Chapter 10 - page no 168

Question 1: Define the principal focus of a concave mirror.

Answer: When Light rays that are parallel to the principal axis incident on a concave mirror converge at a fixed point on its principal axis after reflecting from the mirror. This point is known as the principal focus of the concave mirror, and the distance is known as the focal length of that mirror.

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

Answer: Radius of curvature spherical mirror is R = 20 cm

We know, Radius of curvature = 2 × Focal length (f) / R = 2 f
So, f = R/2 = 20/2 = 10 cm
Hence, the focal length of the spherical mirror is 10 cm.

Question 3: Name the mirror that can give an erect and enlarged image of an object.

Answer: If we place an object between the pole and the principal focus of a concave mirror, the nature of the image will be virtual, erect, and enlarged.

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

Answer: Convex mirrors can give a virtual, erect, and diminished image of large objects. That's why they are preferred as a rear-view mirror in vehicles so that we can get a wider field of view, which helps the driver to see a wide area of the traffic behind him.

Chapter 10 page no 171:

Question 5: Find the focal length of a convex mirror whose radius of curvature is 32 cm.

Answer: Radius of curvature of the mirror R = 32 cm
We know, Radius of curvature = 2 × Focal length (f) / R = 2 f
So, f = R/2 = 32/2 = 16 cm
So, the focal length of the given convex mirror is 16 cm.

Question 6: A concave mirror produces three times magnified (enlarged) real image of an objectplaced at 10 cm in front of it. Where is the image located?

Answer: We know, Magnification produced by a spherical mirror is given by -

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

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

Magnification = -3h/h = -v / u,

v = 3 × u

So, the image distance (v) = −10 cm = 3 × (−10) = −30 cm

Here, the negative sign indicates that the image is real and inverted, formed at a distance of 30 cmin front of the concave mirror.

Page no 176:

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

Answer: The light ray bends towards the normal. Because when a light ray travels from an optically rarer medium to an optically denser medium, it gets bend towards the normal. Since water is optically denser than air, The light ray traveling from air to the water, it will bend towards the normal.

Question 2: Light enters from air to glass, having a refractive index of 1.50. What is the speed of lightin the glass? The speed of light in vacuum is 3×10^8 m s−1.

Refractive index of a medium is given by, n_g = (Speed of light in Vacuum) / (Speed of light in Medium)

Speed of light in vacuum, c = 3×10^8 m s−1 , Refractive index of glass, n_g = 1.50

v = c / n_g = (3×10^8) / 1.50 = (2×10^8) ms^{-1}

Speed of light in the glass is (2×10^8) ms^{-1}

Question 1: Find out, from Table, the medium having highest optical density. Also, find the medium with lowest optical density.

Material Refractive index Material medium Refractive

medium			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	Dense flint glass	1.65
Turpentine oil	1.47	Ruby	1.71
Benzene	1.50	Sapphire	1.77
Crown glass	1.52	Diamond	2.42

Answer: Highest optical density = Diamond (As the refractive index is highest)
Lowest optical density = Air (As the refractive index is lowest)

Question 2: You are given kerosene, turpentine, and water. In which of these does the light travel fastest? Use the information given in Table.

Material medium	Refractive index	Material	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	Dense flint glass	1.65
Turpentine oil	1.47	Ruby	1.71
Benzene	1.50	Sapphire	1.77
Crown glass	1.52	Diamond	2.42

Answer: The relation between the speed of light in a medium is given by -

$$n_m = \frac{\text{Speed of light in air}}{\text{Speed of light in the medium}} = \frac{c}{v}$$

$$v = \frac{c}{n_m}$$

$$v \propto \frac{1}{n_m}$$

So It can be state that light will travel the slowest in the material of the highest refractive index and travel the fastest in the material of the lowest refractive index.
So the answer is, light travels the fastest in water as the refractive index is lowest in the given Table.

Question 3: The refractive index of diamond is 2.42. What is the meaning of this statement?

Answer: The relation between the speed of light in a medium is given by -

$$n_m = \frac{\text{Speed of light in air}}{\text{Speed of light in the medium}} = \frac{c}{v}$$

The refractive index of diamond is 2.42 implies that the ratio of the speed of light in vacuum compared to the speed of light in diamond is given by 2.42.

Question 1: Define 1 diopter of power of a lens.

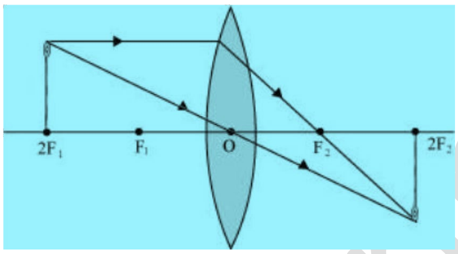
Answer: We know that Power of the lens is defined as the reciprocal of its focal length. If P is the power of a lens, then,

$$P = \frac{1}{f(\text{in metres})}$$

Power of a lens is 1 dioptre means the focal length of the lens is 1 meter.
The S.I. unit of power of a lens is Dioptre, denoted by D.

Question 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.

Answer: If an object is placed at the center of curvature of a convex lens, The image formed by the lens is real, inverted, and of the same size as the object, as shown in the given figure.



Here the object distance, u = −50 cm and image distance, v = 50 cm. Focal length = f cm
According to the lens formula,

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

$$\frac{1}{f} = \frac{1}{50} - \frac{1}{(-50)} = \frac{1}{50} + \frac{1}{50} = \frac{1}{25}$$

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

$$\text{Power of the lens, } P = \frac{1}{f(\text{in meters})} = \frac{1}{0.25} = +4 \text{ D}$$

Hence, the power of the given lens is +4 D.

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

Answer: Focal length of concave lens, f = 2 m

$$\text{Power of a lens, } P = \frac{1}{f(\text{in meters})} = \frac{1}{(-50)} = -0.5\,\text{D}$$

Therefore, the power of the given concave lens is −0.5 D.

Page no 185 -

Question 1: Which one of the following materials cannot be used to make a lens?
Water, Glass, Plastic, Clay

Answer: (d) A lens allows light to pass through it, and light can pass only if it is a transparent material. Since clay does not transparent to light, So, It is not appropriate material for making a lens.

Question 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 center of curvature
(b) At the center of curvature
(c) Beyond the center of curvature
(d) Between the pole of the mirror and its principal focus

Answer: (d) Between the pole of the mirror and its principal focus
If we place an object between the pole and the principal focus of a concave mirror, the nature of image will be virtual, erect, and enlarged.

Question 3: Where should an object be placed in front of a convex lens to get a real image of the same 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 center of the lens and its principal focus.

Answer: (b) When an object is placed at the center of curvature in front of a convex lens that is twice the length of the focal length, The nature of the image formed by the lens is real,inverted, and of the same size as the object.

Question 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

Answer: (a) Both concave.
We know that the focal length of a concave mirror and concave lens are always negative. So, both the spherical mirror and the thin spherical lens are concave in nature.

Question 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

Answer: (d) either plane or convex.
We know that A convex mirror always forms a virtual and erect image of the diminished size of the object placed in front of it, and A plane mirror will always form a virtual and erect image of exactly same size as that of the object. Hence, the given mirror would be either plane or convex.

Question 6: Which of the following lenses would you prefer to use while reading small lettersfound 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

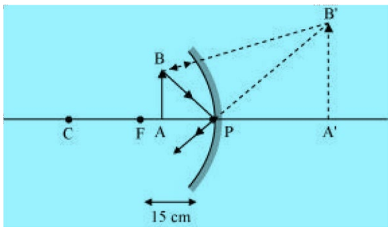
(d) A concave lens of focal length 5 cm

Answer: (c) A convex lens of focal length 5 cm.
A convex lens forms a virtual, erect and magnified image of an object when object is placed between the pole and the focal point. Also, magnification is large for convex lenses having shorter focal length. Therefore, for reading small letters, a convex lens of focal length 5 cm will be more appropriate.

Question 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 showthe image formation in this case.

Answer: Range of object distance = 0 cm to15 cm
A concave mirror gives a virtual, erect, and enlarged image of an object when it is placed between its pole (P) and focus point (F).

Hence, to obtain an erect image of an object by a concave mirror of focal length 15 cm, we must place the object anywhere between the pole and the focus. The image formed will be virtual, erect, and magnified in nature, as shown in the given figure.



Question 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
(d) Support your answer with reason.

Answer: (a) Concave mirror. - Concave mirror is used in the headlights of a car because concave mirror acts as a divergent mirror here and can produce parallel beam of light when the light source (bulb) is placed at their principal focus.

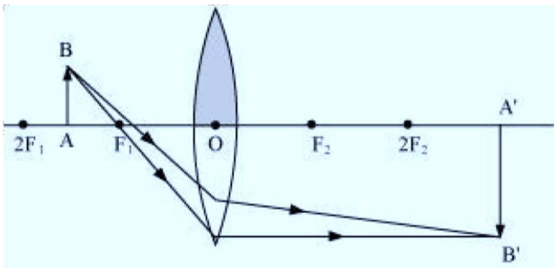
(b) Convex mirror - It is used as a side/rearview mirror of a vehicle because it gives a virtual, erect, and diminished image of the object. Hence, the driver has awide field of view. It helps driver to see most of the traffic behind him/her.

(c) Concave mirror – We know that concave mirrors are convergent in nature. That is why they are used to construct solar furnaces to converge the incident light rays at a single point. Therefore, they can produce a large amount of heat at that point for cooking.

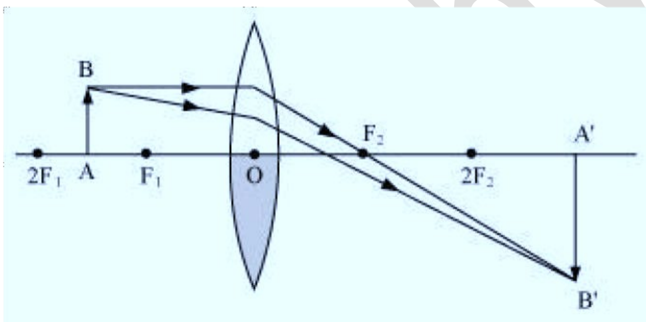
Question 9: One-half of a convex lens is covered with a black paper. Will this lens produce a complete image of the object? Verify your answer experimentally. Explain your observations.

Answer: The convex lens will form complete image of an object but of half intensity, even if its one-half is coveredwith black paper. The step-by-step explanations is given below-

Case I
When the upper half of the lens is covered, light coming from the lower half of the lens will form the image of the given object, as shown in the following figure.



Case II
When the lower half of the lens is covered – The light rays coming from the upper half of the lens will form and real, inverted image of the given object, as shown in the following figure.



But as half of the light rays are blocked by the lenses, The intensity of the image will be decreases.

Question 10: An object 5 cm in length is held 25 cm away from a converging lens of focal length10 cm. Draw the ray diagram and find the position, size, and the nature of the image formed.

Answer: Object distance, u = −25 cm
Object height, h_o = 5 cm
Focal length, f = +10 cm

According to the lens formula,

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$
$$\frac{1}{v}=\frac{1}{f}+\frac{1}{u}=\frac{1}{10}-\frac{1}{25}=\frac{15}{250}$$
$$v=\frac{250}{15}=16.66\text{ cm}$$

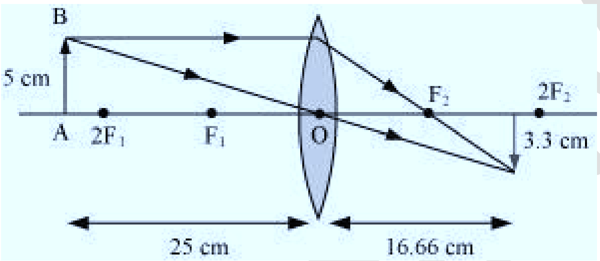
The positive value of v indicates that the image will be real and formed at the other side of the lens.
We know that,

$$\text{Magnification, } m=-\frac{\text{Image distance}}{\text{Object distance}}=-\frac{v}{u}=\frac{-16.66}{25}=-0.66$$

Here, the negative sign indicates that the image is real, inverted and formed behind the lens.

$$\text{Magnification, } m=\frac{\text{Image height}}{\text{Object height}}=\frac{H_1}{H_o}=\frac{H_1}{5}$$
$$H_1=m\times H_o=-0.66\times 5=-3.3\text{ cm}$$

The negative value of image height indicates that the image formed is inverted. The nature of image are shown in the following ray diagram.

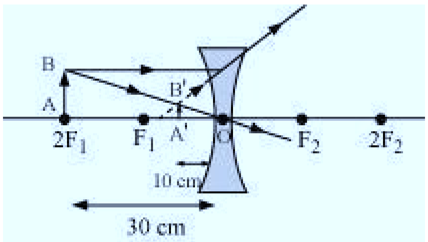


Question 11: A concave lens of focal length 15 cm forms an image 10 cm from the lens. How faris the object placed from the lens? Draw the ray diagram.

Answer: Focal length of concave lens - f = −15 cm.
Image distance, v = −10 cm
So, according to the lens formula-

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$
$$\frac{1}{u}=\frac{1}{v}-\frac{1}{f}=\frac{-1}{10}-\frac{1}{(-15)}=\frac{-1}{10}+\frac{1}{15}=\frac{-5}{150}$$
$$u=-30\text{ cm}$$

The negative value of object distance (u) implies that the object is placed 30 cm in front of the lens just like the figure.



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

Answer: Focal length of convex mirror, f = +15 cm.
Object distance, u = −10 cm.
From mirror formula, We can write -

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{15} + \frac{1}{10} = \frac{25}{150}$$

$$v = 6 \text{ cm}$$

The positive value of v states that the image will be formed behind the mirror (Virtual image).

$$\text{Magnification}, m = -\frac{\text{Image distance}}{\text{Object distance}} = -\frac{v}{u} = \frac{-6}{-10} = +0.6$$

The positive value of m indicates that the nature of image is virtual and erect.
Question 13: The magnification produced by a plane mirror is +1. What does this mean?
Magnification produced by a mirror is given by the relation

$$\text{Magnification}, m = \frac{\text{Image height } (H_1)}{\text{Object height } (H_o)}$$

The magnification produced by a plane mirror is +1states that the image formed by the plane mirror will be always of the same size as that of the object. The positive sign indicates that the nature of image will be virtual and erect and formed behind the mirror.

Question 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.

Answer: Object distance, u = −20 cm.
Object height, h = 5 cm.

Radius of curvature, R = 30 cm.
So the focal length will be = 15 cm
According to the mirror formula,

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

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{15}+\frac{1}{20}=\frac{4+3}{60}=\frac{7}{60}$$
$$v=8.57\ \text{cm}$$

The positive value of v indicates that the image will be virtual and formed behind the mirror.

$$\text{Magnification, } m=-\frac{\text{Image distance}}{\text{Object distance}}=\frac{-8.57}{-20}=0.428$$

The positive value of magnification indicates that the image formed is virtual.

$$\text{Magnification, } m=\frac{\text{Height of the image}}{\text{Height of the object}}=\frac{h'}{h}$$

$$h'=m\times h=0.428\times 5=2.14\ \text{cm}$$

The positive value of image height indicates that the nature of image will be erect and of diminished

Question 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 focused image can be obtained? Find the size and the nature of the image.

Answer: Object distance, u = −27 cm.
Object height, h = 7 cm
Focal length, f = −18 cm.
According to the mirror formula,

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

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{-1}{18}+\frac{1}{27}=\frac{-1}{54}$$
$$v=-54\text{ cm}$$

The screen should be placed at a distance of 54 cm in front of the given mirror for a sharp image.

$$\text{Magnification, } m=-\frac{\text{Image distance}}{\text{Object distance}}=\frac{-54}{27}=-2$$

The negative value of magnification (m) indicates that the nature of image will be is real and inverted.

$$\text{Magnification, } m=\frac{\text{Height of the image}}{\text{Height of the object}}=\frac{h'}{h}$$
$$h'=7\times(-2)=-14\text{ cm}$$

The negative value of image height states that the nature of image will be inverted and of large size.

Question 16: Find the focal length of a lens of power −2.0 D. What type of lens is this?

$$\text{Power of a lens, } P=\frac{1}{f(\text{in metres})}$$
$$P=-2\text{ D}$$
$$f=\frac{-1}{2}=-0.5\text{ m}$$

Answer: We know that a concave lens has negative focal length. So, it is a concave lens.

Question 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?

$$\text{Power of a lens, } P=\frac{1}{f(\text{in metres})}$$
$$\text{Power, } P=1.5\text{ D}$$
$$f=\frac{1}{1.5}=\frac{10}{15}=0.66\text{ m}$$

We know that the focal length of a convex lens. Hence, it is a convex lens or a converging lens.