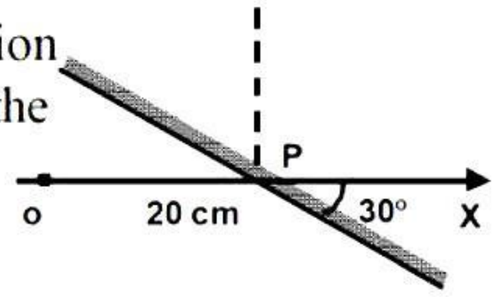
[SINGLE CORRECT CHOICE TYPE]

Q.1 A ray of light passes from a medium of refractive index μ into air. The angle of incidence is found to be half the angle of refraction. What is the angle of refraction?

(A) $\cos^{-1}(\mu/2)$ (B) $\sin^{-1}(\mu/2)$ (C) $2\sin-1(\mu/2)$ (D) $2\cos^{-1}(\mu/2)$

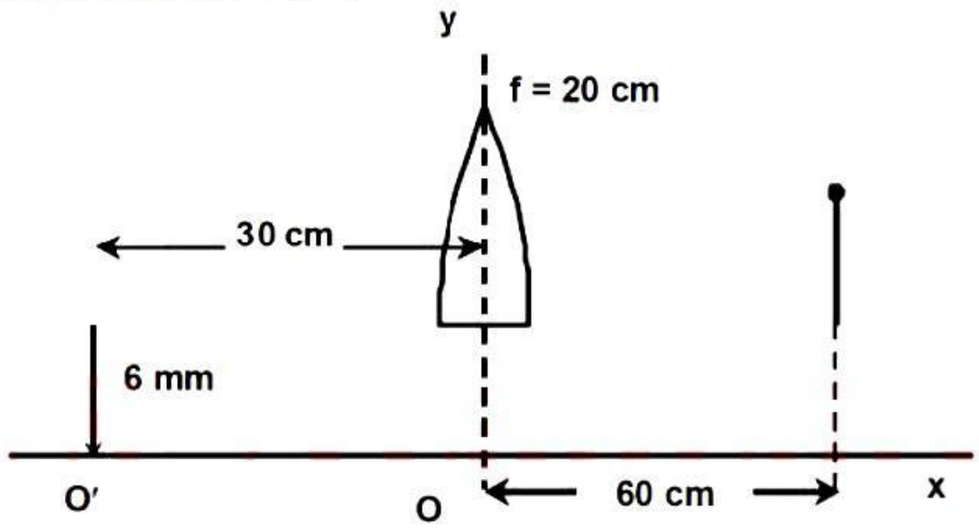
Q.2 Consider the point P as the origin and line OP as the x-axis in the situation shown in the figure. Which of the following represents the coordinates of the image of the point object O. (Take OP = 20 cm)



(A) (20 cm, 0 cm) (B) (10 cm, $10\sqrt{3}$ cm)

(C) (–10 cm, $10\sqrt{3}$ cm) (D) (10 cm, $-10\sqrt{3}$ cm)

Q.3 A thin convex lens is cut along its principal axis and one half of the lens is placed as shown in the figure. What are the x and y coordinates respectively, of the image w.r.t. the origin O of the given coordinate axis? The focal length of the lens is 20 cm.

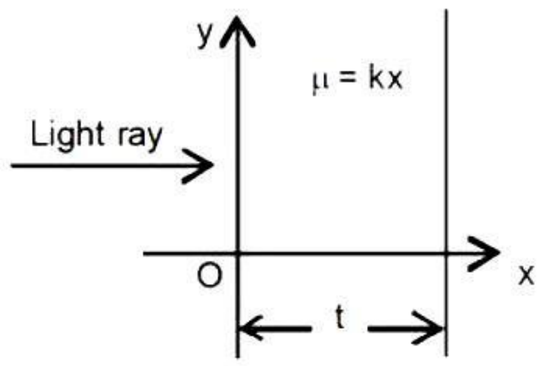


(A) (60 cm, 12 mm) (B) (60 cm, 18 mm) (C) (12 cm, 2.4 mm) (D) (60 cm, –12 mm)

Q.4 An equi convex lens whose focal length in air is 20 cm is made up of a material whose refractive index is 1.5. If one of its surface is silvered and then dipped into a transparent liquid whose refractive index is 1.6. In the liquid it will behave like a

(A) converging lens (B) diverging lens (C) converging mirror (D) diverging mirror

Q.5 Refractive index of a transparent slab varies as $\mu = kx$ where x is the distance from origin. Time taken by the light to travel the slab of thickness t (as shown in the figure)

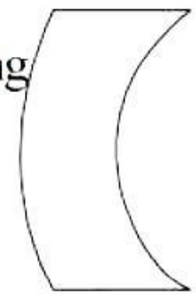


(A) $\frac{t^2k}{2c}$ (B) $\frac{t^2k}{c}$ (C) $\frac{tk}{c}$ (D) $\frac{2tk}{2c}$

Q.6 A ray moving along unit vector $\frac{1}{2}\left(\hat{i}+\hat{j}+\sqrt{2}\hat{k}\right)$ strikes a reflecting surface in xy plane. The unit vector along the reflected ray would be

(A) $-\frac{1}{2}\left(\hat{i}+\hat{j}+\sqrt{2}\hat{k}\right)$ (B) $\frac{1}{2}\left(\hat{i}+\hat{j}-\sqrt{2}\hat{k}\right)$ (C) $-\frac{1}{2}\left(\hat{i}+\hat{j}-\sqrt{2}\hat{k}\right)$ (D) None of these

Q.7 The lens shown in the diagram has a refractive index higher than that of its surrounding medium. It will converge a paraxial beam incident on it



(A) from left only (B) from right only

(C) either from left or right (D) None.

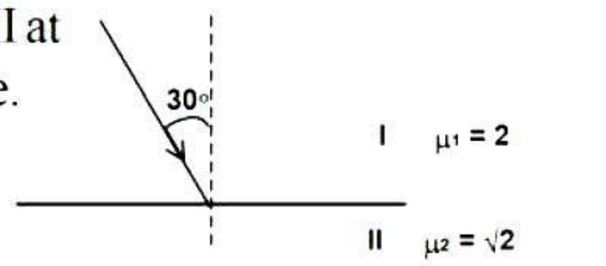
Q.8 A paraxial beam of light having diameter 4 mm is incident on a convex lens having focal length 10 cm. A screen is placed normal to the beam at a distance of 30cm on the other side. Radius of image formed on the screen is-

(A) 6 mm (B) 4 mm (C) 3mm (D) 2 mm

Q.9 A ray of light from air is incident at an angle of 70° into a medium having refractive index μ. The reflected and the refracted rays are found to suffer equal deviations in opposite direction. μ equals

(A) tan70° (B) 2sin70° (C) cosec70° (D) None of these

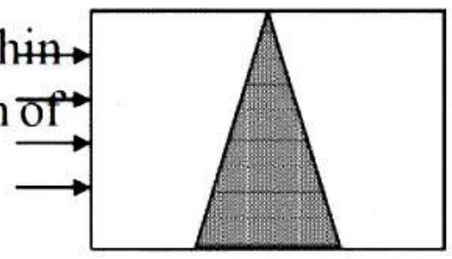
Q.10 In the figure shown a ray of light hits the interface of the media I & II at angle of 30°. Refractive indices of the media are shown in the figure. The angle made by the ray with normal in medium three is



(A) $\sin^{-1}\left(\frac{2}{3}\right)$ (B) $\sin^{-1}\left(\frac{\sqrt{2}}{3}\right)$

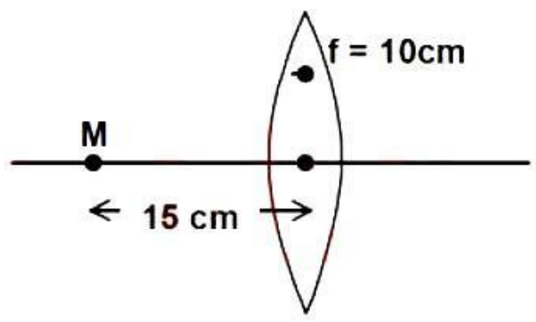
(C) ray will not come in medium III (D) $i_3 = \sin^{-1}\left(\frac{2}{7}\right)$

Q.11 A thin prism with angle 4° and refractive index 1.5 is placed inside a thin transparent tube with water (refractive index , 4/3) as shown. The deviation of light will be



(A) 2.67° upward (B) 0.67° downward (C) 3 (D) 4

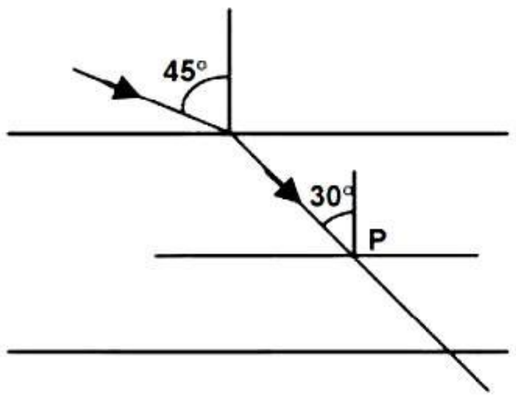
Q.12 As shown in the figure particle at M vibrates simple harmonically about M with amplitude 0.1cm perpendicular to axis along a line. Find the amplitude of vibration of image



(A) 0.3 cm in same phase (B) 0.1 cm in opposite phase

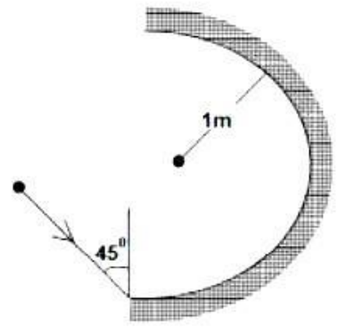
(C) 0.2 cm in same phase (D) 0.2 cm in opposite phase

Q.13 Path of a ray entering from air to a medium of variable refractive index is shown in figure. Find the value of refractive index of the medium at P.



(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{1}{2}$ (C) $\sqrt{2}$ (D) 2

Q.14 Find the final deviation of the incident ray from a semi-circular mirror as shown in the figure.



(A) 270° (B) 180°

(C) 60° (D) 0°

Q.15 A biconvex lens of radii of curvature 20 cm has refractive index 1.56 for blue colour and 1.48 for red colour. The approximate linear spread of focus for white light is

(A) 0.36 cm (B) 0.42 cm (C) 0.30 cm (D) 3 cm

Q.16 When an object is kept at a distance of 20 cm from a concave mirror, the image is formed at a distance of 10 cm. If the object is moved with a speed of 4 m/s along the principal axis, the speed with which the image moves is

(A) 10 cm/sec (B) 1 m/sec (C) 4 m/sec (D) 0.4 m/sec

Q.17 Two small angled prisms of prism angle A and B respectively are combined to produce dispersion without deviation. Then the net dispersion produced is

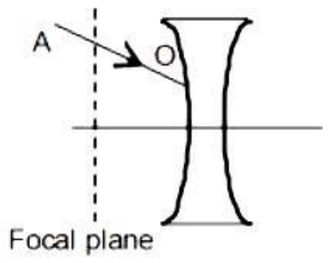
(A) $(\mu_v - \mu_r)A + (\mu_{v'} - \mu_{r'})B$

(B) $(\mu_{v'} - \mu_r)A + (\mu_v - \mu_{r'})B$

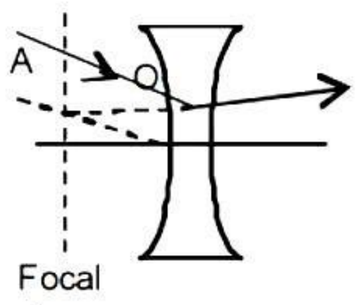
(C) $(\mu_v - \mu_r)A - (\mu_{v'} - \mu_{r'})B$

(D) $(\mu_{v'} - \mu_{r'})A + (\mu_v - \mu_r)B$

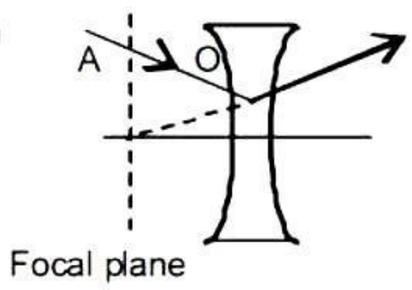
Q.18 A beam of light AO is incident on a diverging lens as shown in the figure. The focal plane of the lens is also given. The possible direction of the refracted beam will be



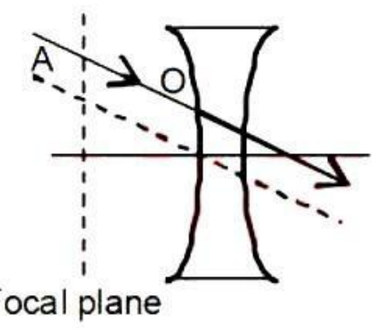
(A)



(B)



(C)

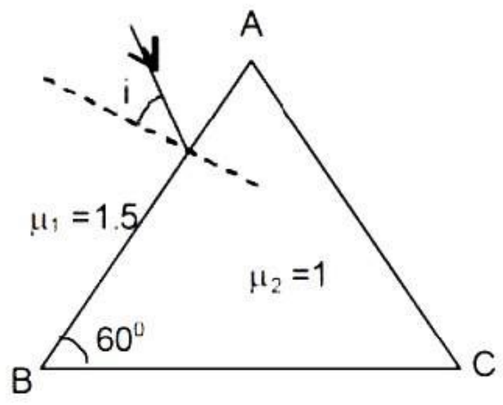


(D) none of the above

Q.19 An object is placed at distance of 10 cm in air from the front surface of a thick glass slab of thickness 6 cm whose back surface has been silvered and is placed in air. The image is formed at a distance of 14 cm from the silvered surface. The refractive index of the material of the thick mirror is

(A) 1.2 (B) 1.3 (C) 1.4 (D) 1.5

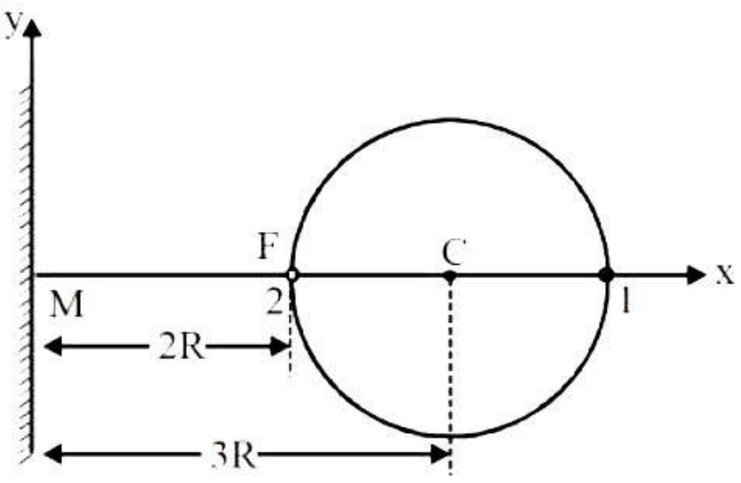
Q.20 What should be the value of i (angle of incidence) so that the ray incident on the face AB of the equilateral prism will pass through BC perpendicularly



(A) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (B) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (C) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (D) $\cos^{-1}\left(\frac{2}{\sqrt{3}}\right)$

[MATRIX TYPE]

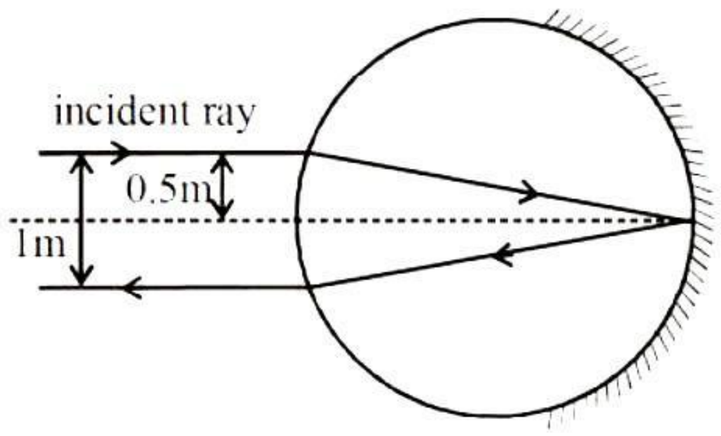
Q.21 A spherical fish bowl of radius R is placed in front of a plane vertical mirror (M). The thickness of the wall of the fish bowl is very thin. The centre (C) of the spherical bowl is at a distance of 3R from the plane mirror. The bowl is filled with water and contains a fish (F). Fish (F) is at a distance of R from the centre of the spherical bowl as shown in the figure. Refractive index of water is $\frac{4}{3}$. Two surfaces are indicated in the bowl as first surface (1) and second surface (2)



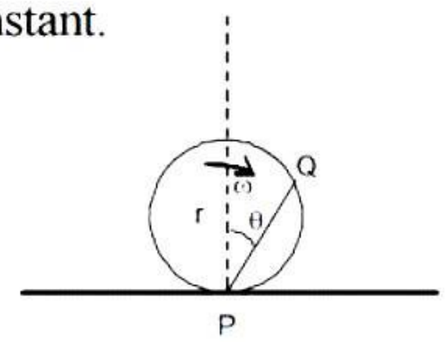
	Column-I **Optical Event**		**Column-II** **Nature of image**
(A)	Refraction at first surface	(P)	Virtual
(B)	Refraction at second surface after reflection from mirror	(Q)	Real
(C)	Refraction at first surface after reflection from mirror and refraction from second surface.	(R)	Magnified
		(S)	Diminished

[SUBJECTIVE TYPE]

Q.22 A transparent cylinder of radius 1m has a mirrored surface on its right half as shown. A ray of light travelling in air is incident on the left side of the cylinder. The ray coming out from the cylinder is parallel to incident ray and at a distance d = 1.00 m from the incident ray. Find the refractive index of the material.



Q.23 A disc of radius r is rolling on a plane horizontal mirror with constant angular velocity ω as shown in the figure. Calculate velocity of image of point Q w.r.t. Q itself. P is contact point and line PQ makes an angle θ with vertical at given instant.



ANSWER KEY

Q.1	D	Q.2	C	Q.3	B	Q.4	C	Q.5	A	Q.6	B	Q.7	D
Q.8	B	Q.9	B	Q.10	D	Q.11	B	Q.12	D	Q.13	C	Q.14	A
Q.15	D	Q.16	B	Q.17	C	Q.18	A	Q.19	A	Q.20	A		

Q.21 (A) P,R (B) Q,R (C) Q,S

Q.22 $\mu = \frac{1}{2\sin 15^0}$

Q.23 $2r\omega \sin 2\theta$

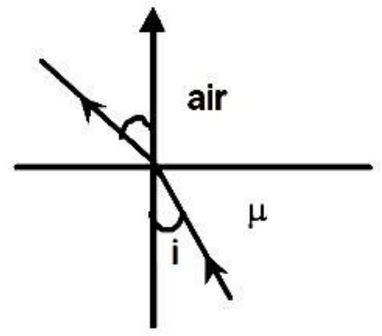
HINTS AND SOLUTIONS

Q.1 D

Sol. $\frac{\sin i}{\sin r} = \frac{1}{\mu} \Rightarrow \sin i = \frac{\sin r}{\mu}$

$\Rightarrow \sin i = \frac{2 \sin i \cos i}{\mu}$

$\Rightarrow i = \cos^{-1}(\mu/2) \Rightarrow r = 2\cos^{-1}(\mu/2)$



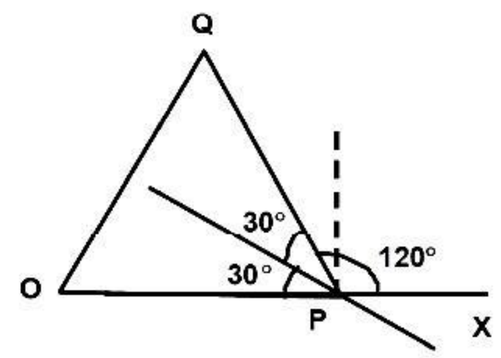
Q.2 C

Sol. x-coordinate of the point Q is

PQ cos120° = 20 cos 120° = –10 cm

y-coordinate of the point Q is

PQ sin 120° = 20 sin 120° = $10\sqrt{3}$ cm



Q.3 B

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

$\Rightarrow \frac{1}{v} = \frac{1}{u} + \frac{1}{f} = -\frac{1}{30} + \frac{1}{20} = \frac{3-2}{60} = \frac{1}{60}$

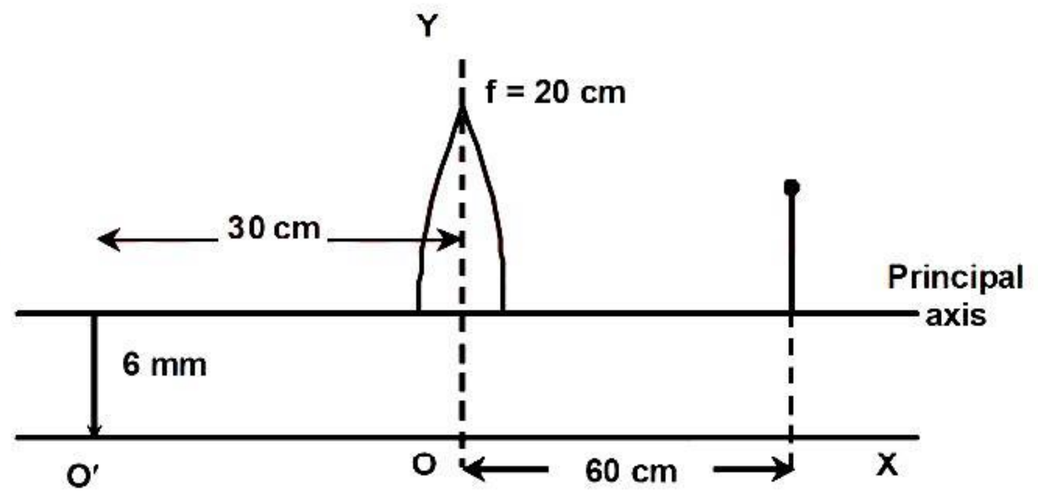
$\Rightarrow v = 60$ cm

m = v/u = 60/–30 = –2

Height of image = (–2) (–6) = 12 mm

Y-coordinate of the image of Q_1 = 12 + 6

= 18 mm



Q.4 C

Sol. $P = 2P_l + P_m$

$P_m = \frac{1}{f}, \frac{1}{f_l} = \left(\frac{\mu_g}{\mu_l} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$. Converging mirror.

Q.5 A

Sol. $v = \frac{c}{kx}$

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

$\int_0^t x\ dx = \frac{c}{k}\int_0^T dt$

$$T = \frac{t^2 k}{2c}$$

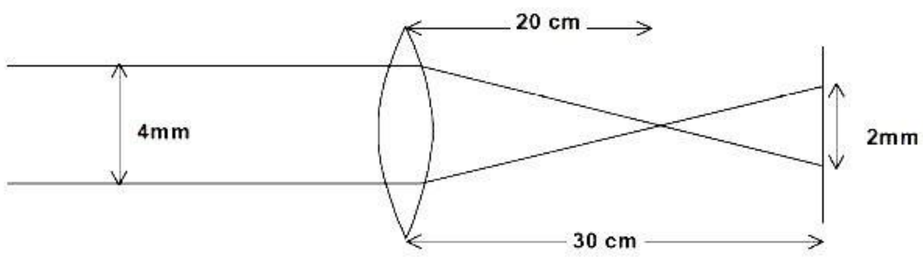
Q.6 B

Sol. Only 'z' component will change.

Q.7 D

Q.8 B

Sol.



Q.9 B

Q.10 D

Q.11 B

Q.12 D

Q.13 C

Q.14 A

Q.15 D

Q.16 B

Sol. Mirror formula

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

$$-\frac{1}{u^2}\frac{du}{dt} - \frac{1}{v^2}\frac{dv}{dt} = 0$$

$$\left|\frac{dv}{dt}\right| = \frac{v^2}{u^2}\left|\frac{du}{dt}\right| = \left(\frac{10}{20}\right)^2 \times 4 = 1 m/sec$$

Q.17 C

Sol. Net dispersion produced $= (\delta_v - \delta_r) - (\delta_{v'} - \delta_{r'}) = (\mu_v - \mu_r)A - (\mu_{v'} - \mu_{r'})B$

Q.18 A

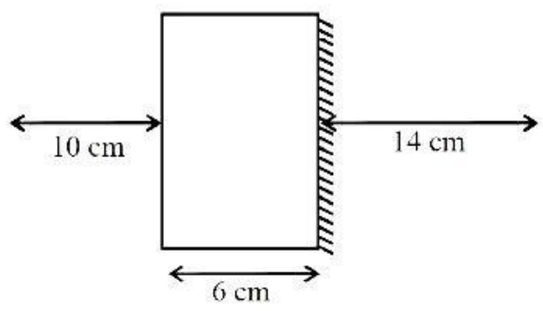
Sol. Sol. For diverging lens, all refracted rays corresponding to an incident beam consisting of parallel rays meet at a point in focal plane when produced backward

Q.19 A

Sol. Dist. between object and image

$$30 = 2\left(10 + \frac{6}{\mu}\right)$$

$$\Rightarrow \mu = 1.2$$

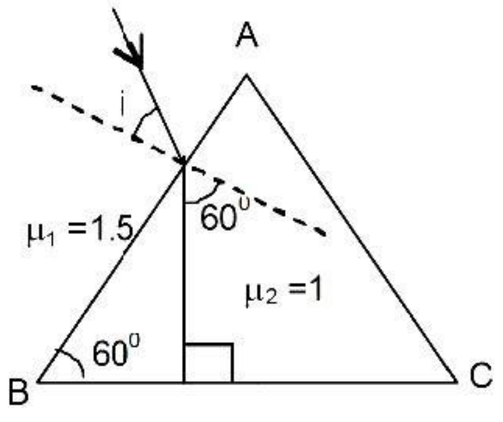


Q.20 A

Sol. $1.5 \sin i = (1) \sin 60°$

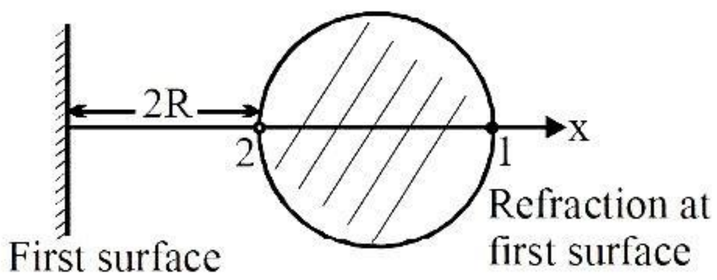
$$\Rightarrow \frac{3}{2} \cdot \sin i = \frac{\sqrt{3}}{2}$$

$$\therefore i = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$$



Q.21 [Ans. (A) P,R (B) Q,R (C) Q,S]

[Sol.



$$\frac{\mu_r}{v} - \frac{\mu_i}{u} = \frac{\mu_r - \mu_i}{R}$$

$$\frac{1}{v} - \frac{4/3}{(-2R)} = \frac{1-4/3}{(-R)}$$

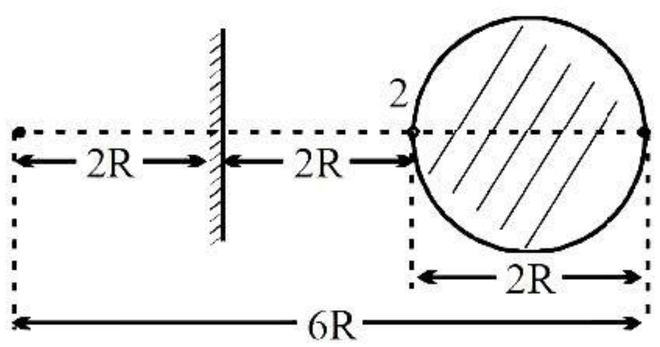
$$\frac{1}{v} + \frac{2}{3R} = -\frac{1}{3R}$$

$v = -3R$ (virtual)

$$m = \frac{\mu_i}{\mu_r} = \frac{4/3}{(1)} \frac{(-3R)}{(-2R)}$$

$m = 2$ (magnified)

Reflection from mirror & refraction from second surface

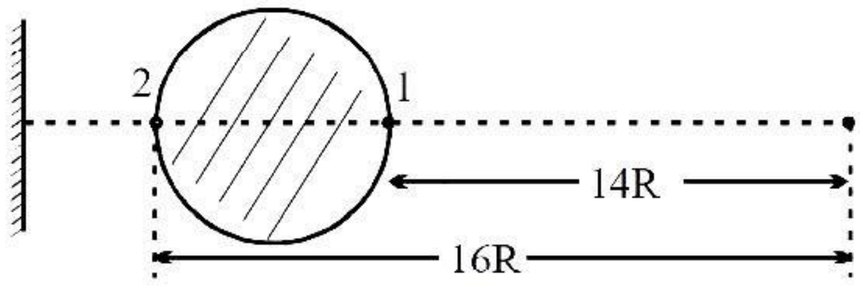


$$\frac{4/3}{v} - \frac{1}{(-4R)} = \frac{4/3-1}{R}$$

$v = 16R$ (Real)

$$m = \frac{\mu_i}{\mu_r}\frac{v}{u} = \frac{1}{4/3}\frac{16R}{(-4R)} \qquad \Rightarrow m = -3 \text{ (magnified)}$$

Refraction a first surface after reflection from mirror and refraction at second surface.



$$\frac{\mu_r}{v}-\frac{\mu_i}{u}=\frac{\mu_r-\mu_i}{R}$$

$$\frac{1}{v}-\frac{4/3}{14R}=\frac{1-4/3}{-R}$$

$$v=\frac{7R}{3}\ \text{(Real)}$$

$$m=\frac{\mu_i}{\mu_r}\frac{v}{u}$$

$$m=\frac{4}{3}\times\frac{7/3R}{+14R}=\frac{4}{3}\times\frac{7}{3\times14}\qquad\Rightarrow m=\frac{2}{9}\ \text{(diminished)}\ ]$$

Q.22 [Ans. $\mu=\dfrac{1}{2\sin 15^0}$]

Sol. Also $R = 1m$

In triangle PQO

$$\frac{PQ}{PO}=\sin 2r$$

$$\frac{0.5}{1}=\sin 2r$$

$\Rightarrow 2r = 30^0$ or $r = 15^0$

It is clear from figure that

$i = 2r = 30^0$

$$\text{so } \mu=\frac{\sin i}{\sin r}=\frac{\sin 30}{\sin 15}=\frac{1}{2\sin 15^0}$$

Q.23 [Ans. $2r\omega\sin 2\theta$]

Sol. Velocity of point Q w.r.t. mirror is

$= (r\omega + r\omega\cos 2\theta)\hat{i} + (r\omega\sin 2\theta)(-\hat{j})$

Horizontal velocity of image is same but vertical velocity is in opposite direction so velocity of image w.r.t. Q in vertical direction is $= 2r\omega\sin 2\theta = 4r\omega\sin\theta\cos\theta$