**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.**

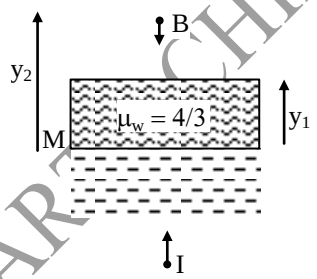
---

**Q.1** **Assertion** : A ray incident along normal to the mirror retraces its path.
**Reason** : In reflection, angle of incidence is always equal to angle of reflection.
**[A]**

**Q.2** **Assertion** : The twinkling of star is due to reflection of light.
**Reason** : The velocity of light changes while going from one medium to the other.
**[D]**

**Q.3** **Assertion :** A bird in air is diving vertically with speed $v_0$ over a tank filled with water and having flat silvered bottom serving as plane mirror, it observes velocity of its image in silvered bottom of tank as $2v_0$ upward relative to itself .
**Reason :** Bird and its image in bottom mirror are always equidistant from bottom mirror. **[C]**

**Sol.**




$$\frac{y_{I/M}}{4/3} = \frac{y_2 - y_1}{1} + \frac{y_1}{4/3}$$

$$y_{I/M} = y_1 + \frac{4}{3}(y_2 - y_1) \neq y_2$$

$$\text{But } y_{I/B} = 2\left[\frac{3y_1}{4} + (y_2 - y_1)\right]$$

$$\frac{d}{dt}y_{I/B} = 2\frac{d}{dt}.\ y_2 = 2v_0$$

**Q.4** **Statement-1 :** Different colours travel with different speed in vacuum.
**Statement-2 :** Wavelength of light depends on refractive index of medium. **[D]**

**Sol.** Option D is correct.

**Q. 5** **Assertion :** We can't see virtual images from our eyes.
**Reason :** Virtual images is not formed on the screen. **[D]**

**Sol.**

**Q.6** **Statement-I :** The size of the mirror affect the nature of the image.
**Statement-II :** Small mirrors always forms a virtual image. **[D]**

**Q.7** **Statement-I :** When an object is placed between two plane parallel mirrors, then all the images found are of equal intensity.
**Statement-II :** In case of plane parallel mirrors, only two images are possible. **[D]**

**Q.8** **Statement–I :** Plane mirror can form real image of real object.
**Statement–II :** Distance of image from plane mirror equals distance of object from mirror.

**Sol.** **[D]**
Statement- I is incorrect and Statement-II is correct

**Q.9** **Statement-I :** If a light ray incidents over one of the two inclined mirrors at 90º with each-other then finally emergent ray is antiparallel with incident ray.
**Statement-II :** Finally reflected and initially incident rays are in same phase when successively reflected from two perpendicularly inclined mirrors.

**Sol.[B]** Both statements are correct but statement II is not correct explanation of statement-I

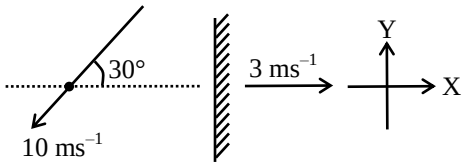
**Q.10** **Statement-I**: Dispersive power of vaccum is one.
**Statement-II** : Dispersive power of a prism does not depend on its apex angle.

**Sol.[D]** Statement I is false while Statement II is true.

**Q.11** **Statement - 1 :** Different colours travel with different speed in vacuum.
**Statement - 2 :** Wavelength of light depends on refractive index of medium.

**Sol.[D]**

**Q.1** A point object is moving with a speed of 10 $ms^{-1}$ in front of a mirror moving with a speed of 3 $ms^{-1}$ as shown in figure –

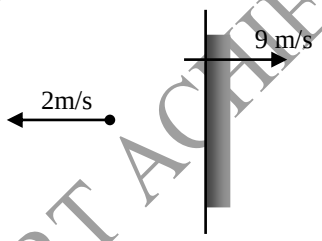



| Column I | Column II |
|---|---|
| (A) velocity of image w.r.t. mirror | (P) $(5\sqrt{3}+6)\,\hat{i}-5\,\hat{j}$ |
| (B) velocity of image w.r.t. object | (Q) $5\sqrt{3}\,\hat{i}-5\,\hat{j}$ |
| (C) velocity of image w.r.t. ground | (R) $(5\sqrt{3}+3)\,\hat{i}-5\,\hat{j}$ |
| (D) velocity of object w.r.t. ground | (S) $(10\sqrt{3}+6)\,\hat{i}$ |

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

**Q.2** **Match the entries of column – I and column – II :**

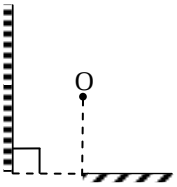
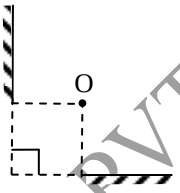
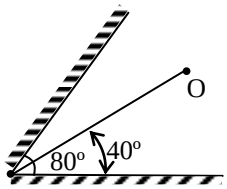
An object is moving in front of mirror as shown in figure.




| Column – I | Column -II |
|---|---|
| (A) Velocity of image | (P) 2 m/s |
| (B) Velocity of image with respect to mirror | (Q) 20 m/s |
| (C) Velocity of image with respect to object | (R) 11 m/s |
| (D) Velocity of image if mirror is stopped | (S) 22 m/s |

**A → Q, B → R, C → S, D → P**

**Q.3**

| Column-I | Column-II |
|---|---|
| (A)   | (P) 2 |
| (B)   | (Q) 4 |
| (C)   | (R) 3 |
| (D)   | (S) 1 |

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

**Q.4** A bird in air is diving vertically over a tank with speed 6 cm/s. Base of the tank is silvered. A fish in the tank is rising upward along the same line with speed 8 cm/s. (Take $\mu_{water} = 4/3$)

| Column I (in cm/s) | Column II |
|---|---|
| (A) Speed of the image of fish as seen by the bird directly | (P) 16 |
| (B) Speed of the image of fish formed after reflection from the mirror as seen by the bird | (Q) 0 |
| (C) Speed of image of bird relative to the fish looking upwards | (R) 12 |
| (D) Speed of image of bird relative to the fish looking downwards in the mirror | (S) 8 |

**Sol.** **A→R , B→Q, C→P, D→P**

(A) Velocity of fish in air = $8 \times \frac{3}{4} = 6 \uparrow$

Velocity of fish w.r.t. bird = 6 + 6 = 12 ↑

(B) Velocity of image of fish after reflection from mirror in air = $8 \times \frac{3}{4} = 6 \downarrow$

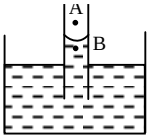
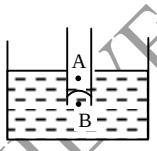
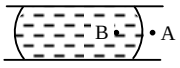
w.r.t. bird = – 6 + 6 = 0

(C) Velocity of bird as seen from water = $6 \times \frac{4}{3}$ = 8 ↓ w.r.t. fish = 8 + 8 = 16 ↓

(D) Velocity of bird in water after reflection from mirror = 8 ↓

w.r.t. fish = 8 – 8 = 0

**Q. 5** Capillary rise and shape of droplets on a plate due to surface tension are shown in column II.

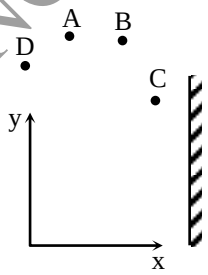
| **Column I** | **Column II** |
|---|---|
| (A) Adhesive forces is greater than cohesive forces | (P)  |
| (B) Cohesive forces is greater than adhesive forces | (Q)  |
| (C) Pressure at A > pressure at B | (R) A mercury drop is pressed between two parallel plates of glass  |
| (D) Pressure at B > Pressure at A | (S)  |

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

(A)

When cohesive forces are greater then adhesive forces shape of meniscus is concave from liquid side and pressure is greater in concave side due to surface tension.

**Q.6** Four particles are moving with different velocities in front of stationary plane mirror (lying in y-z plane). At t = 0, velocity of A is $\vec{v}_A = \hat{i}$. Velocity of B is $\vec{v}_B = -\hat{i} + 3\hat{j}$, velocity of C is $\vec{v}_C = 5\hat{i} + 6\hat{j}$, velocity of D is $\vec{v}_D = 3\hat{i} - \hat{j}$. Acceleration of particle A is $\vec{a}_A = 2\hat{i} + \hat{j}$ and acceleration of particle C is $\vec{a}_C = 2\hat{i} + \hat{j}$. The particle B and D move with uniform velocity (Assume no collision to take place till t = 2 sec). All quantities are in SI. units. Relative velocity of image of object B with respect to object A is denoted by $\vec{v}_{A'A}$. Velocity of images relative to corresponding objects are given in column-I and their values are given in column-II at t = 2 second. Match column-I with corresponding values in column-II.




| **Column-I** | **Column-II** |
|---|---|
| (A) $\vec{v}_{A'A}$ | (P) 2i |
| (B) $\vec{v}_{B'B}$ | (Q) –6i |
| (C) $\vec{v}_{C'C}$ | (R) –12i + 4j |
| (D) $\vec{v}_{D'D}$ | (S) –10i |
| | (T) perpendicular to the plane of mirror |

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

$\vec{v}_A = i + at = i + (2i + j)(2) = 5i + 2j$

$\vec{v}_{A'} = -5i + 2\hat{j}$

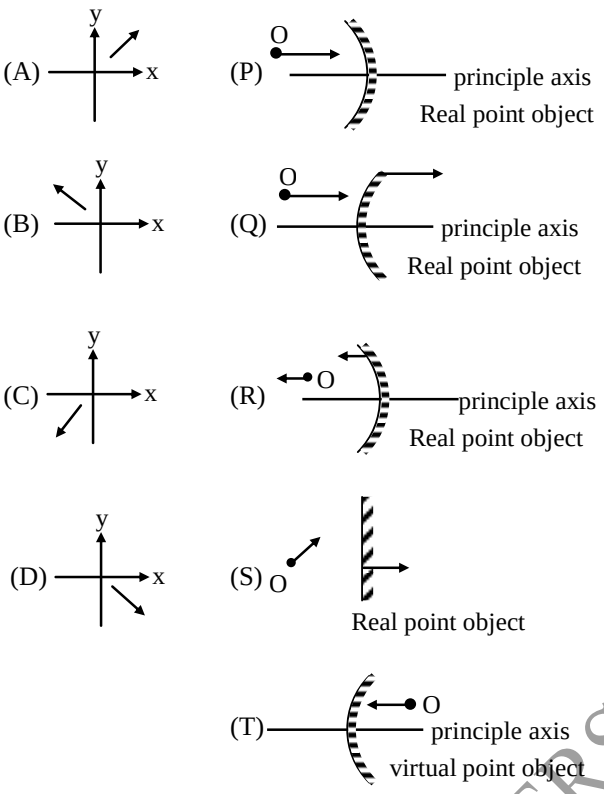
$\vec{v}_{A'A} = \vec{v}_A - \vec{v}_A = -10\hat{i}$

$\vec{v}_B = (-i + 3j), \vec{v}_{B'} = i + 3j$

So $\vec{v}_{B'B} = 2\hat{i}$

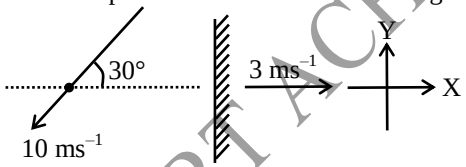
**Q.7** Column-I shows some probable directions of velocity of images formed due to system shown in column-II

**Column –I** **Column -II**




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

**Q.8** A point object is moving with a speed of 10 $ms^{-1}$ in front of a mirror moving with a speed of 3 $ms^{-1}$ as shown in figure –




| **Column I** | **Column II** |
|---|---|
| (A) velocity of image w.r.t. mirror | (P) $(5\sqrt{3}+6)\,\hat{i}-5\,\hat{j}$ |
| (B) velocity of image w.r.t. object | (Q) $-5\sqrt{3}\,\hat{i}-5\,\hat{j}$ |
| (C) velocity of image w.r.t. ground | (R) $(5\sqrt{3}+3)\,\hat{i}-5\,\hat{j}$ |
| (D) velocity of object w.r.t. ground | (S) $(10\sqrt{3}+6)\,\hat{i}$ |
| | (T) $-5\sqrt{3}\,\hat{i}+5\,\hat{j}$ |

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

# PHYSICS

**Q.1** If the light moving in a straight line bends by a small but fixed angle, it may be a case of-

(A) reflection (B) refraction

(C) diffraction (D) dispersion **[A,B]**

**Q.2** Mark the correct options -

(A) If the incident rays are converging, we have a real object

(B) If the final rays are converging, we have a real image

(C) The image of a virtual object is called a virtual image

(D) If the image is virtual, the corresponding object is called a virtual object **[B]**

**Q.3** A plane mirror reflecting a ray of incidence light is rotated through an angle $\theta$ about an axis through the point of incidence in the plane of the mirror perpendicular to the plane of incidence, then -

(A) the reflected ray does not rotate

(B) the reflected ray rotates through an angle $\theta$

(C) the reflected ray rotates through an angle $2\theta$

(D) the incident ray is fixed **[C,D]**

**Q.4** Identify the correct statement(s) -

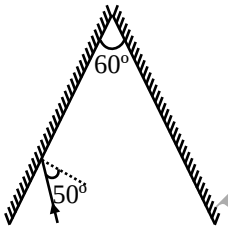
(A) If the incident rays are converging, we have a real object

(B) If the final rays are converging, we have a real image

(C) If the incident rays are diverging, we have a virtual object

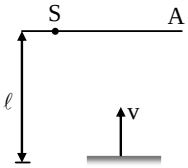
(D) If the final rays are diverging, we have a real image **[B]**

**Q.5** Refer to figure. The angle at which the ray is incident on the second mirror is -




(A) $10^o$ (B) $20^o$ (C) $30^o$ (D) $40^o$ **[A]**

**Q. 6** A plane mirror M is arranged parallel to a wall W at a distance $\ell$ from it. The light produced by a point source S kept on the wall is reflected by the mirror and produces a light spot on the wall. The mirror moves with velocity v towards the wall. Then :




(A) The spot of light move with the speed v on the wall

(B) The spot of light will not move on the wall

(C) As the mirror comes closer, the spot of light will becomes larger and shift away from the wall with speed larger than v

(D) The size of the light spot on the wall remains the same **[B,D]**

**Q. 7** Out of the following , which statements are correct?

(A) Two plane mirrors are inclined to each other at an angle of $60^o$. If a ray of light incident on the first mirror is parallel to the second mirror, it is reflected from the second mirror parallel to the first mirror

(B) A bird flying high up in the air does not cast a shadow on the ground because layers of atmosphere are dense

(C) If a ray reflected successively from two plane mirrors inclined at a certain angle undergoes a deviation of $300^o$, then the number of images observable is 11

(D) A clock indicates a time of 3:25. On seeing it in a plane mirror, the time appears as 8:35

**[A, C, D]**

**Q.8** In case of three plane mirrors meeting at a point to form a corner of a cube, if incident light suffers one reflection on each mirror:

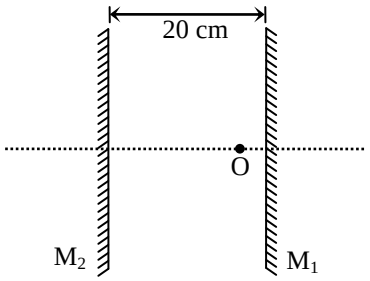
(A) the emergent ray is antiparallel to incident one

(B) the emergent ray is perpendicular to incident one

(C) the emergent ray is in phase with incident one

(D) the emergent ray is in opposite phase with incident one **[A, D]**

**Q.9** Two plane mirror $M_1$ and $M_2$ are placed parallel to each other 20 cm apart. A luminous point object 'O' is placed between them at 5 cm from $M_1$ as shown in figure -



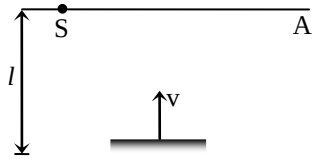

(A) The distances (in cm) of first three nearest images from mirror $M_1$ are 5, 35 and 45 respectively

(B) The distances (in cm) of first three nearest images from mirror $M_2$ are 5, 35 and 45 respectively

(C) The distances (in cm) of first three nearest images from mirror $M_1$ are 15, 25 and 55 respectively

(D) The distances (in cm) of first three nearest images from mirror $M_2$ are 15, 25 and 55 respectively **[A, D]**

**Q.10** A plane mirror M is arranged parallel to a wall W at a distance *l* from it. The light produced by a point source S kept on the wall is reflected by the mirror and produces a light spot on the wall. The mirror moves with velocity v towards the wall. Then –



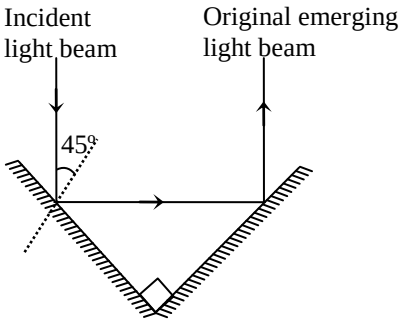

(A) The spot of light will move with the speed v on the wall

(B) The spot of light will not move on the wall

(C) As the mirror comes closer, the spot of light will becomes larger and shift away from the wall with speed larger than v

(D) The size of the light spot on the wall remains the same **[B,D]**

**Q.11** A beam of light strikes one mirror of a right angle mirror assembly at an angle of incidence 45º as shown in the figure. The right angle mirror assembly is rotated such that the angle of incidence becomes 60º. Which of the following statements is (are) correct about the emerging light beam ?




(A) It will move through an angle of 15º with respect to the original emerging beam

(B) It will move through an angle of 30º with respect to the original emerging beam

(C) It will move through an angle of 45º with respect to the original emerging beam

(D) It will emerge parallel to the original emerging beam **[C,D]**

**Q.12** Which of the following statements are correct ?

(A) A ray of light is incident on a plane mirror and gets reflected. If the mirror is rotated through angle θ then reflected ray gets deviated through angle 2θ

(B) A ray of light gets reflected successively from two mirrors which are mutually inclined. Angular deviation suffered by the ray does not depend upon angle of incidence on first mirror

(C) A plane mirror cannot form real image of a real object

(D) If an object approaches towards a plane mirror with velocity v then image approaches the object with velocity 2 v

**[A,B,C,D]**

**Sol.**

**(A)**

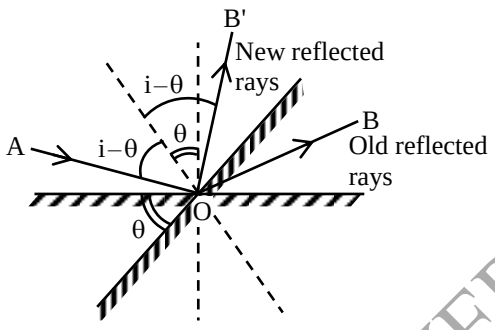



Fig.

Angle BOB′ = ∠ AOB – ∠ AOB′

= 2i – (2i – 2θ)

= 2θ

**(B)**

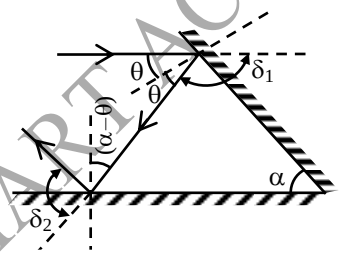



Fig.

Total deviation $\delta = \delta_1 + \delta_2$

$= (180^o - 2\theta) + 180^o - 2(\alpha - \theta)$

$= 360^o - 2\alpha$

which is independent of angle of incidence.

**(D)** Velocity of the image towards the object = v + v = 2v

**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 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.15** Rays coming out of a point are, incident on a plane mirror, then –

(A) object is real (B) object is virtual

(C) image is real (D) image is virtual

**[A, D]**

**Sol.** Incident rays diverge from a real point object and after reflection they appear to come from a virtual point image.

**Q.16** Which of the following statements are correct?

(A) A ray of light is incident on a plane mirror and gets reflected. If the mirror is rotated through angle θ then reflected ray gets deviated through angle 2θ

(B) A ray of light gets reflected successively from two mirrors which are mutually inclined. Angular deviation suffered by the ray does not depend upon angle of incidence on first mirror

(C) A plane mirror cannot form real image of a real object

(D) If an object approaches towards a plane mirror with velocity v then image approaches the object with velocity 2v

**[A, B, C, D]**

**Sol.**

(A)

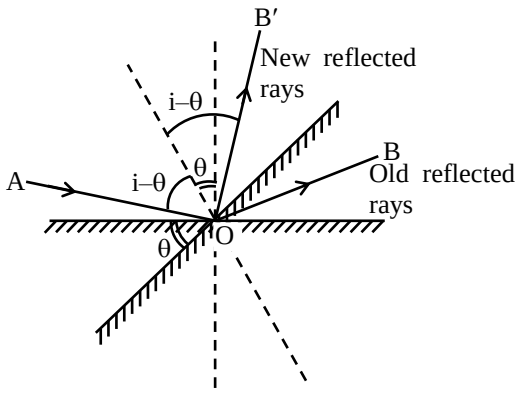



Fig.

Angle BOB′ $= \angle AOB - \angle AOB'$

$= 2i - (2i - 2\theta)$

$= 2\theta$

(B)

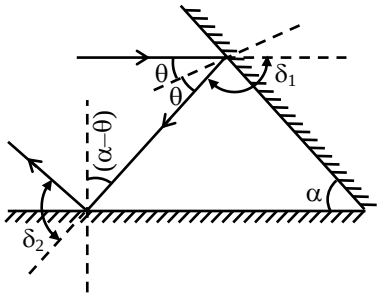



Fig.

Total deviation $\delta = \delta_1 + \delta_2$

$= (180^\circ - 2\theta) + 180^\circ - 2(\alpha - \theta)$

$= 360^\circ - 2\alpha$

which is independent of angle of incidence.

(C) Power of a plane mirror is zero.

(D) Velocity of the image towards the object = v + v = 2v.

**Q.17** In case of three plane mirrors meeting at a point to form a corner of a cube, if incident light suffers one reflection on each mirror –

(A) the emergent ray is antiparallel to incident one

(B) the emergent ray is perpendicular to incident one

(C) the emergent ray is in phase with the incident one

(D) the emergent ray is in opposite phase with the incident one **[A, D]**

**Q.18** A plane mirror –

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

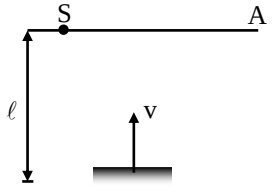
(B) neither converges nor diverges the rays

(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. It means, it neither converges nor diverges the rays. Hence, the reflected rays will also be diverging. Therefore, the position of image will be point of divergence of reflected rays which is behind the mirror. It means, the image formed will be virtual. Hence, options (B) and (C) are correct.

**Q.19** A plane mirror M is arranged parallel to a wall W at a distance $\ell$ from it. The light produced by a point source S kept on the wall is reflected by the mirror and produces a light spot on the wall. The mirror moves with velocity v towards the wall. Then :




(A) The spot of light will move with the speed v on the wall

(B) The spot of light will not move on the wall

(C) As the mirror comes closer, the spot of light will becomes larger and shift away from the wall with speed larger then v.

(D) The size of the light spot on the wall remains he same

**Q.20** A short linear object is placed along optic axis of a concave mirror between focus and curvature centre, then -

(A) a real elongated image will be formed

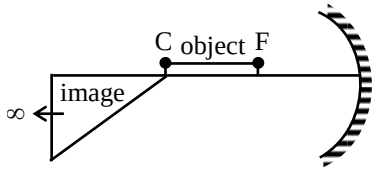
(B) an elongated virtual image will be formed

(C) an inverted, enlarged image will be formed

(D) a diminished virtual image will be formed **[A, C]**

**Sol.** For concave mirror, if object is placed on the optic axis between focus & centre of curvature the image is formed between centre of curvature &

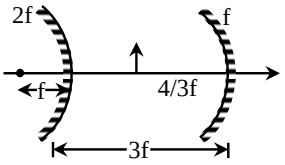
infinity which is real, inverted & enlarged as well as elongated also.



# PHYSICS

**Q.1** A burning candle is placed in front of a concave spherical mirror on its principal axis at a distance of (4/3) f from the pole of the mirror (here f is the focal length of the mirror). The candle is arranged at right angles to the axis. The image of the candle in the concave mirror impinges upon a convex mirror of focal length 2f. The distance between the mirrors is 3f and their axis coincide. The image of the candle in the first mirror plays the part of a virtual object with respect to the second mirror and gives a real image arranged between the two mirror. Then the total linear magnification of the system is (only magnitude )

**Sol. [6]**




Ist reflection $\frac{1}{v}+\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{v}+\frac{3}{-4f}=\frac{1}{-f}$

$\frac{1}{v}=\frac{3}{4f}-\frac{1\times 4}{f\times 4}$, $v=-4f$

$m_1=-\frac{(-4f)}{-4f}\times 3=-3$

2nd reflection $\frac{1}{v}+\frac{1}{f}=\frac{1}{2f}$

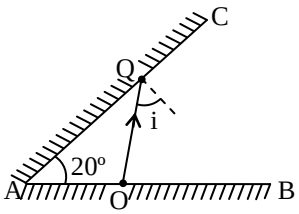
$\frac{1}{v}=\frac{1}{2f}-\frac{1\times 2}{f\times 2}$

$v=-2f$

$m_2=-\frac{(-2f)}{f}=+2$

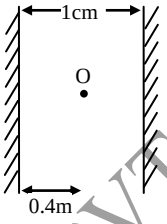
$m_1m_2=-3\times 2=6$

**Q.2** Two plane mirrors are inclined at an angle of 20º. A point object is placed at mirror AB. Light ray OQ is incident on mirror AC at angle ' i ' such that this ray after third reflection becomes parallel to mirror AB can be written as 10 xº. Find x.




**Sol.[3]**

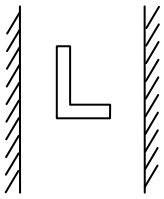
**Q.3** Two plane mirrors are placed parallel to each other at a separation of 1 cm. A point object O is placed at a distance 0.4 cm from mirror M as shown.




Find distance between 5th and 6th image formed by both mirrors closest to system.

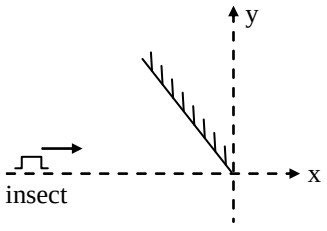
**Sol.[6]**

**Q.4** An object shaped as 'L' is placed between two parallel plane mirrors as shown. In first seven closest image. How many images are formed as laterally inverted.



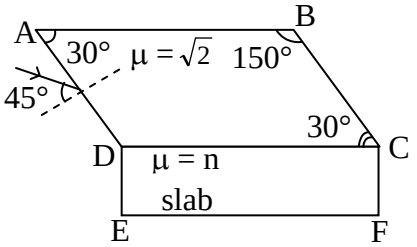
**Sol.[4]** Conceptual

**Q.5** A plane mirror of length 9m is kept along the line y = –x as shown. An insect having velocity of $-3\sqrt{2}\,\hat{i}$ m/sec is moving along x-axis. Find the time (in sec) for which insect can see his image.

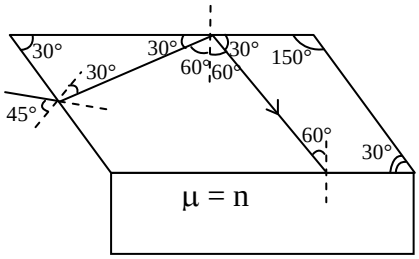



**Sol.[3]** $t=\frac{\ell\sqrt{2}}{v}$

**Q.6** A Light ray is incident on a prism with $\mu = \sqrt{2}$ from air at angle 45°. After first retraction it incidents on surface AB. Find value of n to the nearest integer such while entering in slab it makes an angle 45° with boundary CD.




**Sol.[2]**




At AD

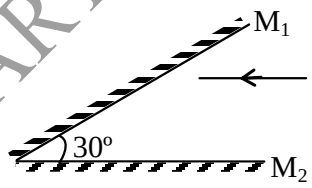
$$\frac{\sin 45°}{\sin r} = \sqrt{2} \Rightarrow r = 30°$$

$$i_C = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45°$$

At CD $\quad \frac{\sin 60°}{\sin 45°} = \frac{n}{\sqrt{2}}$

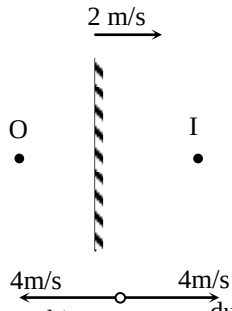
$$n = \sqrt{2} \times \frac{\sqrt{3}}{2} \times \sqrt{2} = \sqrt{3}$$

**Q.7** Two plane mirrors $M_1$ & $M_2$ are inclined at 30º. A light ray strikes $M_1$ and it is parallel to $M_2$. How many total reflections it will under go with both mirrors.




**Sol.[5]** The ray will retrace its path after third reflection & repeat 4th and 5th at the place of of 2nd & 1st so total five reflections.

**Q.8** If in the given figure, image I is not moving. Find the velocity of object for this.

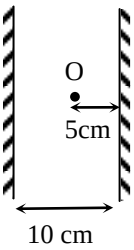



**Sol.[4]** due to object due to mirror

**Q.9** Two vectors in the direction of incident and reflected ray are given as $\hat{e}_1 = 2i - 3j + k$ and $\hat{e}_2 = 2i + aj + k$, Consider reflection from xz plane, find the value of 'a'.

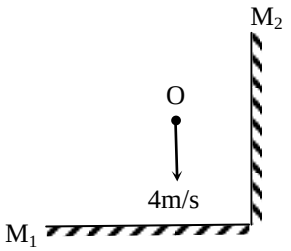
**Sol.[3]** obvious

**Q.10** Find total no. of image up to a distance of 30 cm from object O.




**Sol.[6]** Draw & count

**Q.11** If $I_1$ & $I_2$ are the image of O respectively by $M_1$ & $M_2$. Then find relative velocity of $I_1$ w.r.to $I_2$.

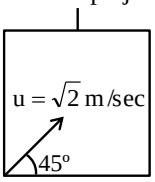



**Sol.[8]** obvious

**Q.12** If total width of face is 20 cm and distance between eyes is 12 cm. Find the minimum width of mirror to see full width of face himself.

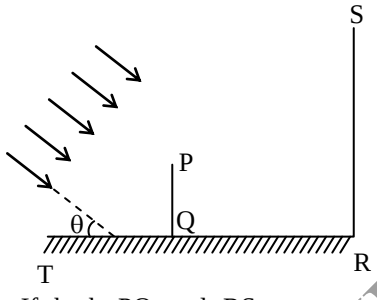
**Sol.[4]** use $w = \frac{a-b}{2}$

**Q.13** An elevator at rest which is at $10^{th}$ floor of a building is having plane mirror fixed to its floor. A particle is projected with a speed $\sqrt{2}$ m/sec and at 45º with the horizontal. At the instant of projection the cable of elevator breaks and elevator starts falling freely. What will be the separation between the particle and its image 0.5 sec. after the projection.




**Sol.** **[1]**

**Q.14** As shown in figure, pole PQ of height 3h is standing on the shining surface RT at a distance 9h from the screen RS. The sunrays are incident from left of the figure making an angle θ with ground. There will be in general, two shadows of PQ, one directly on ground, second indirectly on screen –




(A) If both PQ and RS are perpendicular to ground RT, express the length of shadow of PQ on RS in terms of h

(B) What should be minimum value of θ to the entire indirect shadow to fall on the screen.

**Sol.** (a) 6h (b) $\tan^{-1}(1/3$

# PHYSICS

**Q.1** An unnumbered wall clock shows time 04 : 25 : 37, where 1st term represents hours, 2nd represents minutes & the last term represents seconds. What time will its image in a plane mirror show

(A) 08 : 35 : 23 (B) 07 : 35 : 23

(C) 07 : 34 : 23 (D) None of these **[C]**

**Q.2** Two vertical plane mirrors are inclined at an angle of 60º with each other. A ray of light traveling horizontally is reflected first from one mirror and then from the other. The resultant deviation is -

(A) 60º (B) 120º

(C) 180º (D) 240º

**Sol.[D]** $\delta = 2\pi - 2\theta = 2\pi - 2\,\frac{\pi}{3} = \frac{4\pi}{3}$

**Q.3** When a plane mirror is placed horizontally on level ground at a distance of 60 m from the foot of a tower, the top of the tower and its image in the mirror subtend an angle of 90º at the eye, placed at the mirror itself. The height of the tower is :

(A) 30 m (B) 60 m

(C) 90 m (D) 120 m **[B]**

**Q.4** An object is initially at a distance of 100 cm from a plane mirror. If, the mirror approaches the object at a speed of 5 cm/s. Then after 6 s the distance between the object and its image will be :

(A) 60 cm (B) 140 cm

(C) 170 cm (D) 150 cm **[B]**

**Q.5** A virtual image is formed by a plane mirror, when the pencil of light is incident on the mirror, then the incident pencil on the mirror is.

(A) diverging

(B) parallel

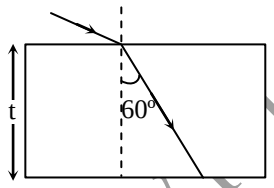
(C) converging

(D) all of the above **[A]**

**Q.6** A ray of light is incident on a glass slab ($\mu$ = 1.5), thickness t, in such a manner that the angle of refraction is 60º. If the speed of light in vacuum is c, then the time taken to cross the slab will be -

(A) 3t/c (B) 3t/2c (C) 2t/c (D) t/c

**Sol.[A]**




$v = \frac{c}{\mu} = \frac{c}{1.5}$

Distance travel by ray to cross the slab

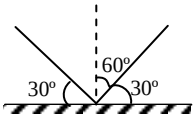
$= \frac{t}{\cos 60} = 2t$

$\therefore$ Time taken to cross slab = $\frac{2t}{c/1.5} = \frac{3t}{c}$

**Q.7** A ray of light making an angle 30º with horizontal is incident on a plane mirror making an angle $\theta$ with horizontal. what should be the value of $\theta$ so that reflected ray goes vertically upwards -

(A) 20º (B) 25º (C) 30º (D) 35º

**Sol. [C]**




The reflected ray is to be rotated by 60º so mirror is to rotate by $\frac{60}{2} = 30º$

$\therefore$ Mirror will make 30º with horizontal

**Q.8** Time taken by the sunlight to pass through a window of thickness 4 mm whose refractive index is 1.5 is

(A) $2 \times 10^{-8}$ sec (B) $2 \times 10^{8}$ sec

(C) $2 \times 10^{-11}$ sec (D) $2 \times 10^{11}$ sec

**Sol.[C]** $t = \frac{d}{v_m} = \frac{d}{c_o/\mu_m} = \frac{d\mu_m}{c_o}$

$= \frac{4\times1.5\times10^{-3}}{3\times10^{8}} = 2 \times 10^{-11}$ sec

**Q.9** Two plane mirrors are inclined at 120º to each-other. A ray of light is incident on either mirror at an angle of 50º is double reflected. The mirrors deviate the incident ray through an angle of -

(A) 120º (B) 100º (C) 80º (D) 60º

**Sol. [A]** $\delta = 360 - 2\theta$ ; $\theta = 120^\circ$

$\therefore \delta = 360 - 2 \times 120$

$\therefore \delta = 120^\circ$

.

**Q.10** A clock hung on a wall shows time as 7 : 10 on the adjoining wall, there is a plane mirror then time shown by image of clock in mirror is -

(A) 5 : 40 (B) 4 : 50 (C) 7 : 10 (D) 5 : 50

**Sol. [B]** 12 : 00 – 7 : 10 = 4 : 50

**Q.11** An object is placed between two plane mirrors set at 60º to each other. The maximum number of images seen will be :

(A) 2 (B) 3 (C) 5 (D) 6

**[C]**

**Q.12** A light ray is incident on a plane mirror at an angle of 30º with the horizontal. At what angle with horizontal must a plane mirror be placed in its path so that it becomes vertically upwards after reflection ?

(A) 30º (B) 60º (C) 70º (D) 90º

**[B]**

**Q.13** Find the angle between two plane mirrors such that a ray of light is incident on the first mirror and parallel to the second is reflected from the second mirror, parallel to the first mirror.

(A) 30º (B) 60º (C) 70º (D) 90º

**[B]**

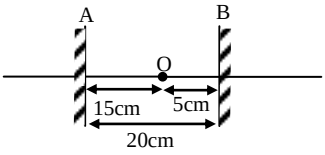
**Q. 14** Two plane mirrors are parallel to each other and spaced 20 cm apart. An object is kept in between them 15cm from A. Out of the following at which point is an image not formed in mirror A (distance measured from the mirror A).

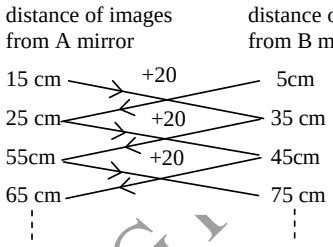
(A) 15 cm (B) 25 cm

(C) 45 cm (D) 55 cm

**Sol. [C]**

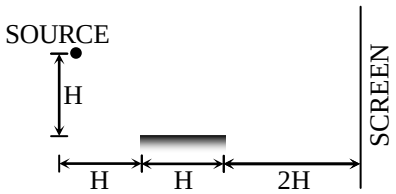
A and B are two plane mirror




Option (C) is correct

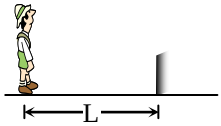
**Q.15** A point source has been placed as shown in the figure. What is the length on the screen that will receive reflected light from the mirror ?




(A) 2 H (B) 3H (C) H (D) None

**[A]**

**Q.16** A boy of height H is standing in front of mirror, which has been fixed on the ground as shown in figure. What length of his body can the man see in the mirror ? The length of the mirror is (H/2)–




(A) H (B) $H^2/(H^2 + L^2)^{1/2}$

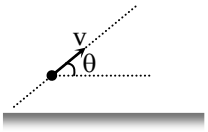
(C) Zero (D) $2H^2/L$ **[C]**

**Q.17** A person's eye level is 1.5 m. He stands in front of 0.3 m long plane mirror which is 0.8m above the ground. The length of the image he sees of himself is –

(A) 1.5 m (B) 1.0 m

(C) 0.8 m (D) 0.6 m **[D]**

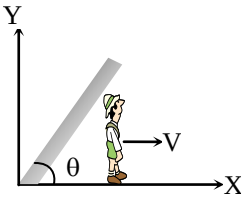
**Q.18** A particle is moving in front of a plane mirror as shown in figure. The velocity of image with respect to object is –




(A) v sin θ (B) v cos θ

(C) 2 v sin θ (D) 2 v cos θ **[C]**

**Q.19** A boy is walking under an inclined mirror at a constant velocity V m/s along the x-axis as shown in figure. If the mirror is inclined at an angle θ with the horizontal then what is the velocity of the image?




(A) V sin θi + V cos θj

(B) V cos θi + V sin θj

(C) V sin 2θi + V cos 2θj

(D) V cos 2θi + V sin 2θj **[D]**

**Q.20** An object is approaching a plane mirror at 5 cm per second. A stationary observer sees the image. At what speed will the image approach the stationary observer ?

(A) 5 cm/second (B) 20 cm/second

(C) 10 cm/second (D) 15 cm/second

**[B]**

**Q.21** A plane mirror is moving with velocity $4\hat{i} + 5\hat{j} + 8\hat{k}$. A point object in front of the mirror moves with a velocity $3\hat{i} + 4\hat{j} + 5\hat{k}$. Here $\hat{k}$ is along the normal to the plane mirror and facing towards the object. The velocity of the image is –

(A) $-3\hat{i} - 4\hat{j} + 5\hat{k}$ (B) $3\hat{i} + 4\hat{j} + 11\hat{k}$

(C) $-3\hat{i} - 4\hat{j} + 11\hat{k}$ (D) $7\hat{i} + 9\hat{j} + 11\hat{k}$

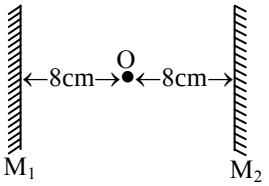
**[B]**

**Q.22** A point object is kept in front of a plane mirror. The plane mirror is doing SHM of amplitude 2 cm. The plane mirror moves along the x-axis and x-axis is normal to the mirror. The amplitude of the mirror is such that the object is always infront of the mirror. The amplitude of SHM of the image is –

(A) zero (B) 2 cm

(C) 4 cm (D) 1 cm **[C]**

**Q.23** Figure below shows two plane mirrors and an object O placed between them. What will be distance of the first three images from the mirror $M_2$ -




(A) 2 cm, 8 cm, 14 cm

(B) 2 cm, 12 cm, 18 cm

(C) 2 cm, 18 cm, 22 cm

(D) 2 cm, 24 cm, 38 cm **[C]**

**Q.24** A point object is placed midway between two plane mirrors distance 'a' apart. The plane mirrors form an infinite number of images due to multiple reflections. The distance between $n^{th}$ order image formed in the two mirrors is -

(A) na (B) 2 na (C) $\frac{na}{2}$ (D) $n^2$ a

**[B]**

**Q.25** Number of images of an object kept symmetrically between two mirrors inclined at angle 72°, would be-

(A) two (B) three (C) six (D) four

**[D]**

**Q.26** Two plane mirrors are inclined to one another at an angle of 40º. A point object is placed symmetrically in between them. The number of images formed due to reflection at both mirrors is -

(A) Infinite (B) 9 (C) 8 (D) 6

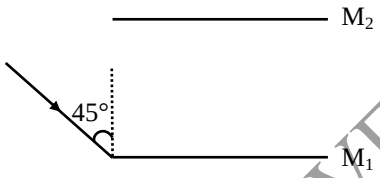
**[C]**

**Q.27** If an object is placed unsymmetrically between two plane mirrors, inclined at an angle of 72º, then the total number of images formed is -

(A) 5 (B) 4 (C) 2 (D) ∞

**[A]**

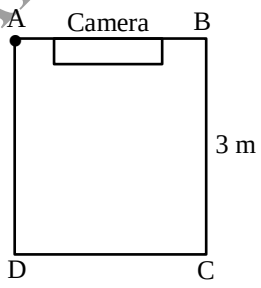
**Q.28** Two plane mirrors $M_1$ and $M_2$ each have length 1 m and are separated by 1 cm. A ray of light is incident on one end of mirror $M_1$ at angle 45º. How many reflections the ray will have before going from the other end ?




(A) 50 (B) 51 (C) 100 (D) 101

**[D]**

**Q.29** Figure shows a cubical room ABCD with the wall CD as a plane mirror. Each side of the room is 3m. We place a camera at the mid-point of the wall AB. At what distance should the camera be focussed to photograph an object placed at A -




(A) 1.5 m (B) 3 m

(C) 6 m (D) more than 6 m

**[D]**

**Q.30** It is necessary to illuminate the bottom of a well by reflected solar beam when the light is incident at an angle of $\alpha = 40^\circ$ to the vertical. At what angle $\beta$ to the horizontal should a plane mirror be placed ?

(A) 70º (B) 20º (C) 50º (D) 40º

**[A]**

**Q.31** Mark the correct options -

(A) If the incident rays are converging, we have a real object

(B) If the reflected rays are converging, we have a real image

(C) The image of a virtual object is called a virtual image

(D) If the image is virtual, the corresponding object is called a virtual object **[B]**

**Q.32** A point source of light is placed in front of a plane mirror -

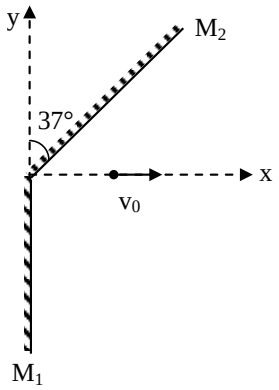
(A) All the reflected rays meet at a point when produced backward

(B) Only the reflected rays close to the normal meet at a point when produced backward

(C) Only the reflected rays making a small angle with the mirror, meet at a point when produced backward

(D) Light of different colours make different images **[A]**

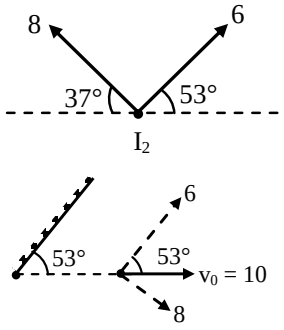
**Q.33** A point object is moving with velocity $v_0 = 10\hat{i}$ m/s along x-axis as shown in figure. Relative velocity of its image in mirror $M_1$ with respect to mirror image velocity in $M_2$ is :
(Take sin 37° = 0.6)




(A) 9 m/s (B) 10 m/s

(C) 12 m/s (D) 15 m/s **[C]**

**Sol.**




$\vec{v}_{1i} = -10\hat{i}$

$\vec{v}_{2i} = (6\cos 53° - 8\cos 37°)\hat{i} + (6\sin 53° + 8\sin 37°)\hat{j}$

$= (3.6 - 6.4)\ \hat{i} + (4.8 + 4.8)\ \hat{j}$

$= -2.8\,\hat{i} + 9.6\,\hat{j}$

$\vec{v}_{1/2} = -7.2\,\hat{i} - 9.6\ \hat{j}$

$v_{12} = \sqrt{7.2^2 + 9.6^2}$

$= 2.4\ \sqrt{3^2 + 4^2}$

$= 12$ m/s

**Q.34** On reflection from a plane surface, the following gets changed -

(A) wavelength (B) frequency

(C) speed (D) amplitude **[D]**

**Q.35** A wave or a pulse is reflected normally from the surface of a denser medium back into the rarer medium. The phase change caused by the reflection-

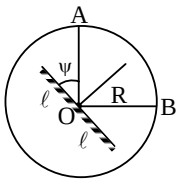
(A) 0 (B) $\pi/2$ (C) $\pi$ (D) $3\pi/2$ **[C]**

**Q.36** A number of images of a candle flame can be seen in a thick mirror. The brightest image is -

(A) The first one (B) The second one

(C) The third one (D) The last one **[B]**

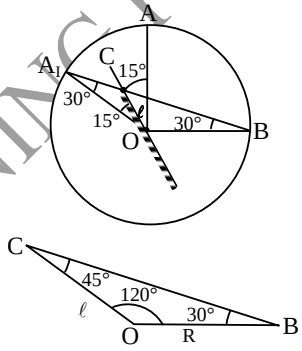
**Q.37** The mirror of length $2\ \ell$ makes 10 revolutions per minute about the axis crossing its mid point O and perpendicular to the plane of the figure. There are a light source in point A and an observer in point B of the circle of radius R drawn around centre O ($\angle AOB = 90°$). What is the proportion $\frac{R}{\ell}$ if the observer B first sees the light source when the angle of mirror with OA, $\psi = 15°$ ?




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

(C) $2\sqrt{2}$ (D) $\frac{1}{2\sqrt{2}}$ **[A]**

**Sol.**

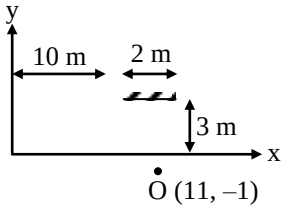



sine rule

$$\frac{R}{\sin 45°} = \frac{\ell}{\sin 30°}$$

$$\frac{R}{\ell} = \frac{\sin 45°}{\sin 30°} = \sqrt{2}$$

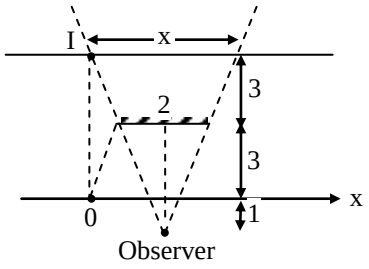
**Q.38** A point object starts moving along x-axis with constant velocity 0.5 m/s in positive x-direction from origin. A plane mirror of length 2 m is placed parallel to x axis at a distance 3 m from x-axis and at a distance 10 m from y-axis as shown in figure. Time for which an observer positioned at (11, –1) m will see image of point object in the mirror will be –




(A) 7 sec (B) 8 sec

(C) 12 sec (D) 6 sec **[A]**

**Sol.**




$$\frac{x}{2}=\frac{7}{4}$$

x = 3.5 m

$$t=\frac{x}{v}=\frac{3.5}{0.5}=7 \text{ sec}$$

**Q.39** Given two identical watch glasses glued together, the rear one silvered. Using autocollimation as sketched (Fig.), sharp focus is obtained for L = 20 cm. Find L for sharp focus when the space between the glasses is subsequently filled with water, $n=\frac{4}{3}$.

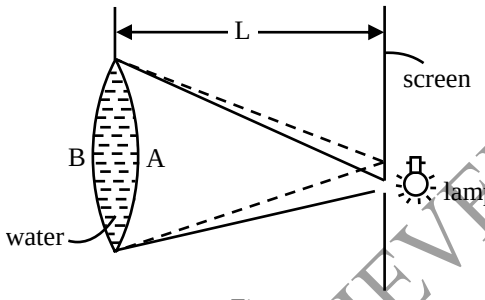



Fig.

(A) 6 cm (B) 8 cm
(C) 10 cm (D) 12 cm **[D]**

**Sol.** With air between the glasses, only the silvered watch glass reflects and converges the rays to form an image, i.e., the system acts as a concave mirror. The formula for a concave mirror

$$\frac{1}{u}+\frac{1}{v}=\frac{2}{r}$$

gives for u = v = 20 cm, r = 20 cm.

With water between the glasses, the incident light is refracted twice at A and reflected once at B before forming the final image. Note that the first image formed by A falls behind the mirror B and becomes a virtual object to B. Similarly the image formed by B is a virtual object to A. We therefore have

$$\frac{1}{L}+\frac{n}{x}=\frac{n-1}{20},$$

$$-\frac{1}{x}+\frac{1}{y}=\frac{1}{10},$$

$$-\frac{n}{y}+\frac{1}{L}=\frac{n-1}{20},$$

which yield L = 12 cm.

Thus, a sharp image will be formed at L = 12 cm.

**Q.40** Two vertical plane mirrors are inclined at an angle of 60º with each other. A ray of light traveling horizontally is reflected first from one mirror and then from the other. The resultant deviation is -

(A) 60º (B) 120º
(C) 180º (D) 240º

**Sol.** **[D]** $\delta = 2\pi - 2\theta = 2\pi - 2\,\frac{\pi}{3} = \frac{4\pi}{3}$

**Q.41** The index of refraction of glass can be increased by diffusing in impurities. It is then possible to make a lens of constant thickness. Given a disk of radius **a** and thickness **d**, find the radial variation of the index of refraction **n(r)** which will produce a lens with focal length F. You may assume a thin lens (d << a).

(A) $n(r) = n_0 - \frac{rF}{2d^2}$ (B) $n(r) = n_0 - \frac{rd}{2F^2}$

(C) $n(r) = n_0 - \frac{r^2}{2dF}$ (D) $n(r) = n_0 - \frac{r}{2F}$

**[C]**

**Sol.** Let the refractive index of the material of the disk be n and the radial distribution of the refractive index of the impurity-diffused disk be represented by n(r), with $n(0) = n_0$.

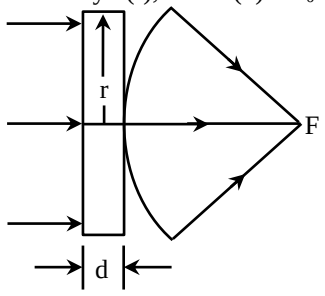



Fig.

Incident plane waves entering the lens refract and converge at the focus F as shown in Fig. We have

$$[n(r) - n_0]d = -\sqrt{F^2 + r^2} + F,$$

$$\text{i.e., } n(r) = n_0 - \frac{\sqrt{F^2 + r^2} - F}{d}.$$

For F >> r, we obtain

$$n(r) = n_0 - \frac{r^2}{2dF}.$$

**Q.42** Rays of light strike a horizontal plane mirror at an angle of 45º. A second plane mirror is arranged at an angle θ with it. If the ray after reflection from the second mirror goes horizontally parallel to the first mirror then θ is-

(A) 45º (B) 60º (C) 67.5º (D) 135º **[C]**

**Q.43** Images formed by an object placed between two plane mirrors whose reflecting surfaces make an angle of 90º with one another lie on a -

(A) Straight line (B) Zig-Zag curve

(C) Circle (D) Ellipse **[C]**

**Q.44** A beaded screen (Fig.) returns light back to the source if light focuses on its back surface. For use by skindivers in water ($n = \frac{4}{3}$), of what index material should the beads be made ideally?

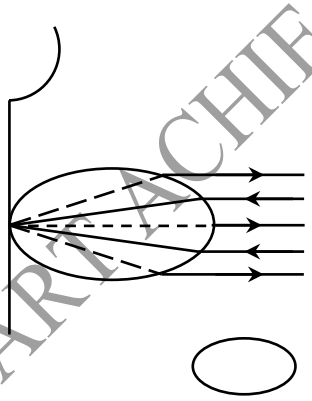


Fig.

(A) $\frac{3}{2}$ (B) $\frac{4}{3}$

(C) $\frac{5}{4}$ (D) $\frac{8}{3}$ **[D]**

**Sol.** Let the required index of refraction be 'n', (see Fig. (b)).

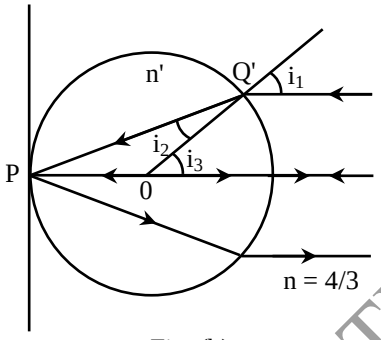



Fig. (b)

If a pencil of paraxial rays which are parallel to the axis, OP, strikes at P, the reflected rays will return back parallel to OP. Snell's law of refraction **n' sin $i_2$ = n sin $i_1$** for small angles $i_1$ and $i_2$ becomes **n' $i_2$ = n$i_1$**. As $i_3 = i_1$, $i_3 = 2i_2$, we have $i_1 = 2i_2$. Therefore, $n' = 2n = \frac{8}{3}$.

**Q.45** A line object 5 mm long is located 50 cm in front of a camera lens. The image is focused on the film plate and is 1 mm long. If the film plate is moved back 1 cm the width of the image blurs to 1 mm wide. What is the F-number of the lens?

(A) 7.33 (B) 8.33

(C) 10 (D) 12 **[B]**

**Sol.** Substituting u = 50 cm and $\frac{v}{u} = \frac{1}{5}$ in the Gaussian lens formula

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

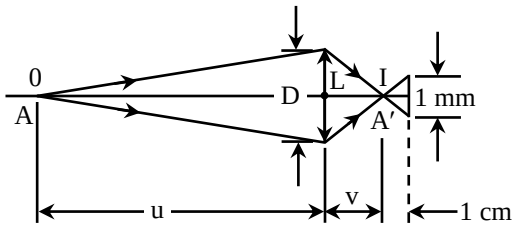



Fig.

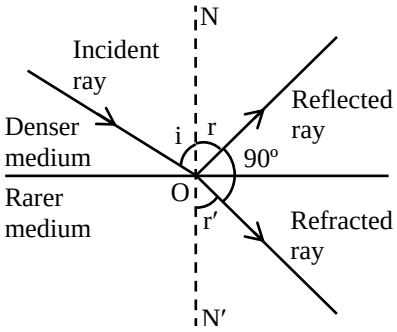
gives f = 8.33 cm, v = 10 cm. From the similar triangles in Fig. we have

$$\frac{D}{v} = \frac{0.1}{1},$$

or D = 0.1 v = 1 cm. Therefore, F = f/D = 8.33.

**Q.46** A ray of light from a denser medium strikes a rarer medium at an angle of incidence **i** as shown in figure. Refracted and reflected rays make an angle of 90º with each other. Angle of

reflection and refraction are **r** and **r′**. Then critical angle is –




(A) $\sin^{-1}$ (sin i) (B) $\sin^{-1}$ (sin r)

(C) $\sin^{-1}$ (tan i) (D) $\sin^{-1}$ (tan r) **[D]**

**Sol.** From fig., $r + r' = 90^\circ$

$\therefore$ $r' = 90^\circ - r = 90^\circ - i$

When light travels from denser medium to rarer medium,

$$\frac{1}{\mu} = \frac{\sin i}{\sin r'} = \frac{\sin i}{\sin(90^\circ - i)} = \frac{\sin i}{\cos i}$$

$$= \tan i$$

Also, $\sin i_c = \frac{1}{\mu}$

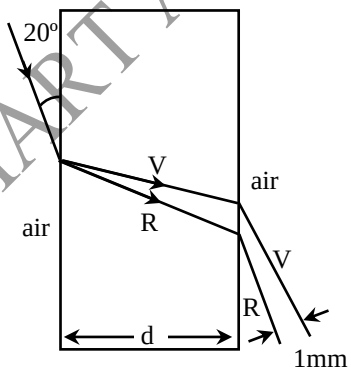
(if angle of incidence = critical angle)

$\therefore$ $\sin i_c = \tan i = \tan r$

$\therefore$ $i_c = \sin^{-1}(\tan i)$

$= \sin^{-1}(\tan r)$

**Q.47** A white light is incident at 20° on a material of silicate flint glass slab as shown. $\mu_{voilet}$ = 1.66 and $\mu_r$ = 1.6. For what value of **d** will the separation be 1 mm in red and violet rays.




(a) $\frac{5}{3}$ cm (b) $\frac{10}{3}$ cm

(c) 5 cm (d) $\frac{20}{3}$ cm **[B]**

**Sol.** $\sin r_1 = \frac{\sin 70}{1.66} = \frac{.9397}{1.66}$ or $r_1 = 34^\circ 30'$

$\sin r_2 = \frac{\sin 70}{1.6} = \frac{.9397}{1.6}$ or $r_2 = 36^\circ$

Using $y = \frac{t\sin(i - r)}{\cos r}$

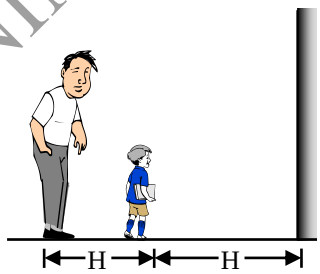
$$y_1 - y_2 = d\left[\frac{\sin(i - r_1)}{\cos r_1} - \frac{\sin(i - r_2)}{\cos r_2}\right]$$

$$0.1 = d\left[\frac{\sin 35^\circ 30'}{\cos 34^\circ 30'} - \frac{\sin 34^\circ}{\cos 36^\circ}\right]$$

$$\text{or } 0.1 = d\left[\frac{0.5807}{0.8241} - \frac{0.5592}{0.8090}\right] = d[0.71 - 0.68]$$

$$\text{or } d = \frac{0.1}{0.03} = \frac{10}{3} \text{ cm.}$$

**Q.48** A child is standing in front of a straight plane mirror. His father is standing behind him, as shown in the fig.

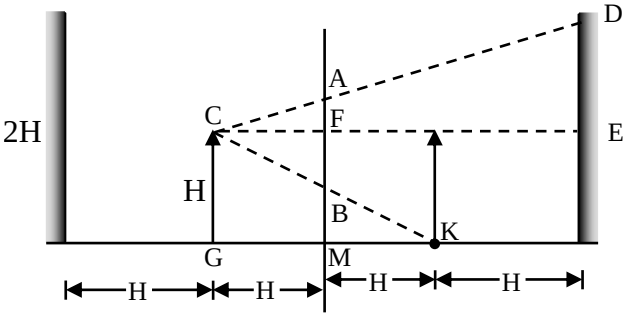



The height of the father is double the height of the child. What is the minimum length of the mirror required so that the child can completely see his own image and his father's image in the mirror? Given that the height of father is 2H.

(A) H/2 (B) 5H/6

(C) 3H/2 (D) None **(B)**

**Sol.**




AB is the required size of mirror

$\Delta AFC$ & CDE similar triangle

$\frac{DE}{AF} = \frac{CE}{CF}$ $\quad AF = \frac{CF \times DE}{CE} = \frac{H \times H}{3H} = \frac{H}{3}$

$\Delta CKG$ & BMK similar $\Delta$

$\therefore \frac{CG}{GK} = \frac{BM}{MK} \quad \Rightarrow \quad BM$

$= \frac{CG \times MK}{GK} = \frac{H \times H}{2H} = \frac{H}{2}$

size of mirror = AB

= AF + FB

$= \frac{H}{3} + (FM - BM)$

$= \frac{H}{3} + H - \frac{H}{2}$ $\quad = \quad H\left[\frac{1}{2} + \frac{1}{3}\right] = \frac{5H}{6}$

**Ans.**

**Q.49** Two plane mirrors are inclined at an angle of $50^o$. Then what is the number of images formed for an object placed in between the mirrors –

(A) 7

(B) 8

(C) 6

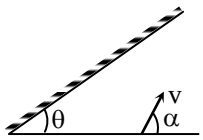
(D) question is absured **[A]**

**Sol.** Here $\theta = 50^o$

therefore $n = \frac{360}{50} = 7.2$

The closest integer value of 7.2 is 7. Thus number of images formed is 7

**Q.50** A plane mirror is inclined at an angle $\theta$ with the horizontal surface. A particle is projected with velocity v at angle $\alpha$. Image of the particle is observed from the frame of the particle projected path of the image as seen by the particle is –




(A) parabolic path (B) straight line

(C) circular path (D) helical path **[C]**

**Sol.** At any instant velocity of particle can be resolved in two components, one parallel and other perpendicular to it. Parallel components of particle velocity and image velocity are identical and hence the path of light is straight line perpendicular to mirror

# PHYSICS

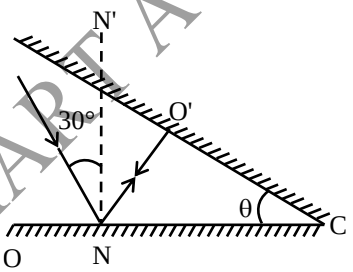
**Q.1** A ray of light is incident on a plane horizontal mirror at an angle of 30º. Calculate the deviation suffered by the ray. **[120º]**

**Q.2** Two plane mirrors are held at angle 'θ' and a ray of light is incident on the 1st mirror. The ray undergoes successive reflections, first at the 1st mirror and next at the second mirror. Calculate the final deviation produced. **[360º–2 θ]**

**Q.3** Find the height of the shortest plane mirror (held vertically) in which a man 1.8 m tall could see his entire image. At what height above the ground should this mirror be placed in order that the man could see his entire image ? Explain with a diagram. **[0.9 m , < 0.9 m]**

**Q.4** Find the angle between two plane mirrors such that a ray of light is incident on the first mirror and parallel to the second is reflected from the second mirror, parallel to the first mirror. **[60º]**

**Q.5** Two plane mirrors are inclined to each other as shown. A ray of light is incident at an angle of 30º on one of them. The ray after reflection falls on second mirror and finally retraces its path. Calculate the angle between the mirrors.




**[30º]**

**Q.6** Calculate the angle between the two plane mirrors, if a ray after successive reflections from them becomes parallel to itself. **[90º]**

**Q.7** An object is kept between two plane mirrors which are inclined at an angle of 45º from each other. Calculate the number of images which are formed. **[7]**

**Q.8** A horizontal fluorescent tube is 80 cm in length. If a square horizontal plane mirror, of each side 20 cm, is placed below the tube at a distance 200 cm from the tube, such that the perpendicular bisector of the length of the tube passes through the mid-point of the mirror and pair of the sides of the mirror are parallel to the length of the tube, find the length of the reflected patch of light on the ceiling, 100 cm above the tube. **[170cm]**

**Q.9** A flat mirror revolves at a constant angular velocity, making n = 0.5 revolution per second. With what velocity will a light spot move along a spherical screen with a radius of 10 metres if the mirror is at the centre of curvature of the screen?

**Sol.** When the mirror turns through an angle $\alpha$ the reflected ray will turn through $2\alpha$ since the angles of incidence and reflection increase by $\alpha$. Hence, the angular velocity of rotation of the reflected ray is $\omega = 2\pi n \times 2$. The linear velocity with which the light spot moves along the screen is $v = 4\pi nR \cong 62.8$ m/s

**Q.10** A ray of light is incident on a plane reflecting surface at an angle of 30º to the normal. Find the deviation in the incident ray. What will be the deviation if the ray suffers a reflection again at a surface inclined at 60º to the 1st surface? **[120º, 240º]**

**Q.11** AB and AC are two plane mirrors inclined at an angle of 15º and P is a point on AB. At what angle must a ray of light from P be incident upon

AC in order that after three successive reflection it may be parallel to AB ? **[45°]**

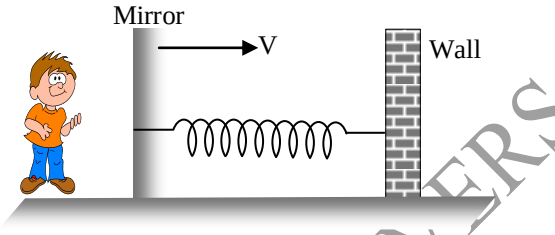
**Q.12** A ray successively reflects from two mirrors inclined at 50°. If the angle of incidence on one mirror is 50°, what is net deviation of this ray ?

**Sol.** $\delta = 360 - 2\theta$

$\theta$ = Angle between two mirrors = 50°

$\therefore \delta = 360 - 2 \times 50 = 260°$

**Q.13** A plane mirror having mass m is tied to the free end of a massless spring having spring constant K. The other end of the spring is attached to a wall. The spring with mirror is held vertically to the floor, can slide along it smoothly. When the spring is at its natural length, the mirror is found to be moving at a speed of V. Find the separation between the images of a man standing before the mirror, when the mirror is in its extreme positions.

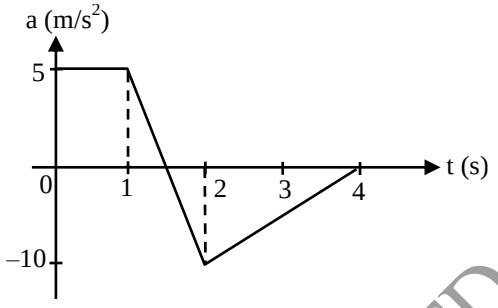



**$4V\sqrt{\frac{m}{K}}$**

**Q.14** Two bodies 1 and 2 are projected simultaneously with velocities $v_1$ and $v_2$ respectively. The body 1 is projected vertically up from the top of a cliff of height h and the body 2 is projected vertically up from the bottom of the cliff. If the bodies meet above the top of the cliff., find the time of meeting of the bodies.

$$\mathbf{t = \frac{h}{(v_2 - v_1)}}$$

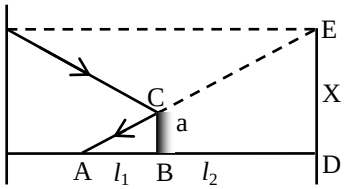
**Q.15** A particle moves vertically with an upward initial speed $v_0$ = 5m/s. If its acceleration varies with time as shown in a-t graph in the figure, find the velocity of the particle at t = 4 s.




**$[-2.5\hat{j}]$**

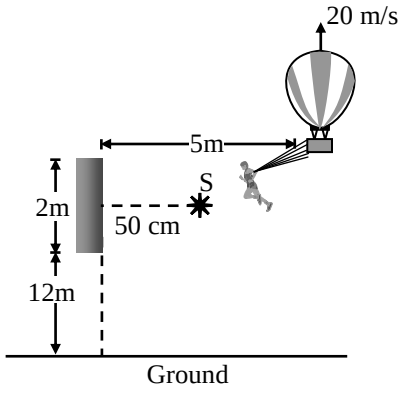
**Q.16** A mirror 1 m high hangs on a wall. A man stands a distance of 2 m away from the mirror. What is the height of the portion of the opposite wall in the room that can be seen by the man in the mirror without changing the position of his head? The wall is 4 m from the mirror.

**Sol.** The image of the wall will be behind the mirror at a distance $l_2$ = 4 m. If the eye is placed at the point A (Fig.) it will see only the rays coming from all the points in the section of the wall image DE after the reflection in the mirror BC. Thus, the section of the wall visible in the mirror will have dimensions.



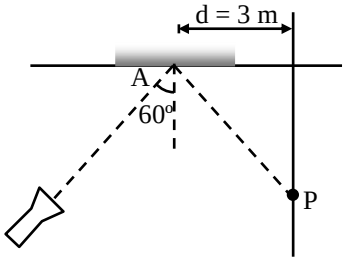

$X = \frac{l_1 + l_2}{l_1} a = 3m.$

**Q.17** A balloon is moving upwards with a speed of 20 m/s. When it is at a height of 14 m from ground in front of a plane mirror in situation as shown in figure, a boy drops himself from the balloon. Find the time duration for which he will see the image of source 'S' placed symmetrically before plane mirror during free fall.



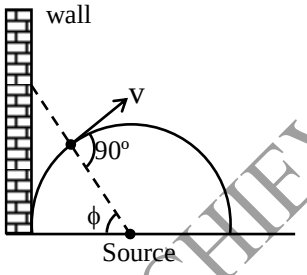

**[7.3 sec]**

**Q.18** Figure shows a torch producing a straight light beam falling on a plane mirror at an angle 60º. The reflected beam makes a spot P on the screen along Y-axis. If at t = 0, mirror starts rotating about the hinge A with an angular velocity ω = 1º per second clockwise. Find the speed of the spot on screen after time t = 15 s.



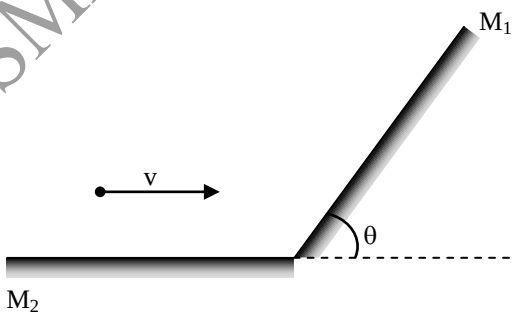

**[** $\frac{2\pi}{15}$ m/s **]**

**Q.19** On a particle moving on a circular path with a constant speed v, light is thrown from a projectors placed at the centre of the circular path. The shadow of the particle is formed on the wall. Find the speed of shadow at the instant as shown in figure.

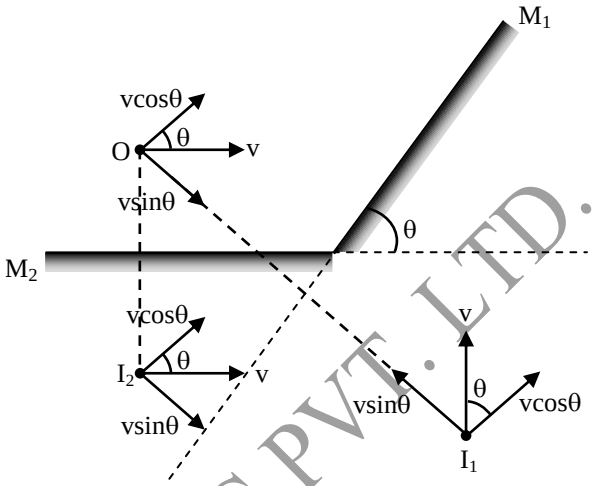



**[**v sec$^2$ ϕ**]**

**Q.20** A point object is moving with a speed v before an arrangement of two mirrors as shown in fig. Find the velocity of image in mirror $M_1$ with respect to image in mirror $M_2$.




**Sol.** Velocity of image in mirror $M_1$ and $M_2$ is as shown in fig.




$\vec{v}_{1/2}$ = Velocity of $I_1$ w.r.t. $I_2$

$= \vec{v}_1 - \vec{v}_2$

or $v_{1/2} = 2v \sin\theta$