PHYSICS

BOOKS - U-LIKE PHYSICS (HINGLISH)

RAY OPTICS AND OPTICAL INSTRUMENTS

N C E R T Textbook Exercises

1. A small candle, 2.5 cm in size is placed at 27 cm in front of a concave mirror of radius of

curvature 36 cm. At what distance from the mirror should a screen be placed in order to obtain a sharp image? Describe the nature and size of the image. If the candle is moved closer to the mirror, how would the screen have to be moved?

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2. A 4.5 cm needle is placed 12 cm away from a convex mirror of focal length 15 cm. Give the location of the image and the magnification.

Describe what happens as the needle is moved farther from the mirror.

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3. A tank is filled with water to a height of 12.5 cm. The apparent depth of a needle lying at the bottom of the tank is measured by a microscope to be 9.4 cm. What is the refractive index of water? If water is replaced by a liquid of refractive index 1.63 up to the same height,

by what distance would the microscope have to be moved to focus on the needle again?

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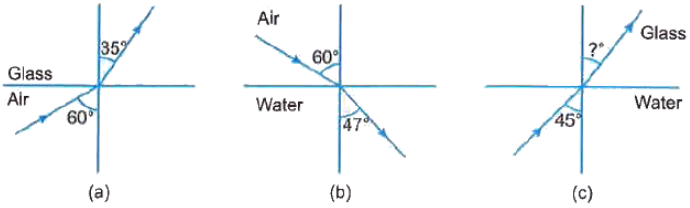
4. Fig. 9.02(a) and (b), show refraction of a ray in air incident at 60° with the normal to a glass - air and water - air interface, respectively. Predict the angle of refraction in glass when the angle of incidence in water is 45° with the normal to a water - glass

interface [Fig. 9.02(c)].



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5. A small bulb is placed at the bottom of a tank containing water to a depth of 80 cm. What is the area of the surface of water through which light from the bulb can emerge out? (Refractive index of water is 1.33. (Consider the bulb to be a point source)

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6. A prism is made of glass of unknown refractive index. A parallel beam of light is incident on a face of the prism. The angle of minimum deviation is measured to be 40°. What is the refractive index of the materal of the prism? The refracting angle of the prism is 60°. If the prism is placed in water (refractive index 1.33), predict the new angle of minimum deviation of parallel beam of light.

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7. Double - convex lenses are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of cavature required if the focal length is to be 20 cm?

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8. A beam of light converges of at a point P. Now a lens is placed in the path of the

convergent beam 12 cm from P. At what point does the beam converge, if the lens is (a) a convex lens of focal length 20 cm, and (b) a concave lens of focal length 16 cm?

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9. An object of size 3.0 cm is placed 14 cm in front of a concave lens of focal length 21 cm. Describe the image produced by the lens. What happens if the object is moved further away from the lens?

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10. What is the focal length of a convex lens of focal length 30 cm in contact with a concave lens of focal length 20 cm? Is the system a converging or a diverging lens? Ignore thickness of the lenses.

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11. A compound microscope conists of an objective lens of focal length 2.0 cm and an

eyepiece of focal length 6.25 cm separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at (a) the least distance of distinct vision (25cm), and (b) at infinity? What is the magnifying power of the microscope in each case?

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12. A person with a normal near point (25 cm) using a compound microscope with objective

of focal length 8.0 mm and an eyepiece of focal length 2.5 cm can bring an object placed at 9.0 mm from the objective in sharp focus. What is the separation between the two lenses? Calculate the magnifying power of the microscope.

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13. A small telescope has an objective lens of focal length 144 cm and an eyepiece of focal length 6.0 cm. What is the magnifying power

of the telescope? What is the separation between the objective and the eyepiece?

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14. (a) A giant refracting telescope at an observatory has an objective lens of focal length 15 m. If an eyepiece of focal length 1.0 cm is used, what is the angular magnification of the telescope?

(b) If this telescope is used to view the moon, what is the diameter of the image of the moon

formed by the objective lens? The diameter of the moon is $3.48 \times 10^6 m$, and the radius of lunar orbit is $3.8 \times 10^8 m$.

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15. Use the mirror equation to deduce that :

(a) an object placed between f and 2f of a concave mirror produces a real image beyond 2f.

(b) a convex mirror always produces a virtual image independent of the locatioin of the

object.

(c) the virtual image produced by a convex mirror is always diminished in size and is located between the focus and the pole.

(d) an object placed between the pole and focus of a concave mirror procuces a virtual and enlarged image.

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16. A small pin fixed on a table top is viewed from above from a distance of 50 cm. By what

distance would the pin appear to be raised if it is viewed from the same point through a 15 cm thick glass slab held parallel to the table ? Refractive index of glass = 1.5. Does the answer depend on the location of the slab ?

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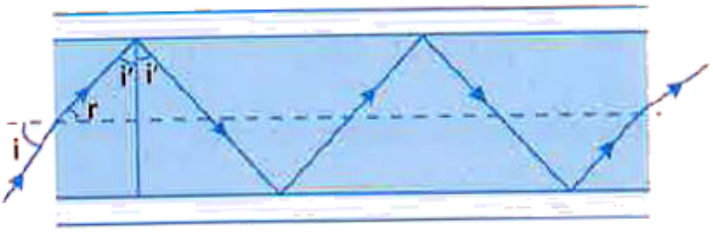
17. (a) Fig. 9.04 shows a cross-section of a Tight pipe' made of a glass fibre of refractive index 1.68. The outer covering of the pipe is made of a material of refractive index 1.44. What is the

range of the angles of the incident rays with the axis of the pipe for which total reflections inside the pipe take place, as shown in the figure.

(b) What is the answer if there is no outer covering of the pipe ?



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18. Answer the following questions :

(a) You have learnt that plane and convex mirrors produce virtual images of objects. Can they produce real images under some circumstances ? Explain.

(b) A virtual image, we always say, cannot be caught on a screen. Yet when we 'see' a virtual image, we are obviously bringing it on to the 'screen' (i.e., the retina) of our eye. Is there a contradiction ?

(c) A diver under water, looks obliquely at a fisherman standing on the bank of a lake.

Would the fisherman look taller or shorter to the diver than what he actually is ?

(d) Does the apparent depth of a tank of water change if viewed obliquely ? If so, does the apparent depth increase or decrease ?

(e) The refractive index of diamond is much greater than that of ordinary glass. Is this fact of some use to a diamond cutter ?

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19. The image of a small electric bulb fixed on the wall of a room is to be obtained on the opposite wall 3 m away by means of a large convex lens. What is the maximum possible focal length of the lens required for the purpose ?

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20. A screen is placed 90 cm from an object. The image of the object on the screen is

formed by a convex lens at two different locations separated by 20 cm. Determine the focal length of the lens.

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21. (a) Determine the 'effective focal length' of the combination of the two lenses in Exercise 9.10, if they are placed 8.0 cm apart with their principal axes coincident. Does the answer depend on which side of the combination a beam of parallel light is incident ? Is the

notion of effective focal length of this system useful at all ? <> (b) An object 1.5 cm in size is placed on the side of the convex lens in the arrangement (a) above. The distance between the object and the convex lens is 40 cm. Determine the magnification produced by the two-lens system, and the size of the image.

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22. At what angle should a ray of light be incident on the face of a prism of refracting

angle 60^{o} so that it just suffers total internal reflection at the other face ? The refractive index of the material of the prism is 1.524.

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23. A card sheet divided into squares each of size $1mm^2$ is being viewed at a distance of 9 cm through a magnifying glass (a converging lens of focal length 9 cm) held close to the eye. (a) What is the magnification produced by the lens ? How much is the area of each square in

the virtual image ?

(b) What is the angular magnification (magnifying power) of the lens ?

(c) Is the magnification in (a) equal to the magnifying power in (b) ? Explain.

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24. (a) At what distance should the lens be held from the figure in Exercise 9.23 in order to view the squares distinctly with the maximum possible magnifying power ?

(b) What is the magnification in this case ?

(c) Is the magnification equal to the magnifying power in this case ? Explain

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25. What should be the distance between the object in Exercise 9.24 and the magnifying glass if the virtual image of each square in the figure is to have an area of $6.25mm^2$. Would you be able to see the squares distinctly with your eyes very close to the magnifier ?

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26. Answer the following questions :

(a) The angle subtended at the eye by an object is equal to the angle subtended at the eye by the virtual image produced by a magnifying glass. In what sense then does a magnifying glass provide angular magnification ?

(b) In viewing through a magnifying glass, one usually positions one's eyes very close to the lens. Does angular magnification change if the

eye is moved back ?

(c) Magnifying power of a simple microscope is inversely proportional to the focal length of the lens. What then stops us from using a convex lens of smaller and smaller focal length and achieving greater and greater magnifying power ?

(d) Why must both the objective and the eyepiece of a compound microscope have short focal lengths ?

(e) When viewing through a compound microscope, our eyes should be positioned not on the eyepiece but a short distance away

from it for best viewing. Why ? How much should be that short distance between the eye and eyepiece ?

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27. An angular magnification (magnifying power) of 30 X is desired using an objective of focal length 1.25 cm and an eyepiece of focal length 5 cm. How will you set up the compound microscope ?

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28. A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. What is the magnifying power of the telescope for viewing distant objects when

(a) the telescope is in normal adjustment (i.e., when the final image is at infinity) ?

(b) the final image is formed at the least distance of distinct vision (25 cm) ?

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29. (a) For the telescope described in Exercise 9.28(a), what is the separation between the objective lens and the eyepiece ?

(b) If this telescope is used to view a 100 m tall tower 3 km away, what is the height of the image of the tower formed by the objective lens ?

(c) What is the height of the final image of the tower if it is formed at 25 cm ?

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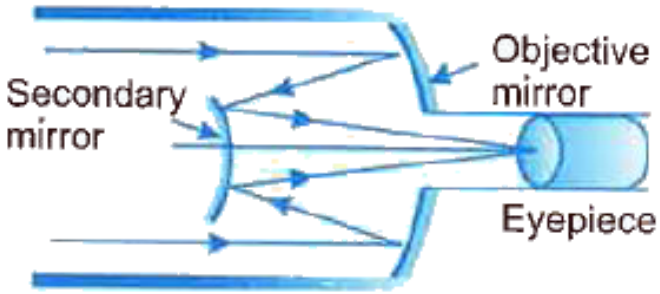
30. A Cassegrain telescope uses two mirrors as shown in Fig. 9.10. Such a telescope is built with the mirrors 20 mm apart. If the radius of curvature of the large mirror is 220 mm and the small mirror is 140 mm, where will the final image of an object at infinity be ?



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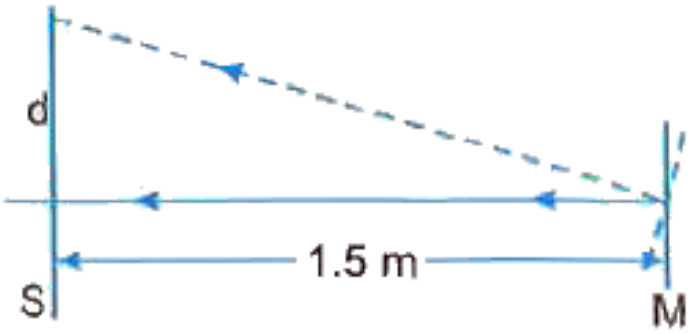
31. Light incident normally on a plane mirror attached to a galvanometer coil retraces backwards as shown in Fig. 9.11. A current in the coil produces a deflection of 3.5^{o} of the mirror. What is the displacement of the reflected spot of light on a screen placed 1.5 m away ?



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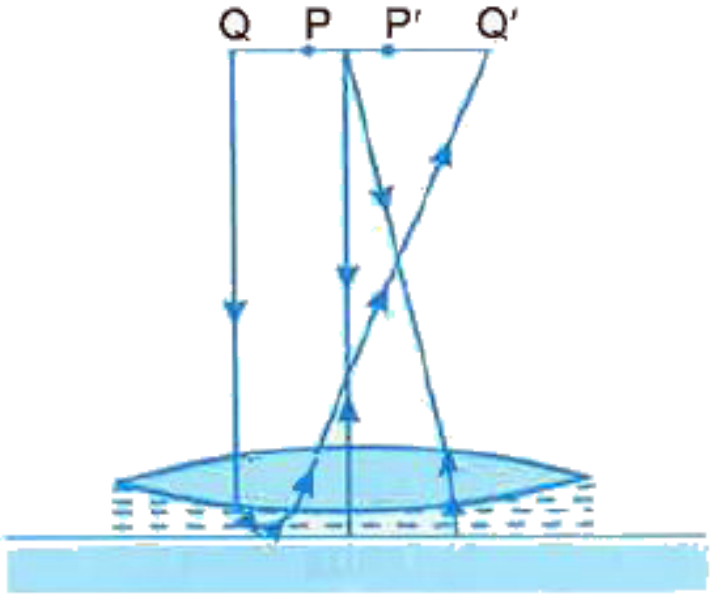
32. Fig. 9.12 shows an equiconvex lens (of refractive index 1.50) in contact with a liquid layer on top of a plane mirror. A small needle with its tip on the principal axis is moved along the axis until its inverted image is found at the position of the needle. The distance of the needle from the lens is measured to be 45.0 cm. The liquid is removed and the experiment is repeated. The new distance is measured to be 30.0 cm. What is the refractive

index of the liquid ?



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Case Based Source Based Integrated Questions

1. When an object is placed normally on the principal axis of a spherial mirror at a distance 'a' from its pole, its image is formed at a distance 'v' from the pole of mirror such that $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$, where f = focal length of given mirror.

The relation is called mirror formula and is true for all types of mirrors under all conditions. However, values of u, v and f must be put with proper signs are per the sign convention followed. If 'h' be the height of the linear object and h' the height of image, then

ratio $\frac{h'}{h}$ is called linear magnification or lateral magnification and its value m is given as :

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

(a) A planer object of length 3 cm and breadth 2 cm is held normal to the principal axis of a concave mirror of focal length 20 cm at a distance of 30 cm from its pole. Where is its image formed?

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2. When an object is placed normally on the principal axis of a spherial mirror at a distance 'a' from its pole, its image is formed at a distance 'v' from the pole of mirror such that $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$, where f = focal length of given mirror.

The relation is called mirror formula and is true for all types of mirrors under all conditions. However, values of u, v and f must be put with proper signs are per the sign convention followed. If 'h' be the height of the linear object and h' the height of image, then

ratio $\frac{h'}{h}$ is called linear magnification or lateral magnification and its value m is given as :

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

What is the surface area of image of linear object formed by the given concave mirror?

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3. When an object is placed normally on the principal axis of a spherial mirror at a distance 'a' from its pole, its image is formed at a

distance 'v' from the pole of mirror such that $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$, where f = focal length of given mirror.

The relation is called mirror formula and is true for all types of mirrors under all conditions. However, values of u, v and f must be put with proper signs are per the sign convention followed. If 'h' be the height of the linear object and h' the height of image, then ratio $\frac{h'}{h}$ is called linear magnification or lateral magnification and its value m is given as :

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

A small match box lies along the principal axis of a concave mirror and one end of match box is at centre of curvature of the mirror. Draw a ray diagram to show its image. Is its magnetification uniform?

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4. When an object is placed normally on the principal axis of a spherial mirror at a distance 'a' from its pole, its image is formed at a distance 'v' from the pole of mirror such that

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$, where f = focal length of given mirror.

The relation is called mirror formula and is true for all types of mirrors under all conditions. However, values of u, v and f must be put with proper signs are per the sign convention followed. If 'h' be the height of the linear object and h' the height of image, then ratio $\frac{h'}{h}$ is called linear magnification or lateral magnification and its value m is given as :

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

(d) Define longitudinal magnification.

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5. When an object is placed normally on the principal axis of a spherial mirror at a distance 'a' from its pole, its image is formed at a distance 'v' from the pole of mirror such that $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$, where f = focal length of given mirror.

The relation is called mirror formula and is true for all types of mirrors under all conditions. However, values of u, v and f must be put with proper signs are per the sign

convention followed. If 'h' be the height of the linear object and h' the height of image, then ratio $\frac{h'}{h}$ is called linear magnification or lateral magnification and its value m is given as :

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

(e) Find an expression for longitudinal magnification of a small object placed linearly along the axis of a spherical mirror.

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6. Lens maker's formula is a formula corelating the power P (or focal length f) of a lens to radii of curvature of the two surfaces of the lens and the refractive index of lens material with respect to its surroundings. The formula is expressed as :

$$P = \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

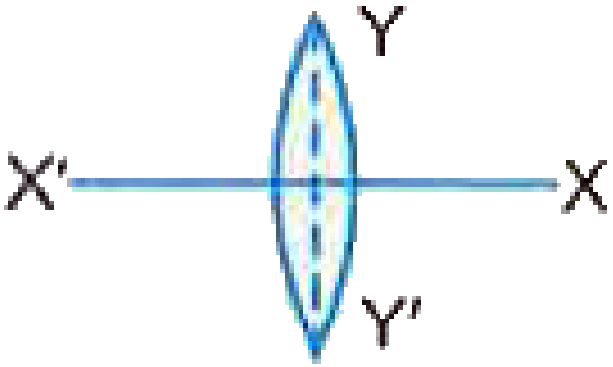
where n = refractive index of the material of lens with respect to its surroundings (ordinarily air) and R_1 and R_2 are the radii of curvature of two surfaces of the lens. The relation is true under all conditions but while

applying it we should put values of P, f, R_1 and R_2 with their proper signs as per sign convention being followed by us.

Let us have a bi- convex lens and let radii of curvature of both its curved surfaces is same i.e., $|R_1| = |R_2| = R$ (say)

Let the given biconvex lens be divided in two equal parts, as shown in Fig. (a), along a section YY' which is perpendicular to the principal axis of lens. What is the power of

each part?



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7. Lens maker's formula is a formula corelating the power P (or focal length f) of a lens to radii of curvature of the two surfaces of the lens and the refractive index of lens material with respect to its surroundings. The formula is

expressed as :

$$P = \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

where n = refractive index of the material of lens with respect to its surroundings (ordinarily air) and R_1 and R_2 are the radii of curvature of two surfaces of the lens. The relation is true under all conditions but while applying it we should put values of P, f, R_1 and R_2 with their proper signs as per sign convention being followed by us.

Let us have a bi- convex lens and let radii of curvature of both its curved surfaces is same i.e., $|R_1| = |R_2| = R \ \ (\text{say})$

How is your answer modified if the given biconvex lens is divided into two parts along a section XX' along its principal axis ?

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8. Lens maker's formula is a formula corelating the power P (or focal length f) of a lens to radii of curvature of the two surfaces of the lens and the refractive index of lens material with respect to its surroundings. The formula is expressed as :

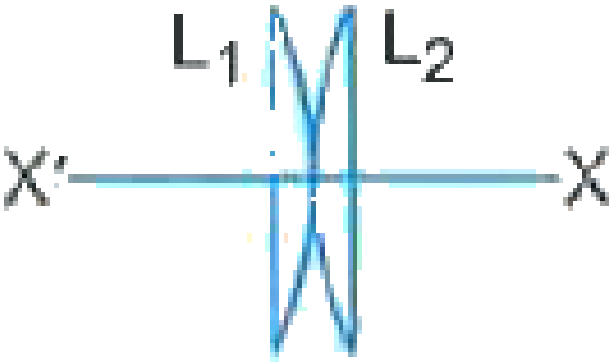
$$P = \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

where n = refractive index of the material of lens with respect to its surroundings (ordinarily air) and R_1 and R_2 are the radii of curvature of two surfaces of the lens. The relation is true under all conditions but while applying it we should put values of P, f, R_1 and R_2 with their proper signs as per sign convention being followed by us.

Let us have a bi- convex lens and let radii of curvature of both its curved surfaces is same i.e., $|R_1| = |R_2| = R$ (say)

If twoplanoconvex lenses fromed as a result of

(a) are joined together as shown in Fig. (b), what is the net power of the combination ?



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9. Lens maker's formula is a formula corelating the power P (or focal length f) of a lens to radii of curvature of the two surfaces of the lens

and the refractive index of lens material with respect to its surroundings. The formula is expressed as :

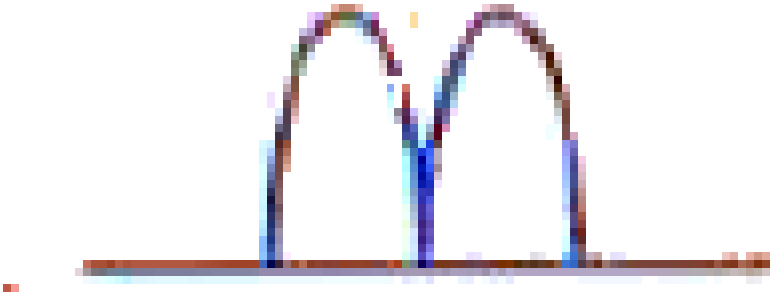
$$P = \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

where n = refractive index of the material of lens with respect to its surroundings (ordinarily air) and R_1 and R_2 are the radii of curvature of two surfaces of the lens. The relation is true under all conditions but while applying it we should put values of P, f, R_1 and R_2 with their proper signs as per sign convention being followed by us.

Let us have a bi- convex lens and let radii of

curvature of both its curved surfaces is same i.e., $|R_1| = |R_2| = R$ (say)

If two lens parts obtained in (b) are joined together as shown in Fig. (c), (i) what is the net power of the combination?



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10. Lens maker's formula is a formula corelating the power P (or focal length f) of a lens to radii of curvature of the two surfaces of the lens and the refractive index of lens material with respect to its surroundings. The formula is expressed as :

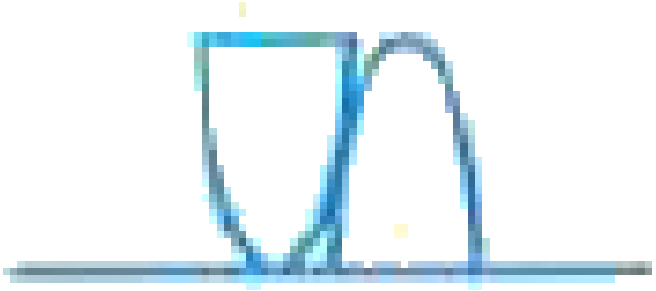
$$P = \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

where n = refractive index of the material of lens with respect to its surroundings (ordinarily air) and R_1 and R_2 are the radii of curvature of two surfaces of the lens. The relation is true under all conditions but while

applying it we should put values of P, f, R_1 and R_2 with their proper signs as per sign convention being followed by us.

Let us have a bi- convex lens and let radii of curvature of both its curved surfaces is same i.e., $|R_1| = |R_2| = R$ (say)

How is result of part (d) modified if two parts are placed together as shown in Fig. (c)(ii)?



(ii)

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11. Answer question (a) - (e) on the basis of data given in the following table and your understanding of the relation studied concepts :

In a school laboratory following lenses are available :

Serial no. of lens	1	2	3	4	5	6	7	8	9	10	11
Focal length of lens of f (cm)	50	100	100	20	10	5	3	25	5	2	2
Aperture of lens A (cm)	10	10	20	5	2	1	2	5	5	1	1.5

All these lenes are converging lenses.

Which two lenses would you select to design a compound microscope and why?

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12. Answer question (a) - (e) on the basis of data given in the following table and your understanding of the relation studied concepts :

In a school laboratory following lenses are available :

Serial no. of lens	1	2	3	4	5	6	7	8	9	10	11
Focal length of lens of f (cm)	50	100	100	20	10	5	3	25	5	2	2
Aperture of lens A (cm)	10	10	20	5	2	1	2	5	5	1	1.5

All these lenes are converging lenses.

Which two lenses would you choose to

prepare an astronomical telescope? Give reason for your choice.

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13. Answer question (a) - (e) on the basis of data given in the following table and your understanding of the relation studied concepts :

In a school laboratory following lenses are available :

Serial no. of lens	1	2	3	4	5	6	7	8	9	10	11
Focal length of lens of f (cm)	50	100	100	20	10	5	3	25	5	2	2
Aperture of lens A (cm)	10	10	20	5	2	1	2	5	5	1	1.5

All these lenes are converging lenses.

Draw the ray diagram for image formation of a far off object in normal arrangement of astronomical telescope.

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14. Answer question (a) - (e) on the basis of data given in the following table and your understanding of the relation studied concepts :

In a school laboratory following lenses are

available :

Serial no. of lens	1	2	3	4	5	6	7	8	9	10	11
Focal length of lens of f (cm)	50	100	100	20	10	5	3	25	5	2	2
Aperture of lens A (cm)	10	10	20	5	2	1	2	5	5	1	1.5

All these lenes are converging lenses.

(d) What should be teh distance between objective and eye piece of your telescope and what is the expected value of its magnifying power?

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15. Answer question (a) - (e) on the basis of data given in the following table and your

understanding of the relation studied concepts :

In a school laboratory following lenses are available :

Serial no. of lens	1	2	3	4	5	6	7	8	9	10	11
Focal length of lens of f (cm)	50	100	100	20	10	5	3	25	5	2	2
Aperture of lens A (cm)	10	10	20	5	2	1	2	5	5	1	1.5

All these lenes are converging lenses.

Why do we prefer an objective lens of large aperature in a telescope?

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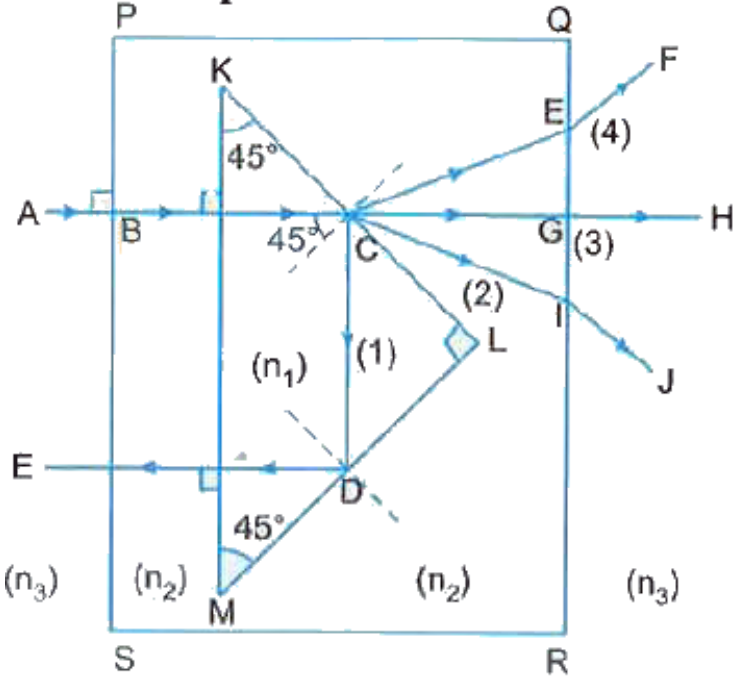
16. A ring angled isosceles prism KLM of refractive index n_1 is placed inside a rectangular block PQRS of refractive index n_2 as shown in the adjoining Fig. The rectangular box is surrounded by a medium of refractive index n_3. A ray of light AB enters the rectangular block normally. Depending upon the relationships between n_1, n_2 and n_3. it takes one of the four possible paths.



Under what condition the ray follows the path no. 1 (i.e., path ABCI)?

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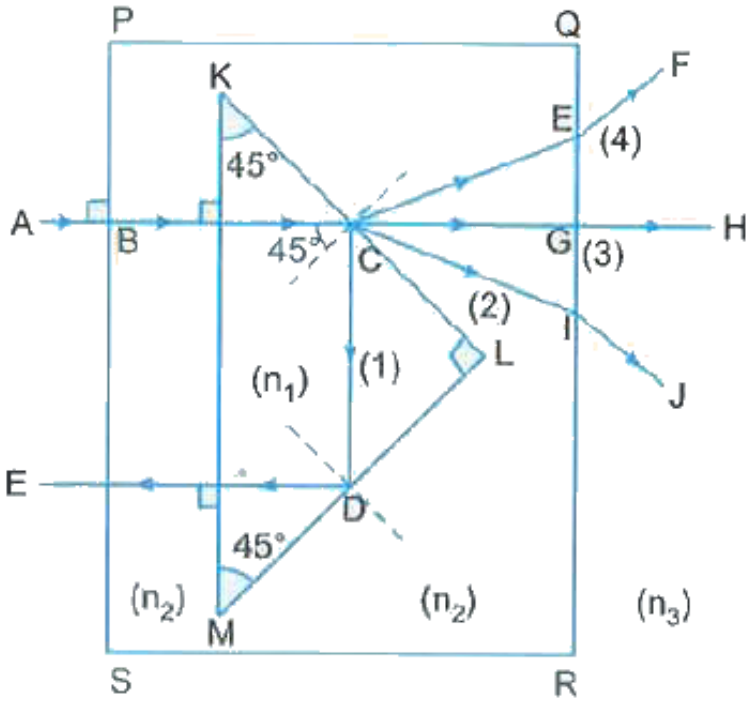
17. A ring angled isosceles prism KLM of refractive index n_1 is placed inside a rectangular block PQRS of refractive index n_2 as shown in the adjoining Fig. The rectangular box is surrounded by a medium of refractive index n_3. A ray of light AB enters the rectangular block normally. Depending upon the relationships between n_1, n_2 and n_3. it takes one of the four possible paths.



Under what condition the ray follows the path no. 2 (i.e., path ABCIJ)?

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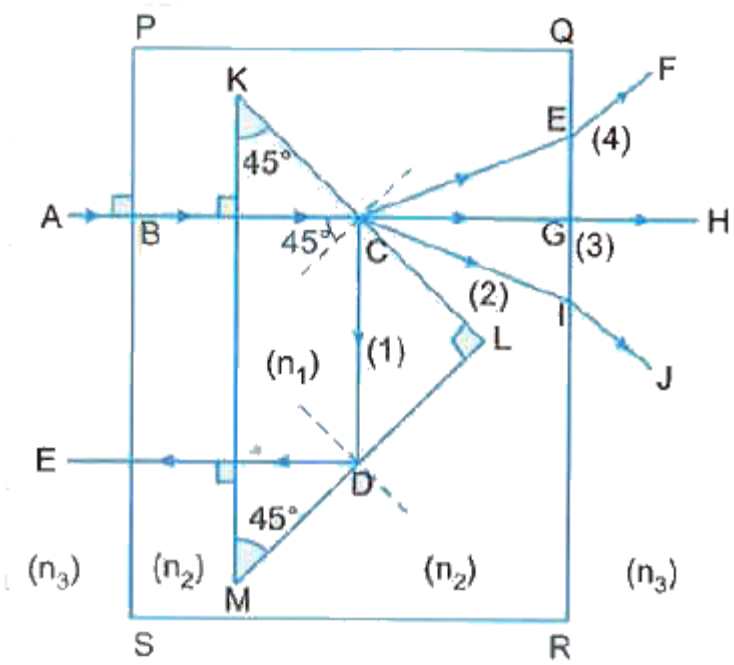
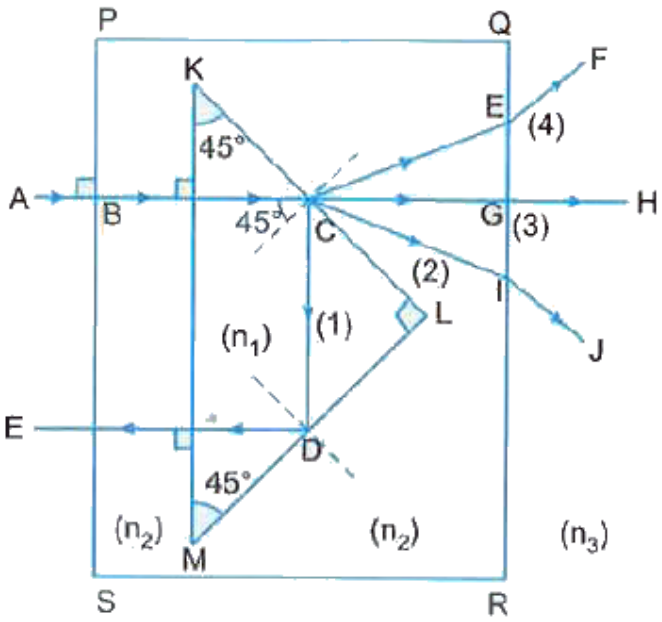
18. A ring angled isosceles prism KLM of refractive index n_1 is placed inside a rectangular block PQRS of refractive index n_2 as shown in the adjoining Fig. The rectangular box is surrounded by a medium of refractive index n_3. A ray of light AB enters the rectangular block normally. Depending upon the relationships between n_1, n_2 and n_3. it takes one of the four possible paths.



State the condition for light ray to travel along path no. 3 (i.e., path ABCGH).

View Text Solution

19. A ring angled isosceles prism KLM of refractive index n_1 is placed inside a rectangular block PQRS of refractive index n_2 as shown in the adjoining Fig. The rectangular box is surrounded by a medium of refractive index n_3. A ray of light AB enters the rectangular block normally. Depending upon the relationships between n_1, n_2 and n_3. it takes one of the four possible paths.



What is the condition for light ray to proceed along the path no. 4 (i.e., path ABCEF)?

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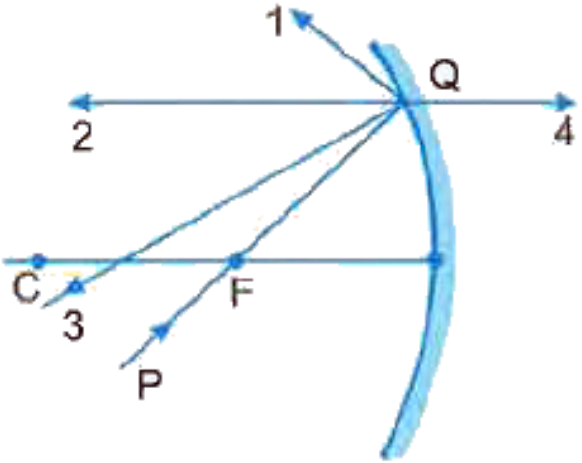
Multiple Choice Questions

1. The direction of ray of light incident on a concave mirror is shown by PQ in Fig. The direction in which the ray would travel after reflection is shown by four rays marked 1, 2, 3 and 4. Which of the four rays correctly shows the direction of reflected ray?



A. 1

B. 2

C. 3

D. 4

Answer: B

View Text Solution

2. The refractive index of a certain glass is 1.5 for light whose wavelength in vacuum is 6000Å. The wavelength of this light when it passes through glass is

A. 4000Å

B. 6000Å

C. 9000Å

D. 15000Å

Answer: A

View Text Solution

3. When a light wave goes from air into water, the quality that remains unchanged is its

A. speed.

B. amplitude.

C. frequency.

D. wavelength.

Answer: C

View Text Solution

4. The phenomenon utilised in an optical fibre is

A. refraction

B. interference

C. polarisation

D. total internal reflection.

Answer: D

View Text Solution

5. Brilliance of diamond is due to

A. shape.

B. cutting

C. reflection.

D. total internal reflection.

Answer: D

View Text Solution

6. A fish looking up through the wave sees the outside world contained in a circular horizon. If the refractive index of water is $\frac{4}{3}$ and the

fish is 12 cm below the surface, the radius of this circle in cm is

A. $36\sqrt{5}$

B. $4\sqrt{5}$

C. $36\sqrt{7}$

D. $\frac{36}{sqry7}$

Answer: D

View Text Solution

7. A planoconvex lens is made of refractive index 1.6. The radius of curvature of curved surface is 60 cm. The focal length of the lens is

A. 50 cm

B. 100 cm

C. 200 cm

D. 400 cm

Answer: B

View Text Solution

8. A ray of light incident at an angle θ on a refracting face of a prism emerges from the other face normally. If the angle of prism is 5° and the prism is made of a material of refractive index 1.5, the angle of incidence is

A. 7.5°

B. 5°

C. 15°

D. 2.5°

Answer: A

View Text Solution

9. A convex lens is dipped in a liquid whose refractive index is equal to the refractive index of the lens. Then its focal length will

A. become infinite.

B. becomes small but non-zero.

C. remain unchanged.

D. become zero.

Answer: A

View Text Solution

10. A convex lens is in contact with a concave lens. The magnitude of the ratio of their focal lengths is $\frac{2}{3}$. Their equivalent focal length is 30 cm. What are their individual focal lengths?

A. $-75cm, 50cm$

B. $-10m, 15cm$

C. $75cm, 50cm$

D. $-15cm, 10cm$

Answer: D

View Text Solution

11. A triangular prism of glass is shown in Fig. A ray incident normally to one face is totally reflected if $\theta = 45^\circ$. The index of refraction of glass is

A. less than 1.41

B. equal to 1.41

C. greater than 1.41

D. none of the above.

Answer: C

View Text Solution

12. When a lens of refractive index n_1 is placed in a liquid of refractive index n_2, the lens looks to be disappeared only if

A. $n_1 = \frac{n_2}{2}$

B. $n_1 = \frac{3}{4} n_2$

C. $n_1 = n_2$

D. $n_1 = \frac{5}{4} n_2$

Answer: C

View Text Solution

13. Two thin lenses of focal lengths f_1 and f_2 are in contact and conxial. The power of the combination is

A. $\frac{f_1 + f_2}{f_1 f_2}$

B. $\sqrt{\frac{f_1}{f_2}}$

C. $\sqrt{\frac{f_2}{f_1}}$

D. $\frac{f_1 + f_2}{2}$

Answer: A

View Text Solution

14. A biconvex lens (n = 1.5) has a radius of curvature of magnitude 20 cm. Which one of

the following options describe best the image formed of an object of height 2 cm place 30 cm from the lens?

A. real, inverted, height = 1cm

B. virtual, upright, height = 1 cm

C. virtual, upright, height = 0.5 cm

D. real, inverted, height = 4 cm

Answer: D

View Text Solution

15. A lens having focal length f and aperture of diameter d forms an image of intensity I. Aperture of diameter $\frac{d}{2}$ is central region of lens is covered by a black paper. Focal length of lens and intensity of image now will be respectively.

A. f and $\frac{3I}{4}$

B. $\frac{f}{2}$ and $\frac{I}{2}$

C. f and $\frac{I}{4}$

D. $2f$

Answer: A

View Text Solution

16. Given a point source of light, which of the following can produce a parallel beam of light?

A. Convex mirror

B. Concave mirror

C. Concave lens.

D. Two plane mirros inclined at an angle of 90°.

Answer: B

View Text Solution

17. A convex mirror has a focal length f. A real object is placed at a distance f in front of it from the pole produces an image at

A. infinity

B. f

C. $\frac{f}{2}$

D. 2f

Answer: C

View Text Solution

18. A concave mirror gives an image three times as large as the object placed at a distance of 20 cm from it. For the image to be real, the focal length should be

A. 10 cm

B. 15 cm

C. 20 cm

D. 30 cm

Answer: B

View Text Solution

19. The minimum distance between the object and its real image for a concave mirror is

A. f

B. 2f

C. 4f

D. zero

Answer: D

View Text Solution

20. A concave mirror of focal length f, in air, is immersed in water of refractive index $\frac{4}{3}$. The focal length of the mirror in water will be

A. f

B. $\frac{4}{3}f$

C. $\frac{3}{4}f$

D. $\frac{2}{3}f$

Answer: A

View Text Solution

21. When light travels from one medium to the other, whose refractive index is different, then which of the following will change

A. frequency, wavelength and speed.

B. frequency and wavelength.

C. frequency and speed.

D. wavelength and speed.

Answer: D

View Text Solution

22. A vessel of depth 2d is half filled with a liquid of refractive index n_1 and the upper half with a liquid of refractive index n_2. The

apparent depth of the vessel when seen normally from the top is

A. $d\left(\frac{n_1 n_2}{n_1 + n_2}\right)$

B. $d\left(\frac{1}{n_1} + \frac{1}{n_2}\right)$

C. $2d\left(\frac{1}{n_1} + \frac{1}{n_2}\right)$

D. $\frac{2d}{n_1 n_2}$

Answer: B

View Text Solution

23. Light travels through a glass plate of thickness 't' and having refractive index n. If c be the speed of light in air then the lime taken by the light to travel the thickness of glass plate is

A. $\frac{t}{nc}$

B. tnc

C. $\frac{nt}{c}$

D. $\frac{tc}{n}$

Answer: C

View Text Solution

24. On a glass plate, a light beam is incident at an angle of 60°. If the reflected and the refracted rays are mutually perpendicular, the refractive index of glass is

A. $\frac{\sqrt{3}}{2}$

B. $\sqrt{3}$

C. $\frac{3}{2}$

D. $\frac{1}{\sqrt{3}}$

Answer: B

View Text Solution

25. A transparent cube of 15 cm edge contains a small air bubble. Its apparent depth when viewed through one face is 6 cm and when viewed through the opposite face is 4 cm. The refractive index of the material of the cube is

A. 2.0

B. 2.5

C. 1.6

D. 1.5

Answer: D

View Text Solution

26. If the critical angle for total internal reflection from a medium to vaccum is 30°, the speed of light in the mediu is

A. $3 \times 10^{8} ms^{-1}$

B. $1.5 \times 10^8 ms^{-1}$

C. $\sqrt{3} \times 10^8 ms^{-1}$

D. $2 \times 10^8 ms^{-1}$

Answer: B

View Text Solution

27. A ray of light propagates from glass (refractive index $= \frac{3}{2}$) to water (refractive index $= \frac{4}{3}$). The value of the critical angel is

A. $\sin^{-1}\left(\frac{1}{2}\right)$

B. $\sin^{-1}\left(\sqrt{\frac{8}{9}}\right)$

C. $\sin^{-1}\left(\frac{8}{9}\right)$

D. $\sin^{-1}\left(\frac{3}{4}\right)$

Answer: C

View Text Solution

28. White light is incident on the interface of glass and air as shown in the Fig. If green light is just totally internally refracted then the

emerging rays in air contains

A. yellow, orange, red

B. violet, indigo, blue.

C. all colours.

D. all colours except green.

Answer: A

View Text Solution

29. A convex lens of focal length 40 cm is in contact with a concave lens of foal length 25 cm. The power of the lens combination is

A. $-1.5D$

B. $+1.5D$

C. $-6.5D$

D. $+6.5D$

Answer: A

View Text Solution

30. A biconvex lens of focal length 20 cm is made of glass of refreactive index $\frac{3}{2}$, when placed completely in water $\left(n_w = \frac{4}{3}\right)$, its focal length will be

A. 20 cm

B. 80 cm

C. 15 cm

D. 22.5 cm

Answer: B

View Text Solution

31. A diminished image of an object is to be obtained on a screen 1.0 m from it. This can be achieved by appropriately placing

A. a convex mirror of suitable focal length.

B. a concave mirror of suitable focal length.

C. a concave lens of suitable focal length.

D. a convex lens of suitable focal length less than 0.25 m.

Answer: D

View Text Solution

32. A concave lens of glass, refractive index 1.5, has both surface of same radius of curvature R. On immersion in a medium of refractive index 1.75, it will have as a

A. convergent lens of focal length 3.5R.

B. convergent lens of focal length 3.0R.

C. divergent lens of focal length 3.5R.

D. divergent lens of focal length 3.0R.

Answer: A

View Text Solution

33. An equiconvex lens is cut into 2 halves along (i) XOX' and (ii) YOY'' as shown in the Fig. Let $f, f_1 \text{ and } f_2$ and f_2 be the focal lengths of the complete lens, of each half in case (i) and of each half in case (ii) respectively, then

A. $f_1 = 2f, f_2 = f$

B. $f_1 = f, f_2 = f$

C. $f_1 = 2f, f_2 = 2f$

D. $f_1 = f, f_2 = 2f$

Answer: D

View Text Solution

34. A point object is placed at the centre of a glass sphere of radius 6 cm and refractive

index 1.5. The distance of the virtual image from the surface of the glass is

A. 2 cm

B. 4 cm

C. 6 cm

D. 12 cm

Answer: C

View Text Solution

35. The angle of minimum deviation for a prism is 40° and the angle of the prism is 60°. The angle of incidence in this position will be

A. 30°

B. 60°

C. 50°

D. 100°

Answer: C

View Text Solution

36. Angle of a prism 30° and its refractive index is $\sqrt{2}$ and one of the prism surface is silvered. At what angle of incidence, a ray should be incident on one surface so that after reflection from the silvered surface, it retraces its path

A. 30°

B. 60°

C. 45°

D. $\sin^{-1}\sqrt{1.5}$

Answer: C

View Text Solution

37. A ray of light passes through an equilateral glass prism in such a manner that the angle of incidence is equal to the angle of emergence and each of these is equal to $\frac{3}{4}$th of the angle of prism. The refractive index of the prism material is

A. $\frac{3}{2}$

B. $\sqrt{2}$

C. $\sqrt{3}$

D. $\frac{\sqrt{3}}{2}$

Answer: B

View Text Solution

38. In a compound microscope, the intermediate image is

A. virtual, erect and magnified.

B. real, erect and magnified.

C. real, inverted and magnified.

D. virtual, erect and diminished.

Answer: C

View Text Solution

39. If f_0 and f_e be the focal lengths of the objective and eyepiece respectively of an astronomical telescope, its magnifying power will be

A. $f_0 + f_e$

B. $f_0 \times f_e$

C. $\frac{f_0 \times f_e}{2}$

D. $\frac{f_0}{f_e}$

Answer: D

View Text Solution

Fill In The Blanks

1. An object viewed directly through a rectangular slan 12 cm thick appears to be raised by 4 cm. The refractive index of the material of slab is _____.

View Text Solution

2. A long vertical pin placed 40 cm in front of a concave mirror gives an image at the same position. The focal length of the mirror is _____.

View Text Solution

3. A light wave has a frequency of $4 \times 10^{14} Hz$ and wavelength on a water $\left[n_w = \frac{4}{3}\right]$ interface. The critical angle of incidence is _____.

View Text Solution

4. If a lens of focal lenth 20 cm, made of glass of refractive index 1.5, is placed in a liquid of

refractiven index 1.25, the focal length of the lens becomes _____.

View Text Solution

5. If a lens of focal length 20 cm, made of glass of refractive index 1.5, is placed in a liquid of refractive index 1.25, the focal length of the lens becomes _____.

View Text Solution

6. The radii of curvature R_1 and R_2 of an equiconvex lens is each 20 cm and the refractive index of the material is 1.5. Its focal length will be _____.

View Text Solution

7. A convex lens of focal length 40 cm is in contact with a concave lens of focal length 20 cm. The power of the combination is _____.

View Text Solution

8. A spherical air bubble is embedded in a piece of glass. For a light ray passing through it the bubble behaves as a _____.

View Text Solution

9. A convex lens of focal length 6 cm is to be used as magnifying glass. In order to produce an erect image which is 5 times magnified, the distance between the object and the lens should be _____.

View Text Solution

10. Critical angle for diamond (refractive index = 2.42) is _____

View Text Solution

11. While passing through a prism of angle 6° a ray of light undergoes a devation of 3°. The refractive index of the material of the prism is _____.

View Text Solution

12. A small telescope has an objective lens of focal length 60 cm and an eyepiece of focal length 4 cm. The magnifying power of the telescope is _____ and the separation between the objective and eyepiece is _____.

View Text Solution

13. In a compound microscope in normal adjustment magnification and produced by

objective lens is 10 cm magnification produced by the eyepiece is 8. Magnification of microscope is _____.

View Text Solution

14. A convex lens of focal length 2.5 cm is used as a magnifying glass. In normal adjustment its magnifying power is _____.

View Text Solution

15. It is observed that for refraction through a prism angle of incidence i is exactly equal to the angle of deviation δ. The prism is in _____.

View Text Solution

16. Optical fibers work on the principle of _____.

View Text Solution

17. As per Rayleigh's law the intensity of scattered light (I) depends on its wavelength (λ) as per relation _____.

View Text Solution

18. The box AB shown in Fig. 9.25 represents a _____.

View Text Solution

19. To remove _____ aberration we prefer to use a refractive type astronomical telescope.

View Text Solution

20. In a reflective astronomical telescope we use a _____ of larger aperture and large focal length as the _____

View Text Solution

True Or False

1. An air bubble in a jar of water shines brightly due to phenomenon of refraction.

View Text Solution

2. A virtual image cannot be formed on a screen but can be photographed.

View Text Solution

3. If objective and eyepiece lenses of a compound microscope are interchanged, it can work as a telescope.

View Text Solution

4. Four convex lenses of focal lengths 1 cm, 2 cm, 10 cm and 50 cm are available. Best pair of lenses for making a telescope will be $f_0 = 10cm$ and $f_e = 50cm$.

View Text Solution

5. A concave mirror and a concave lens are held in water. The focal length of both mirror as well as lens gets changed.

View Text Solution

6. Although the surface of a goggle lens are curved yet it does not have any power.

View Text Solution

7. Blue light is deviated more while undergoing refraction through a prism as compared to red light

View Text Solution

8. A concave lens made of a material of refractiven index n_g is immersed in a transparent medium of refractiven index n_w which is equal to n_g. The nature of the lens remains unchanged.

View Text Solution

9. Light undergoes successive total internal reflection as it moves through an optical fibre.

View Text Solution

10. The power of a lens is defined as the tangent of the angle by which it converges or diverges a beam of light falling at unit distant from the optical centre.

View Text Solution

Assertion Reason Type Questions

1. Assertion (A) : A double convex lens $\left(n_g = 1.5\right)$ has a focal length of 10 cm in air. When the lens is immersed in a medium of refractive index $n_m = \frac{4}{3}$, its focal length becomes 40 cm.

Reason (R) : $\frac{1}{f} = \left(\frac{n_g}{n_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: a

View Text Solution

2. Assertion (A) : The images formed by total internal reflections are much brighter than images formed by mirrors or lenses.

Reason (R) : There is no loss of intensity in total internal reflection.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: a

View Text Solution

3. Assertion (A) : The refractive index of a prism depends only on the kind of glass of which it is made of and the colour of light.

(Reason): The refractive index of a prism depends upon the refracting angle of the prism and the angle of minimum deviation.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: c

View Text Solution

4. Assertion (A): Critical angle of light passing from glass to air is least for light of violet colour. (Reason (R)): Refractive index of glass is maximum for violet light.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: a

View Text Solution

5. Assertion (A): Bluish colour predominates in a clear sky.

Reason (R): Light of shorter wavelengths is

scattered much more than light of longer wavelengths.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: a

View Text Solution

Very Short Answer Questions

1. Why are convex mirrors used as side view mirrors in vehicles ?

View Text Solution

2. When an object is placed between f and 2f of a concave mirror, would the image formed be (i) real or virtual, and (ii) diminished or magnified ?

View Text Solution

3. Define refractive index of a transparent medium ?

View Text Solution

4. If a ray of light propagates from a rarer to a denser medium, how does its frequency change ?

View Text Solution

5. Do the frequency and wavelength change when light passes from a rarer to a denser medium ?

View Text Solution

6. For the same angle of incidence, the angles of refraction in three different media A, B and C are 15^{o}, 25^{o} and 35^{o}, respectively. In which medium will the velocity of light be minimum ?

View Text Solution

7. When light travels from a rarer to a denser medium, the speed decreases. Does this decrease in speed imply a decrease in the

energy carried by the light wave ? Justify your answer.

View Text Solution

8. Write the relation between the refractive index and critical angle for a given pair of optical media.

View Text Solution

9. State the necessary conditions for the phenomenon of total internal reflection to occur.

View Text Solution

10. The refractive index of diamond is much greater than that of glass. How does a diamond cutter makes use of this fact ?

View Text Solution

11. Name the physical principle on which the working of optical fibres is based.

View Text Solution

12. An object is placed at the focus of a concave lens. Where will its image be formed ?

View Text Solution

13. Will the focal length of a lens for red light be more, same or less than that for blue light ?

View Text Solution

14. Under what condition does a biconvex lens of glass having a certain refractive index act as a plane glass sheet when immersed in a liquid ?

View Text Solution

15. A convex lens is held in water. What change, if any, do you expect in its focal length ?

View Text Solution

16. A converging lens of refractive index 1.5 is kept in a liquid medium having same refractive index. What would be the focal length of the lens in this medium ?

View Text Solution

17. A glass lens of refractive index 1.45 disappears when immersed in a liquid. What is the value of refractive index of the liquid ?

View Text Solution

18. How does the power of a convex lens vary, if the incident red light is replaced by violet light ?

View Text Solution

19. How would a biconvex lens appear when placed in a trough of liquid having the same refractive index as that of lens ?

View Text Solution

20. A biconcave lens made of a transparent material of refractive index 1.25 is immersed in water of refractive index 1.33. Will the lens behave as a converging or a diverging lens ? Give reason.

View Text Solution

21. A converging lens is kept coaxially in contact with diverging lens--- both the lenses being of equal focal lengths. What is the focal length of the combination ?

View Text Solution

22. A convex lens is placed in contact with a plane mirror. A point object at a distance of 20 cm on the axis of this combination has its

image coinciding with itself. What is the focal length of the lens ?

View Text Solution

23. A concave lens of refractive index 1.5 is immersed in a medium of refractive index 1.65. What is the nature of the lens ?

View Text Solution

24. Two thin lenses of power + 6 D and - 2 D are in contact. What is the focal length of the combination ?

View Text Solution

25. Two thin lenses of power - 4 D and 2 D are placed in contact coaxially. What is the focal length of the combination ?

View Text Solution

26. A lens of glass is immersed in water, what will be its effect on the power of the lens ?

View Text Solution

27. A glass lens of refractive index 1.5 is placed in a trough of liquid. What must be the refractive index of the liquid in order to mark the lens disappear ?

View Text Solution

28. The refractive index of the material of a concave lens is nv It is immersed in a medium of refractive index n2. A parallel beam of light is incident on the lens. Trace the path of emergent rays

View Text Solution

29. In the adjoining figure 9.27, path of a parallel beam of light passing through a convex lens of refractive index ng kept in a medium of refractive index nm is shown. Is (i)

$n_g = n_{mr}$ or (ii) $n_g > n_m$ or (iii) $n_g < n_m$?

View Text Solution

30. In the Fig. 9.28, path of a parallel beam of light passing through a convex lens of refractive index n_g kept in a medium of refractive index n_m is shown.

Is (i) $n_g = n_m$, or (ii) $n_g < n_m$ or (iii) $n_g > n_m$

View Text Solution

31. A ray of light after refraction through a concave lens travels parallel to its principal axis. By drawing a ray diagram, state the condition for it to occur ?

View Text Solution

32. What is the difference between virtual image formed by a convex lens and that formed by a concave lens ?

View Text Solution

33. A lens behaves as converging lens in air and a diverging lens in water $\left(n = \frac{4}{3}\right)$ the condition on the value of refractive index n of the material of the lens ?

View Text Solution

34. Using lens maker's formula, show how the focal length of a given lens depends upon the colour of light incident on it.

View Text Solution

35. What is the minimum distance, in terms of focal length of lens, between an object and its real image formed by a convex lens ?

View Text Solution

36. A lens of focal length f is splitted into two parts as shown in Fig. 9.30. What is the focal

length of either part ?

View Text Solution

37. A lens of focal length/is splitted into two halves as shown in Fig. 9.31. (a) (b) What is the focal length of each half ?

View Text Solution

38. Under what condition does the formation of rainbow occur ?

View Text Solution

39. Rainbow is never observed on the surface of the moon. Why ?

View Text Solution

40. An unsymmetrical double convex thin lens forms the image of a point object on its axis. Will the position of the image change if the lens is reversed ?

View Text Solution

41. A concave mirror of 20 cm focal length is immersed into water. What is its new focal length ?

View Text Solution

42. On what factors does the angle of minimum deviation produced by a prism depend ?

View Text Solution

43. How does the angle of minimum deviation of a glass prism vary, if the incident violet light is replaced by red light ? Give reason.

View Text Solution

44. Write the relationship between angle of incidence 'i', angle of prism 'A' and angle of minimum deviation for a triangular prism.

View Text Solution

45. A thin prism of 6.0^{o} angle gives a deviation of 3.0^{o}, what is the refractive index of material of prism ?

View Text Solution

46. How does the angle of minimum deviation of a glass prism of refractive index 1.5 change, if4t is immersed in a liquid of refractive index 1.3 ?

View Text Solution

47. Why is the value of angle of deviation for a ray of light undergoing refraction through a glass prism for different colours of light ?

View Text Solution

48. How does amount of scattering depend on the wavelength of light used ?

View Text Solution

49. Why does the bluish colour predominate in a clear sky ?

View Text Solution

50. For a simple microscope would you prefer a lens of higher focal length or smaller focal length ? Why?

View Text Solution

51. What is the magnifying power of a telescope whose objective and eyepiece have focal lengths 180 cm and 3 cm, respectively ?

View Text Solution

52. State the condition under which a large magnification can be achieved in an astronomical telescope.

View Text Solution

53. Define resolving power of a telescope.

View Text Solution

54. You are given following three lenses. Which two lenses will you use as an eyepiece and as an objective to construct an astronomical telescope ?

View Text Solution

Short Answer Questions

1. Show that the focal length of a spherical mirror is one half of its radius of curvature.

View Text Solution

2. Draw a ray diagram to show the image formation by a concave mirror when the object is kept between its focus and the pole. Using this diagram, derive the magnification formula for the image formed.

View Text Solution

3. Draw a ray diagram showing the formation of the image by a concave mirror of an object placed beyond its centre of curvature. If the lower half of the mirror's reflecting surface is covered, what effect will it have on the image ?

View Text Solution

4. Draw a ray diagram for a convex mirror showing the image formation of an object

placed anywhere in front of the mirror. Use this ray diagram to obtain the expression for its linear magnification.

View Text Solution

5. Define critical angle. Obtain a relation between the refractive index and critical angle for a pair of media. Does critical angle depend on the colour of light ? Explain.

View Text Solution

6. A ray of light while travelling from a denser to a rarer medium undergoes total internal reflection.

Derive the expression for the critical angle in terms of the speed of light in the respective media.

View Text Solution

7. Calculate the speed of light in a medium whose critical angle is 30^{o}.

View Text Solution

8. Monochromatic light of wavelength 589 nm is incident from air on a water surface. If refractive index for water is 1.33, find the wavelength, frequency and speed of the refracted light.

View Text Solution

9. (a) State the principle on which the working of an optical fibre is based.

(b) What are the necessary conditions for this phenomenon to occur ?

View Text Solution

10. Draw ray diagrams to show how specially designed prism make use of total internal reflection to obtain inverted image of the object by deviating rays (i) through 90^{o}, and (ii) through 180^{o}.

View Text Solution

11. Show by drawing a ray diagram, how a totally reflecting prism may be used to invert the image without changing its size and direction.

View Text Solution

12. The image of a candle is formed by a convex lens on a screen. The lower half of the lens is painted black to make it completely opaque. Draw the ray diagram to show the image formation. How will this image be

different from the one obtained when the lens is not painted black ?

View Text Solution

13. What do you mean by power of a lens ? Define its unit.

View Text Solution

14. Calculate the distance of an object of height h from a concave mirror of radius of

curvature 20 cm, so as to obtain a real image of magnification 2. Find the location of image also

View Text Solution

15. A concave mirror of focal length/produces a real image n times the size of the object. What is the distance of the object from the mirror ?

View Text Solution

16. A fish in a water tank sees the outside world as if it (the fish) is at the vertex of cone such that the circular base of the cone coincides with the surface of water. Given the depth of water where fish is located being h and the critical angle for water-air interface being ic, find out by drawing a suitable ray diagram the relationship between the radius of the cone and the height h.

View Text Solution

17. A beam of light converges at a point P. A concave lens of focal length 16 cm is placed in the path of this beam 12 cm from P. Draw a ray diagram and find the location of the point at which the beam would now converge.

View Text Solution

18. The radii of curvature of the faces of a double convex lens are 10 cm and 15 cm. If

focal length of the lens is 12 cm, find the refractive index of the material of the lens.

View Text Solution

19. A biconvex lens has a focal length $\frac{2}{3}$ times the radius of curvature of either surface. Calculate the refractive index of lens material.

View Text Solution

20. Find the radius of curvature of the convex surface of a plano-convex lens, whose focal length is 0.3 m and the refractive index of the material of the lens is 1.5.

View Text Solution

21. A converging lens has a focal length of 20 cm in air. It is made of a material of refractive index 1.6. If it is immersed in a liquid of

refractive index 1.3, what will be its new focal length ?

View Text Solution

22. A concave lens has the same radii of curvature for both sides and has a refractive index 1.6 in air. In the second case, it is immersed in a liquid of refractive index 1.4. Calculate the ratio of the focal lengths of the lens in two cases.

View Text Solution

23. A convex lens of focal length 10 cm is placed coaxially 5 cm away from a concave lens of focal length 10 cm. If an object is placed 30 cm in front of the convex lens, find the position of the final image formed by the combined system.

View Text Solution

24. A thin converging lens has a focal length 'f' in air. If it is completely immersed in a liquid,

briefly explain, how the focal length of the lens will vary ?

View Text Solution

25. Calculate the radius of curvature of an equi-concave lens of refractive index 1.5, when it is kept in a medium of refractive index 1.4, to have a power of - 5 D ?

View Text Solution

26. A convex lens of refractive index 1.5 has a focal length of 18 cm in air. Calculate the change in its focal length when it is immersed in water of refraction index $\frac{4}{3}$.

View Text Solution

27. A convex lens of focal length 25 cm is placed coaxially in contact with a concave lens of focal length 20 cm. Determine the power of

the combination. Will the system be converging or diverging in nature ?

View Text Solution

28. The following table gives the values of the angle of deviation for different values of the angle of incidence for a triangular prism :

(a) For what value of the angle of incidence, is the angle of emergence likely to be equal to the angle of incidence itself ?

(b) Draw a ray diagram showing the passage of a ray of light through this prism when the angle of incidence has the above value.

View Text Solution

29. A ray of light, incident on an equilateral glass prism ($\mu_g = \sqrt{3}$) moves parallel to the base line of the prism inside it. Find the angle of incidence for this ray.

View Text Solution

30. Plot a graph to show the variation of the angle of deviation as a function of angle of incidence for light rays passing through a prism. Write the relation for the refractive index of the prism in terms of the angle of minimum deviation and the angle of the prism.

View Text Solution

31. For a glass prism ($n = \sqrt{3}$) the angle of minimum deviation is equal to the angle of

the prism. Find the angle of prism.

View Text Solution

32. A ray of light passes through an equilateral glass prism in such a way that the angle of incidence is equal to the angle of emergence and each of these angles is $\frac{3}{4}$ times the angle of the prism. Determine the angle of deviation and the refractive index of the glass prism.

View Text Solution

33. A ray of light passing through an equilateral triangular glass prism from air undergoes minimum deviation when angle of incidence is $\frac{3}{4}$th th of the angle of prism. Calculate the speed of light in the prism.

View Text Solution

34. Two monochromatic rays of light are incident normally on the face AB of an isosceles right-angled prism ABC. The refractive indices of the glass prism for the

two rays "1" and "2" are respectively 1.35 and 1.45. Trace the path of these rays after entering through the prism.

View Text Solution

35. Obtain an expression for deviation suffered by a ray of light when refracted through a small angle prism.

View Text Solution

36. An equilateral glass prism has a refractive index 1.6 in air. Calculate the angle of minimum deviation of the prism, when kept in a medium of refractive index $4\sqrt{2}/5$

View Text Solution

37. (i) Why does the Sun appear reddish at sunset or sunrise ?

(ii) For which colour the refractive index of prism material is maximum and minimum ?

View Text Solution

38. Explain the scattering of light with an example.

View Text Solution

39. Light from a point source in air falls on a spherical glass surface (n = 1.5 and radius of curvature = 20 cm). The distance of the light source from the glass surface is 100 cm. At what position the image is formed ?

View Text Solution

40. Draw a ray diagram showing formation of image by a magnifying glass when the image is formed at infinity. Find the angular magnification of image.

View Text Solution

41. Draw labelled ray diagram to show image formation in a compound microscope. Write

the expression for its magnifying power.

View Text Solution

42. A compound microscope with an objective of 1.0 cm focal length and an eyepiece of 2.0 cm focal length has a tube length of 20 cm. Calculate the magnifying power of the microscope, if the final image is formed at the near point of the eye.

View Text Solution

43. Using the data given below, state as to which of the given lenses will you prefer to use as (z) an eyepiece, and (») an objective to design a compound microscope. Give reason for your answer.

View Text Solution

44. Define the magnifying power of a compound microscope when the final image is formed at infinity. Why must both the

objective and the eyepiece of a compound microscope has short focal lengths ? Explain.

View Text Solution

45. Draw a labelled ray diagram to show the image formation in an astronomical telescope for normal adjustment position. Write down the expression for its magnifying power.

View Text Solution

46. Draw a labelled ray diagram of an astronomical telescope in the near point adjustment. Write down the expression for its magnifying power.

View Text Solution

47. Draw a ray diagram of an astronomical telescope in the normal adjustment position. State two drawbacks of this type of telescope

View Text Solution

48. Using the data given below, state as to which of the given lenses will you prefer to use as (z) an eyepiece, and (ii) an objective, to construct an astronomical telescope. Give reason for your answer.

View Text Solution

49. Draw a ray diagram to show image formation for a (Cassegrain) reflecting

telescope. What is its magnifying power ?

View Text Solution

50. Draw a schematic diagram of a reflecting telescope (Cassegrain). Write its two advantages

View Text Solution

51. Write three distinct advantages of a reflecting type telescope over a refracting type

telescope.

View Text Solution

52. Modern telescopes prefer using suitable mirrors over using suitable lenses. Give two reasons for this preference.

View Text Solution

53. The magnifying power of an astronomical telescope in the normal adjustment position is

100. The distance between the objective and the eyepiece is 101 cm. Calculate the focal length of the objective and the eyepiece.

View Text Solution

54. A small telescope has an objective lens of focal length 150 cm and eyepiece of focal length 5 cm. What is the magnifying power of the telescope for viewing distant obj ects in normal adjustment ? If this telescope is used to view a 100 m tall tower 3 km away, what is

the height of the image of the tower formed by the objective lens ?

View Text Solution

Long Answer Questions I

1. With the help of a suitable ray diagram, derive the mirror formula for a concave mirror.

View Text Solution

2. (a) A mobile phone lies along the principal axis of a concave mirror. Show by suitable diagram the formation of its image. Explain, why the magnification is not uniform.

(b) Suppose the lower half of the concave mirror's reflecting surface is covered with an opaque material, what effect this will have on the image of the object ? Explain.

View Text Solution

3. Show that linear magnification of an image formed by a curved mirror may be expressed as :

$m = \frac{f}{f-u} = \frac{f-v}{f}$ where the letters have their usual meanings.

View Text Solution

4. An object of 3 cm height is placed at a distance of 60 cm from a convex mirror of

focal length 30 cm. Find the nature, position and size of the image formed.

View Text Solution

5. Define critical angle with reference to total internal reflection.

Calculate the critical angle for glass-air surface, if a ray of light which is incident in air on the glass surface is deviated through 15^{o}, when angle of incidence is 45^{o}.

View Text Solution

6. (a) Define the term 'critical angle' for a pair of media

(b) A point source of monochromatic light S is kept at the centre of the bottom of a cylinder of radius 15.0 cm. The cylinder contains water (refractive index $= \frac{4}{3}$ to a height of 7.0 cm. Draw the ray diagram and calculate the area of water surface through which the light emerges in air.

View Text Solution

7. Explain briefly how the phenomenon of total internal reflection is used in fibre optics.

View Text Solution

8. A converging beam of light travelling in air converges at a point P as shown in the Fig. 9.57. When a glass sphere of refractive index 1.5 is introduced in between the path of the beam, calculate the new position of the image. Also draw the ray diagram for the image

formed.

View Text Solution

9. A point 'O' marked on the surface of a glass sphere of diameter 20 cm is viewed through glass from the position directly opposite to the point O. If the refractive index of the glass is 1.5, find the position of the image formed. Also, draw the ray diagram for the formation

of the image.

View Text Solution

10. Obtain lens maker's formula using the expression $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$, propagating from a rarer medium of refractive index (n_1) to a denser medium of refractive index (n_2) is incident on the convex side of spherical refracting surface of radius of curvature R.

View Text Solution

11. An equiconvex lens of refractive index n, focal length/and radius of curvature R is immersed in a liquid medium of refractive index n_m. For (?) $n_m > n$, and (ii) $n_m < n$, draw the ray diagrams in the two cases when a beam of light coming parallel to the principal axis is incident on the lens. Also find the focal length of the lens in terms of the original focal length and the refractive indices of the lens and that of the medium.

View Text Solution

12. Draw a ray diagram to show the formation of the image of an object placed between the optical centre and principal focus of a convex lens. Deduce the relationship between the object distance, image distance and focal length under the conditions stated.

View Text Solution

13. Derive the lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ for a concave lens, using the necessary ray diagram.

View Text Solution

14. Draw a ray diagram to show how the image is formed when the object is placed between/and 2/distances from a convex lens. Deduce the relation between the distances of the object and the image from the lens and

the focal length of the lens under this condition.

View Text Solution

15. An illuminated object and a screen are placed 90 cm apart. Determine the focal length and nature of the lens required to produce a clear image on the screen, twice the size of the object.

View Text Solution

16. Show that a convex lens produces an N times magnified image when the object distances from the lens have magnitudes $\left(f \pm \frac{f}{N}\right)$ Hence, find the two values of object distance for which a convex lens of power 2.5 D will produce an image that is 4 times as large as the object ?

View Text Solution

17. A convex lens is used to obtain a magnified image of an object on a screen 10 m from the

lens. If the magnification is 19, find the focal length of the lens.

View Text Solution

18. A convex lens of focal length f_1 is kept in contact with another lens of focal length/2. Find an expression for the focal length of the combination.

View Text Solution

19. A double convex lens made of glass refractive index 1.6 has its both surfaces of equal radii of curvature of 30 cm each. An object of 5 cm height is placed at a distance of 12.5 cm from the lens. Find the position, nature and size of the image.

View Text Solution

20. You are given three lenses L_1, L_2 and L_3 each of focal length 20 cm. An object is kept at

40 cm in front of Lv as shown [Fig. 9.67]. The final real image is formed at the focus T of L_3. Find the separations between L_1, L_2 and L_3

View Text Solution

21. In the following diagram, an object 'O' is placed 15 cm in front of a convex lens L_1 of focal length 20 cm and the final image is formed at T at a distance of 80 cm from the second lens L_2. Find the focal length of the

lens L_2

 .

View Text Solution

22. Three lenses of focal lengths + 10 cm, - 10 cm and + 30 cm are arranged coaxially as in the [Fig. 9.70] given below. Find the position of the final image formed by the combination.

View Text Solution

23. (a) Calculate the distance of an object of height h from a concave mirror of radius of curvature 20 cm, so as to obtain a real image of magnification 2. Find the location of image also.

(b) Using mirror formula, explain why does a convex mirror always produce a virtual image.

View Text Solution

24. A convex lens made up of glass of refractive index 1.5 is dipped, in turn, in (i) a

medium of refractive index 1.65, (ii) a medium of refractive index 1.33.

(a) Will it behave as a converging or a diverging lens in the two cases ?

(b) How will its focal length change in the two media ?

View Text Solution

25. A symmetric biconvex lens of radius of curvature R and made of glass of refractive index 1.5, is placed on a layer of liquid placed

on top of a plane mirror as shown in the figure. An optical needle with its tip on the principal axis of the lens is moved along the axis until its real, inverted image coincides with the needle itself. The distance of the needle from the lens is measured to be x. On removing the liquid layer and repeating the experiment, the distance is found to be y. Obtain the expression for the refractive index of the liquid in terms of x and y.

View Text Solution

26. Three rays of light — red (R), green (G) and blue (B) — are incident on the face AB of a right-angled prism ABC. The refractive indices of the material of the prism for red, green and blue wavelengths are 1.39, 1.44 and 1.47, respectively. Trace the path of the rays through the prism. How will the situation change if these rays were incident normally on one of the faces of an equilateral prism ?

View Text Solution

27. Write the conditions for observing a rainbow. Show, by drawing suitable diagrams, how one understands the formation of rainbow.

View Text Solution

28. Draw a ray diagram showing the path of a ray of light entering through a triangular glass prism. Deduce the expression for the refractive index of glass prism in terms of the

angle of minimum deviation and angle of the prism.

View Text Solution

29. A ray PQ is incident normally on the face AB of a triangular prism of refracting angle 60°, made of a transparent material of refractive index $\frac{2}{\sqrt{3}}$, as shown in Fig.

Trace the path of the ray as it passes through the prism. Also calculate the angle of emergence and angle of deviation.

View Text Solution

30. (i) A ray of light incident on face AB of an equilateral glass prism, shows minimum deviation of 30°. Calculate the speed of light through the prism.

(ii) Find the angle of incidence at face AB so that the emergent ray grazes along the face AC.

View Text Solution

31. Draw a labelled diagram showing image formation by a simple microscope when the image is being formed at least distance of its distinct vision. Find an expression for its angular magnification (or the magnifying power.

View Text Solution

32. (i) Draw a neat labelled ray diagram of an astronomical telescope in normal adjustment.

Explain briefly its working.

(ii) An astronomical telescope uses two lenses of powers 10 D and 1 D. What is its magnifying power in normal adjustment ?

View Text Solution

33. Draw a ray diagram to show the formation of image by an astronomical telescope when the final image is formed at the near point. Answer the following giving reasons :

(i) Why the objective has a larger focal length

and a larger aperture than the eyepiece ?

(ii) What would be the effect on the resolving power of the telescope if its objective lens is

View Text Solution

34. i) Draw a neat labelled ray diagram of a compound microscope. Explain briefly its working.

(ii) Why must both the objective and the eyepiece of a compound microscope have short focal lengths ?

View Text Solution

35. (a) Draw a labelled ray diagram showing the formation of a final image by a compound microscope at least distance of distinct vision.

(b) The total magnification produced by a compound microscope is 20. The magnification produced by the eyepiece is 5. The microscope is focussed on a certain object. The distance between the objective and eyepiece is observed to be 14 cm. If least distance of distinct vision is 20 cm, calculate

the focal length of the objective and the eyepiece.

View Text Solution

36. Draw a ray diagram showing the image formation by a compound microscope. Hence, obtain expression for total magnification when the image is formed at infinity.

View Text Solution

37. A compound microscope uses an objective lens of focal length 4 cm and eyepiece lens of focal length 10 cm. An object is placed at 6 cm from the objective lens. Calculate the magnifying power of the compound microscope. Also calculate the length of the microscope

View Text Solution

38. Which two of the following lenses L_1, L_2 and L_3 will you select as objective and eyepiece for constructing best possible (i) telescope, (it) microscope ? Give reason to support your answer.

View Text Solution

Long Answer Questions Ii

1. A ray 'PQ' of light is incident on the face AB of a glass prism ABC [Fig. 9.86] and emerges out of the face AC. Trace the path of the ray. Show that

$\angle i + \angle e = \angle A + \angle B$

where δ and e where 8 and e denote the angle of deviation and angle of emergence respectively.

(b) Plot a graph showing the variation of the angle of deviation as a function of angle of incidence. State the condition under which $\angle\delta$ is minimum.

(c) Find out the relation between the refractive index $\angle A$ of the glass prism and $\angle A$ for the case when the angle of prism (A) is equal to the angle of minimum deviation (δ_m). Hence, obtain the value of the refractive index for angle of prism A = 60°.

View Text Solution

2. Draw a ray diagram to show the formation of the real image of a point object due to a

convex spherical refracting surface, when the ray of light is travelling from a rarer medium of refractive index nx to a denser medium of refractive index n_2 .

Using this diagram derive the relation between object distance (w), image distance (v), radius of curvature (R) of a convex spherical surface. State the sign convention and the assumptions used.

View Text Solution

3. (a) A point object is placed on the principal axis of a convex spherical surface of radius of curvature R, which separates the two media of refractive indices nx and $n_2(n_2 > n_1)$

Draw the ray diagram and deduce the relation between the object distance (w), image distance (v) and the radius of curvature (R) for refraction to take place at the convex spherical surface from rarer to denser medium.

(b) A converging lens has a focal length of 20 cm in air. It is made of a material of refractive

index 1.6. If it is immersed in a liquid of refractive index 1.3, find its new focal length.

View Text Solution

4. Derive the mathematical relation between refractive indices n_1 and n_2 of two media and radius of curvature R for refraction at a convex spherical surface. Consider the object to be a point one lying on the principal axis in rarer medium of refractive index nt and a real image formed in the denser medium of refractive

index n_2. Hence, derive lens maker's formula.

(ii) Light from a point source in air falls on a convex spherical glass surface of refractive index 1.5 and radius of curvature 20 cm. The distance of light source from the glass surface is 100 cm. At what position is the image formed ?

View Text Solution

5. Draw a ray diagram for the formation of image of a distant object by an astronomical

telescope in normal adjustment position. Deduce the expression for its magnifying power.

View Text Solution

6. With the help of a ray diagram, explain the formation of image in an astronomical telescope for a distant object. Define the term magnifying power of a telescope. Derive an expression for its magnifying power when the

final image is formed at the least distance of distinct vision.

View Text Solution

7. (a) Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in normal adjustment position. Define its magnifying power.

(b) You are given three lenses of power 0.5 D, 4 D and 10 D to design a telescope,

(i) Which lenses should be used as objective

and eyepiece ? Justify your answer.

(ii) Why is the aperture of the objective preferred to be large ?

View Text Solution

8. (a) Draw a ray diagram to show the working of a compound microscope. Deduce an expression for the total magnification when the final image is formed at the near point.

(b) In a compound microscope, an object is placed at a distance of 1.5 cm from the

objective of focal length 1.25 cm. If the eyepiece has a focal length of 5 cm and the final image is formed at the near point, estimate the magnifying power of the microscope

View Text Solution

9. How is the working of a telescope different from that of a microscope ?

The focal lengths of the objective and eyepiece of a microscope are 1.25 cm and 5 cm

respectively.

Find the position of the object relative to the objective in order to obtain an angular magnification of 30 in normal adjustment.

View Text Solution

Self Assessment Test Section A Multiple Choice Questions

1. A convex mirror of focal length f forms an image which is $\frac{1}{n}$ times the object. The

distance of the object from the mirror is

A. $(n-1)f$

B. $\left(\frac{n-1}{n}\right)f$

C. $\left(\frac{n+1}{n}\right)f$

D. $(n+1)f$

Answer: A

View Text Solution

2. Consider telecommunication through optical fibres. Which of the following statements is not true?

A. Optical fibres may have homogeneous core with a suitable cladding.

B. Optical fibres can be of graded refractive index.

C. Optical fibres are subject to electromagnetic interference from outside.

D. Optical fibres have extremely low transmission loss.

Answer: C

View Text Solution

3. A convex lens can be fixed at two different positions between a burning candle and a screen so as to form sharp image of candle on the screen. If I_1 and I_2 be the size of the images respectively for the two positions of

lens then the true size of the candle is given by

A. $\frac{I_1}{I_2}$

B. $I_1 \times I_2$

C. $\sqrt{I_1 I_2}$

D. $\frac{I_2}{I_1}$

Answer: C

View Text Solution

4. A ray of light is incident at an angle of 60° on one face of a prism of angle 30°. They ray emerges normally from the other face of the prism. The refractive index of the prism material is

A. $\sqrt{2}$

B. $\sqrt{3}$

C. 2

D. 3

Answer: B

View Text Solution

5. An astronomical telescope has an angular magnification of magnitude 5 for distant object. The seperation between the objective and the eyepiece is 36 cm. and the final image is formed at infinity. The focal length f_0 of the objective and the focal length f_e of the eyepiece are

A. $f_0 = 45cm, f_e = -9cm$

B. $f_0 = 7.2cm, f_e = 5cm$

C. $f_0 = 50cm, f_e = 10cm$

D. $f_0 = 30cm, f_e = 6cm$

Answer: D

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Self Assessment Test Section A Fill In The Blanks

1. To increase the intensity of image of a distant object formed by a telescope we use a telescope objective of _____.

View Text Solution

2. In the minimum deviation position the refracted the refracted ray in the prism is _____ to the base of prism.

View Text Solution

3. In a Cassegrain telescope a large aperture ____mirror and a small aperture _____mirror is used.

View Text Solution

Self Assessment Test Section B

1. A beam of light converges at aoint P. Now a convex lens is placed in the path of the convergent beam at 15 cm from P. At what point does a beam converge if the convex lens has a focal length 10 cm?

View Text Solution

2. A fish in a water tank sees the outside world as if it (the fish) is at the vertex of cone such that the circular base of the cone coincides with the surface of water. Given the depth of water where fish is located being h and the critical angle for water - air interface being i_C, find out by drawing a suitable ray diagram the relationship between the radius of the cone and the height h.

View Text Solution

3. A converging lens is kept coaxially in contact with diverging lens -- both the lenses being of equal focal lengths. What is the focal length of the combination?

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