Chapter

26

Reflection

Single Correct Option Type Questions

Q.1 A plane mirror is placed in y-z plane facing towards negative x-axis. The mirror is moving parallel to y-axis with a speed of 2 cm/s. A point object 'p' is moving in front of the mirror with a velocity $(1\text{cm/s})\,\hat{i} + (1\text{cm/s})\,\hat{j}$. Then which of the following statements is incorrect ?

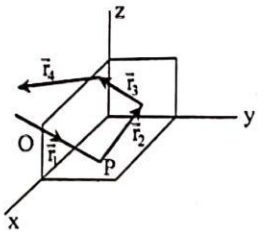
(A) The velocity of image is with $(-\hat{i}+\hat{j})$ cm/s

(B) The velocity of image with respect to mirror is $-(\hat{i}+\hat{j})$ cm/s

(C) The velocity of image with respect to object is $-(2\hat{i})$ cm/s

(D) The unit vector in the direction of reflected ray is $\frac{(\hat{i}+\hat{j})}{\sqrt{2}}$

Q.2 Three plane mirrors are arranged so that they are mutually perpendicular as shown in figure. Let the line of intersection of the mirrors be the coordinate axes. A ray OP represented by vector $\vec{r}_1 = (x_1, y_1, z_1)$ is reflected from the mirror. Which of the following statement is **Incorrect** ?



(A) The components of the reflected vector from mirror in x-y plane is $\vec{r}_2 = (x_1, y_1, -z_1)$

(B) If $\vec{r}_2$ is now reflected at the y-z plane, the components of the reflected vector is $\vec{r}_3 = (-x_1, y_1, -z_1)$

(C) If $\vec{r}_3$ is reflected at the z-x plane, the components of the reflected vector is $\vec{r}_4 = (-x_1, -y_1, -z_1)$

(D) For an incident ray that is reflected from the mirrors in some other order, the components of final ray $\vec{r}_4$ will change

Q.3 An optical device, which could be a mirror, or a lens, plane or spherical, is observed to give an image, sometimes real, sometimes virtual and sometimes diminished or sometimes enlarged, of an extended object placed on its axis. The optical device could be -

(A) a plane mirror, a concave mirror or a convex lens (B) a concave mirror or a convex lens

(C) a convex mirror or a concave lens (D) only a convex lens

Q.4 An object is moving with speed v_0 towards a spherical mirror with radius of curvature R, along the central axis of the mirror. The speed of the image with respect to the mirror is (U is the distance of the object from mirror at any given time t)

(A) $+\left(\frac{R}{U-2R}\right)v_0^2$ (B) $-\left(\frac{R}{R-2U}\right)^2 v_0$ (C) $-\left(\frac{R}{2U-2R}\right)^2 v_0$ (D) $+\left(\frac{R}{2U-2}\right)v_0^2$

Q.5 A point object is moving with velocity $\vec{u} = 2\hat{i} + \hat{j} - \hat{k}$ m/s in front of a stationary plane mirror. The magnitude of relative velocity of the image with respect to object is maximum if the normal of the plane mirror will be along -

(A) $2\hat{i} + \hat{j} + \hat{k}$ (B) $-2\hat{i} + \hat{j} - \hat{k}$ (C) $2\hat{i} + \hat{j} - \hat{k}$ (D) $2\hat{i} - \hat{j} - \hat{k}$

Q.6 A point object P moves towards a stationary convex mirror with a constant speed v, along the optical axis. The speed of the image -

(A) is always less than v

(B) may be greater than, equal to or less than v, depending upon the position of P

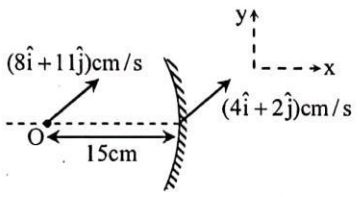
(C) is always greater than v

(D) none of these

Q.7 Two rays are incident on a spherical mirror of radius R = 5 cm parallel to its optical axis at distances $h_1 = 0.5$ cm and $h_2 = 3$ cm. Determine the distance Δx (approximately) between the points at which these rays intersect the optical axis after being reflected at the mirror -

(A) 0.2 cm (B) 1.5 cm (C) 0.6 cm (D) 1.0 cm

Q.8 A point object is located at a distance 15 cm from the pole of a concave mirror of focal length 10cm on its principal axis is moving with a velocity $(8\hat{i} + 11\hat{j})$ cm/s and velocity of mirror is $(4\hat{i} + 2\hat{j})$ cm/s as shown. If $\vec{v}$ is the velocity of image. Then find the value of $|\vec{v}|$ in (cm/s)



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

Q.9 A ray of light travelling along the positive z-axis is reflected twice -

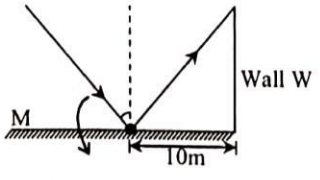
(i) for the first time, by a mirror whose normal is along $(\hat{i} + \hat{k})$

(ii) for the second time, by a mirror whose normal is along $(\hat{i} + \hat{k} + \hat{j})$, where the symbols have their usual meanings.

The final ray is along -

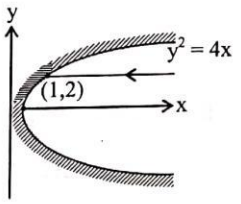
(A) $\hat{j} + \hat{k}$ (B) $\hat{k} + \hat{i}$ (C) $2\hat{j} + 2\hat{k} - \hat{i}$ (D) None of these

Q.10 A light ray is incident on a plane mirror M. The mirror is rotated in direction as shown in figure by an arrow at frequency $(9/\pi)$ revolution/sec. The light reflected by the mirror is received on the wall W at a distance of 10 m from axis of rotation. Speed of the spot on wall when angle of incident = 37° is



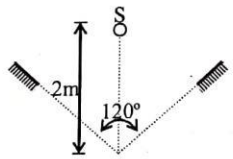
(A) 10 m/sec (B) 1000 m/sec (C) 360 m/sec (D) 500 m/sec

Q.11 A light ray parallel to x-axis is incident on a parabolic concave mirror in XY plane. The focus of this parabola is at (1, 0). The unit vector along the reflected ray will be



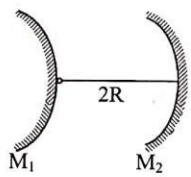
(A) $\hat{j}$ (B) $-\hat{j}$ (C) $\frac{\hat{i}+4\hat{j}}{\sqrt{17}}$ (D) $-\hat{i}$

Q.12 Area of triangle formed by S and its two images is



(A) $3\sqrt{3}$ m^2 (B) $\frac{3\sqrt{3}}{4}$ m^2 (C) $\frac{4}{3\sqrt{3}}$ m^2 (D) Can't be determined

Q.13 Two spherical mirror, one convex and other concave, each of same radius of curvature R are arranged coaxially at a distance 2R from each other. A small circle of radius a is drawn on the convex mirror near the pole as shown in figure. The radius of 2nd image (taking the first reflection at the concave mirror, then the reflection at the convex mirror) of the circle is $\left(\frac{3a}{30+x}\right)$, then value of x is



(A) 1 (B) 2 (C) 3 (D) 4

Q.14 The total number of images formed by two plane mirrors, inclined at an angle of 15°, and an object lying symmetrically is

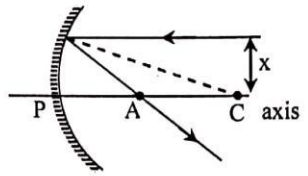
(A) 24 (B) 23 (C) 22 (D) 25

Q.15 A plane mirror coincides with a plane having equation x = 3. A particle is moving along a line with direction ratios 3, 4, 5. If speed of the particle is $\sqrt{2}$, the velocity of its image is

(A) $\frac{3}{5}\hat{i}+\frac{4}{5}\hat{j}+\frac{1}{5}\hat{k}$ (B) $-\frac{3}{5}\hat{i}-\frac{4}{5}\hat{j}-\hat{k}$ (C) $\frac{3}{5}\hat{i}+\frac{4}{5}\hat{j}-\frac{1}{5}\hat{k}$ (D) $-\frac{3}{5}\hat{i}+\frac{4}{5}\hat{j}+\hat{k}$

Statement Based Questions

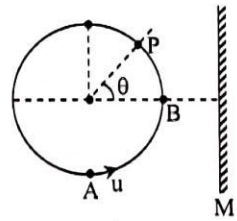
Q.16 **Statement-1 :** As 'x' increases, the distance of point of intersection of the reflected ray with axis from pole decrease.
Statement-2 : As the distance 'x' of a parallel ray from axis increases, angle of incidence decreases.



(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(B) Statement-1 is true, statement-2 true and statement-2 is NOT is correct explanation for statement.
(C) Statement-1 is true, statement-2 is false.
(D) Statement-1 is false, statement-2 is true.

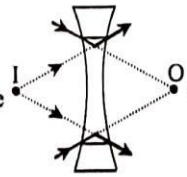
Multiple Correct Option Type Questions

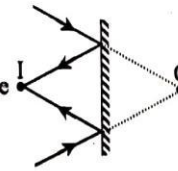
Q.17 A particle is moving along a circle with a constant speed u, as shown in figure. M is a plane mirror, then

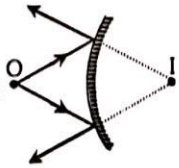


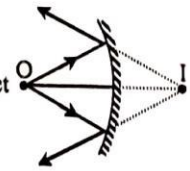
(A) relative velocity of image w.r.t. object becomes zero twice in one revolution
(B) path of image with respect to object is circle
(C) path of image with respect to object is straight line
(D) speed of image with respect to object when particle is at P is $2u \sin\theta$

Q.18 The nature of object and image given with each of the optical condition is shown. Choose the correct option(s)

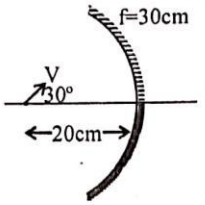
(A) Virtual image  Virtual object

(B) Virtual image  Real object

(C) Real Object  Virtual image

(D) Real Object  Virtual image

Q.19 A ball is projected with initial speed V at distance 20cm from pole of a concave mirror. Speed of image cannot be



(A) Greater than V (B) Less than V (C) Equal to V (D) Zero

Q.20 A point-object is kept at (1, 0, 0). A circular plane mirror of radius 1m is kept in yz plane such that its centre is at the origin. The reflecting side faces positive x-axis. At which of the following points can the image of the object be seen ?

(A) (– 0.5, 0, 0.5) (B) (2, 2, 2) (C) (1, 1.5, 1.5) (D) (1, –1, 1.5)

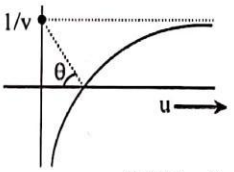
Q.21 An object is moving on principle axis in front of a spherical mirror, m is instantaneous transverse magnification the velocity of object is constant. Mirror is stationary. v and a are velocity and acceleration of image respectively. The correct statement (s) are

(A) $v \propto m^2$ (B) $v \propto m$ (C) $a \propto m^3$ (D) $a \propto m^4$

Passage Based Questions

Passage # 1 (Q.22 & 23)

For an optical element the graph between 1/v and u is given (Assume paraxial ray approximation has been used. Symbols have their usual meaning). For plotting the graph the following sign convention is used.



(a) Pole is taken as origin. (b) Direction of incident light is +ve
(c) Principle axis is used as one of the axis

Q.22 The nature of mirror is -

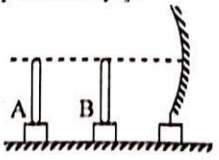
(A) Convex mirror (B) Concave mirror (C) Converging lens (D) Diverging lens

Q.23 Numerical value of cot θ is 4 -

(A) Numerical value of focal length is 2 (B) Numerical value of focal length is 1/2
(C) Numerical value of focal length is 4 (D) Numerical value of focal length is 1/4

Passage # 2 (Q.24 & 25)

A concave mirror M is mounted on an optical bench. Two pins A and B are placed on bench such that their tips also lie on the principal axis of the mirror as shown. The image of tip of one tip is formed on the tip of the other pin. Now if pin B is moved 80 cm towards left and pin A is moved 80cm towards right, image of tip of one pin is again on the tip of the other pin. The magnitude of transverse magnification of the larger image is three. [All the images are formed by paraxial rays].

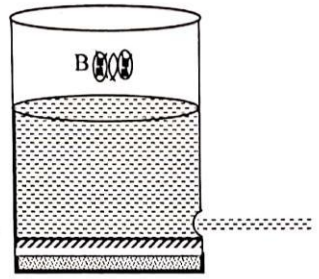


Q.24 The focal length of the mirror is -
(A) 30 cm (B) 60 cm (C) 40 cm (D) 15 cm

Q.25 The magnification of the image of the pin B in second case is -
(A) 3 (B) 4.5 (C) 1/4.5 (D) 1/3

Passage # 3 (Q.26 & 27)

In a cylindrical container of area 100 cm^2, water is filled upto a height 80m. there is a small orifice at the bottom of the container. The area of orifice is 1cm^2 . The base of the container is silvered and behaves like plane mirror.
An insect is crawling down on the wall of the container with velocity 2 cm /s and at t= 0 it is at 81 m from the base.
At t = 0 water starts flowing out from the orifice. (refractive index of water is 4/ 3)

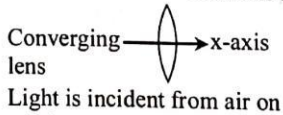
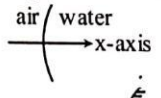
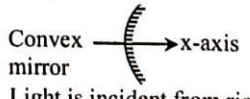
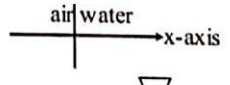
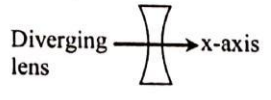


Q.26 The velocity of image of insect as observed by the insect at t = 200 sec.
(A) 2 cm/s (B) 6 cm/s (C) 3 cm/s (D) 8 cm/s

Q.27 After a certain time velocity of image of insect becomes constant. The time at which this happens will be
(A) 200 sec (B) 10 sec (C) 400 sec (D) 300 sec

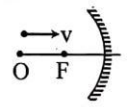
Column Matching Type Questions

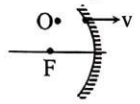
Q.28 In column-I certain combination of small object and image are given. Match them with possible refracting / reflecting body in column-II. In all cases, object is perpendicular to x-axis. Object can't be at zero distance from the interface.

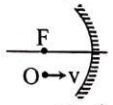
Column-I		Column-II
(A) Virtual image of virtual object	(P)	Converging lens  x-axis
(B) Real image of real object	(Q)	Light is incident from air on the spherical surface  air / water x-axis
(C) Erect real image of same size as object	(R)	Convex mirror  x-axis
(D) Erect and virtual image of larger size	(S)	Light is incident from right to left  air water x-axis
	(T)	Diverging lens  x-axis

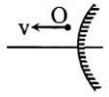
Q.29 In column-I possible instantaneous velocity vector of the object/mirror (as shown in figure) with respect to ground. The corresponding velocity vectors of images are the situations shown in column-II. Match column-I with the column-II.

Column-I

(A) 

(B) 

(C) 

(D) 

Column-II

(P) 

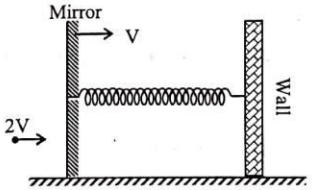
(Q) 

(R) 

(S) 

(T) None of these

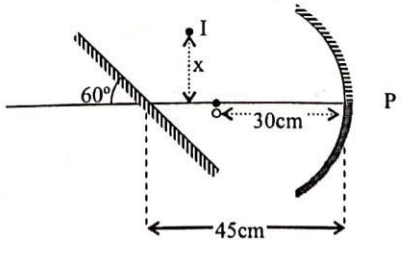
Q.30 A plane mirror is tied to the free end of an ideal spring. The other end of the spring is attached to a wall. The spring with mirror is held vertically to the floor, can slide along it smoothly. When the spring is at its natural length, the mirror is found to be moving at a speed of V with respect to ground frame. An object is moving towards the mirror with speed 2V with respect to ground frame. Then, Match the following :



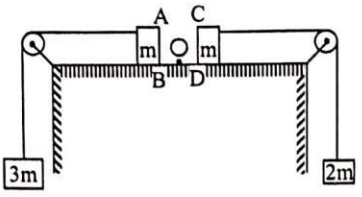
Column I	Column II
(A) Speed of image with respect to ground frame when spring is at natural length	(P) V
(B) Speed of image with respect to mirror when spring is at natural length	(Q) O
(C) Speed of image with respect to object when spring is at natural length	(R) 2V
(D) Speed of image with respect to ground frame when spring is at maximum compressed state	(S) 3V

Numeric Response Type Questions

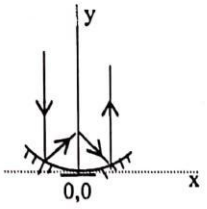
Q.31 A concave mirror of focal length 20cm and a plane mirror are kept as shown in the fig. Consider two reflections, first from concave mirror and second from plane mirror. If the image for an object kept at 30cm from concave mirror is formed at I then the value of x is $\left(\frac{60}{n}\sqrt{3}\right)$ cm. Find n



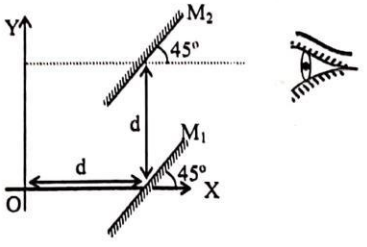
Q.32 Two blocks each of mass m lie on a smooth table. They are attached to two other masses as shown in the figure. The pulleys and strings are light. An object O is kept at rest on the table. The sides AB & CD of the two blocks are made reflecting. The acceleration of two images formed those two reflecting surfaces w.r.t. each other is $\left(\frac{17g}{x}\right)$ m/s^2. Find the value of x



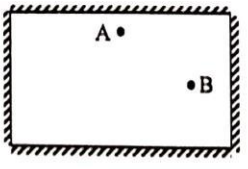
Q.33 A beam of light parallel to y - axis falls on reflecting surface $y = \frac{x^2}{16}$ as shown in the figure . Find the point where the beam will converge after reflection.



Q.34 Find the coordinates of the image formed that of an object placed at origin, which the eye will observe in mirror M_2.

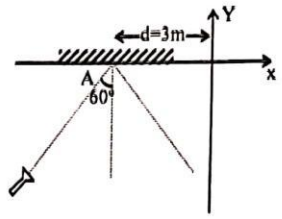


Q.35 How will you draw a beam of light to be sent from point A (see figure) contained in a mirror box for it to fall onto point B after being reflected once from all four walls? Points A and B are in one plane perpendicular to the walls of the box (i.e. in the plane of the drawing).



Q.36 A balloon is rising up along the axis of a concave mirror of radius of curvature 20 m. A ball is dropped from the balloon at a height 15 m from the mirror when the balloon has velocity 20 m/s. Find the speed of the image of the ball formed by concave mirror after 4 seconds? [Take : g = 10 m/s^2]

Q.37 Figure shows a torch producing a straight light beam falling on a plane mirror at an angle 60°. The reflected beam make a spot P on the screen along Y-axis. If at t = 0, mirror starts rotating about the hinge A with an angular velocity $\Omega = 1°$ per second clockwise. Find the speed of the spot on screen after time t = 15s.



Q.38 A kid of height 1.1 ft is sleeping straight between focus and centre of curvature along the principal axis of a concave mirror of small aperture. His head is towards the mirror and is 0.5 ft from the focus of the mirror. How a plane mirror should be placed so that the image formed by it due to reflected light from concave mirror looks like a person of height 5.5 ft standing vertically. Draw the diagram. Find the focal length of the concave mirror.

Q.39 An observer whose least distance of distinct vision is 'd', views his own face in a convex mirror of radius of curvature 'r'. Prove that magnification produced can not exceed $\frac{r}{d+\sqrt{d^2+r^2}}$.

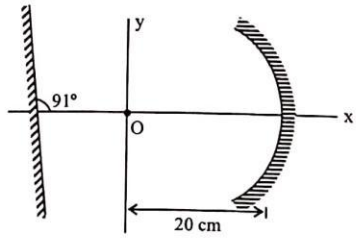
Q.40 A thief is running away in a car with velocity of 20 m/s. A police jeep is following him, which is sighted by thief in his rear view mirror which is a convex mirror of focal length 10 m. He observes that the image of jeep is moving towards him with a velocity of 1 cm/s. If the magnification of the mirror for the jeep at that time is 1/10. Find

(a) actual speed of jeep;

(b) rate at which magnification is changing

Assume that police jeep is on axis of the mirror.

Q.41 A point object is placed at the centre of curvature of a concave mirror (taken as origin). A plane mirror is also placed at a distance of 10 cm from the object as shown. Consider two reflection first at plane mirror and then at concave mirror. Find the coordinates of the image thus formed.



Q.42 A concave mirror has the form of a hemisphere with a radius of R = 60 cm. A thin layer of an unknown transparent liquid is poured into the mirror. The mirror-liquid system forms one real image and another real image is formed by mirror alone, with the source in a certain position. One of them coincides with the source and the other is at a distance of l = 30 cm from source. Find the possible value(s) refractive index μ of the liquid.

ANSWER KEY

Single Correct Option type Questions

1. (D) **2.** (D) **3.** (B) **4.** (B) **5.** (C) **6.** (A) **7.** (C)

8. (A) **9.** (C) **10.** (B) **11.** (C) **12.** (A) **13.** (C) **14.** (B)

15. (D)

Statement Based Questions

16. (C)

Multiple Correct Option type Questions

17. (A,C,D) **18.** (A,C,D) **19.** (B,C,D) **20.** (B,D) **21.** (A,C)

Passage Based Questions

22. (A) **23.** (B) **24.** (A) **25.** (D) **26.** (B) **27.** (C)

Column Matching Type Questions

28. A $\rightarrow$ R,T ; B $\rightarrow$ P,Q ; C $\rightarrow$ S ; D $\rightarrow$ P,Q **29.** A $\rightarrow$ R; B $\rightarrow$ P; C $\rightarrow$ Q; D $\rightarrow$ S

30. A $\rightarrow$ Q; B $\rightarrow$ P; C $\rightarrow$ R; D $\rightarrow$ R

Numeric Response Type Questions

31. 8 **32.** 6 **33.** 4 **34.** (– d, d) **36.** 80 m/sec. **37.** $\frac{2\pi}{15}$ m/sec.

38. 2 feet **40.** (a) 21 m/sec., (b) 1×10^{-3} sec. **41.** $\frac{20}{3}$ cm, $\frac{\pi}{27}$ cm. **42.** 1.5° OR $(\sqrt{5}-1)$