

NCERT Solutions for Class 10 Science

Chapter 9 – Light – Reflection and Refraction

Intext Questions with Solutions of Class 10 Science Chapter 9 – Light – Reflection and Refraction

1.

Define the principal focus of a concave mirror.

Ans: Light rays parallel to the principal axis converge at a location on the principal axis following reflection from the concave mirror.

The convergence point along the principal axis of a concave mirror is referred to as the principal focus of the concave mirror.

2.

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

Ans:

$$\text{Focal length} = \frac{1}{2} \times \text{Radius of curvature} = \frac{1}{2} \times 20 \text{ cm} = 10 \text{ cm}$$

3.

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

Ans: Concave mirror.

4.

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

Ans: In cars and other vehicles, a convex mirror is the ideal rearview mirror because it provides a larger field of view, allowing the driver to see most of the traffic behind him. Convex mirrors always create an erect, virtual, and diminished image of the item placed in front of them.

5.

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

Ans:

$$R = +32 \text{ cm and } f = \frac{R}{2} = +\frac{32}{2} = +16 \text{ cm}$$

6.

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?

Ans: The magnifying effect of a spherical mirror:

$$m = \frac{\text{Height of the image}}{\text{Height of the object}} = -\frac{\text{Image Distance}}{\text{Object Distance}}$$

$$m = \frac{h_1}{h_0} = -\frac{v}{u}$$

Let the height of the object, $h_0 = h$

Then the height of the image

$$h_1 = -3h \text{ (Image Formed is Real)}$$

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

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

$$\text{Object distance (u)} = -10 \text{ cm}$$

$$v = 3 \times (-10) = -30 \text{ cm}$$

As a result, the negative sign shows that, at a distance of 30 cm, an inverted picture forms in front of the specified concave mirror.

7.

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?

Ans: When a light ray transitions from a rarer media to a denser medium, it refracts towards the normal line.

The light ray refracts towards the normal as it transitions from a rarer media (air) to a denser medium (water).

8.

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 vacuum is $3 \times 10^8 \text{ m s}^{-1}$

Ans: Refractive index of a medium (n_m) = Speed of light in vacuum/Speed of light in the medium

Speed of light in vacuum (c) = $3 \times 10^8 \text{ m/s}$

Refractive index of glass (n_g) = 1.50

Speed of light in the glass (v) = Speed of light in vacuum/ Refractive index of glass

= c/n_g

= $3 \times 10^8 / 1.50 = 2 \times 10^8 \text{ ms}^{-1}$.

9.

Find out, from Table 9.3, the medium having highest optical density. Also find the medium with lowest optical density.

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

Ans: According to table 9.3, diamond has the largest optical density since it has the highest refractive index (= 2.42).

Air has the lowest optical density because it has the lowest refractive index (1.0003).

10.

You are given kerosene, turpentine and water. In which of these does the light travel fastest? Use the information given in Table 9.3.

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

Ans: Kerosene has $n = 1.44$.

$n = 1.47$ for turpentine

$n = 1.33$ for water

Light moves more quickly through water than through kerosene and turpentine oil because it has the lowest refractive index.

11.

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

Ans: Since a diamond has a refractive index of 2.42, light traveling through it will travel at a speed that is 2.42 slower than it would in the atmosphere.

Stated differently, light travels $1/2.42$ times faster in a diamond than it does in a vacuum.

12.

Define 1 dioptre of power of a lens.

Ans: The dioptre is the SI unit of lens power, represented by the letter D. One dioptre is defined as the optical power of a lens with a focal length of one metre.

13.

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.

Ans:

Here $v = +50\text{cm}$

Because the real image is of the same size as the object,

Therefore, $m = \frac{h'}{h} = \frac{v}{u} = -1$

Or $u = -v = -50\text{cm}$

Now, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{+50} - \frac{1}{-50} = +\frac{2}{50} = +\frac{1}{25}$

Or $f = 25\text{cm} = 0.25\text{m}$

$P = \frac{1}{f} = +\frac{1}{0.25\text{m}} = +4\text{D}$

14.

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

Ans:

The focal length of the concave lens (f) = 2 m

Power of lens (P) = $\frac{1}{f} = \frac{1}{(-2)} = -0.5\text{D}$

Exercise Questions with Solutions of Class 10 Science Chapter 9 – Light – Reflection and Refraction

1.

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

- (a) Water (b) Glass (c) Plastic (d) Clay**

Ans: (d) Clay

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.**

Ans: (d) Between the pole of the mirror and its principal focus.

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.**

Ans: (b) At twice the focal length.

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.**

Ans: (a) Both concave

5.

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

- (a) only plane.
- (b) only concave.
- (c) only convex.
- (d) either plane or convex.

Ans: (d) Either plane or convex.

6.

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

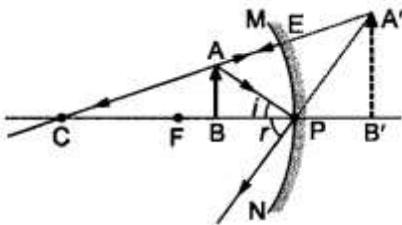
- (a) A convex lens of focal length 50 cm.
- (b) A concave lens of focal length 50 cm.
- (c) A convex lens of focal length 5 cm.
- (d) A concave lens of focal length 5 cm.

Ans: (c) A convex lens of focal length 5 cm.

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? Draw a ray diagram to show the image formation in this case.

Ans: When an object is positioned between the concave mirror's focus F and pole P, or between 0 and 15 cm from the mirror, it produces an erect picture. The resulting image will be larger than the actual thing, upright, and imaginary.



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.

Support your answer with reason.

Ans:

- a. Concave Mirror: When positioned at their principal focus, concave mirrors can generate a strong parallel beam of light.
- b. Due to its widest field of view, the Convex Mirror is the best option.
- c. Concave Mirror: Due to its ability to concentrate the sun's parallel beams at a primary point.

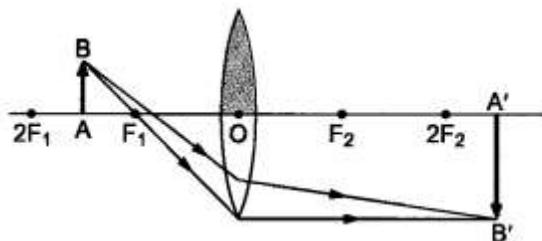
9.

One-half of a convex lens is covered with a black paper. Will this lens produce a complete image of the object? Verify your answer experimentally. Explain your observations.

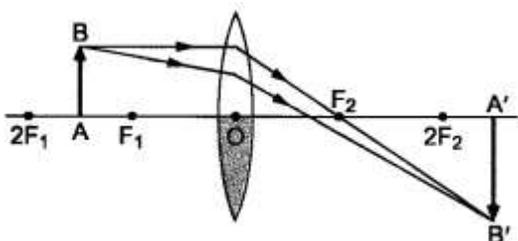
Ans: A convex lens produces a complete image of an item, even when one half is obscured by black paper. This can be elucidated by examining the following two scenarios.

Scenario I: When the superior portion of the lens is obscured

A ray of light originating from the item will be refracted by the inferior portion of the lens. The rays converge on the other side of the lens to create the image of the specified object, as illustrated in the subsequent figure.



Scenario II: When the inferior part of the lens is obscured. A ray of light originating from the item is refracted by the upper portion of the lens. The rays converge on the other side of the lens to create the image of the specified object, as illustrated in the accompanying figure.



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.

Ans:

Height of the object, $h_0 = 5$ cm

Distance of the object from converging lens,

$$u = -25 \text{ cm}$$

Focal length of a converging lens, $f = 10$ cm

Using the lens formula,

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

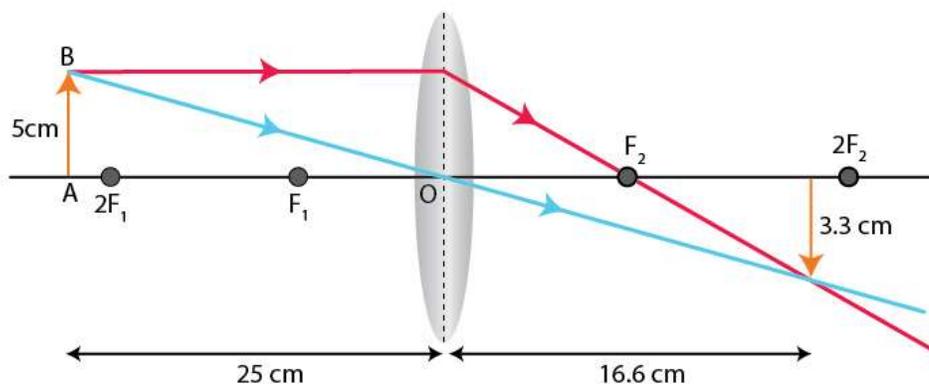
$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} - \frac{1}{25} = \frac{15}{250}$$

$$v = \frac{250}{15} = 16.66 \text{ cm}$$

Also, for a converging lens, $\frac{h_i}{h_0} = \frac{v}{u}$

$$h_i = \frac{v}{u} \times h_0 = \frac{16.66 \times 5}{-25} = -3.3 \text{ cm}$$

The image is inverted, located at a distance of 16.7 cm behind the lens, and has a measurement of 3.3 cm. The ray diagram is presented below.



11.

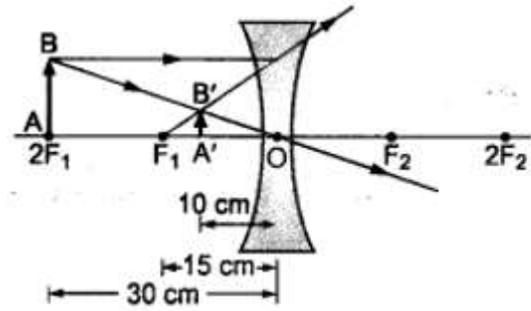
A concave lens of focal length 15 cm forms an image 10 cm from the lens. How far is the object placed from the lens? Draw the ray diagram.

Ans:

Focal length, $f = -15$ cm, Image distance, $v = -10$ cm
(as concave lens forms the image on the same side of the lens)

From the lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we have

$$\frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{-10} - \frac{1}{-15} = \frac{-1}{30}$$



Object distance, $u = -30$ cm

The negative value of u indicates that the object is placed in front of the 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.

Ans:

Focal length of convex mirror (f) = +15 cm

Object distance (u) = - 10 cm

According to the mirror formula,

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

$$\frac{1}{v} = \frac{1}{15} - \frac{1}{-10} = \frac{2 + 3}{30}$$

$$v = \frac{5}{30} = 6\text{cm}$$

$$\text{Magnification} = \frac{-v}{u} = \frac{-6}{-10} = 0.6$$

The picture on the opposite side of the mirror is situated 6 cm away from it.

The image created is virtual, erect, and decreased, as indicated by the positive and a value of less than one magnification.

13.

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

Ans:

Magnification is defined as,

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

Given that $m = +1$, it follows that $h' = h$ and $v = -u$.

- The value of $m = 1$ signifies that the size of the image is identical to that of the object.
- The positive sign of m indicates the formation of an erect image.
- The differing signs of v and u signify that the image is located on the opposite side of the mirror relative to the object's position, indicating that the image is formed behind the mirror and is therefore virtual.

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.

Ans:

Since object size, $h = +5$ cm,

object distance, $u = -20$ cm

and radius of curvature, $R = +30$ cm

Therefore, Focal Length $f = \frac{R}{2} = +\frac{30}{2} = 15$ cm

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

$$\text{Or } \frac{1}{v} = \frac{1}{+15} - \frac{1}{-20} = \frac{4+3}{60} = \frac{7}{60}, \quad v = \frac{60}{7} = 8.6\text{cm}$$

$$\therefore \text{Magnification, } m = -\frac{v}{u} = \frac{h'}{h}$$

$$\therefore \text{Image size, } h' = -\frac{vh}{u} = -\frac{8.6 \times 5}{-20} = 2.15 \cong 2.2 \text{ cm}$$

A virtual, erect image of height 2.2 cm is formed behind the mirror at a distance of 8.6 cm from the mirror.

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 sharp focussed image can be obtained? Find the size and the nature of the image.

Ans:

Here, object size, $h = +7.0$ cm,

object distance, $u = -27$ cm

and focal length, $f = -18$ cm

Image distance, $v = ?$

and image size, $h' = ?$

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

$$\frac{1}{v} = \frac{1}{-18} - \frac{1}{-27} = \frac{-3+2}{54} = -\frac{1}{54} \text{ or } v = -54\text{cm}$$

The screen should be placed at a distance of 54 cm on the object side of the mirror to obtain a sharp image.

$$\text{Now, Magnification, } m = \frac{h'}{h} = -\frac{v}{u}$$

$$\text{Or image size, } h' = -\frac{vh}{u} = \frac{(-54) \times (+7)}{(-27)} = -14\text{cm}$$

The image is real, inverted and enlarged in size.

16.

Find the focal length of a lens of power – 2.0 D. What type of lens is this?

Ans:

Here, $P = -2.0 \text{ D}$

The type of lens is concave because the focal length is negative.

$$\therefore f = \frac{1}{P} = \frac{1}{-2.0\text{D}} = -0.5\text{m}$$

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?

Ans:

Here, $P = +1.5 \text{ D}$

$$\begin{aligned}\therefore f &= \frac{1}{P} = \frac{1}{+1.5\text{D}} = +\frac{10}{15}\text{m} \\ &= +0.6667\text{m} = +66.67\text{cm}\end{aligned}$$

Because the focal length is positive, the prescribed lens is converging.