CHAPTER – LIGHT : REFLECTION AND REFRACTION

I. MULTIPLE TYPE QUESTIONS [MCQ'S 1 MARK EACH]

EASY LEVEL

1. The radius of curvature of a spherical mirror is 20 cm. The focal length of mirror is

   (a) 10 cm (b) 20 cm (c) 30 cm (d) 40 cm

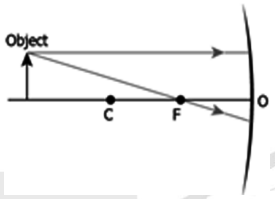
2. A doctor has prescribed a corrective lens of power +1.5. D. The focal length of the lens is

   (a) 67 cm (b) 70 cm (c) 40 cm (d) 65 cm

3. 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

4. Where would the reflected rays meet for the image formation to take place?



   (a) Behind the mirror (b) Between F and O (c) Between C and F (d) Beyond C

5. A student conducts an activity using a flask of height 15 cm and a concave mirror. He finds that the image formed is 45 cm in height. What is the magnification of the image?

   (a) -3 times (b) -1/ 3 times (c) 1/ 3 times (d) 3 times

II. ASSERTION AND REASON TYPE QUESTIONS [1 MARK EACH]

EASY LEVEL

1. **Assertion(A) :** A ray of light travelling from a rarer medium to a denser medium slows down and bends away from the normal. When it travels from a denser medium to a rarer medium, it speeds up and bends towards the normal.

   Reason (R) : The speed of light is higher in a rarer medium than a denser medium.

2. **Assertion(A):** The mirrors used in search lights are concave spherical.

   Reason (R) : In concave spherical mirror the image formed is always virtual.

3. **Assertion(A) :** Light travels faster in glass than in air.

   Reason (R) : Glass is denser than air.

4. **Assertion(A) :** For observing traffic at back, the driver mirror is convex mirror.

   Reason (R) : A convex mirror has much larger field of view than a plane mirror.

5. **Assertion(A) :** The height of an object is always considered positive.

   Reason (R) : An object is always placed above the principal axis in this upward direction.

6. **Assertion(A) :** Refractive index has no units.

   Reason (R) : The refractive index is a ratio of two similar quantities.

III. CASE BASED QUESTIONS

EASY LEVEL

1. The curved surface of a spoon can be considered as a spherical mirror. A highly smooth polished surface is called a mirror. The mirror whose reflecting surface is curved inwards or outwards is called a spherical mirror. Inner part works as a concave mirror and the outer bulging part acts as a convex mirror. The center of the reflecting surface of a mirror is called pole and the radius of the sphere of which the mirror is formed is called radius of curvature.

(i) When a concave mirror is held towards the sun and its sharp image is formed on a piece of carbon paper for some time, a hole is burnt in the carbon paper. What is the name given to the distance between the mirror and carbon paper?

(a) Radius of curvature (b) Focal Length (c) Principal focus (d) Principal axis

(ii) The distance between pole and focal point of a spherical mirror is equal to the distance between

(a) pole and center of curvature (b) focus point and center of curvature

(c) pole and object (d) object and image

(iii) The focal length of a mirror is 15 cm. The radius of curvature is

(a) 15 cm (b) 30 cm (c) 45 cm (d) 60 cm

(iv) The normal at any point on the mirror passes through

(a) focus (b) pole (c) center of curvature (d) any point

(v) In a convex spherical mirror, reflection of light takes place at

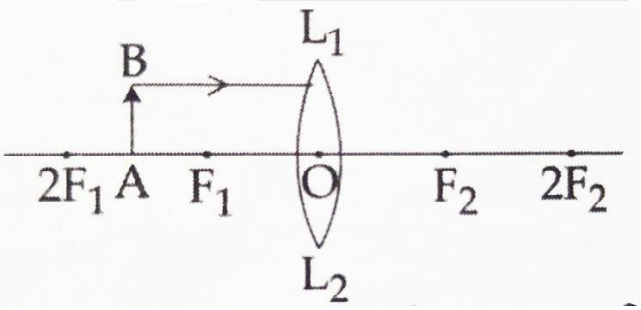
(a) a flat surface (b) a bent-in surface (c) a bulging-out surface (d) an uneven surface

IV. SHORT ANSWER TYPE QUESTIONS [2 MARKS EACH]

EASY LEVEL

1. Two convex lenses P and Q have focal lengths 0.5 m and 0.4 m respectively. Find the power of the combination.

2. In the ray diagram, AB is an object placed in front of a convex lens L_1L_2. F_1 and F_2 are its foci. F_1OF_2 is principal axis.



Complete the ray diagram to locate the position of image formed after refraction through it. Also compare the size of the object and the image.

3. State the laws of refraction of light. Explain the term 'absolute refractive index of a medium'and write an expression to relate it with the speed of light in vaccum.

V. SHORT ANSWER TYPE QUESTIONS [3 MARKS EACH]

EASY LEVEL

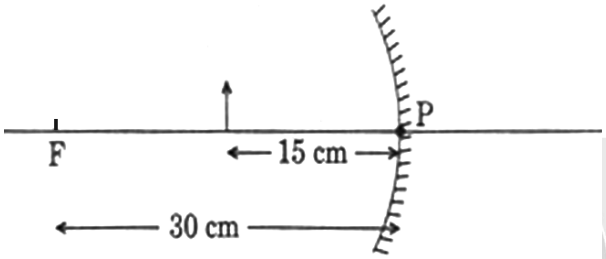
1. With the help of a ray diagram state what is meant by refraction of light. State Snell's law for refraction of light and also express it mathematically.

   The refractive index of air with respect to glass is 2/3 and the refractive index of water with respect to air is 4/3. If the speed of light in glass is 2×10^8 m/s, find the speed of light in: (a) air, (b) water.

VI. LONG ANSWER TYPE QUESTIONS [5 MARKS EACH]

EASY LEVEL

1. i. Complete the following ray diagram



   ii. Find the nature, position and size of the image formed.

   iii. sUse mirror formula to determine the magnification in this case.

I. MULTIPLE TYPE QUESTIONS [MCQ'S 1 MARK EACH]

MEDIUM LEVEL

1. 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?

   (a) 30 cm (b) 40 cm (c) -30 cm (d) -40 cm

2. The speed of light in a transparent medium is 0.6 times that of its speed in vacuum. The refractive index of the medium is:

   (a) 1.66 (b) 1.96 (c) 1.26 (d) 1.29

3. An image of an object produced on a screen which is about 36 cm using a convex lens. The image produced is about 3 times the size of the object. What is the size of the object?

   (a) 12 cm (b) 33 cm (c) 39 cm (d) 108 cm

4. In your laboratory you trace the path of light rays through a glass slab for different values of angle of incidence ($\angle$i) and in each case measure the values of the corresponding angle of refraction ($\angle$r) and angle of emergence ($\angle$e). On the basis of your observations your correct conclusion is :

   (a) $\angle$i is more than $\angle$r, but nearly equal to $\angle$e (b) $\angle$i is less than $\angle$r, but nearly equal to $\angle$e

   (c) $\angle$i is more than $\angle$e, but nearly equal to $\angle$r (d) $\angle$i is less than $\angle$e, but nearly equal to $\angle$r

II. ASSERTION AND REASON TYPE QUESTIONS [1 MARK EACH]

MEDIUM LEVEL

1. **Assertion(A) :** The centre of curvature is not a part of the mirror. It lies outside its reflecting surface.

   Reason (R) : The reflecting surface of a spherical mirror forms a part of a sphere. This sphere has a centre.

2. **Assertion (A) :** A ray passing through the centre of curvature of a concave mirror after reflection, is reflected back along the same path.

   Reason (R) : The incident rays fall on the mirror along the normal to the reflecting surface.

3. **Assertion(A) :** Mirror formula can be applied to a plane mirror.

   Reason (R) : A plane mirror is a spherical mirror of infinite focal length.

4. **Assertion(A) :** When the object moves with a velocity 2 m/s, its image in the plane mirror moves with a velocity of 4 m/s.

   Reason (R) : The image formed by a plane mirror is as far behind the mirror as the object is in front of it.

5. **Assertion(A) :** Concave mirrors are used as make-up mirrors.

   Reason (R) : When the face is held within the focus of a concave mirror, then a diminished image of the face is seen in the concave mirror.

6. **Assertion(A) :** The formula connecting u, v and f for a spherical mirror is valid in all situations for all spherical mirrors for all positions of the object.

   Reason (R) : Laws of reflection are strictly valid for plane surfaces.

III. CASE BASED QUESTIONS

MEDIUM LEVEL

1. The lenses forms different types of images when object placed at different locations. When a ray is incident parallel to the principal axis, then after refraction, it passes through the focus or appears to come from the focus.

   When a ray goes through the optical centre of the lens, it passes without any deviation. If the object is placed between focus and optical center of the convex lens, erect and magnified image is formed.

   As the object is brought closer to the convex lens from infinity to focus, the image moves away from the convex lens from focus to infinity. Also the size of image goes on increasing and the image is always real and inverted.

   A concave lens always gives a virtual, erect and diminished image irrespective to the position of the object.

(i) The location of image formed by a convex lens when the object is placed at infinity is

(a) at focus (b) at 2F (c) at optical center (d) between F and 2F

(ii) When the object is placed at the focus of concave lens, the image formed is:

(a) real and smaller (b) virtual and inverted (c) virtual and smaller (d) real and erect

(iii) The size of image formed by a convex lens when the object is placed at the focus of convex lens is

(a) small (b) point in size (c) highly magnified (d) same as that of object

(iv) When the object is placed at 2F in front of convex lens, the location of image is

(a) at F (b) at 2 F on the other side

(c) at infinity (d) between F and optical center

(v) At which location of object in front of concave lens, the image between focus and optical centre is formed

(a) anywhere between centre and infinity (b) at F

(c) at 2F (d) infinity

2. The spherical mirror forms different types of images when the object is placed at different locations.

When the image is formed on screen, the image is real and when the image does not form on screen, the image is virtual. When the two reflected rays meet actually, the image is real and when they appear to meet, the image is virtual.

A concave mirror always forms a real and inverted image for different positions of the object. But if the object is placed between the focus and pole, the image formed is virtual and erect.

A convex mirror always forms a virtual, erect and diminished image. A concave mirror is used as doctor's head mirror to focus light on body parts like eyes, ears, nose etc., to be examined because it can form an erect and magnified image of the object. The convex mirror is used as a rear view mirrors in automobiles because it can form an small and erect image of an object.

(i) When an object is placed at the centre of curvature of a concave mirror, the image formed is

(a) larger than the object (b) smaller than the object

(c) same size as that of the object (d) highly enlarged.

(ii) 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.

(iii) A child is standing in front of a magic mirror. She finds the image of her head bigger, the middle portion of her body of the same size and that of the legs smaller. The following is the order of combinations for the magic mirror from the top.

(a) Plane, convex and concave (b) Convex, concave and plane

(c) Concave, plane and convex (d) Convex, plane and concave

(iv) To get an image larger than the object, one can use

(a) convex mirror but not a concave mirror (b) a concave mirror but not a convex mirror

(c) either a convex mirror or a concave mirror (d) a plane mirror.

(v) A convex mirror has wider field of view because

(a) the image formed is much smaller than the object and large number of images can be seen

(b) the image formed is much closer to the mirror

(c) both (a) and (b)

(d) none of these.

IV. SHORT ANSWER TYPE QUESTIONS [2 MARKS EACH]

MEDIUM LEVEL

1. If the image formed by a spherical mirror for all positions of the object placed in front of it is always erect and diminished, what type of mirror is it? Draw a labelled ray diagram to support your answer.

2. An object is placed at a distance of 30 cm in front of a convex mirror of focal length 15 cm. Write four characteristics of the image formed by the mirror.

3. (i) A ray of light starting from diamond is incident on the interface separating diamond and water. Draw a labelled ray diagram to show the refraction of light in this case.

(ii) Absolute refractive indices of diamond and water are 2.42 and 1.33 respectively. Find the value of refractive index of water w.r.t diamond.

V. SHORT ANSWER TYPE QUESTIONS [4 MARKS EACH]

MEDIUM LEVEL

1. A concave mirror is used for image formation for different positions of an object. What inferences can be drawn about the following when an object is placed at a distance of 10 cm from the pole of a concave mirror of focal length 15 cm?

   (a) Position of the image

   (b) Size of the image

   (c) Nature of the image

   Draw a labelled ray diagram to justify your inferences.

2. What is meant by power of a lens? What does its sign (+ve or -ve) indicate? State its S.I. unit related to focal length of a lens.

3. "A ray of light incident on a rectangular glass slab immersed in any medium emerges parallel to itself." Draw labeled ray diagram to justify the statement".

4. The absolute refractive indices of glass and water are 1.5 and 1.33 respectively. In which medium does light travel faster? Calculate the ratio of speeds of light in the two media.

5. Refractive indices of media A, B, C and D are given below :

Media	**Refractive Index**
A	1.33
B	1.44
C	1.52
D	1.65

   In which of these four media is the speed of light (i) maximum and (ii) minimum ? Find refractive index of medium D w.r.t. medium A.

6. (a) List four characteristics of the image formed by a concave lens of focal length 20 cm when the object is placed at a distance of 40 cm from its optical centre.

   (b) The size of image of an object by a convex lens of focal length 20 cm is observed to be reduced to 1/3rd of its size. Find the distance of the object from the optical centre of the lens.

VI. LONG ANSWER TYPE QUESTIONS [5 MARKS EACH]

MEDIUM LEVEL

1. i. Draw a labelled ray diagram to show the path of a ray of light incident obliquely on one face of a glass slab.

   ii. Calculate the refractive index of the material of a glass slab. Given that the speed of light through the glass slab is 2×10^8 m/s and in air is 3×10^8 m/s.

   iii. Calculate the focal length of a lens, if its power is -2.5 D.

I. MULTIPLE TYPE QUESTIONS [MCQ'S 1 MARK EACH]

DIFFICULT LEVEL

1. The focal length of a plane mirror is

   (a) 0 (b) infinite (c) 25 cm (d) -25 cm

2. Magnification produced by a rearview mirror fitted in vehicles:

   (a) is less than one (b) is more than one (c) is equal to one

   (d) can be more than or less than one, depending upon the position of the object in front of it.

3. A student has obtained an image of a well-illuminated distant object on a screen to determine the focal length, F_1 of the given spherical mirror. The teacher then gave him another mirror of focal length, F_2 and asked him to obtain a focused image of the same object on the same screen. The student found that in order to focus the same object using the second mirror, he has to move the mirror away from the screen. From this observation it may be concluded that both the spherical mirrors given to the student were:

   (a) Concave and $F_1 < F_2$ (b) Concave and $F_1 > F_2$ (c) Convex and $F_1 < F_2$ (d) Convex and $F_1 > F_2$

4. In torch lights and head lights of vehicles, the bulb is placed

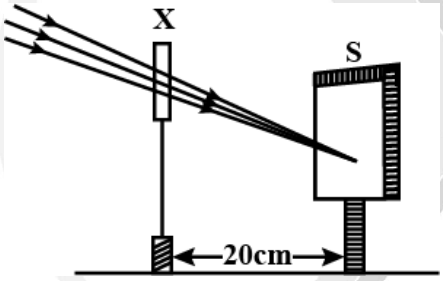
   (a) between the pole and the focus of the reflector.

   (b) very near to the focus of the reflector.

   (c) between the focus and the centre of curvature of the reflector.

   (d) at the centre of curvature of the reflector.

5. A student focused the sun rays using an optical device 'X' on a screen S as shown.

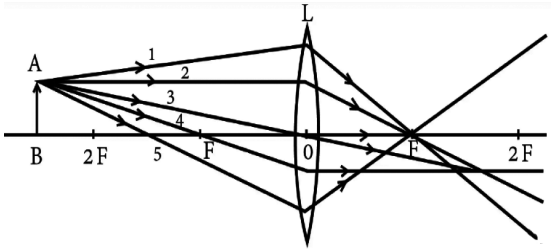


   From this it may be concluded that the device 'X' is a:

   (a) Convex lens of focal length 10 cm. (b) Convex lens of radius of curvature 20 cm.

   (c) Convex lens of focal length 20 cm. (d) Convex mirror of focal length 20 cm.

6. A student is using a convex lens of focal length 18 cm to study the image formation by it for the various positions of the object. He observes that when he places the object at 27 cm, the location of the image is at 54 cm on the other side of the lens. Identify from the following diagram the three rays that are obeying the laws of the refraction and may be used to draw the corresponding ray diagram.



   (a) 1, 2 and 4 (b) 1, 3 and 5 (c) 2, 4 and 5 (d) 2, 3 and 4

II. ASSERTION AND REASON TYPE QUESTIONS [1 MARK EACH]

DIFFICULT LEVEL

1. **Assertion (A) :** Light does not travel in the same direction in all the media.

   Reason (R) : The speed of light does not change as it enters from one transparent medium to another.

2. **Assertion(A) :** The emergent ray is parallel to the direction of the incident ray.

   Reason (R) : The extent of bending of the ray of light at the opposite parallel faces (air- glass interface and glass-air interface) of the rectangular glass slab is equal and opposite.

3. **Assertion(A) :** It is not possible to see a virtual image by eye.

   Reason (R): The rays that seem to emanate from a virtual image do not in fact emanates from the image.

4. **Assertion(A):** A person cannot see his image in a concave mirror, unless, he is standing beyond the center of curvature of the mirror.

   Reason (R) : In a concave mirror, image formed is real provided the object is situated beyond its focus.

5. **Assertion(A):** Virtual images are always erect.

   Reason (R) : Virtual images are formed by diverging lenses only.

III. CASE BASED QUESTIONS

DIFFICULT LEVEL

1. The refraction of light on going from one medium to another takes place according to two laws which are known as the laws of refraction of light. These laws are:

   i. The ratio of sine of angle of incidence to the sine of angle of refraction is always constant for the pair of media in contact. sini/sinr = μ = constant

   This constant is called refractive index of the second medium with respect to the first medium.

   Refractive index is also defined as the ratio of speed of light in vacuum to the speed of light in medium.

   ii. The incident ray, refracted ray and normal all lie in the same plane.

   This law is called Snell's law of refraction.

(i) When light travels from air to glass,

(a) angle of incidence > angle of refraction (b) angle of incidence < angle of refraction

(c) angle of incidence = angle of refraction (d) can't say

(ii) When light travels from air to medium, the angle of incidence is 45° and angle of refraction is 30°. The refractive index of second medium with respect to the first medium is

(a) 1.41 (b) 1.50 (c) 1.23 (d) 1

(iii) In which medium, the speed of light is minimum?

(a) Air (b) Glass (c) Water (d) Diamond

(iv) If the refractive index of glass is 1.5 and speed of light in air is 3×10^8 m/s. The speed of ligh in glass is

(a) 2×10^8 m/s (b) 2.9×10^8 m/s (c) 4.5×10^8 m/s (d) 3×10^8 m/s

(v) Refractive index of a with respect to b is 2. Find the refractive index of b with respect to a.

(a) 0.4 (b) 0.5 (c) 0.25 (d) 2.4

2. The relation between distance of an object from the mirror (u), distance of image from the mirror (v) and the focal length (F) is called mirror formula. This formula is valid in all situations for all spherical mirrors for all positions of the object. The size of image formed by a spherical mirror depends on the position of the object from the mirror. The image formed by a spherical mirror can be bigger than the object, equal to the object or smaller than the object. The size of the image relative to the object is given by the linear magnification (m). Thus, the magnification is given by the ratio of height of image to the height of object. If magnification is negative, image is real and if it is positive, image is virtual.

(i) What is the position of an image when an object is placed at a distance of 20 em from a concave mirror of focal length 20 cm?

(a) 5 cm (b) 20 cm (c) 10 cm (d) infinity

(ii) Which of the following ray diagrams is correct for the ray of light incident on a concave mirror as shown in figure?

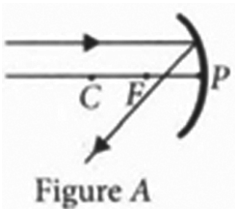
(a) 

Figure A

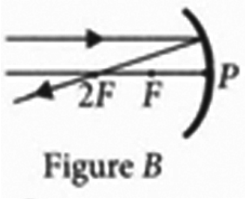
(b) 

Figure B

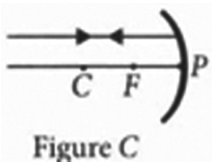
(C) 

Figure C

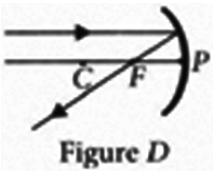
(d) 

Figure D

(iii) If the magnification of an image is -2, the characteristic of image will be

(a) real and inverted (b) virtual and enlarged (c) virtual and inverted (d) real and small

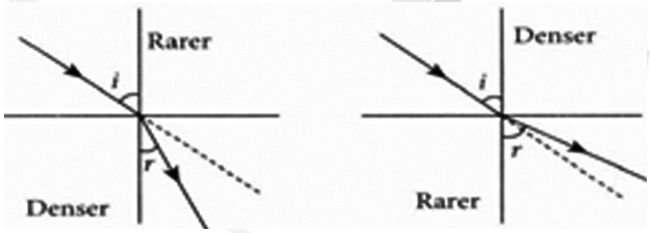
(iv) The mirror formula holds for

(a) concave mirror (b) convex mirror (c) plane mirror (d) all of these

(v) A parallel beam of light is made to fall on a concave mirror. An image is formed at a distance of 7.5 from the mirror. The focal length of the mirror is

(a) 15 cm (b) 7.5 cm (c) 3.75 cm (d) 10 cm

3. When the rays of light travels from one transparent medium to another, the path of light is deviated. This phenomena is called refraction of light. The bending of light depends on the optical density of medium through which the light pass.



The speed of light varies from medium to medium. A medium in which the speed of light is more is optically rarer medium whereas in which the speed of light is less is optically denser medium. Whenever light goes from one medium to another, the frequency of light does not change however, speed and wavelength change. It concluded that change in speed of light is the basic cause of refraction.

(i) When light travels from air to glass, the ray of light bends

(a) towards the normal (b) away from normal (c) anywhere (d) none of these

(ii) A ray of light passes from a medium A to another medium B. No bending of light occurs if the ray of light hits the boundary of medium B at an angle of

(a) 0° (b) 45° (c) 90° (d) 120°

(iii) When light passes from one medium to another, the frequency of light

(a) increases (b) decreases (c) remains same (d) none of these

(iv) When light passes from glass to water, the speed of light

(a) increases (b) decreases

(c) remains same (d) first increases then decrease

(v) The bottom of pool filled with water appears to be _____ due to refraction of light

(a) shallower (b) deeper (c) at same depth (d) empty

IV. SHORT ANSWER TYPE QUESTIONS [2 MARKS EACH]

DIFFICULT LEVEL

1. "The magnification produced by a spherical mirror is -4". List four informations you obtain from this statement about the mirror/ image.
2. The magnification produced by a plane mirror is +1. What does it mean?
3. Is it possible for the refractive index of a medium to be less than 1?
4. List in proper sequence the steps of the experiment for determining the approximate focal length of a given concave mirror by obtaining the image of a distant object.
5. A student has to trace the path of a ray of light passing through a rectangular glass slab for four different values of angle of incidence.

   i. Write two important precautions for this experiment.

   ii. List two conclusions the student will draw based on his experiment.

V. SHORT ANSWER TYPE QUESTIONS [4 MARKS EACH]

DIFFICULT LEVEL

1. List two possible ways in which a concave mirror can produce a magnified image of an object placed in front of it. State the difference if any between these two images.
2. The image of a candle flame placed at a distance of 30 cm from a mirror is formed on a screen placed in front of the mirror at a distance of 60 cm from its pole. What is the nature of the mirror? Find its focal length. If the height of the flame is 2.4 cm, find the height of its image. State whether the image formed is erect or inverted.
3. A student took three concave mirrors of different focal lenghts and performed the experiment to see the image formation by placing an object at different distances with these mirrors as shown in the following table.

Case No.	Object-distance	Focal length
I	45 cm	20 cm
II	30 cm	15 cm
III	20 cm	30 cm

Now answer the following questions :

i. List two properties of the image formed in Case I.

ii. In which one of the cases given in the table, the mirror will form real image of same size and why ?

iii. Name the type of mirror used by dentists. Give reason why do they use such type of mirrors.

or,

Look at the table and identify the situation (object distance and focal length) which resembles the situation in which concave mirrors are used as shaving mirrors ? Draw a ray diagram to show the image formation in this case.

LIGHT REFLECTION & REFRACRTION

VI. LONG ANSWER TYPE QUESTIONS [5 MARKS EACH]

DIFFICULT LEVEL

1. Rishi went to a palmist to show his palm. The palmist used a special lens for this purpose.

   (i) State the nature of the lens and reason for its use.

   (ii) Where should the palmist place/hold the lens so as to have a real and magnified image of an object?

   (iii) If the focal length of this lens is 10 cm, the lens is held at a distance of 5 cm from the palm, use lens formula to find the position and size of the image.

2. 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. (a) Under what condition with a glass lens placed in a transparent liquid become invisible.

   (b) Describe and illustrate with a diagram, how we should arrange two converging lenses so that a parallel beam of light entering one lens emerges as a parallel beam after passing through the second lens.

   (c) An object is placed at a distance of 3 cm from a concave lens of focal length 12 cm. Find the (i) position and (ii) nature of the image formed.

4. It is desired to obtain an erect image of an object, using concave mirror of focal length of 12 cm.

   1. What should be the range of distance of an object placed in front of the mirror?

   2. Will the image be smaller or larger than the object. Draw ray diagram to show the formation of image in this case.

   3. Where will the image of this object be, if it is placed 24 cm in front of the mirror ? Draw ray diagram for this situation also to justify your answer.

   Show the positions of pole, principal focus and the centre of curvature in the above ray diagrams.