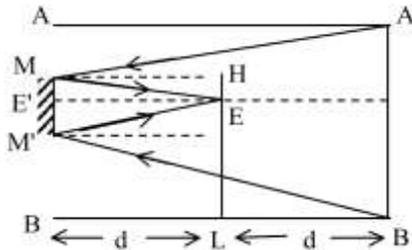


SOLVED EXAMPLES

Ex1. Find the minimum height of a mirror required to see the complete wall behind him.



Sol. From, $\triangle A'ME'$ & $\triangle ME'E'$ we have

$$\frac{A'M}{2d} = \frac{ME'}{d}$$

$$\Rightarrow A'M = 2ME'$$

Again From, $\triangle EE'M'$ & $\triangle M'B'B$ we have.

$$\frac{E'M'}{d} = \frac{M'B'}{2d}$$

$$\Rightarrow M'B' = 2E'M'$$

$$\begin{aligned} \text{Now, } MM' &= A'B' - A'M - M'B' \\ &= AB - 2(ME' + E'M') \\ &= AB - 2MM' \end{aligned}$$

$$MM' = \frac{1}{3}AB$$

Thus, minimum height of the mirror be $\frac{1}{3}$ of the wall and the person must be in the middle of the mirror and the wall.

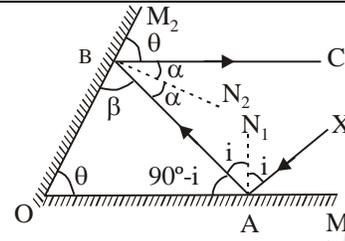
Ex2. Two mirrors are inclined at an angle of 50° . Then what is the number of images formed for an object placed in between the mirrors?

Sol. For the given $\theta = 50^\circ$,

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

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

Ex.3 Two plane mirrors are inclined at an angle θ . A ray of light is incident on one mirror at an angle of incidence i . The ray is reflected from this mirror, falls on the second mirror from where it is reflected parallel to the first mirror. What is the value of i , the angle of incidence in terms of θ ?



Sol. The situation is illustrated in figure. XA is the incident ray. BC is the final reflected ray. It is given that BC is parallel to mirror M_1 . Look at the assignment of the angles carefully. Now N_2 is normal to mirror M_2 . Therefore

$$\beta = \theta$$

Then from $\triangle OAB$

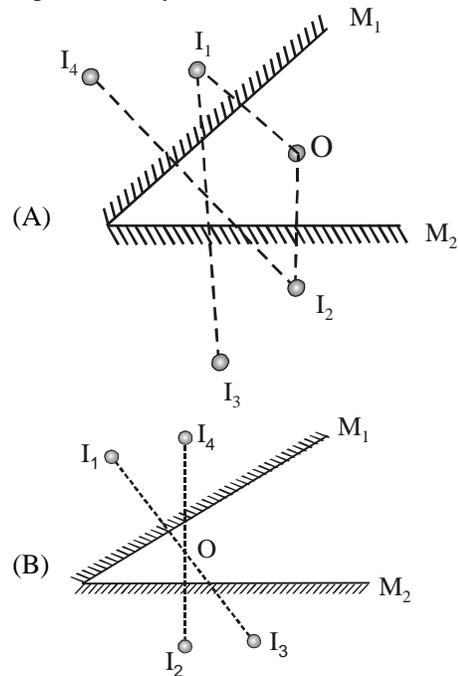
$$\theta + \beta + 90^\circ - i = 180^\circ$$

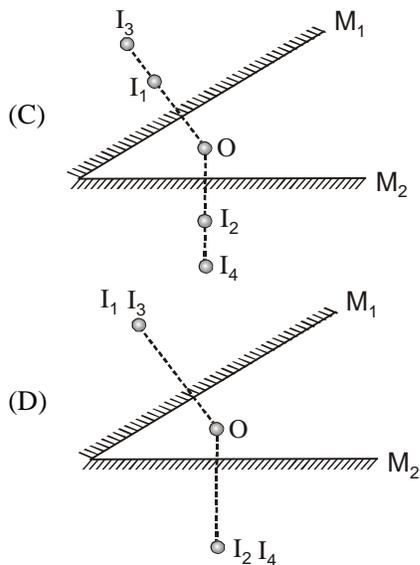
$$\text{or } \theta + \theta + 90^\circ - i = 180^\circ$$

$$\text{or } i = 2\theta - 90^\circ$$

Thus if the angle of incidence is $i = 2\theta - 90^\circ$, then the final reflected ray will be parallel to the first mirror.

Ex.4 Two plane mirrors are inclined at an angle of 30° . Then the first four images of an object O placed between the two mirrors are correctly represented by

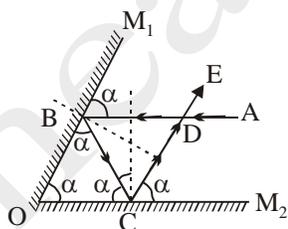




Sol. The image of object O from mirror M_1 is I_1 and the image of I_1 (the virtual object) from mirror M_2 is I_3 . The image of object O from mirror M_2 is I_2 and the image of I_2 (the virtual object) from mirror M_1 is I_4 . Notice that this interpretation, according to ray diagram rules, is valid only for Fig. (A). All others are inconsistent. Hence correct is (A)

Ex.5 Two plane mirrors are placed at an angle θ so that a ray parallel to one mirror gets reflected parallel to the second mirror after two consecutive reflections. The value of θ will be
 (A) 30° (B) 60°
 (C) 75° (D) 90°

Sol. As shown in figure, ray AB goes to mirror M_1 , gets reflected and travels along BC and then gets reflected by M_2 and goes in CD direction. If the angle between M_1 and M_2 be α , then



In ΔOBC , $\angle OBC$ and $\angle OCB$ are equal to α
 $\therefore 3\alpha = 180^\circ$
 $\alpha = 60^\circ$

Hence correct answer is (B).

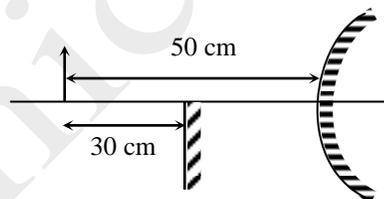
Ex.6 A girl stands at a distance 30 cm from the mirror. She is able to see her erect image but of $1/5$ height of actual height. The mirror will be :

- (A) plane mirror
- (B) concave mirror
- (C) convex mirror
- (D) plane convex mirror

Sol. Small and erect image is formed only by convex mirror. Plane mirror from images equal to object and concave mirror form images bigger than object.

Hence correct answer is (C).

Ex.7 An object is placed at a distance of 50 cm from a convex mirror. A plane mirror is placed in front of the convex mirror in such a way that it covers half of the convex mirror. If the distance between object and plane mirror is 30 cm then there is no parallax between the images formed by two mirrors, the radius of curvature of convex mirror will be :



- (A) 50 cm
- (B) 25 cm
- (C) 12.5 cm
- (D) 100cm

Sol. The image will be formed by the plane mirror at a 30 cm behind it, while the image by convex mirror will be formed at 10 cm behind the convex mirror. Since for convex mirror $u = -50$ cm as shown in figure.

$$v = 10 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{-50} + \frac{1}{10} = \frac{-1+5}{50} = \frac{4}{50}$$

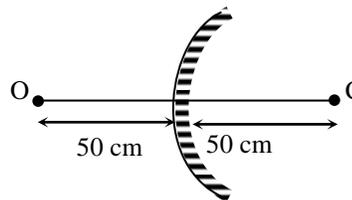
$$f = \frac{50}{4} = 12.5 \text{ cm}$$

Therefore the radius of curvature of convex mirror is

$$r = 2f = 25 \text{ cm}$$

Hence correct answer is (B).

Ex.8 There is a convex mirror of radius 50 cm. The image of a point at a distance 50cm from the pole of mirror on its axis will be formed at :



- (A) infinity
 (B) pole
 (C) focus
 (D) 16 cm behind the mirror

Sol. $u = -50 \text{ cm}$, $f' = 25 \text{ cm}$

$$\frac{1}{25} = -\frac{1}{50} + \frac{1}{v}$$

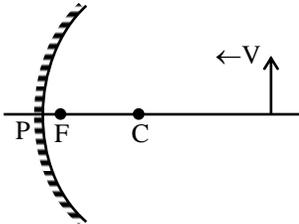
$$\frac{1}{v} = \frac{1}{25} + \frac{1}{50}$$

$$= \frac{2+1}{50} = \frac{3}{50}$$

$$v = \frac{50}{3} = 15.3 \text{ cm}$$

Hence correct answer is (D)

Ex.9 A particle is moving at a constant speed v from a large distance towards a concave mirror of radius R along its principle axis. Find the speed of the image formed by the mirror as a function of the distance x of the particles from the mirror.



Sol.

Let initially, the particle is at A. where, $PA = u_1 = x$ and after one second, the particle is at B where, $PB = u_2 = x - v \times 1$

We know, $\frac{1}{v} + \frac{1}{u} = \frac{2}{R} \Rightarrow v = \frac{uR}{2u - R}$

$$\frac{dv}{dt} = \frac{(2u - R).R - uR.2}{(2u - R)^2} \cdot \frac{du}{dt}$$

$$= \left(\frac{R}{2u - R} \right)^2 \cdot \frac{du}{dt}$$

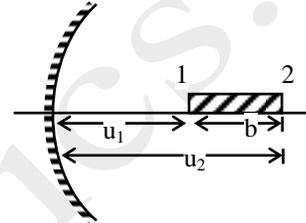
For concave mirror $R = (+ve)$, $u = (+ve)$. As the object approaches the mirror

$$\frac{du}{dt} = (-ve)$$

$$\therefore \text{Velocity of Image } \frac{dv}{dt} = \left(\frac{R}{2u - R} \right)^2 \cdot U$$

Ex.10 A short linear object of length b lies along the axis of a concave mirror of focal length f at a distance u from the pole of the mirror. Find the approximate size of the image.

Sol. Here, u_1 is the distance of front side of the object from the pole and u_2 is that for back side of the object.



We know, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow v = \frac{uf}{u - f}$

$$\therefore v_1 = \frac{u_1 f}{u_1 - f} \quad \& \quad v_2 = \frac{u_2 f}{u_2 - f}$$

It is given that $u_2 - u_1 = b$

$$\therefore v_2 - v_1 = \frac{u_2 f}{u_2 - f} - \frac{u_1 f}{u_1 - f}$$

$$= f \left[\frac{u_2}{u_2 - f} - \frac{u_1}{u_1 - f} \right]$$

$$= \frac{f(u_1 u_2 - u_2 f - u_1 u_2 + u_1 f)}{(u_2 - f)(u_1 - f)}$$

$$= \frac{f^2(u_1 - u_2)}{(u_2 - f)(u_1 - f)} = \frac{-f^2 b}{(u_1 + b - f)(u_1 - f)}$$

As, $u_1 = u \gg b$ we have

$$|v_2 - v_1| = \frac{f^2 b}{(u - f)^2} = b \left(\frac{f}{u - f} \right)^2$$

LEVEL # 1

Questions based on

Properties of reflection

- Q.1** When light is reflected from a mirror a change occurs in its -
(A) phase, (B) frequency,
(C) wavelength, (D) speed
- Q.2** On reflection from a plane surface, the following gets changed –
(A) wavelength (B) frequency
(C) speed (D) amplitude
- Q.3** 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) π (D) $3\pi/2$
- Q.4** The frequency of incident ray is 3×10^8 Hz. The frequency after reflection -
(A) decreases (B) remain same
(C) increases (D) either 1 or 3
- Q.5** The images of clouds and trees in water always less bright than in reality –
(A) because water is forming the image dirty
(B) because there is an optical illusion due to which the image appears to be less bright
(C) because only a portion of the incident light is reflected and quite a large portion goes mid water
(D) because air above the surface of water contains a lot of moisture

Questions based on

Laws of reflection

- Q.6** If a ray of light is incident on a plane mirror at an angle of incidence of 30° , then deviation produced by mirror is -
(A) 30° (B) 60°
(C) 90° (D) 120°

- Q.7** A rays is incident at an angle 38° on a mirror. The angle between normal and reflected ray is -
(A) 38° (B) 52°
(C) 90° (D) 76°

Questions based on

Image formation by plane mirror

- Q.8** The image of a real object formed by a plane mirror is -
(A) Erect, real and of equal size
(B) Erect, virtual and of equal size
(C) Inverted, real and of equal size
(D) Inverted, virtual and of equal size
- Q.9** If you want to see your full image, then minimum size of the mirror -
(A) should be of your height
(B) should be half of your height
(C) should be twice of your height
(D) depends upon distance from the mirror
- Q.10** 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.
- Q.11** 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

- Q.12** Which of the following is not the case with image formed by a plane mirror -
 (A) It is erect
 (B) It is virtual
 (C) It is diminished
 (D) It is at the same distance as the object
- Q.13** A man 160 cm height stands in front of a plane mirror. His eyes are at a height of 150 cm from the floor. Then the minimum length of the plane mirror for him to see his full length image is -
 (A) 85 cm (B) 170 cm
 (C) 80 cm (D) 340 cm
- Q.14** Which of the following letters do not suffer lateral inversion -
 (A) HGA (B) HOX (C) VET (D) YUL
- Q.15** A small object is 10 cm in front of a plane mirror. A man stands 30 cm from the mirror, behind the object and looks at the object's image. He should focus his eyes to see the image at a distance -
 (A) 25 cm. (B) 35 cm.
 (C) 45 cm. (D) 40 cm.
- Q.16** A plane mirror produces a magnification of -
 (A) -1 (B) + 1
 (C) zero (D) between 0 and + ∞

Questions based on

Motion of image by plane mirror

- Q.17** 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
- Q.18** A plane mirror is approaching you at 10 cm per second. You can see your image in it. At what speed will your image approach you -
 (A) 10 cm/s (B) 5 cm/s
 (C) 20 cm/s (D) 15 cm/s
- Q.19** If an object approaches towards a plane mirror with velocity V , then image approaches the object with velocity -
 (A) V (B) $1.5 V$
 (C) $2 V$ (D) $3 V$

- Q.20** A car is moving towards a plane mirror at a speed of 30 m/s. Then the relative speed of its image with respect to the car will be -
 (A) 30 m/s (B) 60 m/s
 (C) 15 m/s (D) 45 m/s
- Q.21** An object is approaching a plane mirror at 5 cms per second. A stationary observer sees the image. At what speed will the image approach the stationary observer -
 (A) 5 cms per second
 (B) 20 cms per second
 (C) 10 cms per second
 (D) 15 cms per second
- Q.22** A person is standing in front of a plane mirror. If the mirror recedes with velocity v , the relative separation of person and his image per second is -
 (A) 0 (B) v (C) $2 v$ (D) $v/2$

Questions based on

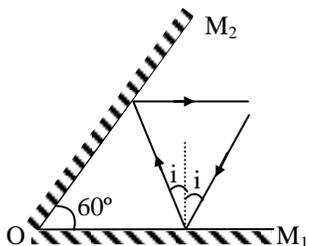
Two inclined plane mirrors

- Q.23** Two mirrors are placed perpendicular to each other. A ray strikes the first mirror and after reflection from the first mirror it falls on the second mirror. The ray after reflection from second mirror will emerge -
 (A) Perpendicular to the original ray
 (B) Parallel to the original ray
 (C) At 45° to the original ray
 (D) At 60° to the original ray
- Q.24** An object is placed between two plane mirrors set at 60° to each other. The maximum number of images seen will be -
 (A) 2 (B) 3 (C) 5 (D) 6
- Q.25** A person is in a room whose ceiling and two adjacent walls are mirrors. How many images are formed ?
 (A) 5 (B) 6 (C) 7 (D) 8
- Q.26** The number of images observable between two parallel plane mirrors is -
 (A) 2 (B) 4
 (C) 11 (D) infinite
- Q.27** An object is placed symmetrically between the two plane mirrors inclined at an angle of 30° , then the total number of images formed, is -
 (A) 12 (B) 2
 (C) 11 (D) infinite

Q.28 If an object is placed unsymmetrically between two plane mirrors, inclined at the angle of 60° , then the total number of images formed is -
 (A) 5 (B) 4 (C) 2 (D) infinite

Q.29 If an object is placed unsymmetrically between two plane mirrors, inclined at an angle of 72° , then the total number of images formed is -
 (A) 5 (B) 4 (C) 2 (D) Infinity

Q.30 Two plane mirrors are inclined to one another at an angle of 60° . A ray is incident on mirror M_1 at an angle i . The reflected ray from mirror M_2 is parallel to mirror M_1 as shown in figure. The angle of incidence i is -



(A) 20° (B) 10° (C) 30° (D) 40°

Q.31 Images formed by an object placed between two plane mirrors whose reflecting surfaces make an angle of 90° with one another lie on -
 (A) Straight line (B) Zig-zag curve
 (C) Circle (D) Ellipse

Q.32 Two plane mirrors are inclined to one another at an angle of 40° . 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

Q.33 At what angle must two plane mirrors be placed so that incident and resulting reflected rays are always parallel to each other -
 (A) 0° (B) 30° (C) 60° (D) 90°

Q.34 How many images of himself, does an observer see if two adjacent walls of rectangular room are mirror surfaced -
 (A) 3 (B) 5 (C) 7 (D) 9

Q.35 A ray gets successively reflected from two mirrors inclined at an angle of 40° . If the angle of incidence on the first mirror is 60° , then the net deviation of this ray is -
 (A) 40° (B) 280°
 (C) 80° (D) 100°

Questions based on

Focal length of spherical mirrors

Q.36 The focal length of spherical mirror is -
 (A) Maximum for red light
 (B) Maximum for blue light
 (C) Maximum for white light
 (D) Same for all lights

Q.37 If a spherical mirror is immersed in a liquid, its focal length will -
 (A) Increase
 (B) Decrease
 (C) Remains unchanged
 (D) Depends on the nature of liquid

Questions based on

Reflection from concave mirror

Q.38 In a concave mirror experiment, an object is placed at a distance x_1 from the focus and the image is formed at a distance x_2 from the focus. The focal length of the mirror would be -

(A) x_1x_2 (B) $\sqrt{x_1x_2}$
 (C) $\sqrt{x_1/x_2}$ (D) $\frac{x_1+x_2}{2}$

Q.39 An object is placed at a distance of 40 cm in front of a concave mirror of focal length 20cm. The image produced is -
 (A) virtual and inverted
 (B) real and erect
 (C) real inverted and diminished
 (D) real, inverted and of same size as the object.

- Q.40** An object of length 5cm is placed at a distance 1m from a concave mirror. If radius of curvature of mirror is 20 cm. Size of image will be -
 (A) 0.11 cm (B) 0.50 cm
 (C) 0.55 cm (D) 0.60 cm
- Q.41** When an object is placed at a distance of x m from a concave mirror, the magnification of the real image produced is 2. Then the radius of curvature of the mirror is -
 (A) $4x$ (B) $4x^2$ (C) $4x/3$ (D) $3x/4$
- Q.42** A short linear object is placed along optic axis of a concave mirror. If distance of nearer end of the object from the mirror is greater than radius of curvature then -
 (A) a real and elongated image will be formed.
 (B) a virtual and elongated image will be formed.
 (C) a real and diminished image will be formed.
 (D) a virtual and diminished image will be formed.
- Q.43** Sun subtends an angle of 0.5° at the pole of a concave mirror of radius of curvature 15 m. The diameter of the image of the sun formed by the mirror is -
 (A) 8.55 cm (B) 7.55 cm
 (C) 6.55 cm (D) 5.55 cm
- Q.44** The focal length of a concave mirror is 12 cm. Where should an object of length 4 cm be placed so that an image 1 cm long is formed ?
 (A) 48 cm (B) 3 cm
 (C) 60 cm (D) 15 cm
- Q.45** The focal length of a concave mirror is 20 cm. Determine where an object must be placed to form an image magnified two times when the image is real -
 (A) 30 cm from the mirror
 (B) 10 cm from the mirror
 (C) 20 cm from the mirror
 (D) 15 cm from the mirror
- Q.46** In the above question, if the magnified image is virtual, the distance of the object from the mirror must be -
 (A) 30 cm (B) 10 cm
 (C) 20 cm (D) 15 cm
- Q.47** A virtual image, larger than the object can be produced by -
 (A) convex mirror (B) concave mirror
 (C) plane mirror (D) concave lens
- Q.48** Given a point source of light, which of the following can produce a parallel beam of light-
 (A) convex mirror
 (B) concave mirror
 (C) concave lens
 (D) two plane mirrors inclined at 90° to each other
- Q.49** The image formed by a concave mirror -
 (A) is always real
 (B) is always virtual
 (C) is certainly real if the object is virtual
 (D) is certainly virtual if the object is real.
- Q.50** A short linear object is placed along optic axis of a concave mirror. If the object is in between pole and focus, then -
 (A) a virtual image will be formed.
 (B) a real diminished image will be formed.
 (C) If object is in between pole and focus then a real and elongated image will be formed.
 (D) none of these.

Questions based on

Reflection from convex mirror

- Q.51** The image formed by convex mirror of focal length 30 cm is a quarter of the size of the object. Then the distance of the object from the mirror, is -
 (A) 30 cm (B) 90 cm
 (C) 120 cm (D) 60 cm
- Q.52** A convex mirror is used to form an image of a real object. Then tick the wrong statement -
 (A) the image lies between the pole and the focus
 (B) the image is diminished in size
 (C) the image is erect
 (D) the image is real

- Q.53** The largest distance of the image from a convex mirror of focal length 10 cm can be -
(A) 20 cm
(B) infinite
(C) 10 cm
(D) depends on the position of the object
- Q.54** An object is placed at a distance of 25 cm from the pole of a convex mirror and a plane mirror is set so that the virtual images formed by two mirrors do not have any parallax. The plane mirror is 20 cm from the object. The focal length of the mirror is -
(A) 37.5 cm (B) -7.5 cm
(C) -37.5 cm (D) +75 cm
- Q.55** The rear-view mirror of a car is -
(A) Plane
(B) Convex
(C) Concave
(D) None of the above
- Q.56** An inverted image of a real object can be seen in a convex mirror -
(A) Under no circumstances
(B) When object is very far from the mirror
(C) When the object is at a distance equal to the radius of the mirror
(D) When the object is at a distance equal to the focal length of the mirror
- Q.57** A point source is placed 15 cm away from a convex mirror. A virtual image is formed at a distance of 6 cm. The radius of curvature of the mirror is -
(A) 4.3 cm (B) 8.6 cm
(C) 10 cm (D) 20 cm
- Q.58** A boy of height 1 m stands in front of a convex mirror. His distance from the mirror is equal to its focal length. The height of his image is -
(A) 0.25 m (B) 0.33 m
(C) 0.5 m (D) 0.67 m
- Q.59** A convex mirror has a focal length f . A real object is placed at a distance f in front of it from the pole, produces an image at -
(A) infinity (B) f
(C) $f/2$ (D) $2f$
-