed between the radius of curvature and focal length. Also, magnification is more for convex lenses having shorter focal length.

Therefore, for reading small letters, a convex lens of focal length 5 cm will be preferred.

7. We wish to obtain an erect image of an object, using a concave mirror of focal length 15 cm. What should be the range of distance of the object from the mirror? What is the nature of the image? Is the image larger or smaller than the object?

Solution:

We know when an object is placed between the pole(P) and focus(F) from the concave mirror, the image formed is virtual and erect. So, to obtain erect image, the object should be placed between pole and focus or between 0 cm to 15 cm. The image formed will be virtual and enlarged.

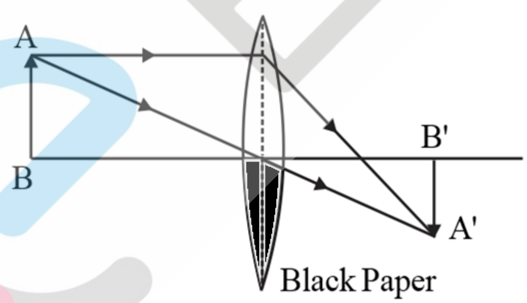
8. Name the type of mirror used in the following situations. (a) Headlights of a car. (b) Side/rear-view mirror of a vehicle. (c) Solar furnace.

Solution:

Situation	Mirror Used
(a) Headlights of a car	Concave Mirror
(b) Side/rear-view mirror of a vehicle	Convex Mirror
(c) Solar furnace.	Concave Mirror

9. One-half of a convex lens is covered with a black paper. Will this lens produce a complete image of the object?

Solution:



Yes, it will produce a complete image of the object, as shown in the figure above. This can be verified experimentally by observing the image of a distant object like the tree on a screen when half of the is covered with a black paper. However, the intensity of the brightness of the image will reduce.

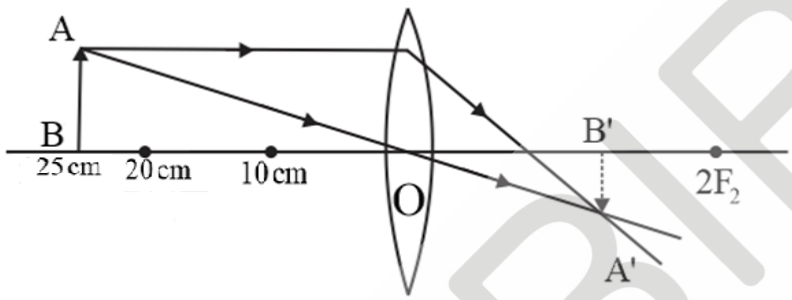
10. An object 5 cm in length is held 25 cm away from a converging lens of focal length 10 cm. Draw the ray diagram and find the position, size and the nature of the image formed.

Solution:

Given: focal length $f = +10$ cm

Object distance $u = -25$ cm

Height of object $h = 5$ cm



Using lens formula,

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

$$\Rightarrow \frac{1}{10} = \frac{1}{v} - \left(\frac{1}{-25}\right)$$

$$\Rightarrow \frac{1}{v} = \frac{1}{10} - \frac{1}{25}$$

$$\Rightarrow \frac{1}{v} = \frac{3}{50} \text{ cm} \Rightarrow v = \frac{50}{3} = 16.7 \text{ m}$$

The image is real at a distance of 16.7 cm behind the lens.

The magnification of the lens is given as,

$$m = \frac{h'}{h} = \frac{v}{u}$$

$$\Rightarrow \frac{h'}{5} = \frac{50/3}{-25} \Rightarrow h' = \frac{50/3 \times 5}{-25} = -\frac{10}{3} \text{ cm}$$

Height of the image is 3.3 cm.

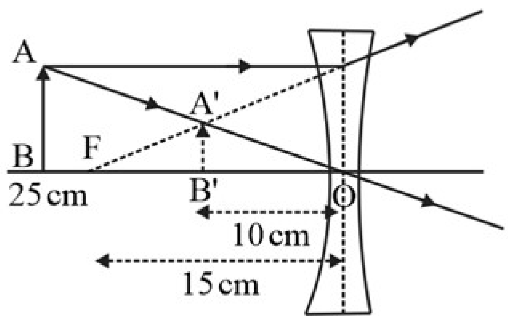
11. A concave lens of focal length 15 cm forms an image 10 cm from the lens. How far is the object placed from the lens? Draw the ray diagram.

Solution:

Given: focal length $f = -15$ cm

Object distance $u = -10$ cm

Height of object $h = 5$ cm



$u = -10$ cm, $f = -15$ cm

Using the lens formula.

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

$$\Rightarrow \frac{1}{-10\text{ cm}} - \frac{1}{u} = \frac{1}{-15\text{ cm}}$$

$$\Rightarrow \frac{1}{u} = \frac{1}{15} - \frac{1}{10} = \frac{2-3}{30} = -\frac{1}{30}$$

$$\Rightarrow u = -30\text{ cm}$$

Thus, the object is placed at a distance of 30 cm from the concave lens.

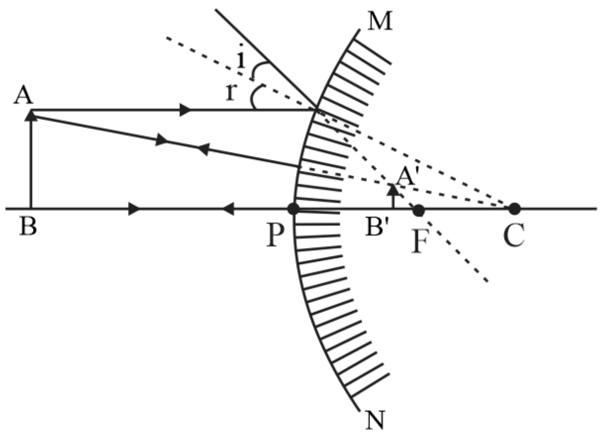
12. An object is placed at a distance of 10 cm from a convex mirror of focal length 15 cm. Find the position and nature of the image.

Solution:

Given: focal length $f = +15$ cm

Object distance $u = -10$ cm

In this case, the object is placed between pole and infinity in front of a convex mirror, the image formed is between the pole and focus, virtual, erect, and smaller than the object (or diminished).



To find the position we need to apply the mirror formula,

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

$$\Rightarrow \frac{1}{15} = \frac{1}{v} + \frac{1}{(-10)}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{15} + \frac{1}{10}$$

$$\Rightarrow v = 10 \text{ cm}$$

The image distance is positive, so the image is virtual, is on the opposite side of the mirror as the object and is 10 cm from the mirror.

13. The magnification produced by a plane mirror is $+1$. What does this mean?

Solution:

Magnification of $+1$ means the size of the image is the same as object and image are erect. Hence, the image produced by the plane mirror will be erect and of the same size as the object.

14. An object 5.0 cm in length is placed at a distance of 20 cm in front of a convex mirror of radius of curvature 30 cm. Find the position of the image, its nature, and size.

Solution:

Given: Radius of curvature $R = 30$ cm

Object distance $u = -20$ cm

Height of object $h = 5.0$ cm

$\therefore$ Focal length of a convex mirror $(f) = \frac{R}{2} = \frac{30 \text{ cm}}{2} = 15$ cm

Using mirror formula, $\frac{1}{f}=\frac{1}{v}+\frac{1}{v}$

$$\Rightarrow \frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{15}+\frac{1}{20}=\frac{4+3}{60}=\frac{7}{60}\text{ cm}$$

$$\Rightarrow v=\frac{60}{7}\text{ cm}=8.57\text{ cm}$$

The image is virtual, behind the mirror and erect.

$$m=\frac{h'}{h}=-\frac{v}{u}=\frac{h'}{5\text{ cm}}=\frac{60/7\text{ cm}}{-20\text{ cm}}$$

$$\Rightarrow h'=\frac{60/7\text{ cm}\times 5\text{ cm}}{-20\text{ cm}}=\frac{3}{7}\times\text{ cm}=\frac{15}{7}\text{ cm}$$

$\Rightarrow h'=+2.14$ cm [*It is erect and diminished*].

15. An object of size 7.0 cm is placed at 27 cm in front of a concave mirror of focal length 18 cm. At what distance from the mirror should a screen be placed so that a sharply focused image can be obtained? Find the size and nature of the image.

Solution:

Given: Focal length $f=-18$ cm

Object distance $u=-27$ cm

Height of object $h=7.0$ cm

Using the mirror formula,

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{u}\Rightarrow\frac{1}{-18}=\frac{1}{v}+\frac{1}{(-27)}$$

$$\Rightarrow\frac{1}{v}=\frac{1}{-18}+\frac{1}{27}$$

$$\Rightarrow v=-54\text{ cm}$$

The image distance is negative, so the image is real, is on the same side of the mirror as the object and is 54 cm from the mirror. To find the magnification and orientation of the image,

$$m=\frac{v}{u}=-\frac{(-54)}{-18}=-3$$

The image is real, inverted and larger by a factor of 3.

16. Find the focal length of a lens with power -2.0 diopter. What type of lens is this?

Solution:

Given: Power of lens $P=-2.0$ D

The focal length can be obtained as,

$f = -\frac{1}{2}\ \text{m} = -50\ \text{cm},$

Negative focal length means it is a diverging lens.

17. A doctor has prescribed a corrective lens of power $+1.5$ D. Find the focal length of the lens. Is the prescribed lens diverging or converging?

Solution:

Given: The power of the lens, $P = +1.5$ D

f (in meters) $= \frac{1}{P} = \frac{10}{15} = \frac{2}{3} = 66.6$ cm

As the focal length and power of the lens are positive therefore, the lens is a convex (converging) lens).

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