



PHYSICS

BOOKS - RESNICK AND HALLIDAY

PHYSICS (HINGLISH)

GEOMETRICAL OPTICS : REFLECTION

Sample Problem

1. A pole and its shadow have same length, find the angle of the sun ray made with the earth at

that time.



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2. Find the deviation of the ray after two reflections as shown in Fig. 33.10.

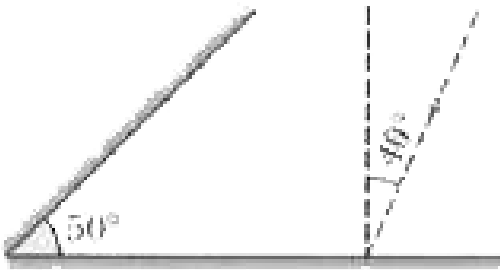
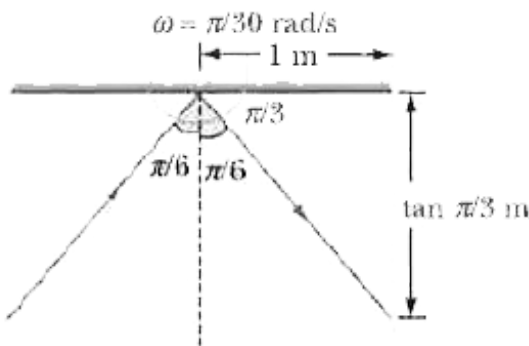


Figure 33.10 Two plane mirrors are inclined at an angle to each other. A ray is incident on one of the mirrors.

3. A light ray is incident on a mirror rotating with a constant angular velocity of $\frac{\pi}{30}$ rad/s in the anticlockwise direction. This light ray is reflected from the mirror and falls on a wall nearby as shown in Fig. 33-12. Find the location of the spot on the wall and its velocity after 5 s.

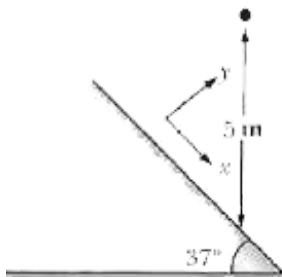


Ray incident on a rotating mirror.

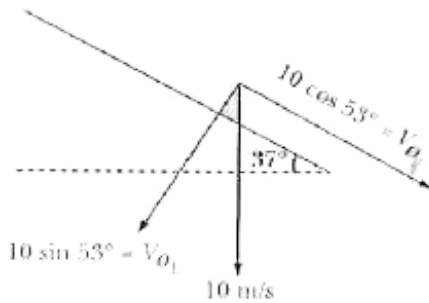


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4. Find the velocity of image and the object in the vector form when the ball is just about to hit the inclined plane as shown in Fig. 3-20a. The inclined plane is at an angle of 37° to the horizontal. The surface of the inclined plane acts like a mirror.



(a)



(b)

(a) An object is dropped from a height on an inclined mirror. (b) Resolving the velocity of the object in a direction parallel to an perpendicular to the mirror.



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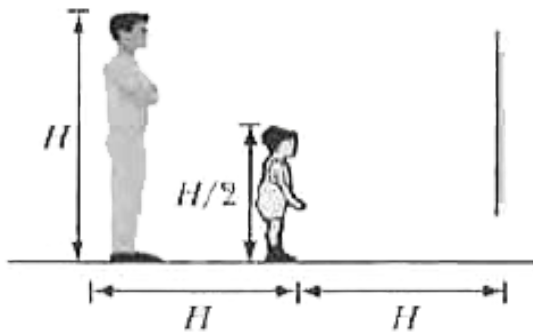
5. An object is at a distance of 0.5 in front of a plane mirror. Distance between the object and image is



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6. Find the minimum length of the mirror required so that the boy can see the image of himself as well as his father standing behind.

The father is of height H and the boy is of height $\frac{H}{2}$ (Fig 33-26). Assume that the eyes of the boy are at his head.



A boy standing in front of a mirror such that he can see his own image as well as his father's image.



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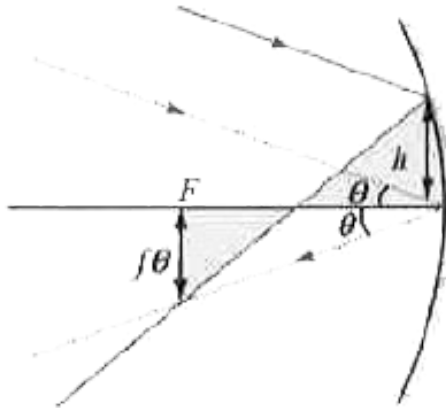
7. An object of height h is held before a spherical mirror of focal length $|f| = 40\text{cm}$.

The image of the object produced by the mirror has same orientation as the object and has $height = 0.2h$. Is the image real or virtual ? Is the image on the convex or concave? What is focal length of mirror with proper sign?



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8. A light ray is incident on a concave mirror at an angle θ at a height h above the principal axis as shown in Fig. 33-43. Find the angle of deviation of the ray after reflection.



Finding the path of a ray incident on a concave mirror. We draw an imaginary ray parallel to it incident at the pole for visualizing the image.





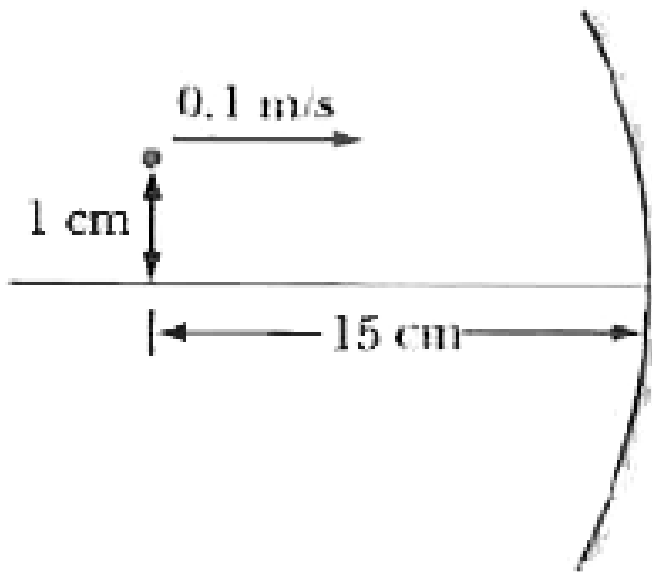
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9. An L -shaped object with dimensions 1 cm each is kept on the principal axis of a concave mirror of focal length 10 cm as shown in Fig 33-45. Its edge is 15 cm away from the pole. Find the location, shape and size of the image.



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10. An object is traveling toward a concave mirror of focal length 10 cm. It moves with a velocity of 0.1 m/s parallel to the principal axis (Fig. 33-46). When it is at a distance of 15 cm from the mirror at a height of 1 cm from the principal axis, find the velocity of image in x and y direction?



An object is moving parallel to the principal axis with a speed of 10 cm/s.



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11. A mirror is broken into two parts and these parts are separated by a distance of 1 cm as

shown in Fig. 33-47. Find the location of the images formed by the two parts of mirror. The object is midway between the two principal axes(Fig. 33-47)



A point object is kept midway between the principal axes of the two parts of the mirror. For the upper mirror, the object is below the principal axis and for the lower mirror, the object is above the principal axis.



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Checkpoint

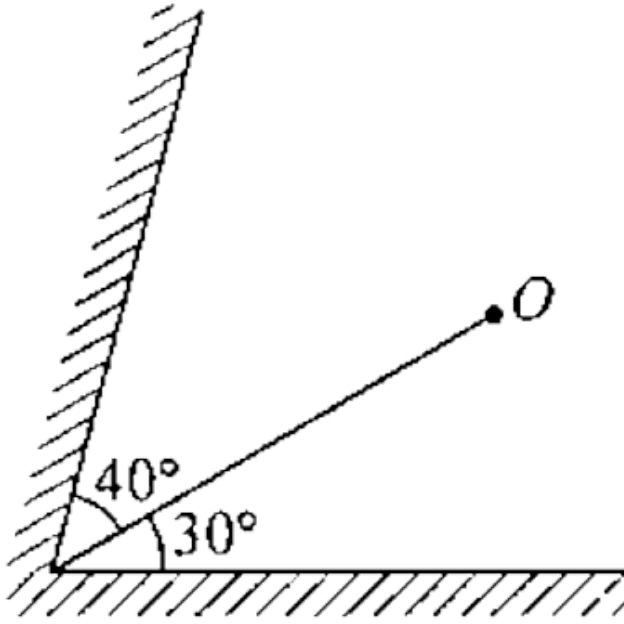
1. Two plane mirrors are placed perpendicular to each other. A ray strikes one mirror and after reflection falls on the second mirror. The ray after reflection from the second mirror will be



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2. Two plane mirrors are inclined at an angle of 70° to each other. Find the total number of images formed when object is placed as shown.

In figure-. Total images = 5



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3. एक वस्तु 30 सेमी फोकस-दूरी वाले अवतल लेन्स के फोकस पर स्थित है। प्रतिबिम्ब कहाँ बनेगा ?



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4. A converging lens of focal length 20 cm is placed between an object & a concave mirror of focal length 10 cm as shown in figure. The final image is: (A) Coinciding with object enlarged, inverted, real (B) Coinciding with object same size, erect, real (C) Coinciding with object same size, inverted, virtual (D) Coinciding with object same size, inverted, real



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5. Of the three types of mirrors: plane, concave, and convex,

(a) which will have larger field of view, if aperture of all the three mirrors is the same?

(b) Can you think of a practical application of this?



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Problems

1. A small object is placed 10 cm in front of a plane mirror. If you stand behind the object 30 cm from the object and look at its image, the distance focused for your eye will be



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2. A car travels at a speed of 80 km/h during the first half of its running time and at 40 km/h during the other half. Find the average speed of the car. (60 km/h)



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3. An object is moving towards a concave mirror of focal length 24 cm. When it is at a distance of 60 cm from the mirror, its speed is $9\text{ cm} / \text{s}$. The speed of its image at that instant, is



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4. A ray of light makes an angle of 10° with the horizontal and strikes a plane mirror which is inclined at an angle θ to the horizontal. The

angle θ for which the reflected ray becomes vertical, is



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5. Two plane mirrors are placed parallel to each other and 40 cm apart. An object is placed 10 cm from one mirror .What is the distance from the object to the image for each of the five images that are closest to the object?



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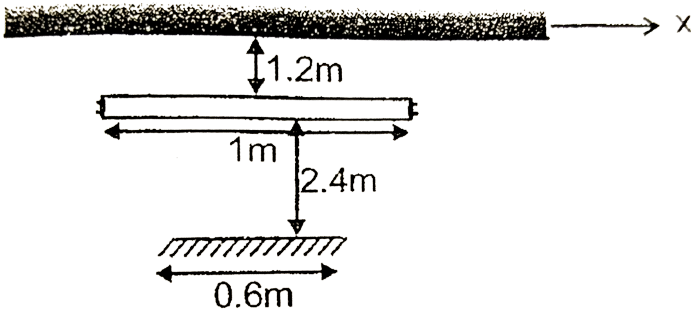
6. Two plane mirrors are inclined at an angle of 72° . The number of images of a point object placed between them will be



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7. A fluorescent lamp of length $1m$ is placed horizontally at a depth of $1.2m$ below a ceiling. A plane mirror of length $0.6m$ is placed below the lamp parallel to and symmetric to the lamp at a distance $2.4m$ from it as shown in figure. Find the length in meters (distance between

the extreme points of the visible region along x -axis) of the reflected patch of light on the ceiling.



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8. A concave mirror forms an image of 20 cm high object on a screen placed 5.0 m away from the mirror. The height of the image is 50 cm.

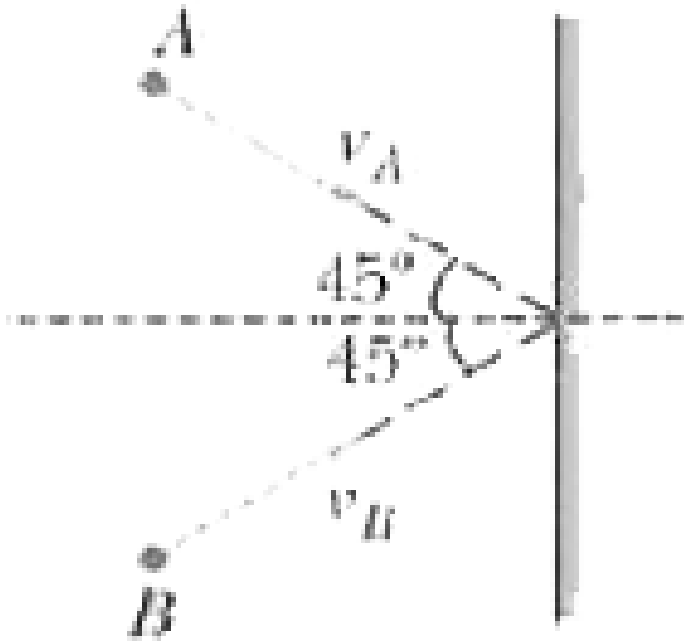
Find the focal length of the mirror and the distance between the mirror and the object.



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9. Two bodies A and B are moving toward a plane mirror with speed v_A and v_B respectively, as shown in Fig. 33-49. What is the speed of

image of A with respect to the body B?



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10. A concave shaving mirror has a radius of curvature of 35.0cm . It is positioned so that the

(upright) image of man's face is 2.50 times the size of the face. How far is the mirror from the face ?



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11. An object is 30.0 cm from a spherical mirror along the central axis. The absolute value of lateral magnification is $\frac{1}{2}$. The image produced is inverted. What is the focal length of the mirror?



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12. The image of a candle flame placed at a distance of 30 cm from a mirror is formed on a screen placed in front of the mirror at a distance of 60 cm from its pole. What is the nature of the mirror ? Find its focal length. If the height of the flame is 2.4 cm, find the height of its image. State whether the image formed is erect or inverted.



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13. A converging beam of light rays is incident on a concave spherical mirror whose radius of curvature is $0.8m$. Determine the position of the point on the optical axis of the mirror where the reflected rays intersect, if the extensions of the incident rays intersect the optical axis $40cm$ from the mirror's pole.



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14. An object is placed in front of a concave mirror, a three times magnified image is formed.

If the object is moved through a distance 20 cm towards the mirror, a virtual image of same magnification is formed. What is the focal length of the mirror?



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15. A concave shaving mirror has a radius of curvature of 35.0cm . It is positioned so that the (upright) image of man's face is 2.50 times the size of the face. How far is the mirror from the face ?



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16. The sun (diameter d) subtends an angle θ radian at the pole of a concave mirror of focal length f . Determine the diameter of the image of the sun formed by the mirror.



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17. A small piece of wire bent into an L shape, with upright and horizontal portions of equal lengths, is placed with the horizontal portion

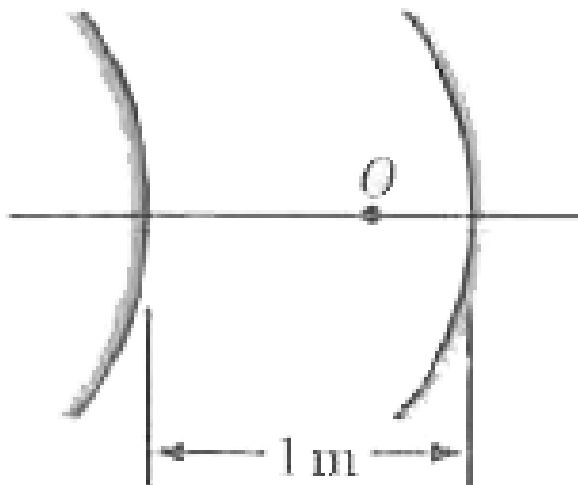
along the axis of the concave mirror whose radius of curvature is 10cm. If the bend is 20cm from the pole of the mirror, then the ratio of the lengths of the images of the upright and horizontal portions of the wire is



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18. Two spherical mirrors (convex and concave) having the same focal length of 36 cm are arranged so that their optical axes coincide. The separation between the mirrors is 1 m (Fig 33-50). At what distance from the concave mirror

should an object be placed so that its images formed by the concave and convex mirror independently are identical in size?



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19. A point source of light is 60cm from a screen and is kept at the focus of a concave mirror which reflects light on the screen. The focal length of the mirror is 20cm . The ratio of average intensities of the illumination on the screen when the mirror is present and when the mirror is removed is:



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20. An object is placed exactly midway between a concave mirror of $R = 40\text{cm}$ and a convex

mirror of $R = 30\text{cm}$. The mirrors face each other and are 50cm apart. Determine the nature and position of image formed by successive reflections first at concave mirror and then at convex mirror.



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21. A police inspector in a jeep is chasing a pickpocket on a straight road. The jeep is going at its maximum speed v (assumed uniform). The pickpocket rides on the motorcycle of a waiting friend when the jeep is at a distance of a

waiting friend when the jeep is at a distance d away, and the motorcycle starts with a constant acceleration a . Show that the pickpocket will be caught if $v \geq \sqrt{2ad}$.



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22. A real point source is 5cm away from a plane mirror whose reflecting ability is 50% , while the eye of an observer (pupil diameter 5mm) is 10cm away from the mirror. Assume that both source and eye are on the same line

perpendicular to the surface and refracted rays have no effect on intensity. Then,



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23. Two rays are incident on a spherical mirror of radius $R = 5 \text{ cm}$ parallel to its optical axis at distances $h_1 = 0.5 \text{ cm}$ and $h_2 = 3 \text{ cm}$. Determine the distance Δx between the points at which these rays intersect the optical axis after being reflected at the mirror.



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24. A small block of mass m and a concave mirror of radius R fitted with a stand lie on a smooth horizontal table with a separation d between them. The mirror together with its stand has a mass m . The block is pushed at $t = 0$ towards the mirror so that it starts moving towards the mirror at a constant speed V and collides with it. The collision is perfectly elastic. Find the velocity of the image (a) at a time $t < \frac{d}{V}$, (b) at a time $t > \frac{d}{V}$.



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Practice Questions Single Correct Choice Type

1. An object is moving towards a stationary plane mirror with a speed of 2 m/s. Velocity of the image w.r.t. the object is

A. $5 \frac{km}{h}$

B. $-\frac{5km}{h}$

C. $10 \frac{km}{h}$

D. $-10 \frac{km}{h}$

Answer: B



2. समतल दर्पण के सामने 10 सेमी दूरी पर 5 सेमी लम्बी वस्तु रखी गयी है। दर्पण द्वारा बने वस्तु के प्रतिबिम्ब की लम्बाई बताइए।

A. $(0.2)m$

B. $(0.5)m$

C. $(0.1)m$

D. $1m$

Answer: B



3. On the axis of a spherical mirror of focal length f a short linear object of length L lies on the axis at a distance μ from the mirror. Its image has an axial length L' equal to

A. $L \left[\frac{f}{u - f} \right]^{\frac{1}{2}}$

B. $L \left[\frac{u + f}{f} \right]^{\frac{1}{2}}$

C. $L \left[\frac{u - f}{f} \right]^2$

D. $L \left[\frac{f}{u - f} \right]^2$

Answer: D



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4. A plane mirror is approaching you at a speed of 10 cm/sec . You can see your image in it. At what speed will your image approach you

A. $+ 10\frac{\text{cm}}{\text{s}}$

B. $- 10\frac{\text{cm}}{\text{s}}$

C. $+ 20\frac{\text{cm}}{\text{s}}$

D. $- 20\frac{\text{cm}}{\text{s}}$

Answer: B



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5. To get three images of a single object, one should have two plane mirrors at an angle of

A. 60°

B. 90°

C. 120°

D. 30°

Answer: B



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6. A ray of light is incident on a plane mirror along a vector $\hat{i} + \hat{j} - \hat{k}$.

The normal on incidence point is along $\hat{i} + \hat{j}$

.Find a unit vector along the

reflected ray.

A. $-\frac{1}{\sqrt{19}} \left(-3\hat{i} + 3\hat{j} + \hat{k} \right)$

B. $\frac{1}{\sqrt{19}} \left(3\hat{i} + 3\hat{j} - \hat{k} \right)$

C. $-\frac{1}{\sqrt{19}}(\hat{i} + \hat{j} + \hat{k})$

D. \hat{k}

Answer: C



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7. A bullet of mass $50g$ is fired from a gun of mass $6kg$ with a velocity of $400m/s$. Calculate the recoil velocity of the gun.

A. $\left(1 + \frac{m_2}{m_1}\right)$

B. $\left(\frac{m_1 + m_2}{m_1}\right)v$

C. $\left(\frac{2m_1 + m_2}{m_1}\right)v$

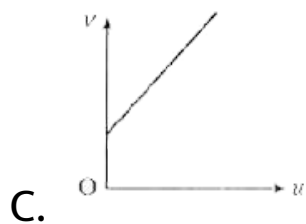
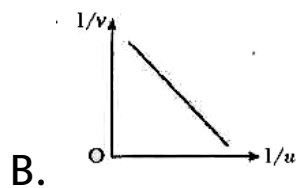
D. None of these

Answer: C



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8. इनमें से कौन एक गोलीय सतह पर अपवर्तन के लिए $\frac{1}{v}$ तथा $\frac{1}{u}$ के बीच ग्राफ हो सकता है ?



D. 

Answer: B



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9. An object placed in front of a concave mirror of focal length 0.15 m produces a virtual image, which is twice the size of the object. The position of the object with respect to the mirror is

A. -5.5cm

B. -6.5cm

C. -7.5cm

D. -8.5cm

Answer: C



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10. A watch shows time as 3:25 when seen through a mirror, time appeared will be

A. 8:35

B. 9:35

C. 7:35

D. 8:25

Answer: C



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11. A convex mirror and a concave mirror of radius 10cm each are placed 15cm apart facing each other. An object is placed midway between them. If the reflection first takes place in the concave mirror and then in convex mirror, the position of the final image is

- A. On the pole of the convex mirror
- B. On the pole of the concave mirror
- C. At a distance of 10 cm from convex mirror
- D. At a distance of 5 cm from concave mirror

Answer: A



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12. Two plane mirrors are inclined to each other at an angle 60° . If a ray of light is incident on the first mirror parallel to the second mirror, it is reflected from the second mirror

- A. Perpendicular to the first mirror
- B. Parallel to the first mirror
- C. Parallel to the second mirror

D. Perpendicular to the second mirror

Answer: B



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13. A plane mirror is placed at origin parallel of y-axis, facing the positive x-axis. An object starts from $(2\text{m}, 0, 0)$ with a velocity of $(2\hat{i} + 2\hat{j})\text{m/s}$. The relative velocity of image with respect to object is along

A. Positive x axis

B. Negative x axis

C. Positive y axis

D. Negative y axis

Answer: B



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14. The number of roamn capital letters such as A,B,C,D... Which are not laterally inverted by a plane mirror is

A. 6

B. 7

C. 11

D. 13

Answer: C



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15. You are standing upright in a room in front of a vertical mirror. In this mirror, you can see from your position only the upper two - third of

your body. You wish to see the entire length of your body reflected in the mirror. Which combination of the following three courses of action will achieve this?

(I) Move away from the mirror

(II) Move toward the mirror

(III) Use a mirror whose height will allow you to see your whole image.

A. (I) Only

B. (II) Only

C. (III) Only

D. Either (I) or (III)

Answer: C



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16. Two plane mirrors are placed parallel to each other at a distance L apart. A point object O placed between them, at a distance $\frac{L}{3}$ from one mirror. Both mirrors form multiple images. The distance between any two images cannot be

A. $\frac{3L}{2}$

B. $\frac{2L}{3}$

C. $2L$

D. None of these

Answer: A



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17. The light reflected by a plane mirror may form a real image

A. If rays incident on the mirror are converging

B. If the rays incident on the mirror are diverging

C. If the object is placed very close to the mirror

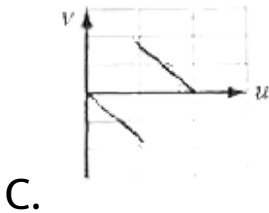
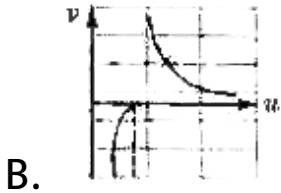
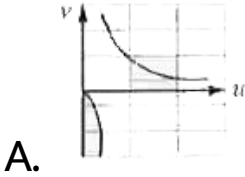
D. Under no circumstances

Answer: A

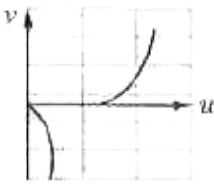


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18. As the position of an object (u) reflected from a concave mirror is varies, the position of the image (v) also varies. By letting the u changes from 0 to $+\infty$ the graph between v versus u will be



D.



Answer: A

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19. You walk slowly toward a large concave mirror. At first, you see your inverted image moving toward you. After you pass a certain point, you no longer see your image clearly. Moving still closer, you see a clear, enlarged and erect image of yourself behind

the mirror. During the time when you cannot see a clear image

A. you are closer to the mirror than the focal point and the image is now virtual and invisible

B. You are between the center of curvature and the focal point, and the image is now behind you

C. You are between the centre of curvature and the focal point, and the image is now

virtual and invisible

D. You are closer to the mirror than the focal point and the image is now behind you

Answer: D



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20. What can be the largest distance of an image of a real object from a convex mirror of radius of curvature 20 cm

A. 10 cm

B. Infinity

C. 20 cm

D. None

Answer: A



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21. A particle moves toward a concave mirror of focal length 30 cm along its axis and with a constant speed of $\frac{4\text{cm}}{s}$. What is the speed of

its image when the particle is at 90 cm from the mirror?

A. $\frac{2cm}{s}$

B. $\frac{8cm}{s}$

C. $\frac{1cm}{s}$

D. $\frac{4cm}{s}$

Answer: C



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

A. Real and will remain at C

B. Real and located at a point between C and

∞

C. Virtual and located at a point between C

and O .

D. Real and located at a point between C and

O.

Answer: D



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23. Statement - 1 : The formula connecting u , v and f for a spherical mirror is valid only for mirrors whose sizes are very small compared to their radii of curvature. Because

Statement - 2 : Laws of reflection are strictly

valid for plane surfaces, but not for large spherical surfaces.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for statement-1.

B. Statement-1 is True, Statement-2 is True, Statement-2 is not a correct explanation for statement-1.

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True.

Answer: C



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24. An object is placed near two perpendicular plane mirrors as shown in the figure. How many images will be formed?

width="80%">

A. 1

B. 2

C. 3

D. 4

Answer: C



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25. Daniel walks directly toward a plane mirror at a speed of $0.25 \frac{m}{s}$. Determine the speed of the image relative to him.

A. $0.13 \frac{m}{s}$

B. $0.50 \frac{m}{s}$

C. $0.25 \frac{m}{s}$

D. $0.75 \frac{m}{s}$

Answer: B



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26. Which one of the following statements concerning a convex mirror is true?

A. A convex mirror can form a real image.

B. A convex mirror must be spherical in shape.

C. The image produced by a convex mirror will always be inverted relative to the object.

D. The image a convex mirror produces is closer to the mirror than it would be in a plane mirror for the same object distance.

Answer: D



27. An object is placed 30.0 cm from a convex spherical mirror with radius of curvature 40.0 cm. Which one of the following phrases best describes the image?

- A. Virtual and located at infinity
- B. Virtual and located 12 cm from the mirror
- C. Real and located 12 cm from the mirror
- D. Virtual and located 17 cm from the mirror

Answer: B



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Practice Questions More Than One Correct Choice Type

1. A student performed the experiment of determination of focal length of a concave mirror by $u - v$ method using an optical bench of length 1.5 meter. The focal length of the mirror used is 24 cm. The maximum error in the

location of the image can be 0.2 cm. The 5 sets of (u, v) values recorded by the student (in cm) are:

$(42, 56)$, $(48, 48)$, $(60, 40)$, $(66, 33)$, $(78, 39)$.

The data set (s) that cannot come from experiment and is (are) incorrectly recorded, is (are)

A. $(42, 56)$

B. $(48, 48)$

C. $(66, 33)$

D. $(78, 39)$

Answer: C::D



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2. 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 anti - parallel 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

Answer: A::D



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3. A plane mirror, reflecting a ray of incident light, is rotated through an angle θ 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 θ

C. The reflected ray rotates through an angle 2θ

D. The incident ray is fixed

Answer: C::D



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4. If a converging beam of light is incident on a concave mirror, the reflected light

- A. May form a real image
- B. Must form a real image
- C. May form a virtual image
- D. May be a parallel beam

Answer: A::C::D



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5. A point object P moves towards a convex mirror with a constant speed v , along its optic axis. The speed of the image

A. Is always less than v

B. May be greater than and equal to v or less than v depending on the position of P

C. Increases as P comes closer to the mirror

D. Decreases as P comes closer to the mirror

Answer: A::C



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6. Two concave mirrors of the same focal length f are kept facing each other. A point source is kept symmetrically between them. What should be the distance between them so that only one image is formed at the source?

A. f

B. $2f$

C. $3f$

D. $4f$

Answer: B::D



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Practice Questions Linked Comprehension

1. A 3.0 cm object is placed 8.0 cm in front of a mirror. The virtual image is 4.0 cm further from the mirror when the mirror is concave than when it is planar.

Determine the focal length of the concave mirror.

A. 6.0 cm

B. 24 cm

C. 12 cm

D. 48 cm

Answer: B



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2. A 3.0 cm object is placed 8.0 cm in front of a mirror. The virtual image is 4.0 cm further from the mirror when the mirror is concave than

when it is planar. Determine the image height in the concave mirror.

A. 0.5

B. 4.5

C. 1.5

D. 3.0

Answer: B



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Practice Questions Integer Type

1. A girl with two normal eyes want to see full width of her face by a plane mirror. The eye- to - eye and ear- to -ear distances of her fave are 10 cm and 14 cm, respectively. Find the minimum width of required mirror.



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2. A man stands in front of a large vertical plane mirror. His height is 1.8 m. The distance of image from the man is 4 m. At what distance is the man standing from the mirror?



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3. A man wants to distinguish between two pillars located at a distance of 11km . What should be the minimum distance between the pillars ?



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