NCERT X CLASS PHYSICS
Chapter-1 - Light-Reflection and Refraction

Q.1 Which one of the following materials cannot be used to make a lens?
(A) Water (B) Glass (C) Plastic (D) Clay
Sol. (D)

Q.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.
Sol. (D)

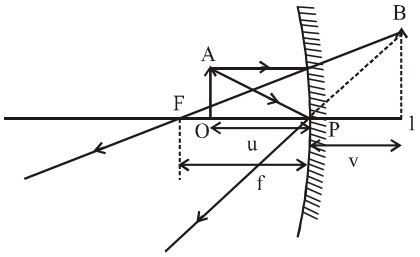
Q.3 Where should an object be placed in front of a convex lens to get a real image of the size of the object?
(A) At the principal focus of the lens
(B) At twice the focal length
(C) At infinity
(D) Between the optical centre of the lens and its principal focus.
Sol. (B)

Q.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
Sol. (A)

Q.5 No matter how far you stand from a mirror, your image appears erect. The mirror is likely to be
(A) plane (B) concave (C) convex (D) either plane or convex
Sol. (D)

Q.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.
Sol. (C)

Q.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.
Sol. f = – 15 cm.
For getting an erect image using a concave mirror the object should be placed at a distance less than the focal length (i.e.) 15cm. from pole. Image will be virtual, enlarged are erect.



Q.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.

Sol. (a) Concave mirror is used in car headlights, to get powerful beams of light. When a small but powerful light source is placed at the focus of the concave mirror, then the concave mirror produces a powerful beam of parallel light rays. This helps us to see things up to a considerable distance in the darkness of light.
(b) Convex mirror is used as side/rear-view mirror of a vehicles.
(c) Concave mirror is used in the field of the solar energy to focus sun's rays for heating solar furnaces. The solar furnace is placed at the focus of a large concave mirror.
The concave mirror focuses the sun's infra-red (heat rays) on the furnace due to which the solar furnace gets very hot.

Q.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.

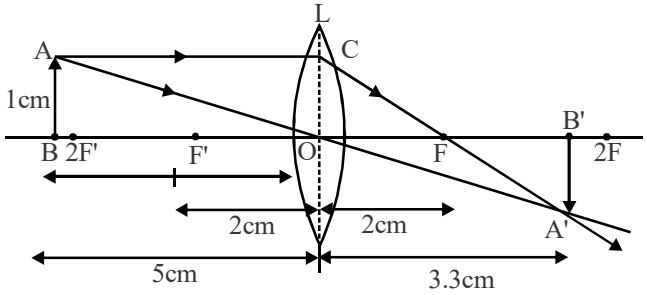
Sol. Yes, even when one half of the lens is covered with a black paper, complete image will be formed.
Take a convex lens and focus the light from a distant object on to a screen. As expected an image (sharp) is formed at a distance equal to the focal length. Cover the lower or the upper half of the lens and focus the light from the same object on to the same screen. You will be able to get a sharp image, however the brightness of the image will be less in the second case. The same effect will be seen even if the covering is with intermittent black strips.

Q.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.

Sol. For a converging (convex) lens: Here $u = -25$ cm (u is always negative)
$f = +10$cm (convex lens), $h = 5$ cm, $v = ?$ and $I = ?$

From the lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} + \frac{1}{-25} = \frac{3}{50}$

or $v = \frac{50}{3} = 16.67$cm from the lens on the other side.



Also, magnification, $m = \frac{h'}{h} = \frac{v}{u}$

or $h' = \frac{v}{u} \times h = \frac{16.67}{-25} \times 5 = -3.33$ cm

The negative sign shows that the image is inverted and hence real.
The image is smaller in size.
For drawing of ray diagram: Here, the distances given are large

so we will choose a suitable scale, i.e., 1 cm represents 5 cm.

Therefore, in the ray-diagram we will take : u = –5 cm, f = 2 cm, AB = O = 1 cm.

(i) Draw a horizontal line to represent the principal axis.

(ii) Draw a convex lens, keeping optical centre O on the principal axis.

(iii) Mark two foci F' and F on two sides of the lens each at a distance of 2 cm from the optical centre of the lens.

(iv) Draw an arrow AB of height 1 cm on the left side of the lens at a distance of 5 cm from the optical centre O of the lens.

(v) Draw a line AC parallel to the prncipal axis which after refraion through the lens will pass through the focus F on the right side of the lens.

(vi) Draw another ray AO passing through the optical centre which goes straight undeviated.

(vii) Let the two rays meet at A'.

(viii) Draw a perpendicular A'B' on the principal axis from A'.

(ix) Here A'B' represents the real and inverted image of AB.

(x) Measure OB' which gives the position of the image v

OB' = 3.3 cm

Now exact position of the image will be v = 3.3 × 5 = 16.5 cm

i.e., away from the optical centre of the lens on the opposite side.

Q.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.

Sol. Here focal length of the concave (diverging) lens is f = –15 cm (negative)

v = –10 cm (image same side in concave lens), u = ?

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

or $\frac{1}{u}=\frac{1}{v}-\frac{1}{f}=\frac{1}{(-10)}-\frac{1}{(-15)}=-\frac{1}{10}+\frac{1}{15}=\frac{-3+2}{30}=-\frac{1}{30}$ or u = –30 cm

The object is placed at a distance of 30 cm away from the lens.

For drawing a ray diagram:

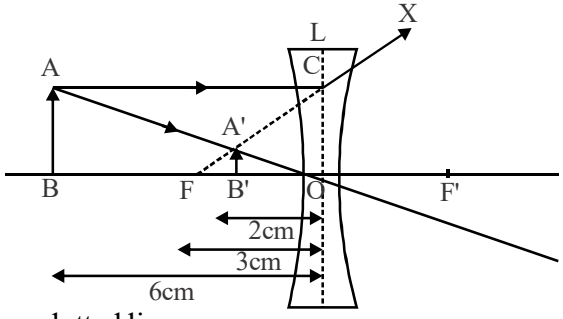
Using the given values in the proper scale i.e., representing 5 cm equal to 1 cm, we get

v = –2 cm and f = –3 cm.

(i) Draw a horizontal line to represent the principal axis.

(ii) Draw a concave lens, keeping optical centre O on the principal axis.

(iii) Mark focus F on the left side of the optical centre of the lens at distance of 3 cm and imageA'B' = v at 2cm respectively as shown in figure.



(iv) Since height of the image is not given hence take any point C nearly on the edge of the lens and join it with F by a dotted line.

(v) Draw a perpendicular on the principal axis at point B' which cut the dotted line F'C on A'. Thus A'B' is the image.

(vi) Now draw a line AC parallel to the principal axis and another line through OA' produced in the backward direction which meets the parallel line drawn from C. This cuts at point A as shown.

(vii)Draw a perpendicular from A on the principal axis AB which js the required object.

(viii) Measure BO, the position of the object from the optical centre of the concave lens. It is found to be 6cm in the diagram. Using the scale assumed it is equivalent to 30 cm = (6 cm × 5 cm).

Q.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.

Sol. Given u = – 10 cm, f = + 15 cm, v = ?

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

we have $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{15}-\frac{1}{(-10)}$ or $\frac{1}{v}=\frac{1}{15}+\frac{1}{10}=\frac{2+3}{30}=\frac{5}{30}$ or v = 30/5 = 6cm.

Hence, the image is formed at a distance of 6 cm. behind the mirror.
The image is virtual and erect.

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

Sol. The positive (+) sign of magnification (m) indicates that the image is virtual and erect. The magnification, m = 1 indicates that the image is of the same size as the object. Thus, the magnification of +1 produced by a plane mirror means – the image formed in a plane mirror is virtual, erect and of the same size as the object.

Q.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.

(14) Radius of curvature of convex mirror, R = 30 cm.

$\therefore$ Focal length of convex mirror, $f=\frac{R}{2}=\frac{30cm}{2}=15cm.$

Now h = 5 cm, u = – 20 cm, v = ? , h' = ?

Using the mirror formula $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$, we have

$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{15}-\frac{1}{-20}=\frac{1}{15}+\frac{1}{20}=\frac{4+3}{60}$; $v=\frac{60}{7}=8.6$ cm.

Thus, image is formed at a distance of 8.6 cm. behind the convex mirror. The image is virtual and erect.

$m=\frac{h'}{h}=-\frac{v}{u}$; $\frac{h'}{5}=-\frac{8.6}{-20}\Rightarrow h'=\frac{8.6}{20}\times 5=2.15$ cm.

Q.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.

Sol. h_0 = 7.0 cm., u = – 27 cm., f = – 18 cm.

Using, $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$, we get $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{-18}-\frac{1}{(-27)}=\frac{-1}{18}+\frac{1}{27}=\frac{-3+2}{54}=\frac{-1}{54}$ or v = – 54 cm.

Using $m=\frac{h_1}{h_0}=\frac{v}{u}$ we get, $h_1=h_0\frac{v}{u}=7\times\frac{-54}{-27}=14cm.$

Since $h_1 > h_0$, the image is enlarged. Since v is –ve, the image is real and inverted.

Q.16 Find the focal length of a lens of power –2.0 D. What type of lens is this ?

Sol. The power of this lens has negative (–) sign, so it is a concave lens.

Power, $P = \frac{1}{f \text{ (in m)}}$

$\therefore \quad -2.0 = \frac{1}{f} \qquad \text{or} \qquad f = \frac{1}{-2.0}\text{m} \text{ or } f = -0.50 \text{ m}$

$\therefore$ Focal length, $f = -0.50$ m

Q.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 ?

Sol. $P = +1.5$ D; $f = \frac{100}{P}\text{cm} = \frac{100}{1.5} = \frac{1000}{15} = +66.67 \text{ cm} = +0.67\text{m}$

So the focal length is +ve, it is convex lens. Hence it is a converging lens.