The following question given below consist of an "Assertion" (A) and "Reason" (R) Type questions. Use the following Key to choose the appropriate answer.

(A) If both (A) and (R) are true, and (R) is the correct explanation of (A).

(B) If both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) If (A) is true but (R) is false.

(D) If (A) is false but (R) is true.

Q.1 **Assertion** : A convex lens behaves as a concave lens when placed in a medium of refractive index greater than the refractive index of its material.

Reason : Light in that case will travel through the convex lens from denser to rarer medium. It will bend away from normal, i.e., the convex lens would diverge the rays and behave as concave. **[A]**

Q.2 **Assertion** : Magnification produced by a convex mirror is always positive, but that by a concave mirror may be both positive or negative.

Reason : Based on sign convention, magnification can be positive or negative **[D]**

Q.3 **Assertion** : The minimum distance between an object and its real image formed by a convex lens is 2f.

Reason : The distance between an object and its real image is minimum when its magnification is one **[D]**

Q.4 **Assertion** : Spherical aberration of a lens can be reduced by blocking the central portion or peripheral portion of the lens.

Reason : Spherical aberration arises on account of inability of the lens to focus central and peripheral rays at the same point. **[A]**

Q.5 **Assertion** : The lens formula $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ indicates that focal length of a lens depends on distances of object and image from the lens.

Reason : The formula does indicate but when u is changed v also changes, so that f of a particle lens remains constant **[D]**

Q.6 **Assertion :** We can't see virtual images from our eyes.

Reason : Virtual image is not formed on the screen. **[D]**

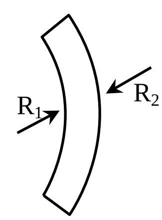
Q.7 **Assertion :** Convex mirror is used in cars & automobile as a rear view mirror.

Reason : Convex mirror give erect image for all positions of the object behind the cars. **[B]**

Q.8 **Assertion :** Although the surfaces of a goggle lens are curved, it does not have any power.

Reason : In case of goggles, lenses are concavo convex and both the surface of lens have equal radii of curvature.

Sol. **[A]**



$$\frac{1}{f}=\left(\frac{\mu-1}{1}\right)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

$\frac{1}{f}$ = 0 [as $R_1 = R_2$]

$\therefore$ power = $\frac{1}{f}$ = 0

Q.9 **Assertion :** We can't see virtual images from our eyes.

Reason : Virtual images are not formed on the screen. **[D]**

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Q.10 **Assertion :** Normal human eyes can see clearly all the objects at different distance.

Reason : The human eyes has the capacity to suitably adjust the focal length of its lens to a certain extent. **[A]**

Q.11 **Assertion :** Although the surfaces of a goggle lens are curved, it does not have any power.

Reason : In case of goggles, both the curved surfaces have equal radii of curvature

Sol. **[A]**

The focal length of a lens is given by ,

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

For, goggle, $R_1 = R_2$

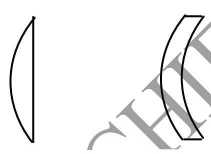
$$\therefore \ \frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = 0$$

Therefore, Power $P = \frac{1}{f} = 0$.

Q.12 **Assertion :** Focal length of a thin spherical glass lens decreases on increasing curvature of its spherical surfaces.

Reason : Refraction takes place at these curved surfaces of lens. **[D]**

Sol. Consider two cases



Plano convex lens   Watch glass

Q.13 **Assertion :** Spherical mirror, unlike a plane mirror, does not form a precise point image of a point object.

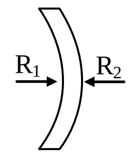
Reason : Path of reflected rays depends on angle of incidence on mirror. **[A]**

Sol. If we increase the angle of an incident ray with the optic axis, the point where the ray intersects the optic axis moves somewhat closer to the vertex than for a paraxial ray and hence the image is smeared out. This property of a spherical mirror is called spherical aberration.

Q.14 **Assertion :** Although the surfaces of a goggle lens are curved, it does not have any power.

Reason : In case of goggles lenses are concavo- convex and both the surface of lens have equal radii of curvature. **[A]**

Sol



$$\frac{1}{f} = \frac{\mu - 1}{1}\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

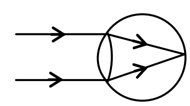
$$\frac{1}{f} = 0 \qquad [\text{as } R_1 = R_2]$$

$$\therefore \quad \text{Power} = \frac{1}{f} = 0$$

Q.15 **Assertion :** If you focus on a point closer to your eyes the radius of curvature of eye lens decreases.

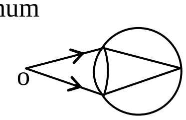
Reason : When rays are to be focussed more strongly, a shorter focal length is required. **[A]**

Sol.



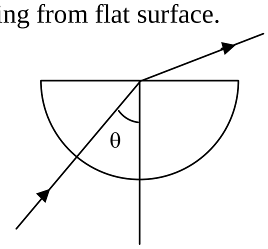
Relaxed eye

f is maximum



To see object at closer distance more converging power is needed to focus image at retina hence R decreases.

Q.16 **Assertion :** A beam of white light enters the curved surface of a semicircular piece of glass along the normal. The incoming beam is moved clockwise (so that angle θ increases), the color of the refracted beam is red before it steps emerging from flat surface.



Reason : The index of refraction for light at the red end of the visible spectrum is lesser than at the violet end. **[A]**

Sol. Vertical angle for red is more than violet end

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Q.17 **Assertion :** We can't see virtual images from our eyes.

Reason : Virtual images are not formed on the screen. **[D]**

Q.18 **Assertion :** Convex mirror is used in cars & automobile as a rear view mirror.

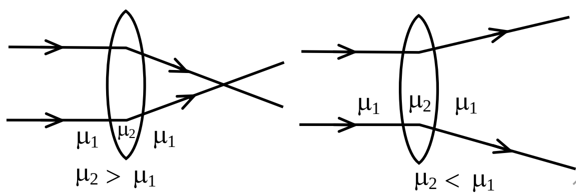
Reason : Convex mirror give erect image for all positions of the object behind the cars. **[B]**

Q.19 **Statement I :** A convex lens can be convergent in one medium and divergent in other medium.

Statement II : In denser medium, convex lens is convergent and in rarer medium, convex lens is divergent. **[C]**

Sol.

Statement I is true & Statement II is false.



Q.20 **Statement - I :** Minimum distance between real object and real image for convex lens is 4f.

Statement - II : Convex lens forms real image only when real object is placed beyond 2f. **[C]**

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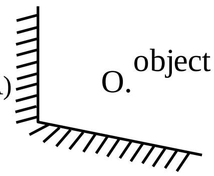
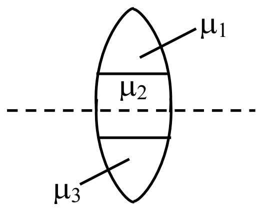
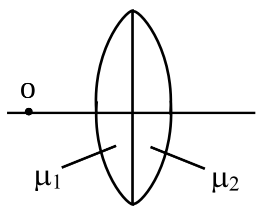
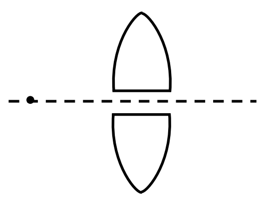
PHYSICS

Q.1

Column I (Arrangement)	**Column II (No. of images formed)**
(A) 	(P) 1
(B) 	(Q) 2
(C) 	(R) 3
(D) 	(S) 4

The same lens is cut & displaced by small distance

[(A) ⟶ P, R **(B) ⟶ R**
(C) ⟶ P **(D) ⟶ Q]**

Q.2 For a real object, match the following

Column I	**Column II**
(A) Concave mirror	(P) virtual image
(B) Convex mirror	(Q) real image
(C) Concave lens	(R) enlarged image
(D) Convex lens	(S) diminished image

(A) ⟶ P, Q, R, S **(B) ⟶ P, S**
(C) ⟶ P,S **(D) ⟶ P, Q, R, S**

Q.3 Focal length of objective & eyepiece of a telescope are f_O & f_e respectively.

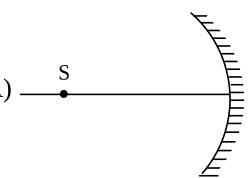
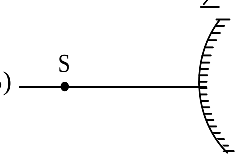
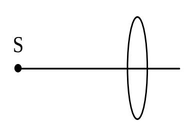
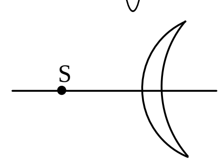
[IIT-JEE 2006]

Column - I	**Column - II**
(A) Intensity of the image	(P) Radius of curvature (R)
(B) Angular magnification of lens	(Q) Dispersion
(C) Length of telescope	(R) Focal length f_O & f_e
(D) Sharpness of image	(S) Spherical aberration

[(A) → P, R ; (B) → R ; (C) → R; (D) → P, Q, S]

Q.4 An optical component and an object S placed along its optic axis are given in **Column I**. The distance between the object and the component can be varied. The properties of images are given in **Column II**. Match all the properties of images from **Column II** with the appropriate components given in **Column I**.

[IIT-JEE 2008]

Column I	**Column II**
(A) 	(P) Real image
(B) 	(Q) Virtual image
(C) 	(R) Magnified image
(D) 	(S) Image at infinity

[(A)→ P, Q, R, S; (B)→ Q;
(C) → P, Q, R, S; (D) → P, Q, R, S]

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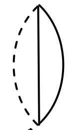
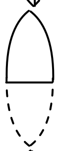
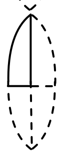
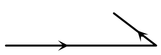
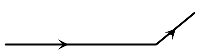
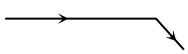
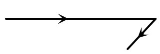
Q.5 A equiconvex lense of focal length f is cut into four type as shown and object is placed in front of remaining part of lens

Column I	**Column II**
(A) 	(P) intensity of image decreases
(B) 	(Q) $\frac{f}{2}$ is focal length
(C) 	(R) 2f is focal length
(D) 	(S) magnification changes

[(A) → R,S ; (B) → R.S ; (C) → P; (D) → P, R, S]

Q.6 Four rays of light parallel to optic axis and their path after passing through an optical system are shown column-I. Match the corresponding optical instrument from column-II.

Column I	**Column II**
(A) 	(P) Convex lens
(B) 	(Q) Concave lens
(C) 	(R) Convex mirror
(D) 	(S) Concave mirror

[(A) → R ; (B) → Q ; (C) → P; (D) → S]

Q.7

Column I	**Column II**
(A) Convex mirror, virtual object.	(P) Real image
(B) Concave mirror, virtual object.	(Q) Virtual image
(C) Concave lens, real object.	(R) Magnified image
(D) Convex lens, real object	(S) Diminished image

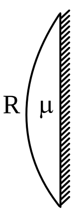
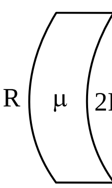
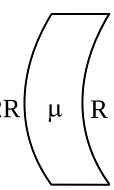
A – P, Q, R, S **B– P, S**
C – Q, S **D – P, Q, R, S**

Q.8

Column I	**Column II**
(A) Virtual image for all positions of real object	(P) Concave mirror
(B) Always diminished image for virtual object	(Q) Convex lens
(C) Always real image for virtual objects	(R) Convex mirror
(D) Real object at focus image at finite distance	(S) Concave lens

Ans. **A → R,S; B → P,Q; C → P,Q; D → R,S**

Q.9

Column-I	**Column-II**
(A) R μ R 	(P) Converging
(B) R μ 	(Q) Concave-convex
(C) R μ 2R 	(R) Convex-concave
(D) 2R μ R 	(S) Diverging

Ans. **A → P; B → P; C → Q,P; D → R,S**

Q.10

Column-I	**Column-II**
(A) Myopia	(P) bifocal lens
(B) Hypermetropia	(Q) cylindrical lens
(C) Presbyopia	(R) concave lens
(D) Astigmatism	(S) convex lens

Sol. **(A) → (R), (B) → (S), (C) → (P), (D) → (S)**

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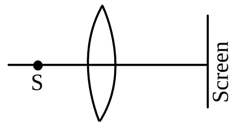
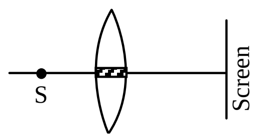
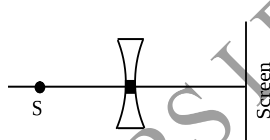
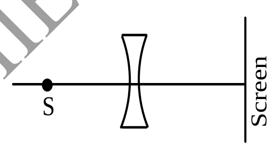
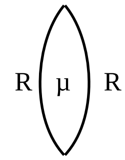
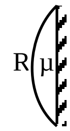
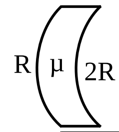
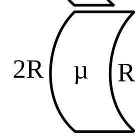
Q.11 Light from source S (| u | < | f |) falls on lens and screen is placed on the other side. The lens is formed by cutting it along principal axis into two equal parts and are joined as indicated in column–II. Match the entries of column–I with those of column–II.

Column I	Column II
(A) Plane of image moves towards screen if | f | is increased	(P)  Small portion of each part near pole is removed. The remaining part are joined.
(B) Images formed will be virtual	(Q)  The two parts are separated slightly. The gap is filled by opaque material
(C) Separation between images increases if |u| decreases	(R)  The two parts are separated slightly. The gap is filled by opaque material
(D) Interference pattern can be obtained if screen is suitably positioned	(S)  Small portion of parts near pole is removed. The remaining parts are joined.

Ans. **A → P,Q; B → P,Q,R,S; C → R,S ; D → P**

Q.12 Match the following -

Column-I	Column-II
(A) 	(P) Converging
(B) 	(Q) Concave-convex
(C) 	(R) Convex-concave
(D) 	(S) Diverging

Sol. **A → P ;B → P; C → P,Q; D → R,S**

Q.13 A convex lens (f) forms an image on a screen. Considering the object to be at the zero mark in a scale, match the following -

Column I		Column II	
(A)	Image	(P)	Moves the image of infinite object further away
(B)	Additional lens in contact	(Q)	Not unique as lens is moved between object and source
(C)	Reduction in refractive index	(R)	Virtual for screen position at a distance < 4f from the object
(D)	Slicing the lens to have one plane and another convex surface	(S)	Object at ∞ forms real image further nearer plano-convex lens

Sol. A → Q,R ; B → S ; C → P ; D →P,R

Q.14 Match the following -

Column-I	Column-II
(A) Diamond	(P) Total internal reflection
(B) Air bubble in water	(Q) Diverging lens
(C) An equiconvex lens made of glass kept in a liquid of $\mu = 1.70$ ($\mu_g = 1.5$)	(R) Converging lens
(D) An equiconvex	(S) Refraction through

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	lens made of glass kept in water ($\mu_g = 1.5$, $\mu_{water} = 1.33$)		curved surface

Sol. **A → P ;** **B → Q, S, P ;**

C → Q, S ; **D → R,S**

Q.15 A real object is kept in front of a lens. The object is a linear extended object with its length perpendicular to the optic axis of lens. With reference to different cases of image formation.

	Column -I		**Column -II**
(A)	The image has a magnification –2.5	(P)	Image is virtual
(B)	Magnification of the image is +0.5	(Q)	Image is real
(C)	Length of image is the same as that of object	(R)	Power of is positive
(D)	Length of image is four times the length of object	(S)	Power of lens the is negative
		(T)	None

Sol.1 **A → Q, R; B → P, S;**
C → Q, R; D → P,Q, R

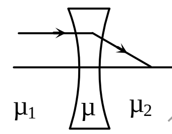
Q.16 Consider a linear extended object that could be real or virtual with its length at right angles to the optic axis of a lens with regard to image formation by lenses. Match column-I with column-II.

	Column - I		**Column - II**
(A)	Image of the same size as the object	(P)	Concave lens in case of real object
(B)	Virtual image of a size greater than the object	(Q)	Convex lens in case of real object
(C)	Real image of a size smaller than the object	(R)	Concave lens in case of virtual object
(D)	Real and erect image	(S)	Convex lens in case of virtual object

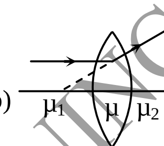
2. **A → Q,R** **B → Q,R** **C → Q,S** **D → R,S**

Q.17 Consider sign convention. All distances are measured from pole. Match Column-I with Column –II.

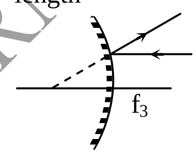
Column I **Column II**

(a) 

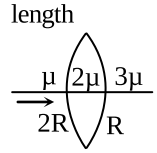
(p) $\mu < \mu_2$ & $\mu = \mu_1$

(b) 

(q) Positive focal length

(c) 

(r) Negative focal length

(d) 

(s) $\mu > \mu_2$ & $\mu = \mu_1$

(A) a → p,q; b → p, r; c → q;d → r
(B) a → p,r ;b → q, r; c → p ; d → s
(C) a →q,r; b → s, r; c → p; d → r
(D) a → p,s ; b → q, r; c → q,s; d → p

Sol. [A] a → p,q; b → p, r; c → q;d → r

Q.18 All questions refer to the diagram given below. The dotted lines represent the two surfaces of a lens that may be plane or curved. R_1 and R_2 are the radii of curvature of the surfaces on the left and right respectively. The refractive index of the medium to the left of the lens is n_1, that of the material of the lens itself is n_2, and that of the medium to the right of the lens is n_3. The first and second focal lengths of the lens are f_1 and f_2 respectively. Column I contains certain conditions and Column II contains some results which may follow from such conditions -

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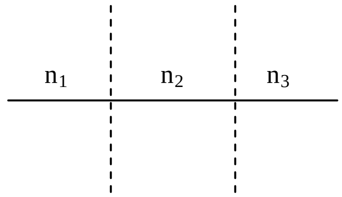
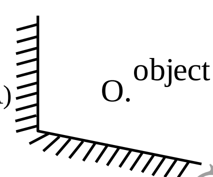


Column I	Column II
(a) $n_1 = n_3$	(p) Both f_1 and f_2 are either positive or negative
(b) $R_1 > 0$, $R_2 < 0$, with $n_2 < n_1$; n_3	(q) f_1 is positive but f_2 is negative
(c) R_1 and R_2 have opposite signs, with $n_2 > n_1$, n_3	(r) $f_1 = f_2$
(d) R_1 and R_2 are both negative, with $\|R_1\| < \|R_2\|$ and $n_2 > n_1 = n_3$	(s) Both f_1 and f_2 are negative

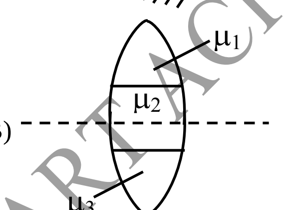
(A) $a \to q$, $b \to r$, $c \to s$, $d \to s$
(B) $a \to r$, $b \to s$, $c \to p$, $d \to s$
(C) $a \to p$, $b \to q$, $c \to r$, $d \to s$
(D) $a \to p$, $b \to s$, $c \to r$, $d \to s$

Ans. [B]

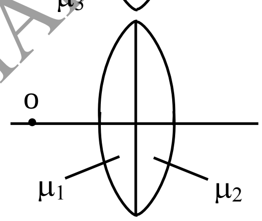
Q.19 **Column I (Arrangement)** **Column II (No. of images formed)**

(A) 

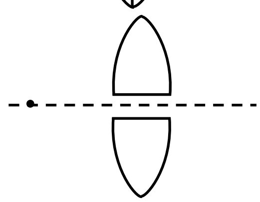
(P) 1

(B) 

(Q) 2

(C) 

(R) 3

(D) 
(S) 4

The same lens is cut & displaced by small distance

(T) no image

Sol. **$A \to P,R$; $B \to R$; $C \to P$; $D \to Q$**

Q.20 In column-(I) some optical devices with type of object are given. Match them with column-II in which some characteristic of possible images are given :

Column -I	Column-II
(A) Concave mirror, virtual object	(P) Real and enlarged image
(B) Convex mirror, virtual object	(Q) Virtual, enlarged image
(C) Convex lens, virtual object	(R) Real and Erect image
(D) Concave lens, real object	(S) Virtual and inverted image
	(T) Virtual and diminished image

Sol. **$A \to R$; $B \to P,Q,S$; $C \to R$; $D \to T$**
Concave lens and convex mirror can form both types of images real and virtual for virtual object

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Q.1 A converging lens of focal length f_1 is placed in front of and coaxially with a convex mirror of focal length f_2. Their separation is d. A parallel beam of light incident on the lens returns as a parallel beam from the arrangement -

(A) The beam diameters of the incident and reflected beams must be the same

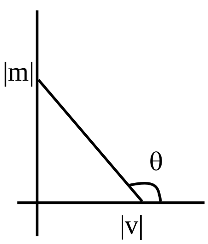
(B) $d = f_1 - 2|f_2|$

(C) $d = f_1 - |f_2|$

(D) If the entire arrangement is immersed in water, the conditions will remain unaltered

[A,B]

Q.2 Figure shows variation of magnification m (produced by a thin convex lens) and distance v of image from pole of lens. Which of the following statements is/are correct -



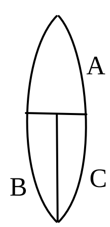
(A) Focal length of the lens is equal to intercept on v-axis

(B) Focal length of thin lens is equal to negative of inverse of slope of the line

(C) Magnitude of intercept on m-axis is equal to unity

(D) None of these **[A,B,C]**

Q.3 A thin, symmetric double-convex lens of power P is cut into three parts A, B and C as shown. The power of -

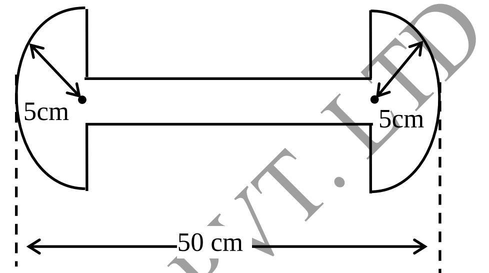


(A) A is P (B) A is 2P

(C) B is $\frac{P}{2}$ (D) B is $\frac{P}{4}$

[A,C]

Q.4 A glass dumbbell of length 50 cm, made of material of index 1.50 has ends of 5 cm radius (as shown). Consider refraction at just refracting surface only–



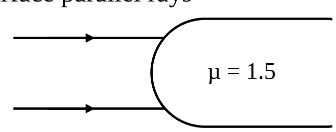
(A) An object at 20 cm from the left-most end, the image will be 30 cm inside the dumbbell

(B) For an object 5 cm from the dumb-bell the image will be 15 cm on the same side.

(C) Image will not be formed

(D) Image is always virtual **[A,B]**

Q.5 Parallel rays of light are falling on convex spherical surface of radius of curvature R = 20 cm as shown. Refractive index of the medium is μ = 1.5. After refraction from the spherical surface parallel rays -



(A) actually meet at some point

(B) appears to meet after extending the refracted rays backwards

(C) meet (or appears to meet) at a distance of 30 cm from the spherical surface

(D) meet (or appears to meet) at a distance of 60 cm from the spherical surface

[A,D]

Sol. Using $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$,

$\frac{1.5}{v} - \frac{1}{\infty} = \frac{1.5 - 1.0}{20}$

$\Rightarrow$ v = + 60 cm

since v is positive, the rays actually meet

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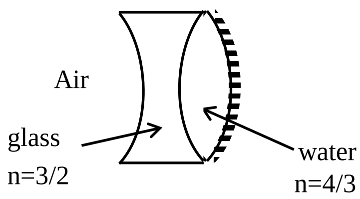
Q.6 The radius of curvature of the left and right surface of the concave lens are 10 cm and 15 cm respectively. The radius of curvature of the mirror is 15 cm -



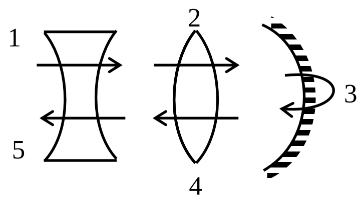
(A) equivalent focal length of the combination is 18 cm

(B) equivalent focal length of the combination is + 36 cm

(C) the system behaves like a concave mirror

(D) the system behaves like a convex mirror

Sol. **[A,C]**



$$\frac{1}{f_{eq}} = \frac{2}{f_1} + \frac{2}{f_2} + \frac{1}{f_3}$$

$$\frac{1}{f_{eq}} = 2\left[\frac{3}{2}-1\right]\left[-\frac{1}{10}-\frac{1}{15}\right]$$

$$+ 2\left[\frac{4}{3}-1\right]\left[\frac{2}{15}\right]+\frac{2}{15}$$

$$\frac{1}{f_{eq}} = 1 \times \left[\frac{-25}{150}\right] + 2 \times \frac{1}{3} \times \frac{2}{15} + \frac{2}{15}$$

$$\frac{1}{f_{eq}} = -\frac{1}{6} + \frac{4}{45} + \frac{2}{15}$$

$$\Rightarrow \frac{1}{f_{eq}} = \frac{-15+8+12}{90} = \frac{5}{90} = \frac{1}{18}$$

f_{eq} = 18 cm concave mirror.

Q.7 A plane mirror having a square shape is mounted parallel to a vertical wall at some distance from it. A point light source is fixed on the wall. Light from it gets reflected from the mirror and forms a patch on the wall, when the mirror is moved parallel to itself towards the wall –

(A) centre of patch may remain stationary

(B) the patch may remain square in shape

(C) area of patch decreases

(D) none of the above **[A,B,C]**

Sol. If the mirror is moved parallel to itself with velocity along the line, normal to wall and passing through the source, then patch will remain unchanged in shape and size.

Q.8 A short linear object is placed along the optic axis of a concave mirror between focus and curvature centre, then –

(A) a real elongated image will be formed

(B) an elongated virtual image will be formed

(C) an inverted, enlarged image will be formed

(D) a diminished virtual image will be formed

[A,C]

Sol. If an object is placed between focus and curvature centre of a concave mirror, then a real, elongated image is formed. Hence, option (A) is correct.

Since, real image is always inverted; therefore, option (C) is also correct.

Q.9 An equiconvex lens of refractive index 1.5 and focal length 10 cm (in air) is placed on the surface of water $\left(\mu = \frac{4}{3}\right)$ such that its lower surface is immersed in water but its upper surface is in contact with air outside. Principal axis is perpendicular to water. A beam parallel to its principal axis is incident on lens from air then -

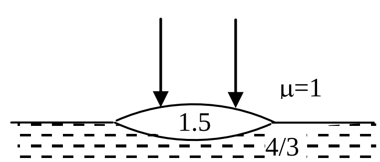
(A) The beam will focus at a distance 20 cm from lens

(B) The beam will focus at a distance 30 cm from lens

(C) Focal length if lens wholly immersed in water will be 40 cm

(D) Focal length of lens wholly immersed in water will be 30 cm **[A,C]**

Sol.



(A) $\frac{1}{f} = \frac{1.5-1}{1}\left(\frac{2}{R}\right) \Rightarrow f = R = 10$ cm

$$\frac{4/3}{v} - \frac{1}{-\infty} = \frac{\frac{3}{2}-1}{10} + \frac{\frac{4}{3}-\frac{3}{2}}{-10}$$

$\Rightarrow v = 20$ cm

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(B) $\frac{1}{f} = \frac{1.5 - \frac{4}{3}}{4/3} \times \frac{2}{10} \Rightarrow f = 40$ cm

Q.10 Focal length of a lens in air is f. Refractive index of the lens is μ. Focal length changes to f_1 if lens is immersed in a liquid of refractive index $\frac{\mu}{2}$ and it becomes f_2 if the lens is immersed in a liquid of refractive index 2μ. Then -

(A) $f_1 = \frac{f}{2}$ (B) $f_2 = -2f$

(C) $f_2 = -\frac{3f}{2}$ (D) data is insufficient

[D]

Sol. Without knowing the value of μ, we can't find out f_1 and f_2.

Q.11 A particle is moving towards a fixed convex mirror. The image also moves. If V_i = speed of image and V_0 = speed of the object, then -

(A) $V_i \le V_0$ if $|u| < |F|$

(B) $V_i > V_0$ if $|u| > |F|$

(C) $V_i < V_0$ if $|u| > |F|$

(D) $V_i = V_0$ if $|u| = |F|$ **[A,C]**

Sol. For convex mirror

$|m| < 1$ for any real object

Now, $V_{image} = -m^2 V_{object}$

$\Rightarrow |V_{image}| < |V_{object}|$ always.

Q.12 The distance between a screen and an object is 120 cm. A convex lens is placed closed to the object and is moved along the line joining object and screen, towards the screen. Two sharp images of the object are found on the screen. The ratio of magnification of two real images is 1 : 9. Then -

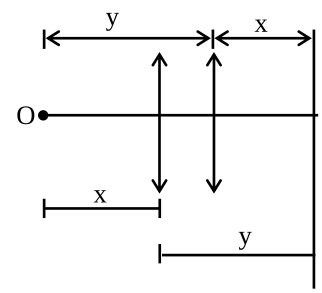
(A) focal length of the lens is 22.5 cm

(B) smaller image is brighter than the layer one

(C) focal length of the lens is 45 cm

(D) smaller image is less brighter than the larger one

Sol. **[A,B]**



$x + y = 120$ … (i)

$\frac{x}{y} = m_1$

$\frac{y}{x} = m_2$

$\left(\frac{x}{y}\right)^2 = \frac{1}{9}$

$3x = y$

$\therefore x + 3x = 120 \Rightarrow x = 30, y = 90$

$\frac{1}{f} = \frac{1}{30} + \frac{1}{90} \Rightarrow f = 22.5$ cm.

Q.13 A plane mirror –

(A) can form a real image of a real object

(B) neither converges nor diverges the rays

(C) cannot form a real image of a real object

(D) none of the above **[B,C]**

Sol. Position of image is the point of divergence or convergence of reflected rays. If light rays are incident from a real object on a plane mirror, then the rays incident on the plane mirror will be diverging. Power of a plane mirror is zero

Q.14 A concave mirror is placed on a horizontal table, with its axis directed vertically upwards. Let O be the pole of the mirror and C its centre of curvature. A point object is placed at C. It has a real image, also located at C. If the mirror is now filled with water, the image will be -

(A) real and will remain at C

(B) real and located at a point above C

(C) virtual and located at a point between C and O

(D) real and located at a point between C and O

[D]

Sol. Image is formed between C & O & it is real.

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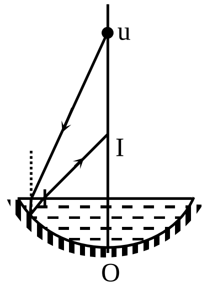


Q.15 A point object is placed at 30 cm from a convex glass lens $\left(\mu_g = \frac{3}{2}\right)$ of focal length 20 cm. The final image of object will be formed at infinity if -

(A) another concave lens of focal length 60 cm is placed in contact with the previous lens

(B) another convex lens of focal length 60 cm is placed at a distance of 30 cm from the first lens

(C) the whole system is immersed in a liquid of refractive index 4/3

(D) the whole system is immersed in a liquid of refractive index 9/8 **[A,D]**

Sol. Final image is formed at infinity if the combined focal length of two lenses becomes 30 cm or

$\frac{1}{30} = \frac{1}{20} + \frac{1}{f} \Rightarrow f = -60$ cm

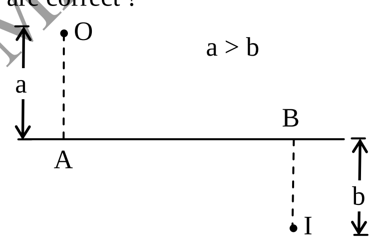
Similarly, let μ be the refractive index of liquid in which focal length of the given lens becomes 30 cm.

Then, $\frac{1}{20} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ …(1)

$\Rightarrow \frac{1}{30} = \left(\frac{3/2}{\mu} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ …(2)

solving (1) & (2), $\mu = \frac{9}{8}$

Q.16 A luminous point object is placed at O, whose image is formed at I as shown in figure. Line AB is optic axis. Which of the following statements are correct ?



(A) If the lens is used to obtain the image, the lens must be a converging lens and position of its principal focus can be found out.

(B) If the mirror is used to obtain the image, the mirror must be a convex mirror whose pole will be at point of intersection of line OI with the optic axis.

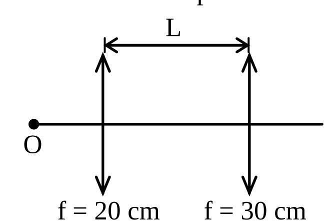
(C) Position of principal focus of the mirror cannot be found out.

(D) I is a real image.

Sol. **[A, D]**

If lens is used, then image is inverted & diminished i.e. magnification is less than 1. When converging lens is used, image is real.

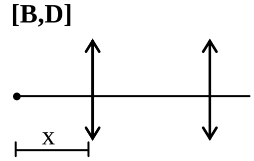
Q.17 Two converging lens have focal length 20 cm & 30 cm. Optical axis of both lens coincide. This lens system is used to form an image of an object. It turn out that size of the image does not depend on the distance between the lens system & the object. If L is distance between lens & M is magnification after all possible refraction-



(A) L = 10 cm (B) L = 50 cm

(C) $| M | = \frac{3}{2}$ (D) $| M | = \frac{2}{3}$

Sol. **[B,D]**



Calculate M_{net}, as a function of x,

Then $\frac{dM_{net}}{dx} = 0$

Q.18 Which of the following quantities increases when wavelength is increased. Consider only the magnitudes -

(A) The focal length of a converging lens

(B) The focal length of a diverging lens

(C) The angle of minimum deviation caused by

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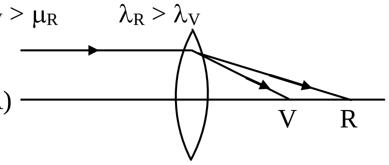
a prism

(D) The angle of maximum deviation caused by a prism, without total internal reflection

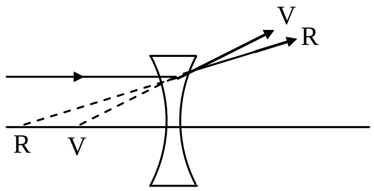
[A.B]

Sol. $\mu_V > \mu_R$ $\lambda_R > \lambda_V$

(A)

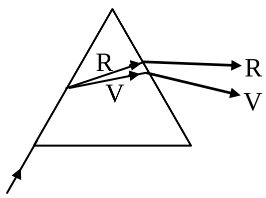


(B)



(C) $\delta_{min} = 2\sin^{-1}\left(\mu \sin \frac{A}{2}\right) - A$

(D)



$$\delta_{max} = \sin^{-1}[\mu \sin(A - \theta_C)] + \frac{\pi}{2} - A$$

Q.19 A Plano convex lens (μ = 1.5) of focal length 20 cm has its plane side silvered -

(A) The radius of curvature of its curved surface is half that of a surface of equiconvex lens of focal length 20 cm made of same material

(B) An object place at 15 cm on the axis on the convex side gives rise to an image at a distance of 30 cm from it

(C) An object located at a distance of 20 cm on the axis on the convex side gives rise to an image at 40 cm from it

(D) It acts as a convex mirror **[A,B]**

Sol. (A) $\frac{1}{F} = \frac{(\mu-1)}{R} = \frac{1}{20}$

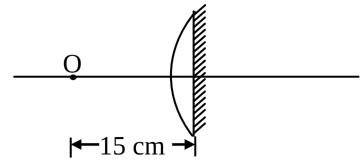
$\Rightarrow \frac{1}{20} = \frac{\mu-1}{R} = (\mu - 1)\left(\frac{1}{2R} + \frac{1}{2R}\right)$

$\Rightarrow$ equiconvex lens of f = 20 cm with radius of curvature = 2R

(B) F_{eq} = – 10 cm like a concave mirror

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

$\Rightarrow$ v = – 30 cm



(C) for u = – 20 cm

v = – 20 cm, so C is wrong.

Q.20 Optical axis of a thin equiconvex lens is the x-axis. The co-ordinate of a point object and its image are (–20 cm, 1 cm) and (40 cm, – 4 cm) respectively -

(A) The lens is located at x = 12 cm

(B) The lens is located at x = – 8 cm

(C) The focal length of the lens is 9.6 cm

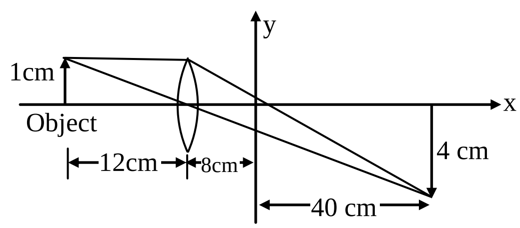
(D) The focal length of the lens is 12 cm

[B,C]

Sol. $m = \frac{v}{u} = -4$

v + u = 60

$\Rightarrow$ u = 12, v = 48



$\frac{1}{f} = \frac{1}{48} - \frac{1}{-12} \Rightarrow f = \frac{48}{5} = 9.6$ cm

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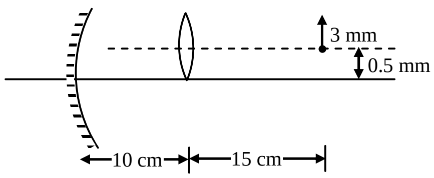
Q.1 A concave mirror of focal length 20 cm and a convex lens of focal length 10 cm are kept with their optic axes parallel but separated by 0.5 cm as shown in figure. The distance between lens and mirror is 10 cm. An object of height 3 mm is placed on the optic axis of lens at a distance 15 cm from the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

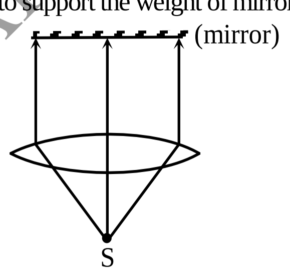
$$\frac{1}{v_2} + \frac{1}{20} = \frac{1}{-20}$$

$\Rightarrow v_2 = -10$ cm

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

Length of image = 1 × 3 = 3 mm

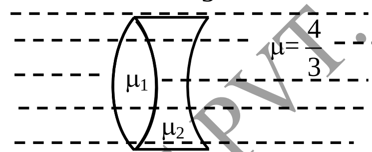
Q.2 A totally reflecting small plane mirror placed horizontally faces a parallel beam of light as shown in figure. The mass of mirror is 20 gm. Assume that there is no absorption in the lens and that 30% of the light emitted by source goes through lens. Find the power of source in MW needed to support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

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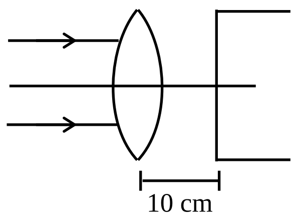
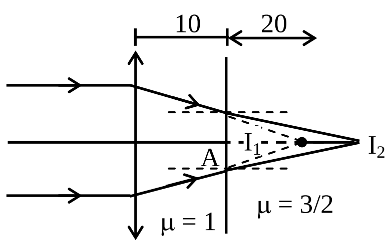
$$-\left(\frac{dN}{dt}\right)_A = -\left(\frac{dN}{dt}\right)_B \Rightarrow n = 1$$

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]**



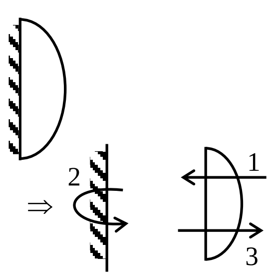
$$\frac{AI_1}{1} = \frac{AI_2}{\mu}$$

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

∴ 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.

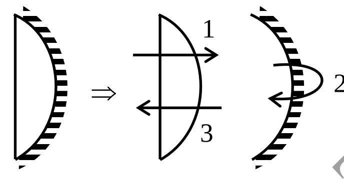
Sol. **[3]**



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

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

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



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

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

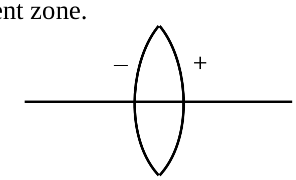
$$\frac{1}{10} = \frac{1}{f_{eq_1}} + \frac{2}{R}$$

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

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.

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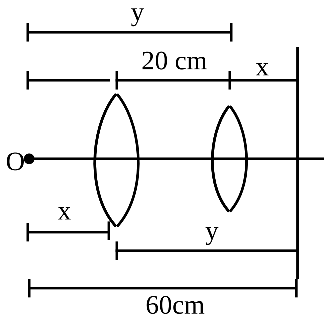
Sol. **[4]**



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

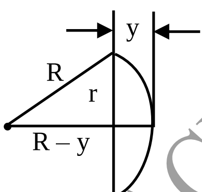
$$\frac{1}{f} = \frac{1}{y} + \frac{1}{x}$$

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

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

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]**



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

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

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

$$\mu = \frac{c}{v} = \frac{3.0\times10^8}{2.0\times10^8} = 1.5$$

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

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

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

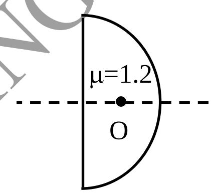
$$m = -\frac{v}{u} = -2$$

$v = -2u$

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

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

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]**

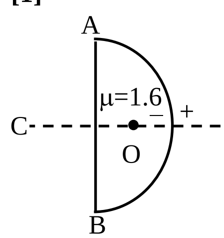


image distance from AB plane face

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

image distance from AB curved surface = x

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

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

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

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

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

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

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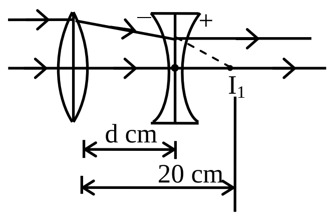
Q.12 A convex lens A of focal length 20 cm and a concave lens B of focal length 10 cm are kept along the same axis with a distance d between them. If a parallel beam of light incident on A leaves B as a parallel beam then the value of d is …… × 10 cm.

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]

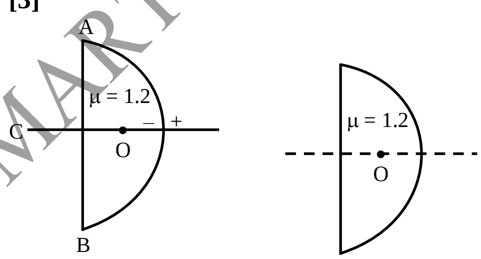


Image distance from AB plane face

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

image distance from curved surface = x

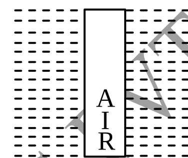
$$\frac{1}{x} - \frac{1.2}{-4} = \frac{1-1.2}{-8} \quad \text{or } x = 3 \text{ cm}$$

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.

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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

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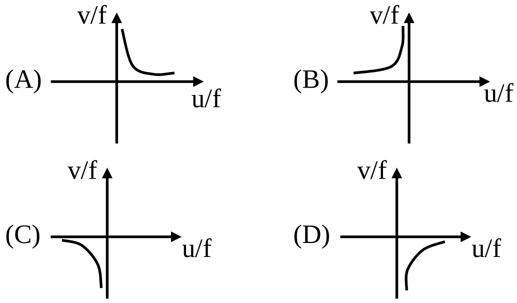
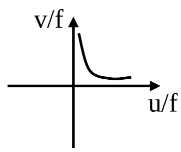
Q.1 A virtual erect image by a diverging lens is represented by (u, v, f are coordinates)



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

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

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

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 -

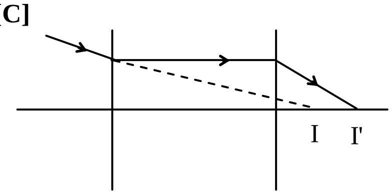
(A) away from the lens by $t(\mu - 1)$

(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.

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$\therefore$ 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

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

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

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

$\boxed{m = -3}$

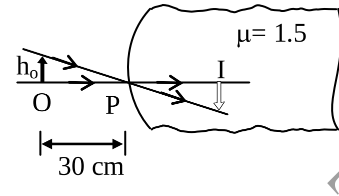
Velocity of image = $m^2 \times$ velocity of object

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

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

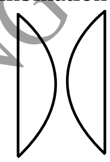
Option (C) is correct.

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

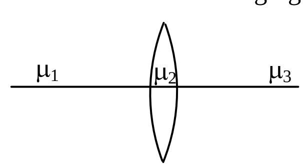
Sol. **[D]** $m = \frac{f}{f+u}$

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

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 -



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(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

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

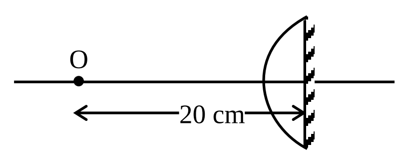
$\Rightarrow -\frac{1}{2x} + \frac{1}{x} = \frac{1}{20}$

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

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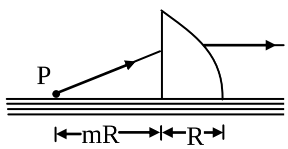
Q.18 A point object is placed at a distance of 15 cm from a convex lens. The image is formed on the other side at a distance of 30cm from the lens. When a concave lens is placed in contact with the convex lens, the image shifts away further by 30 cm. Calculate the focal lengths of the concave and convex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

(A) 10 cm, 60 cm (B) 20 cm, 30 cm

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

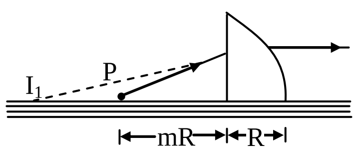
Q.19 A quarter cylinder of radius R and R.I. 1.5 is placed on a table. A point object P is kept at a distance mR from it. For which value of m, when a ray from P will emerge parallel to the table as shown in figure?



(A) 2/3 (B) 3/2

(C) 3/4 (D) 4/3

Sol. **[D]**



For Ist surface

$u = -mR$, $v = ?$, $R_1' = \infty$, $\mu_1 = 1$, $\mu_2 = 1.5 = \frac{3}{2}$

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

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

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

From 2nd surface

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

$v' = \infty$, $R'_2 = -R$, $\mu_1 = \mu = 1.5$, $\mu_2 = 1$

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

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

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

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

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 $\mu = 4/3$?

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(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]

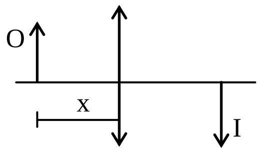
Q.26 A thin equiconvex lens has focal length 10 cm and refractive index 1.5 . One of its faces is now silvered and for an object placed at a distance u in front of it, the image coincides with the object. The value of u is-
(A) 10 cm (B) 5 cm
(C) 20 cm (D)15 cm **[B]**

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

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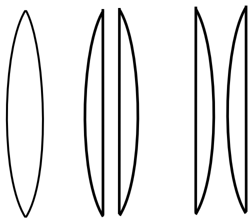


(A) zero (B) 5 cm
(C) 10 cm (D) 20 cm **[D]**

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

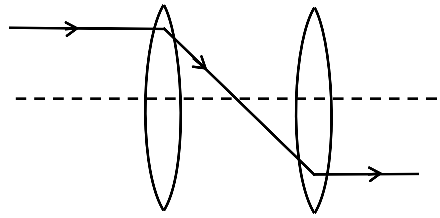
(C) $\left(\frac{1}{A_1}+\frac{1}{A_2}\right)^{-1}$

(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

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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

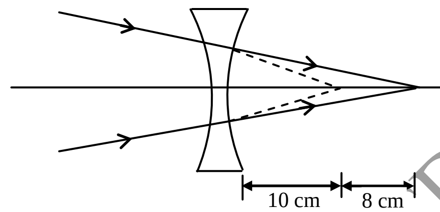
(C) $\frac{(\mu-1)}{\mu}$ f (D) (μ + 1) f **[C]**

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 -

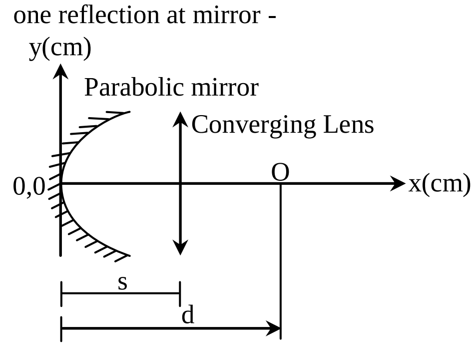
(A) 2 real inverted images of the object

(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]**

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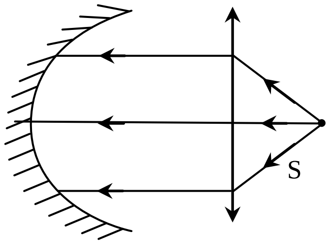


In parabolic mirror, parallel incident ray converge at focus $y^2 = \frac{x}{8}$

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

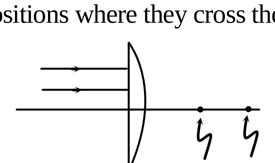
$$\frac{1}{mx} + \frac{1}{x} = \frac{1}{f} \quad \text{... (i)}$$

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

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

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

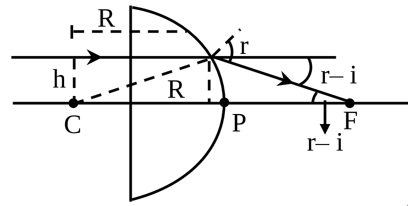
Q.50 Two rays travelling parallel to the principal axis strike a large plano-convex lens having a refractive index of 1.60. If the convex face is spherical, a ray near the edge does not pass through the focal point (spherical aberration). If this face has a radius of curvature of 20.0 cm & the two rays 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 –



(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 = $PF_2 - PF_1$

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Q.1 A small mark on the side of a spherical glass vessel of radius 20 cm full of water is viewed along a diameter through the opposite side of the vessel. Neglecting the thickness of the glass, find the position of the image.
R.I. of water = 4/3. **[60 cm (virtual)]**

Q.2 One end of a horizontal cylindrical glass rod (n = 1.5) of radius 5.0 cm is rounded in the shape of hemisphere. An object 0.5 mm high is placed perpendicular to the axis of the rod at a distance of 20.0 cm from the rounded edge. Find out the position of the image and its height.

Sol. **[The image is formed inside the rod at a distance of 30 cm from the vertex and final image will be of same height as the object but inverted]**

Q.3 Rays of light from a luminous object are brought to focus at a point A. A convex lens of 24cm focal length is then placed 24cm from A, so as to intercept the rays before they meet at A. If now, they meet at B, find the distance AB. **[12 cm]**

Q.4 Two glasses with refractive indices of 1.5 and 1.7 are used to make two identical double convex lenses
(i) Find the ratio between their focal lengths.
(ii) How will each of these lenses act on a ray parallel to its optical axis if the lenses are submerged into a transparent liquid with a refractive index of 1.6 ?

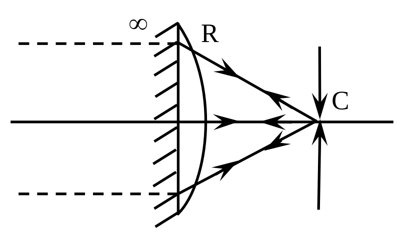
Sol. **[(i) 1.4**
(ii) In the liquid the first lens will be a diverging & the second a converging one size of image = 23.846 cm.]

Q.5 Find the nature and focal length of a lens which must be placed in contact with a concave lens of focal length 25cm in order that the lens combination may produce a real image three times the size of the object, placed 20cm from the combination. **[9.38 cm, convex]**

Q.6 A convex lens mounted on an optical bench forms an image of an object on a screen, the magnification being 2.5. The object and the screen are kept fixed and the lens is moved through a distance of 10cm, when a sharp image is again formed on the screen, the magnification being now 0.4. What is the focal length of the lens ? **[4.76 cm]**

Q.7 An object is D cm from a screen. A convex lens forms an image of it on the screen. When moved through a distance x cm. It forms another image. Prove that the ratio of sizes of two images produced is $\left[\frac{(D+x)^2}{(D-x)^2}\right]$.

Q.8 The plane surface of a plano convex lens is silvered and it then acts like a concave mirror of 30cm focal length. Calculate the radius of curvature of the convex surface if R.I. for lens is 1.5.



[30 cm]

Q.9 An object placed in air on the principal axis of thin glass lens at 30cm from it, produces a real image at 60cm from the lens. If the whole system is immersed in a tank of liquid of refractive index 6/5, find the new position, nature and magnification of the image (μ_g = 1.5).

Sol. **[120 cm from lens, real & times magnified]**

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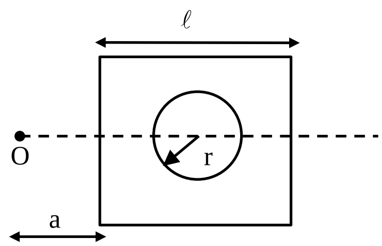
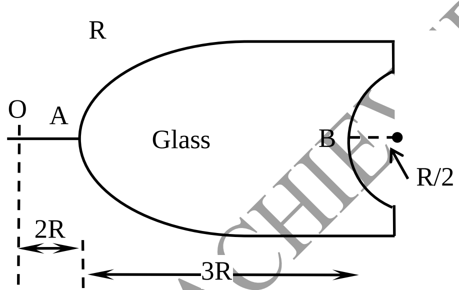
Q.10 A cubical block of glass (refractive index $\mu = 1.5$) has a concentric spherical cavity of radius r = 3cm. Each edge of the cube is $\ell = 12$ cm long. A luminous point object is at a distance a = 12 cm on left of left face of the cube as shown in figure. Calculate apparent position of the object when seen from right side of the cube.



Sol. **[52/9 cm on left right face]**

Q.11 A glass rod has ends as shown in figure. The refractive index of glass is μ. The object O is at a distance 2R from the surface of larger radius of curvature. The distance between apexes of ends is 3R. Find the distance of image formed of the point object from right hand vertex. What is the condition to be satisfied if the image is to be real ?



Sol. **[$v = \frac{(9-4\mu)R}{(10\mu-9)(\mu-2)}$, the image will be virtual if R.I. of glass is between 2 and 9/4.]**

Q.12 A convex lens is held 45cm above the bottom of an empty tank. The image of a point on the bottom of a tank is formed 36cm above the lens. Now liquid is poured into the tank to a depth of 40cm. It is found that the distance of the image of the same point on the bottom of the tank is 48cm above the lens. Find the refractive index of the liquid. **[1.37]**

Q.13 A converging lens of 20cm focal length is arranged coaxially with a diverging lens of focal length 8cm. A point object lies on the same side as the converging lens and very far away on the axis.

(i) What is the smallest possible distance between the lenses if the combination is to form a real image ?

(ii) If the lenses are placed 6cm apart what is the position and nature of the final image of the distant object ?

Sol. **[x_{min} = 12 cm, –56/3 cm (virtual) (from concave lens)]**

Q.14 An object of height 4cm is placed to the left of and on the axis of a converging lens of focal length 10cm. A plane mirror is placed inclined at 45º to the axis, 10cm to the right of the lens. Find the position and size of the image formed by the lens and mirror. Trace the path of the rays forming the image. The distance of the object is 15cm to the left of the lens.

[8 cm, 20 cm from the mirror]

Q.15 A hollow glass sphere has outer diameter 4R and inner diameter 2R. A point object on the inner surface is viewed along the diameter from the opposite side. Find the distance between the object and its image. **[$\frac{R(\mu-1)}{3\mu-1}$]**

Q.16 A thin converging lens with focal length f = 25cm projects the image of an object on a screen removed from the lens by a distance ℓ = 5.0m. Then the screen was drawn closer to the lens by a distance $\Delta\ell$ = 18cm. By what distance should the object be shifted for its image to become sharp again ?

[$\Delta x = \Delta\ell\, f^2 / (\ell - f)^2 = 0.5$ mm]

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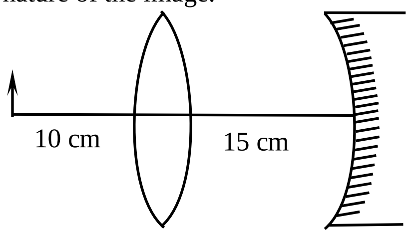
Q.17 A convex lens of focal length 20cm is placed 15cm in front of a concave mirror of radius of curvature 26cm, and further 10cm away from the lens is placed an object. The principal axis of the lens and the mirror are coincident and the object is on this axis. Find the position and nature of the image.



[–4.42 cm]

Q.18 A convex lens B of focal length 20cm is placed at a distance of 30cm to the right of an identical lens A. A point object is placed at a distance of 30cm to the left of A. On the common axis of the two lenses.

(i) Where should a convex mirror of radius of curvature 7cm be placed so that the final image coincides with the objects.

(ii) Trace the path of the rays. **[5 cm]**

Q.19 An aligned optical system consists of two thin lenses with focal lengths f_1 and f_2 the distance between the lenses being equal to d. The given system has to be replaced by one thin lens which, at any position of an object, would provide the same transverse magnification as the system. What must the focal length of this lens be equal to and in what position must it be placed with respect to the two-lens system ?

Sol. **[$f = \dfrac{f_1 f_2}{f_1 + f_2 - d}$, the lens should be positioned in the front principal plane of the system; i.e. at the distance of $x = f_1 d/(f_1 + f_2 - d)$ from the second lens]**

Q.20 A thin equi-convex lens is placed on a horizontal plane mirror and a pin held 20cm above the lens coincides in position with its own image. The space between the lens and mirror is filled with water (μ = 4/3) and then to coincide with its own image as before the pin has to be raised until its distance from the lens is 27.5 cm. Find the radius of curvature of lens.

[R = 24.44 cm]

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