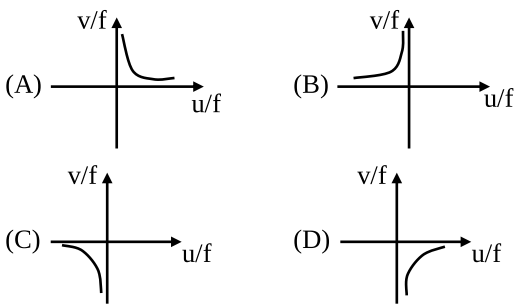
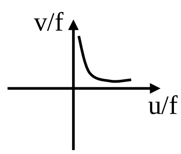
Q.1 A virtual erect image by a diverging lens is represented by (u, v, f are coordinates)



[A]

Sol.



Q.2 Two thin lens have a combined power of 10 D in contact. When separated by 20 cm their equivalent power is 6.25 D. Find their individual powers in dioptres –

(A) 3.5 and 6.5 (B) 5 and 5

(C) 7.5 and 2.5 (D) 9 and 1 **[C]**

Sol. $P = P_1 + P_2 \Rightarrow 10 = \frac{1}{f_1} + \frac{1}{f_2}$

$P = P_1 + P_2 - d\,P_1P_2 \Rightarrow 6.25 = \frac{1}{f_1} + \frac{1}{f_2} - \frac{20}{f_1 f_2}$

On solving (C) option is obtained

Q.3 The exposure time of a camera a lens at f/2.8 setting is 1/200 seconds. The correct time of exposure for f/5.6 setting is -

(A) 0.04 sec (B) 0.20 sec

(C) 0.40 sec (D) 0.02 sec **[D]**

Sol. $(\text{f. no})^2 \propto t$

$\left(\frac{2.8}{5.6}\right)^2 = \frac{1/200}{t}$

$t = \frac{1}{50} = 0.02$ sec

Q.4 For a spherical surface of radius of curvatures R, separating two media of refractive index μ_1 and μ_2, the two principal focal lengths are f_1 and f_2 respectively. Which relation is correct -

(A) $f_1 = f_2$

(B) $f_2/\mu_2 = f_1/\mu_1$

(C) $f_2/\mu_2 = -f_1/\mu_1$

(D) $-f_2/\mu_1 = f_1/\mu_2$ **[C]**

Sol. The surface has two principal focus given by

$f_1 = \frac{-R}{\mu - 1}$, $f_2 = \frac{\mu R}{\mu - 1}$

$f_2 = -\mu f_1 \Rightarrow f_2 = -\frac{\mu_2}{\mu_1} f_1$

Q.5 A converging lens forms a real image I on its optical axis. A rectangular glass slab of refractive index μ and thickness t is introduced between the lens and I. I will move -

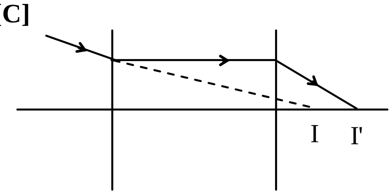
(A) away from the lens by $t(\mu - 1)$

(B) towards the lens by $t(\mu - 1)$

(C) away from the lens by $t(1 - 1/\mu)$

(D) towards the lens by $t(1 - 1/\mu)$

Sol. **[C]**



Rays coming from the lens formed the image at I initially due to refraction in the slab, the rays would move as shown and form the image at I'.

Q.6 A man who wears glasses of power 3 diopters must hold a newspaper at least 25 cm away to see the print clearly. How far away would the newspaper have to be if he took off the glasses and still wanted clear vision?

(A) Hold the paper 1m away

(B) Hold the paper 33.3cm away

(C) Hold the paper 100m away

(D) Hold the paper 2m away **[A]**

Sol. The virtual image formed by the lens is at the naked eye's true near point.

$\therefore$ P = 25 cm

$f = \frac{1}{P} = \frac{1}{3}$ m = 33.3 cm

$\therefore \frac{1}{25} + \frac{1}{q} = \frac{1}{33.3}$

$\therefore \frac{1}{q} = -0.01$

$\therefore$ q = – 100 cm

$\therefore$ When the man is not wearing the glasses he should hold the newspaper 1m away for clear vision.

The answer is (A).

Q.7 A plano-convex lens has focal length of 20 cm. If its plane surface is silvered, then new focal length will be -

(A) 10 cm (B) 15 cm

(C) – 10 cm (D) – 15 cm

Sol. **[C]** $\frac{1}{F} = \frac{-2}{f_L} + \frac{2}{R}$

$\Rightarrow \frac{1}{F} = \frac{-2}{+20} + \frac{2}{\infty}$

$\therefore$ F = –10 cm

Q.8 An object is placed at a distance of 0.4m from a lens having focal length 0.3 m. The object is moving towards the lens at a speed of 0.01 m/s. What is the rates of change of position of image and lateral magnification of image ?

(A) 3, 0.03 m/s (B) 9, 0.09 m/s

(C) 3, 0.09 m/s (D) 9, 0.03 m/s

Sol. **[C]** u = – 0.4 m = – 40 cm, v = ?

f = 0.3 m = 30 cm

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

$\frac{1}{30} = \frac{1}{v} - \frac{1}{-40} \Rightarrow v = 120\,cm$

Lateral magnification $m = \frac{v}{u} = \frac{120cm}{-40cm} = -3$

$\boxed{m = -3}$

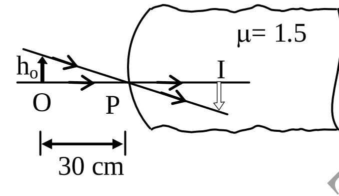
Velocity of image = $m^2 \times$ velocity of object

$= 3^2 \times 0.01$ m/s

$\boxed{v_I = 0.09\ m/s}$

Option (C) is correct.

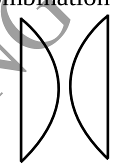
Q.9 A small object of height 0.5 cm is placed in front of a convex surface of glass (μ = 1.5) of radius of curvature 10 cm. Find the height of the image formed in glass .



(A) 2 cm (B) 1 cm

(C) 3 cm (D) 4 cm **[B]**

Q.10 If the space between the lenses in the lens combination shown were filled with water, what would happen to the focal length and power of the lens combination?



Focal Length	Power
(A) Decreased	increased
(B) Decreased	unchanged
(C) Increased	unchanged
(D) Increased	decreased

Sol. [D] $P = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

μ-decreases, P-decreases, f-increases

Q.11 At what distance from a convex lens of focal length 30 cm, an object should be placed so that the size of image be half of object -

(A) 30 cm (B) 60 cm

(C) 15 cm (D) 90 cm

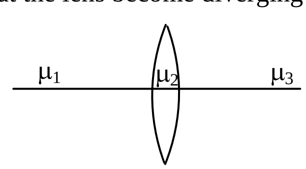
Sol. **[D]** $m = \frac{f}{f+u}$

$\therefore -\frac{1}{2} = \frac{+30}{+30+u}$

30 + u = – 60

$\therefore$ u = – 90 cm

Q.12 The diagram shows an equiconvex lens. What should be the condition on the refractive indices so that the lens become diverging -



(A) $2\mu_2 > \mu_1 - \mu_3$ (B) $2\mu_2 < \mu_1 + \mu_3$
(C) $2\mu_2 > 2\mu_1 - \mu_3$ (D) $2\mu_2 > \mu_1 + \mu_3$ **[B]**

Sol. $\frac{\mu_3}{v} - \frac{\mu_1}{-\infty} = \frac{\mu_2 - \mu_1}{R} + \frac{\mu_3 - \mu_2}{-R}$

v should be – ve

$\Rightarrow \frac{(\mu_2 - \mu_1) - (\mu_3 - \mu_2)}{R} < 0$

$\Rightarrow 2\mu_2 < \mu_1 + \mu_3$

Q.13 A double convex lens made of material of refractive index 1.5 and having a focal length of 10 cm is immersed in a liquid of refractive index 3.0. The lens will behave as

(A) Converging lens of focal length 10 cm
(B) diverging lens of focal length 10 cm
(C) converging lens of focal length 10/3 cm
(D) converging lens of focal length 30 cm. **[B]**

Q.14 A point source of light is placed at a distance of 2 f from a converging lens of focal length f. The intensity on the other side of the lens is maximum at a distance

(A) *f* (B) between *f* and 2 *f*
(C) 2 *f* (D) more than 2 **[C]**

Q.15 An experimenter needs to heat a small sample to 900 K, but the only available oven has a maximum temperature of 600 K. Could the experimenter heat the sample to 900 K by using a large lens to concentrate the radiation from the oven into the sample ?

(A) Yes, if the sample is placed at the focal point of the lens.
(B) No, because it would violate the law of conservation of energy
(C) No, because it would violate the second law of thermodynamics
(D) Yes, if the areas of the front of the oven is at least as much as the area of the front of the sample.

Sol. **[A]**

The temperature of the sun is not sufficient of burn a paper. But by focussing by a lens one can concentrate the energy into a small beam. This does not violate the conservation of energy because we are only concentrating the available energy. A lens does not generate energy. The same thing is true when the oven replaces the sun.

Q.16 The magnification of an object is +2 when placed at 20 cm from a convex lens. To obtain magnification of –2, the object should be moved a distance equal to -

(A) 10 cm (B) 20 cm
(C) 30 cm (D) 40 cm

Sol. **[B]** When m = +2

$\Rightarrow$ u = – x; v = – 2x; f = +20

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

$\Rightarrow -\frac{1}{2x} + \frac{1}{x} = \frac{1}{20}$

x = 10 cm

when m = – 2

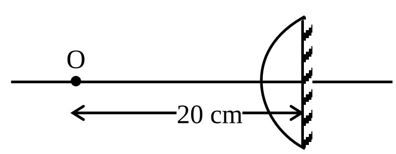
u = – y; v = + 2y; f = +20

$\frac{1}{2y} + \frac{1}{y} = \frac{1}{20}$

$\Rightarrow$ y = 30 cm

$\Rightarrow$ y – x = 20 cm

Q.17 A point object is placed at distance of 20 cm from a thin plano convex lens of focal length 15 cm. The plane surface of lens is now silvered, the image created by the system is at -



(A) 60 cm to the left of the system
(B) 60 cm to the right of the system
(C) 12 cm to the left of the system
(D) 12 cm to the right of the system

Sol. **[C]** $\frac{1}{f} = \frac{2}{F_\ell} + \frac{1}{F_M} = \frac{2}{15} + \frac{1}{\infty} \Rightarrow f = \frac{15}{2}$,

as concave mirror

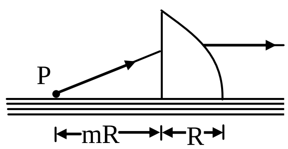
$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-15/2} - \frac{1}{-20} = -\frac{2}{15} + \frac{1}{20}$

$\Rightarrow \boxed{v = 12cm}$ left side

Q.18 A point object is placed at a distance of 15 cm from a convex lens. The image is formed on the other side at a distance of 30cm from the lens. When a concave lens is placed in contact with the convex lens, the image shifts away further by 30 cm. Calculate the focal lengths of the concave and convex lenses

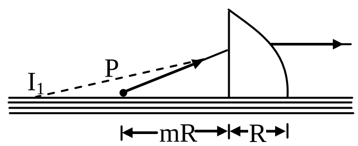
(A) 10 cm, 60 cm (B) 20 cm, 30 cm
(C) 60 cm, 10 cm (D) 30 cm, 20 cm **[A]**

Q.19 A quarter cylinder of radius R and R.I. 1.5 is placed on a table. A point object P is kept at a distance mR from it. For which value of m, when a ray from P will emerge parallel to the table as shown in figure?



(A) 2/3 (B) 3/2
(C) 3/4 (D) 4/3

Sol. **[D]**



For Ist surface

u = –mR, v = ?, $R'_1 = \infty$, μ_1 = 1, $\mu_2 = 1.5 = \frac{3}{2}$

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\frac{3}{2v} - \frac{1}{-mR} = \frac{1.5-1}{\infty}$$

$$\frac{3}{2v} = -\frac{1}{mR} \Rightarrow v = -\frac{3mR}{2} \quad \text{.... (1)}$$

From 2nd surface

$$u = -\left(\frac{3mR}{2} + R\right)$$

v' = ∞, R'_2 = –R, $\mu_1 = \mu = 1.5$, μ_2 = 1

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R'_2}$$

$$\frac{1}{\infty} - \frac{2\mu}{-R(3m+2)} = \frac{1-\mu}{-R}$$

$$+\frac{2\times\frac{3}{2}}{R(3m+2)} = \frac{1.5-1}{R} \Rightarrow \frac{3}{3m+2} = \frac{1}{2} \Rightarrow 3m+2=6$$

$$\boxed{m = 4/3}$$

Option (D) is correct.

Q.20 A convex lens of focal length 15 cm is placed coaxially in front of a convex mirror. The lens is 5 cm from the apex of the mirror . When an object is placed on the axis at a distance of 20 cm from the lens, it is found that the image coincides with the object. Calculate the radius of curvature of the mirror.

(A) 45 cm (B) 55 cm
(C) 65 cm (D) 85 cm **[B]**

Q.21 Two thin converging lenses of same focal length
= f are placed on a common axis so that the centre of them coincides with the focus of the other . An object is placed at a distance twice the focal length from left the hand lens . Where will its image be ? What is the lateral magnification ?

(A) $\frac{1}{2}$ (B) $+\frac{1}{3}$

(C) $-\frac{1}{2}$ (D) $-\frac{1}{3}$ **[C]**

Q.22 A convex lens of focal length f produces a virtual image n times the size of the object. Then the distance of the object from the lens is -

(A) (n –1) f (B) (n + 1) f

(C) $\left(\frac{n-1}{n}\right)f$ (D) $\left(\frac{n+1}{n}\right)f$ **[C]**

Sol. $m = \frac{f}{f-u}$

so u = – u f = f m = + n

$n = \frac{f}{f+u} \Rightarrow f + u = \frac{f}{n}$

$u = \frac{f}{n} - f = f\left(\frac{1}{n} - 1\right)$

$u = -f\left(1 - \frac{1}{n}\right) \Rightarrow u = -f\left(\frac{n-1}{n}\right)$

so $|u| = \left(\frac{n-1}{n}\right)f$

Q.23 A plane concave glass lens silvered at one surface behaves as

(A) concave mirror (B) convex mirror
(C) plane mirror (D) none of the above

[B]

Q.24 A thin hollow equi-convex lens, silvered at the back, converges a parallel beam of light at a distance of 0.2 m in front of it. where will it converge the same light if filled with water having μ = 4 / 3 ?

(A) 10 cm (B) 22 cm
(C) 12 cm (D) 14 cm **[C]**

Q.25 The plane face of a plano convex lens is silvered. If μ be the refractive index and R, the radius of curvature of curved surface, then the system will behave like a concave mirror of radius of curvature-

(A) μ R (B) R/2 (μ –1)
(C) R^2 / μ (D) {(μ+ 1)/(μ –1)R} **[B]**

Q.26 A thin equiconvex lens has focal length 10 cm and refractive index 1.5 . One of its faces is now silvered and for an object placed at a distance u in front of it, the image coincides with the object. The value of u is-

(A) 10 cm (B) 5 cm
(C) 20 cm (D)15 cm **[B]**

Q.27 A convex lens A of focal length 20 cm and a concave lens B of focal length 5 cm are kept along the same axis with a distance d between them. If a parallel beam of light falling on A leaves B as a parallel beam then the distance d in cm will be -

(A) 25 (B) 15 (C) 30 (D) 50 **[B]**

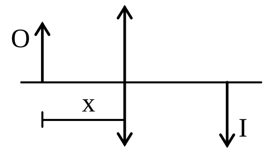
Q.28 A convex lens makes a real image 4 cm long on a screen. When the lens is shifted to a new position without disturbing the object or the screen, we again get real image on the screen which is 9 cm long. The length of the object must be -

(A) 2.25 cm (B) 6 cm
(C) 6.50 cm (D) 36 cm **[B]**

Q.29 A converging lens forms an image of an object on a screen. The image is real & has twice the size of the object. If the positions of the screen & the object are interchanged, leaving the lens in its original position, what is the new image size on the screen.

(A) Twice the object size
(B) Same as the object size
(C) Half the object size
(D) Can't say as it depends on the focal length of the lens

Sol. **[C]**



$m_1 m_2 = 1$

$m_2 = \frac{1}{m_1}$

$m_2 = \frac{1}{2}$

Q.30 A convex lens forms a real image on a screen placed at a distance 60 cm from the object . When the lens is shifted towards the screen by 20 cm , another image of the object is formed on the screen. The focal length of the lens is -

(A) 45 cm (B) 40 /3 cm
(C) 30 cm (D) 12 cm **[B]**

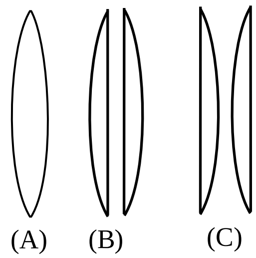
Q.31 For a spherical surface of radius of curvature R, separating two media of refractive indices μ_1 and μ_2 , the two principal focal lengths are f_1 and f_2 respectively. Which one of the following relations is correct -

(A) $f_1 = f_2$ (B) $f_2/\mu_2 = f_1/\mu_1$
(C) $f_2/\mu_2 = -f_1/\mu_1$ (D) $f_2/\mu_1 = f_1/\mu_2$ **[C]**

Q.32 The distance between object and the screen is D. Real images of an object are formed on the screen for two positions of a lens separated by a distance d. The ratio between the sizes of two images will be-

(A) D/d (B) D^2/d^2
(C) $(D - d)^2 / (D + d)^2$ (D) $\sqrt{(D/d)}$ **[C]**

Q.33 A convex lens of focal length 20 cm is cut into two equal parts so as to obtain two plano-convex lenses as shown in fig. (B). The two parts are then put in contact as shown in fig.(C). What is the focal length of combination



(A) zero (B) 5 cm

(C) 10 cm (D) 20 cm **[D]**

Q.34 A convex lens of focal length f is placed some where in between an object and a screen. The distance between the object and the screen is x. If the numerical value of the magnification produced by the lens is m, the focal length of the lens is -

(A) $\frac{mx}{(m+1)^2}$ (B) $\frac{mx}{(m-1)^2}$

(C) $\frac{(m+1)^2}{m}x$ (D) $\frac{(m-1)^2}{m}x$ **[A]**

Q.35 A lens is placed between a source of light and a wall. It forms images of area A_1 and A_2 on the wall for its two different positions. The area of the source of light is -

(A) $\sqrt{(A_1A_2)}$

(B) $\frac{A_1+A_2}{2}$

(C) $\left(\frac{1}{A_1}+\frac{1}{A_2}\right)^{-1}$

(D) $\left(\frac{\sqrt{A_1}+\sqrt{A_2}}{2}\right)^2$ **[A]**

Q.36 A screen is placed a distance 40 cm away from an illuminated object. A converging lens is placed between the source and the screen and it is attempted to form the image of the source on the screen. If no position could be found, the focal length of the lens -

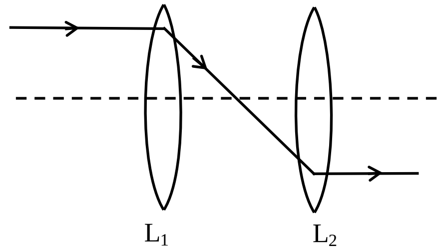
(A) must be less than 10 cm

(B) must be greater than 20 cm

(C) must not be greater than 20 cm

(D) must not be less than 10 cm. **[B]**

Q.37 In the figure given below there are two convex lens L_1 and L_2 having focal lengths F_1 and F_2 respectively. The distance between L_1 and L_2 will be -



(A) F_1 (B) F_2

(C) $F_1 + F_2$ (D) $F_1 - F_2$ **[C]**

Q.38 A ray of light falls on the surface of a spherical paper weight making an angle α with the normal and is refracted in the medium at an angle β. The angle of deviation of the emergent ray from the direction of the incident ray is -

(A) (α – β) (B) 2 (α – β)

(C) (α – β) / 2 (D) (β – α) **[B]**

Q.39 A concave lens of focal length f produces an image (1/μ) times the size of the object. The distance of the object from the lens is -

(A) (μ – 1) f (B) $\frac{(\mu-1)}{\mu}f$

(C) $\frac{(\mu+1)}{\mu}f$ (D) (μ + 1) f **[A]**

Q.40 A convex lens of focal length f produces an image, μ times the size of the object; then the distance of the object from the lens is, if the image is real -

(A) (μ –1) f (B) (μ +1) f

(C) $\frac{(\mu-1)}{\mu}f$ (D) $\frac{(\mu+1)}{\mu}f$ **[D]**

Q.41 A plano-convex lens (μ = 1.5) having radius of curvature 0.2 m is silvered on the curved surface. The power of the system is -

(A) 10 D (B) 15 D

(C) – 10 D (D) –12 D **[B]**

Q.42 A lens forms a sharp image on a screen. On inserting a parallel sided glass slab between the lens and the screen , it is found necessary to move the screen a distance d away from the lens in order for the image to be sharp again. If the refractive index of the glass relative to air is μ, then the thickness of slab is -

(A) μ d
(B) d/μ
(C) (μ –1) d/μ
(D) μd/(μ –1) **[D]**

Q.43 In the displacement method, a convex lens is placed in between an object and a screen. If the magnifications in the two positions are m_1 and m_2 and the displacement of the lens between the two positions is x, the focal length of the lens is

(A) $\frac{x}{(m_1+m_2)}$
(B) $\frac{x}{(m_1-m_2)}$
(C) $\frac{x}{(m_1+m_2)^2}$
(D) $\frac{x}{(m_1-m_2)^2}$ **[B]**

Q.44 One of the curved surfaces of an equiconvex lens of radius of curvature 20 cm and power + 4 D is silvered. The power of the system is-

(A) + 8 D
(B) + 10 D
(C) + 18 D
(D) + 14 D **[C]**

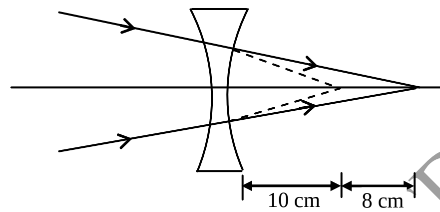
Q.45 A convex lens of focal length f produces an image, μ times the size of the object; then the distance of the object from the lens is, if the image is virtual -

(A) (μ – 1)
(B) $\frac{(\mu+1)}{\mu}$ f
(C) $\frac{(\mu-1)}{\mu}$ f
(D) (μ + 1) f **[C]**

Q.46 A converging beam of light forms a sharp image on a screen. A lens is placed 10 cm from the screen in the path of the beam. It was found that the screen has to be moved 8 cm further away to obtain the sharp image. Focal length of the lens is -

(A) 6.43 cm
(B) – 2.5 cm
(C) – 22.5 cm
(D) 2.66 cm **[C]**

Sol. Since the screen has to be moved away, the lens used should be concave.



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

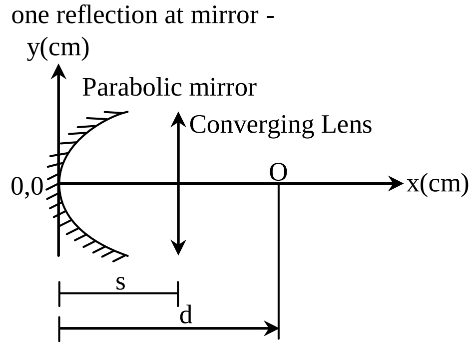
$$\Rightarrow \frac{1}{f} = \frac{1}{18} - \frac{1}{10}$$

$$f = \frac{180}{10-18} = -22.5 \text{ cm}$$

Q.47 A lens of focal length 0.3 m is placed between an illuminated object and screen which are 1 m apart. By varying the position of the lens, it is possible to produce on the screen -

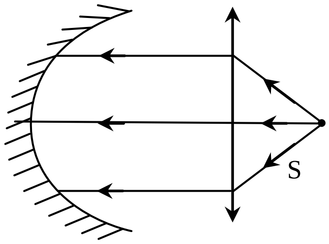
(A) 2 real inverted images of the object
(B) 1 real inverted image of the object
(C) No images of the object at all
(D) 1 erect image of the object. **[C]**

Q.48 Focal length of converging lens is 20 cm, S = 80 cm & d =100 cm. Find the position coordinate of final image after one refraction & one reflection at mirror -



(A) 3.16 cm
(B) 8.23 cm
(C) 10.53 cm
(D) 1.16 cm

Sol. **[A]**



In parabolic mirror, parallel incident ray converge at focus $y^2 = \frac{x}{8}$

Here $f = \frac{1}{32}$ m

$\therefore$ Image will formed at $\frac{1}{32}$ m or 3.16 cm

Q.49 When an object is at distance x and y from a lens, a real image and a virtual image is formed respectively having same magnification. The focal length of the lens is –

(A) $\frac{x+y}{2}$ (B) x – y

(C) $\sqrt{xy}$ (D) x + y

Sol. **[A]**

The given lens is a convex lens. Let the magnification be m, then for real image

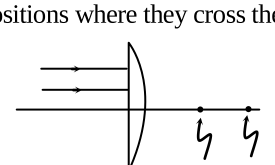
$$\frac{1}{mx} + \frac{1}{x} = \frac{1}{f} \quad \text{... (i)}$$

and for virtual image $\frac{1}{-my} + \frac{1}{y} = \frac{1}{f}$ ... (ii)

From Eq. (i) and Eq. (ii), we get

$$f = \frac{x+y}{2}$$

Q.50 Two rays travelling parallel to the principal axis strike a large plano-convex lens having a refractive index of 1.60. If the convex face is spherical, a ray near the edge does not pass through the focal point (spherical aberration). If this face has a radius of curvature of 20.0 cm & the two rays are h_1 = 0.5 cm & h_2 = 12.0 cm from the principal axis, find the difference in the positions where they cross the principal axis –

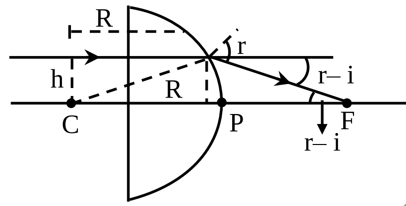


two points where ray cross the principal axis

(A) 42.6 cm (B) 21.3 cm

(C) 10.6 cm (D) 11.3 cm

Sol. **[B]**



$1.60 \sin i = \sin r$

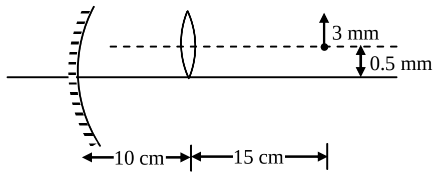
$\frac{1.60 \times h}{R} = \sin r$

$\frac{h}{PF} = \tan(r - i)$

in this way we can calculate PF for both rays and difference in position = $PF_2 - PF_1$

PHYSICS

Q.1 A concave mirror of focal length 20 cm and a convex lens of focal length 10 cm are kept with their optic axes parallel but separated by 0.5 cm as shown in figure. The distance between lens and mirror is 10 cm. An object of height 3 mm is placed on the optic axis of lens at a distance 15 cm from the lens. Find length of image formed by mirror in mm.



Sol. For image formed by lens

$$\frac{1}{v_1} - \frac{1}{-15} = \frac{1}{+10}$$

$\Rightarrow v_1 = +30$ cm

i.e. 20 cm behind mirror

For mirror

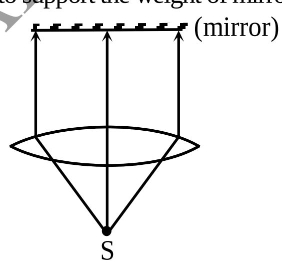
$$\frac{1}{v_2} + \frac{1}{20} = \frac{1}{-20}$$

$\Rightarrow v_2 = -10$ cm

Overall magnification = $\left(\frac{30}{-15}\right) \times \left(\frac{10}{20}\right) = -1$

Length of image = 1 × 3 = 3 mm

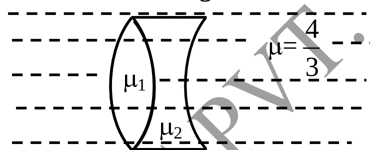
Q.2 A totally reflecting small plane mirror placed horizontally faces a parallel beam of light as shown in figure. The mass of mirror is 20 gm. Assume that there is no absorption in the lens and that 30% of the light emitted by source goes through lens. Find the power of source in MW needed to support the weight of mirror. ($g = 10$ m/sec^2)



Sol. **[0100]**

Q.3 Two thin symmetrical lens of different nature have equal radii of curvature of all faces R = 20 cm. The lenses are put close together and immersed in water. The focal length of the system is 24 cm. The difference between refractive indices of the two lenses is …… $\times \frac{1}{9}$. Refractive index of water is $\frac{4}{3}$.

Sol.[5]



$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{f_1} = \frac{(\mu_1 - \mu)}{\mu}\left[\frac{2}{R}\right] = \frac{(\mu_1 - 4)}{4}\left[\frac{2}{R}\right] = \frac{3\mu_1 - 4}{2R}$$

$$\frac{1}{f_2} = -\left[\frac{\mu_2 - \mu}{\mu}\left(\frac{2}{R}\right)\right] = -3\left[\frac{\mu_2 - \mu}{2R}\right]$$

$$\frac{1}{24} = \frac{3(\mu_1 - \mu_2)}{2R} \Rightarrow \mu_1 - \mu_2 = \frac{2R}{24 \times 3} = \frac{R}{12 \times 3} = \frac{20}{36} = \frac{5}{9}$$

Q.4 There is a small air bubble inside a glass sphere ($\mu = 1.5$) of radius 10 cm. The bubble is 4.0 cm below the surface and is viewed normally from the outside. Find the apparent depth of the bubble.

Sol.[3] Apply $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

$\mu_2 = 1$, $\mu_1 = \frac{3}{2}$, R = – 10 cm, u = – 4 cm

Q.5 A pin of length 2.0 cm lies along the principal axis of a converging lens, the centre being at a distance of 11 cm from the lens. The focal length of the lens is 6 cm. Find the size of the image.

Sol. **[1]**

$\lambda_B = 2\lambda_A$

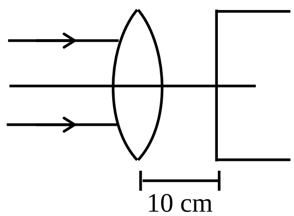
Initially rate of decay A = $\lambda_A N_0$

Initially rate of decay B = $2\lambda_A N_0$

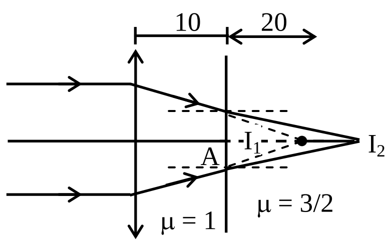
After one half life of A, rate of decay of A will become $\frac{\lambda_A N_0}{2}$ & that of B be $\frac{\lambda_A N_0}{2}$ After one half life of A on two half lives of B.

$$-\left(\frac{dN}{dt}\right)_A = -\left(\frac{dN}{dt}\right)_B \Rightarrow n = 1$$

Q.6 Focal length of a thin convex lens is 30 cm. At a distance of 10 cm from the lens there is a plane refracting surface of refractive index 3/2. The parallel rays incident on lens converge at a distance of …..... × 10 cm from lens.



Sol. **[4]**



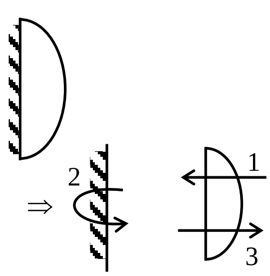
$$\frac{AI_1}{1} = \frac{AI_2}{\mu}$$

$AI_2 = AI_1 \times \mu = 20 \times \frac{3}{2} = 30$

∴ distance of 40 cm from lens.

Q.7 A plano convex lens behave as a concave mirror of focal length 30 cm when its plane surface is silvered and as a concave mirror of focal length 10 cm when its curved surface is silvered. The radius of curvature of curved surface in cm is ….. × 10 cm.

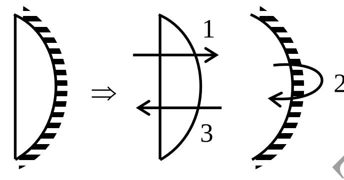
Sol. **[3]**



$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

$$\frac{1}{f_{eq}} = \frac{2}{f_1}$$

$$\frac{1}{30} = 2 \times \left[\frac{\mu - 1}{1}\right] \times \frac{1}{R}$$



$$\frac{1}{f_{eq_2}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

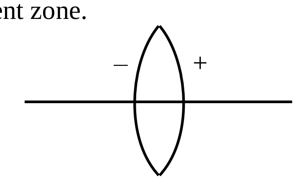
$$= \frac{2}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{10} = \frac{1}{f_{eq_1}} + \frac{2}{R}$$

$$\frac{1}{10} = \frac{1}{30} + \frac{2}{R} \Rightarrow R = 30 \text{ cm}$$

Q.8 An equiconvex lens of focal length 10 cm and refractive index (μ_g = 1.5) is placed in a liquid whose refractive index varies with time as $\mu(t) = 1 + \frac{t}{10}$. If the lens was placed in the liquid at t = 0 after what time lens will act as concave lens (Here t is in second) ?

Sol. **[5]**
To behave as a concave lens its focus should be in incident zone.



$$\frac{1}{f} = \frac{1.5 - \mu}{\mu}\left[\frac{2}{R}\right]$$

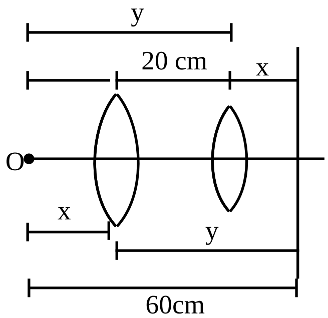
when f will be negative lens will behave as concave lens

$$1.5 - \mu < 0 \Rightarrow 1.5 - \left[1 + \frac{t}{10}\right] < 0$$

t > 5

Q.9 A convex lens form a real image on a screen placed at a distance 60 cm from the object. When the lens is shifted towards the screen by 20 cm, another image of the object is formed on the screen. Focal length of the lens is ….. × $\frac{10}{3}$ cm.

Sol. [4]



$x + y = 60$
$y - x = 20$
$2y = 80 \Rightarrow y = 40, x = 20$

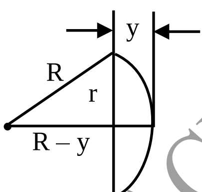
$$\frac{1}{f} = \frac{1}{y} + \frac{1}{x}$$

$$\frac{1}{f} = \frac{1}{40} + \frac{1}{20}$$

$$f = \frac{40}{3} \text{ cm}$$

Q.10 Diameter or Aperture of a plano-convex lens is 6 cm and its thickness at the centre is 3 mm. The image formed is real and twice the size of object. If speed of light in the material of lens is 2×10^8m/s, the distance where object is placed from plano convex lens is ….. × 15 cm.

Sol. [3]



$(R - 4)^2 + r^2 = R^2$

$$R = \frac{r^2}{2y} = \frac{\left(\frac{6}{2}\right)^2}{2 \times 0.3} = 15 \text{ cm}$$

$$\frac{1}{f} = \frac{\mu - 1}{R}$$

$$\mu = \frac{c}{v} = \frac{3.0 \times 10^8}{2.0 \times 10^8} = 1.5$$

$\therefore$ f = 30cm converging
Now f = 30 cm

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

$$\frac{1}{30} = \frac{1}{v} - \frac{1}{u}$$

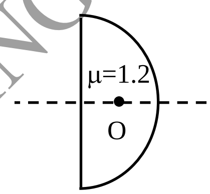
$$m = -\frac{v}{u} = -2$$

$v = -2u$

$$\frac{1}{30} = \frac{-1}{2u} - \frac{1}{u}$$

$$\frac{1}{30} = \frac{-3}{2u} \Rightarrow u = -45$$

Q.11 A plastic hemisphere has a radius of curvature of 8 cm and an index of refraction of 1.2. On the axis half way between the plane surface and the spherical one (4 cm from each) is a small object O. The distance between two images when viewed along the axis from the two sides of the hemisphere is approximately in cm.



Sol. [1]

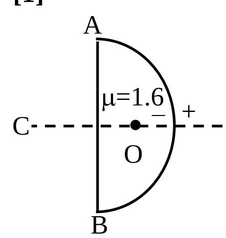


image distance from AB plane face

$$= \frac{t}{\mu} = \frac{4c}{1,2} = \frac{40}{12} = 3.3 \text{ cm}$$

image distance from AB curved surface = x

$$\frac{1}{x} - \frac{1.2}{-4} = \frac{1 - 1.2}{-8}$$

$$\frac{1}{x} + 0.3 = \frac{+0.2}{+80} \quad \frac{1}{4}$$

$$\frac{1}{x} = \frac{1}{40} - \frac{3}{10}$$

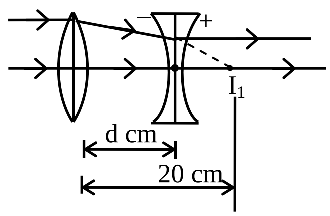
$$\frac{1}{x} = \frac{-11}{40}$$

$$x = \frac{40}{11} = 3.6 \text{ cm}$$

distance between images = 8 – (3.3 + 3.6)
= 1 cm.

Q.12 A convex lens A of focal length 20 cm and a concave lens B of focal length 10 cm are kept along the same axis with a distance d between them. If a parallel beam of light incident on A leaves B as a parallel beam then the value of d is …… × 10 cm.

Sol. **[1]**



V = ∞
U = + (20 – d)
f = –10

$$\frac{1}{-10} = \frac{1}{\infty} - \frac{1}{(20-d)}$$

$$-\frac{1}{10} = -\frac{1}{20-d}$$

20 – d = 10
d = 10 cm

Q.13 A plastic hemisphere has a radius of curvature of 8 cm and an index of refraction of 1.2 and a small object O is present on the axis half way between the plane surface and the spherical one (4 cm from each). The distance between two images of object O when viewed along the axis from the two sides of the hemisphere is approximately. (in cm)-

Sol. **[3]**

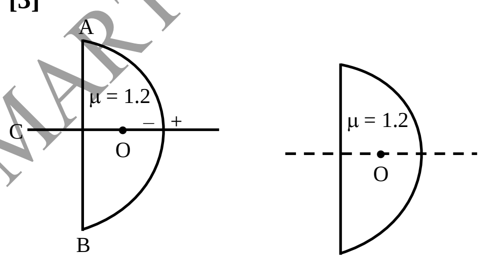


Image distance from AB plane face

$$= \frac{t}{\mu} = \frac{4}{1.2} = \frac{40}{12} = 3.3 \text{ cm}$$

image distance from curved surface = x

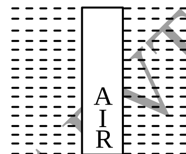
$$\frac{1}{x} - \frac{1.2}{-4} = \frac{1-1.2}{-8} \quad \text{or } x = 3 \text{ cm}$$

Q.14 One of the curved surface of an equiconvex lens (Radius of curvature 50 cm and RI = 1.5) is silvered. Find the power of system.

Sol.[8] f_e = 50 cm and f_m = 35 cm

$$-\frac{1}{f_{eq}} = \left[\frac{2}{f_e} - \frac{2}{f_m}\right] = P$$

Q.15 An air slab of thickness 9 cm is dipped in water (RI = 4/3). If an object in the left of slab is viewed from right. Find the shift in object position in cm.



Sol.[3] Use ΔS = d (n – 1)

Q.16 If an object is moved 12 cm right towards a convex lens its image also moves by same displacement. Find the focal length of lens.

Sol.[8] It is possible when movement is $\frac{3f}{2}$

so $\frac{3f}{2}$ = 12 ⇒ f = 8 cm

Q.17 A light ray hits a convex lens parallel to p-axis at a distance of π/5 cm from principal axis. The focal length is 18 cm. Find the deviation suffered by ray in degrees.

Sol.[2] Use S = $\frac{h}{f}$

Q.18 A concave and a convex lens of focal lengths 20 cm and 25 cm respectively are placed coaxially. Find minimum separation between them so that they can form a real image of distant object.

Sol.[5] d = $f_1 \sim f_2$

Q.19 A symmetric double convex lens is cut in two parts by a plane perpendicular to the principal axis. If power of the original lens is 14D. Find the power of cut lens.

Sol.[7] Conceptual.

Q.20 A photographic camera with a lens of 5.6 cm is used for capturing images. Vertical length of film used is 24 mm in which image of a 1.68 m tall man is to be captured. Find minimum distance (in m) of the man from lens such that his complete image can be obtained. (Approx answer to the nearest integer).

Sol.[4] $m = \frac{h_I}{h_0} = \frac{-24\,mm}{1.68\,m} = \frac{-1}{70}$

(lens is convex and image is inverted)

$m = \frac{v}{u}$ Let $u = -x$

so $v = \frac{x}{70}$

with f = 5.6 cm

solving x = 3.96 m $\simeq$ 4.0 m