O P JINDAL SCHOOL, SAVITRINAGAR

ASSIGNMENT

CLASS X PHYSICS

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101 The image of a candle flame placed at a distance of 30 cm from a spherical lens is formed on a screen placed on the other side of the lens at a distance of 60 cm from the optical centre of the lens. Identify the type of lens and calculate its focal length. If the height of the flame is 3 cm, find the height of its image. 3

ANS: Given: $u = -30$ cm, $v = +60$ cm, $h_o = +3$ cm

Using lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{60} - \frac{1}{-30} = \frac{1}{60} + \frac{1}{30} = \frac{3}{60} = \frac{1}{20}$

$f = +20$ cm

The positive sign of the focal length indicates that the given lens is convex in nature whose focal length is 20 cm.

Again, $m = \frac{h_i}{h_o} = \frac{v}{u}$

or $h_i = \frac{v}{u} \times h_o = \frac{+60}{-30} \times 3 = -6$ cm

So, the height of image is 6 cm. The negative sign indicates that the image is formed below the principal axis and is real and inverted.

102 A 6 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 15 cm. The distance of the object from the lens is 10 cm. Find the position, size and nature of the image formed, using the lens formula. 3

ANS: Given: $h_o = +6$ cm, $f = +15$ cm, $u = -10$ cm

Using lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

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

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

$v = -30$ cm

Thus, the image is formed on the same side of the object at a distance of 30 cm from the optical centre of the lens. The negative sign indicates that the image is virtual.

$m = \frac{h_i}{h_o} = \frac{v}{u}$

$$h_i = \frac{v}{u} \times h_o = \frac{-30}{-10} \times 6 = +18 \text{ cm}$$

So, the image is three times larger than the size of the object, i.e. 18 cm.
The positive sign indicates that the image is erect.

103 A convex lens has a focal length of 10 cm. At what distance from the lens should the object be placed so that it forms a real and inverted image 20 cm away from the lens? What would be the size of the image formed if the object is 2 cm high? With the help of a ray diagram show the formation of the image by the lens in this case. 3

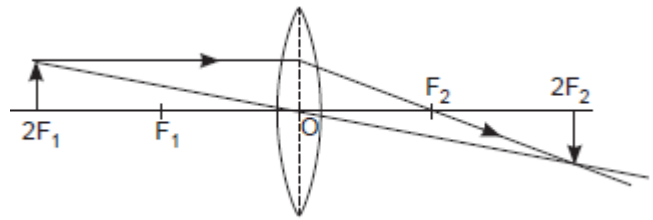
ANS: Given: $f = +10$ cm, $v = +20$ cm as image is real and inverted.
Height of the object = 2 cm (Say +ve)

Using lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get

$$\frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{+20} - \frac{1}{10} = \frac{+1-2}{20} = -\frac{1}{20}$$

$u = -20$ cm ($= 2f$)

Hence the object is placed at $2F_1$, the image is also formed at $2F_2$ on the other side of the lens. So, the image will be of the same size as the object as $|u| = |v|$ and therefore, the height of the image will be 2 cm.



104 An object placed on a metre scale at 8 cm mark was focussed on a white screen placed at 92 cm mark, using a converging lens placed on the scale at 50 cm mark.
(i) Find the focal length of converging lens. 3
(ii) Find the position of the image formed if the object is shifted towards the lens at a position of 29.0 cm.
(iii) State the nature of the image formed if the object is further shifted towards the lens.

ANS: (i) • $u = -(50 - 8) = -42$ cm, $v = 92 - 50 = 42$ cm
Focal length of converging lens (convex lens) is given by

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \quad \text{(lens formula)} \qquad \frac{1}{f} = \frac{1}{42} - \frac{1}{-42} = \frac{2}{42} = \frac{1}{21}$$

• $f = 21$ cm

(ii) Now, the object is shifted towards the lens at a position of 29.0 cm. Therefore, new object distance, $u' = -(50 - 29) = -21$ cm.

Again lens formula,

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

$$\frac{1}{21} = \frac{1}{v'} - \frac{1}{-21} = \frac{1}{v'} + \frac{1}{21} \qquad \frac{1}{v'} = \frac{1}{21} - \frac{1}{21} = 0$$

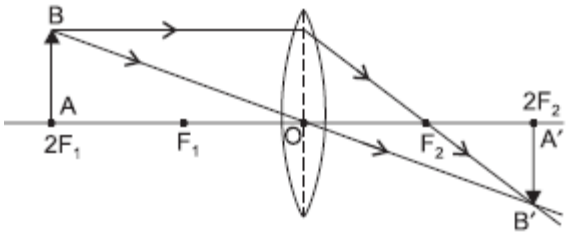
or $v' = \frac{1}{0} = \infty$

So, the image will be formed at infinity.
(iii) If the object is further shifted towards the lens, the object is now within the focus of a convex lens so the nature of image formed is
• virtual and erect, and

• enlarged or magnified, i.e. larger than the size of the object.

105 An object 2 cm high is placed at a distance of 64 cm from a white screen. On placing a convex lens at a distance of 32 cm from the object it is found that a distinct image of the object is formed on the screen. What is the focal length of the convex lens and size of the image formed on the screen ? Draw a ray diagram to show the formation of the image in this position of the object with respect to the lens. 3

ANS: Since the object-screen distance is double of the object-lens separation, the object is at a distance of $2f$ from the lens and the image should be of the same size of the object and formed at $2F_2$ on the screen.



So, $2f = 32$ — $f = 16$ cm

Height of image = Height of object = 2 cm

106 (a) Two lenses have powers of (i) + 2D and (ii) – 4D. What is the nature and focal length of each lens?
(b) An object is kept at a distance of 100 cm from each of the above lenses. Calculate the (i) image distance and (ii) magnification in each of the two cases. 3

ANS: (a) (i) Given: $P = +2D$
It is a convex lens of focal length

$$f = \frac{100}{2}\ \text{cm} = 50\ \text{cm}$$

(ii) Given: $P = -4D$
It is a concave lens of focal length

$$f = -\frac{100}{4}\ \text{cm} = -25\ \text{cm}$$

(b) For a convex lens,

Using lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get $\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{50} + \frac{1}{(-100)} = \frac{1}{100}$

v = 100 cm (Real image)

and $m = \frac{v}{u} = \frac{100}{-100} = -1$

Therefore, the image is inverted and of the same size as the object.

For a concave lens,

Using lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get $\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{-25} + \frac{1}{-100} = -\left(\frac{5}{100}\right) = -\frac{1}{20}$

v = – 20 cm (Virtual image)

$m = \frac{v}{u} = \frac{-20}{-100} = \frac{1}{5}$

Therefore, the image is diminished.

107 An object is kept at a distance of 18 cm, 20 cm, 22 cm and 30 cm respectively from a lens of power +5D.
(i) In which case or cases would you get a magnified image? 3
(ii) Which of the magnified image can be got on a screen?

ANS: • Power of lens = + 5 D

• $f = \frac{1}{P} = \frac{1}{+5} = +0.2 \text{ m} = +20 \text{ cm}$

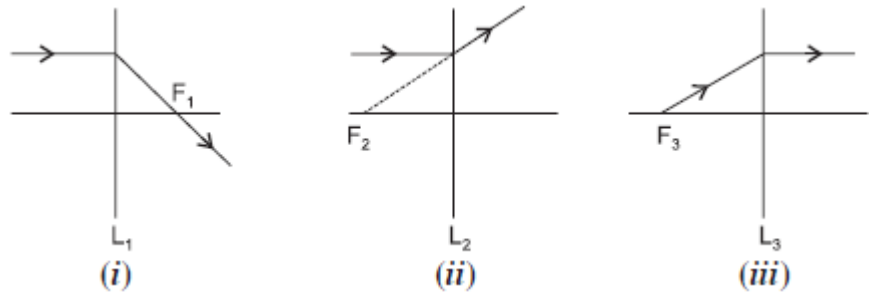
(i) We would get a magnified image only when the object is kept at a distance of 18 cm, 20 cm and 22 cm respectively.
(ii) The object at the positions of 20 cm and 22 cm will produce a magnified image on a screen.

Reason:

(i) A magnified virtual image is formed by a convex lens when the object lies between the focus and the optical centre of the lens.
(ii) A magnified real image is formed by a convex lens when the object is at F or between F and 2F.

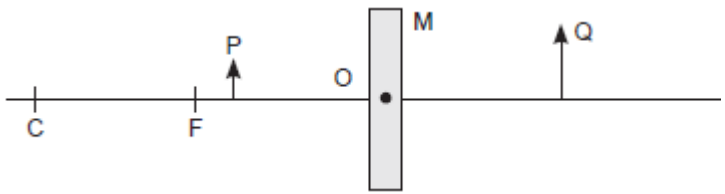
108 (a) What is the focal length of the lens used in sunglasses? 3
(b) The following figures show the path of light rays through three lenses marked L_1, L_2 and L_3 and their focal points F_1,

F_2 and F_3 respectively. Identify the nature of lenses.



ANS: (a) Since power is zero so the focal length is infinity.
(b) (i) L_1 – Convex lens (ii) L_2 – Concave lens (iii) L_3 – Convex lens

109 (a) Define the following terms in the context of spherical mirrors:
(i) Pole (ii) Centre of curvature (iii) Principal axis (iv) Principal focus
(b) Draw ray diagrams to show the principal focus of a (i) concave mirror (ii) convex mirror
(c) Consider the following diagram in which M is a mirror and P is an object and Q is its magnified image formed by the



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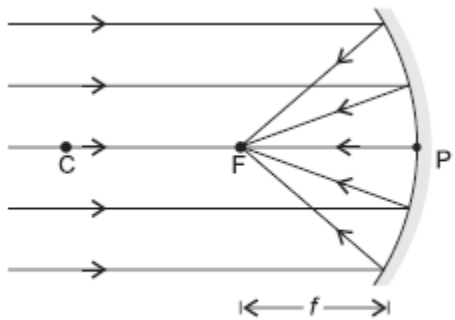
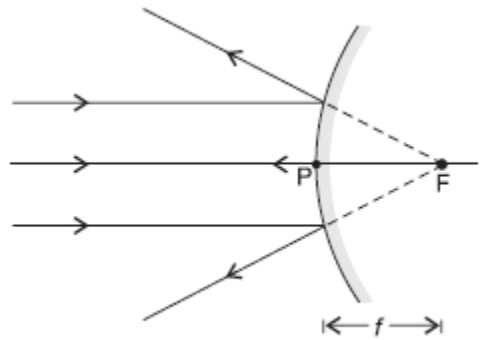
mirror. State the type of the mirror M and one characteristic property of the image Q.

ANS: (a) Pole: The central point of the reflecting spherical surface is called the pole (P). It lies on the surface of the mirror.
Centre of Curvature: The centre of the hollow sphere of which the spherical mirror is a part, is called the centre of curvature (C).
Principal Axis: The straight line joining the pole and the centre of curvature is called the principal axis.
Principal Focus: The point ‘F’ on the principal axis, where the incident light rays parallel to the principal axis actually

meet (converge) (in case of a concave mirror) or appear to diverge or come from (in case of a convex mirror) after reflection, is called its principal focus (F).
For a concave mirror, the focus lies on the same side of the reflecting surface, whereas in case of a convex mirror, it lies on the opposite side of the reflecting surface.



(b) Focus of concave mirror

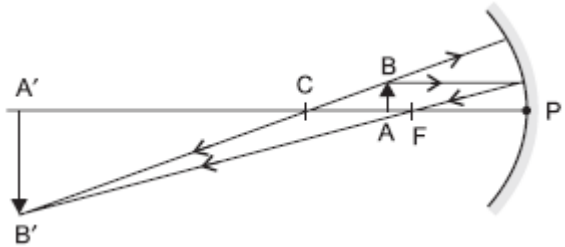


Focus of convex mirror

(c) The given mirror M is a concave spherical mirror. When the object lies between the pole and the focus of the concave mirror, an erect, virtual and enlarged image is formed. So one characteristic property of the image Q formed in the given figure is that it is virtual.

110 (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 centre 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? 5

ANS: (a) Rays which are chosen to construct a ray diagram for reflection are:
(i) A ray parallel to the principal axis and
(ii) A ray passing through the centre of curvature of a concave mirror or appears to pass through the centre of curvature of a convex mirror.
Path of these light rays after reflection:
(i) It will pass through the principal focus of a concave mirror or appear to diverge in case of a convex mirror.



(ii) It gets reflected back along the same path.

(b) When an object is placed between the pole and the principal focus of a concave mirror, a virtual, erect and enlarged image is formed behind the concave mirror as shown in the adjoining figure.

If the concave mirror is replaced by a converging lens of the same focal length, a virtual, erect and enlarged image is formed on the same side of object for the same position of object, i.e. between the principal focus and the optical centre of the lens.