Section A

I. Multiple Choice Questions:

1. Which of the following is NOT a property of light?

a) Light travels in a straight line
b) Light is a form of energy
c) Light travels faster in water than in air
d) Light can be reflected

Answer: c) Light travels faster in water than in air

Explanation: Light actually travels slower in water than in air. The speed of light is reduced when it passes through a denser medium like water.

2. What image is formed by a concave mirror when an object is placed beyond its focus?

a) Virtual, erect, and diminished
b) Virtual, inverted, and magnified
c) Real, inverted, and diminished
d) Real, inverted, and magnified

Answer: d) Real, inverted, and magnified

Explanation: When an object is placed beyond the focus of a concave mirror, the image formed is real, inverted, and magnified.

3. A convex mirror always forms an image that is:

a) Real, inverted, and diminished
b) Real, erect, and magnified
c) Virtual, erect, and diminished
d) Virtual, inverted, and magnified

Answer: c) Virtual, erect, and diminished

Explanation: A convex mirror always forms a virtual, erect, and diminished image, regardless of the position of the object.

4. What is dispersion of light?

a) Splitting of light into its components
b) Reflection of light on a surface
c) Refraction of light through a prism
d) Absorption of light by an object

Answer: a) Splitting of light into its components

Explanation: Dispersion is the process by which light splits into its component colors (spectrum) when passed through a prism. This occurs because different colors of light have different wavelengths and thus refract by different amounts.

5. What type of mirror is used in car headlights to produce a parallel beam of light?

a) Concave mirror b) Convex mirror c) Plane mirror d) None of the above

Answer: a) Concave mirror

Explanation: Concave mirrors are used in car headlights because they can focus the light rays and reflect them as a parallel beam, helping to illuminate the road ahead.

6. What happens when light passes through a convex lens?

a) It bends away from the optical axis
b) It bends toward the optical axis
c) It passes through without bending
d) It forms a virtual image at infinity

Answer: b) It bends toward the optical axis

Explanation: A convex lens converges light rays that are parallel to its optical axis. This causes the rays to bend towards the optical axis.

7. A rainbow is formed due to:

a) Reflection of light
b) Refraction and dispersion of light
c) Scattering of light
d) Absorption of light

Answer: b) Refraction and dispersion of light

Explanation: A rainbow is formed when sunlight is refracted and dispersed through water droplets in the atmosphere. The light is split into its component colors due to different wavelengths of light bending by different amounts

8. The color of an object is determined by:

a) The wavelength of light it absorbs
b) The color of light it reflects
c) The color of light it emits
d) The wavelength of light it refracts

Answer: b) The color of light it reflects

Explanation: The color of an object depends on the light it reflects. For example, a red object appears red because it reflects the red wavelengths of light and absorbs others

9. Which type of mirror is used in rear-view mirrors of vehicles?

a) Concave mirror
b) Convex mirror
c) Plane mirror
d) None of the above

Answer: b) Convex mirror

Explanation: Convex mirrors are used in rear-view mirrors because they provide a wide field of view and form smaller, virtual images, making it easier to see more of the area behind the vehicle.

10. Which of the following is true for a plane mirror?

a) It forms a real and inverted image
b) It forms a real and upright image
c) It forms a virtual and upright image
d) It forms a virtual and inverted image

Answer: c) It forms a virtual and upright image

Explanation: A plane mirror forms a virtual, upright image that is the same size as the object. The image appears behind the mirror.

11. In which of the following mediums does light travel the fastest?

a) Air b) Water c) Glass d) Vacuum

Answer: d) Vacuum

Explanation: Light travels fastest in a vacuum because there are no particles to slow it down. In other mediums like air, water, or glass, light is slowed down due to their different refractive indices.

12. What type of mirror is used in a magnifying mirror for shaving or makeup?

a) Concave mirror
b) Convex mirror
c) Plane mirror
d) None of the above

Answer: a) Concave mirror

Explanation: A concave mirror is used in magnifying mirrors because it converges light and forms a magnified, virtual, and upright image, making objects appear larger.

13. Which of the following will cause a decrease in the intensity of light as it travels?

a) Reflection b) Scattering c) Refraction d) Dispersion

Answer: b) Scattering

Explanation: Scattering causes the light to spread out, reducing its intensity. It occurs when light interacts with small particles in the medium, causing it to deviate in different directions.

14. Which of the following best describes the nature of the image formed by a convex lens when the object is placed beyond 2F (twice the focal length)?

a) Virtual, upright, and magnified
b) Real, inverted, and diminished
c) Real, upright, and magnified
d) Virtual, inverted, and diminished

Answer: b) Real, inverted, and diminished

Explanation: When an object is placed beyond 2F of a convex lens, the image formed is real, inverted, and diminished (smaller in size than the object).

15. Which of the following is true about the focal point of a concave mirror?

a) It is behind the mirror
b) It is in front of the mirror
c) It is at the surface of the mirror
d) It is always at infinity

Answer: b) It is in front of the mirror

Explanation: The focal point of a concave mirror is in front of the mirror. It is the point where parallel rays of light converge after reflection.

16. Which of the following best explains the reason we see the Sun as yellow instead of white?

a) Refraction of sunlight
b) Scattering of sunlight
c) Absorption of sunlight
d) Reflection of sunlight

Answer: b) Scattering of sunlight

Explanation: The scattering of sunlight by the Earth's atmosphere causes shorter wavelengths (blue and violet) to scatter more, leaving the longer wavelengths (yellow, orange, and red) to dominate, making the Sun appear yellow.

17. In a convex lens, if the object is at the focus, where will the image form?

a) At infinity
b) At the focal point
c) At the center of curvature
d) At a distance beyond the focus

Answer: a) At infinity

Explanation: If the object is placed at the focal point of a convex lens, the light rays will be parallel after passing through the lens, forming an image at infinity.

18. What does a convex lens do to parallel light rays?

a) It causes them to converge
b) It causes them to diverge
c) It passes them through without bending
d) It forms a virtual image

Answer: a) It causes them to converge

Explanation: A convex lens converges parallel light rays to a point known as the focal point.

19. What type of lens is used in microscopes?

a) Concave lens b) Convex lens c) Bifocal lens d) Cylindrical lens

Answer: b) Convex lens

Explanation: Microscopes use convex lenses to magnify small objects. The convex lens helps to converge light rays to form a magnified image of the object.

20. What does the term 'focal length' refer to in a lens?

a) The distance between the lens and the object
b) The distance between the lens and the image
c) The distance from the center of the lens to the focal point
d) The distance between the two focal points

Answer: c) The distance from the center of the lens to the focal point

Explanation: The focal length of a lens is the distance from the lens to the focal point, where parallel light rays converge after passing through the lens

21. Which of the following devices uses a concave mirror to focus light?

a) Flashlight
b) Rearview mirror
c) Car side mirror
d) Solar cooker

Answer: d) Solar cooker

Explanation: A solar cooker uses a concave mirror to focus sunlight onto a small area, increasing the intensity of the light and heating the food.

22. Which of the following is responsible for the formation of a mirage?

a) Reflection b) Refraction c) Diffraction d) Dispersion

Answer: b) Refraction

Explanation: A mirage is formed due to the refraction of light as it passes through layers of air at different temperatures, creating the illusion of water or an object in the distance.

23. What is the role of a biconvex lens in a magnifying glass?

a) It diverges light rays
b) It converges light rays to a point
c) It produces a diminished image
d) It reflects light rays

Answer: b) It converges light rays to a point

Explanation: A biconvex lens in a magnifying glass converges light rays to form a magnified, virtual image of an object.

24. Which of the following is true about the image formed by a convex lens when the object is placed between the focal point and the lens?

a) The image is real and diminished
b) The image is virtual and magnified
c) The image is real and magnified
d) The image is virtual and diminished

Answer: b) The image is virtual and magnified

Explanation: When an object is placed between the focal point and a convex lens, the image formed is virtual, upright, and magnified.

25. What type of image does a concave lens form when an object is placed at any distance?

a) Virtual, diminished, and upright
b) Virtual, magnified, and inverted
c) Real, diminished, and upright
d) Real, magnified, and inverted

Answer: a) Virtual, diminished, and upright

Explanation: A concave lens always forms a virtual, diminished, and upright image, regardless of the object's position.

26. What is the focal length of a concave lens?

a) Positive b) Negative c) Zero d) Infinite

Answer: b) Negative

Explanation: The focal length of a concave lens is negative because it diverges light rays, unlike a convex lens that converges light rays.

27. What is the effect of increasing the angle of incidence in refraction?

a) The light ray bends less
b) The light ray bends more
c) The light ray slows down
d) The light ray speeds up

Answer: b) The light ray bends more

Explanation: The larger the angle of incidence, the greater the angle of refraction, causing the light to bend more as it passes into a different medium.

28. What happens when a ray of light strikes a convex mirror at the focal point?

a) The light ray is reflected back to the focus
b) The light ray passes straight through the mirror
c) The light ray diverges and never meets
d) The light ray is reflected parallel to the principal axis

Answer: d) The light ray is reflected parallel to the principal axis

Explanation: When light strikes a convex mirror at the focal point, it is reflected parallel to the principal axis.

29. When light passes through a prism, the angle of deviation depends on:

a) The angle of incidence
b) The thickness of the prism
c) The refractive index of the prism
d) The color of the light

Answer: c) The refractive index of the prism

Explanation: The angle of deviation of light passing through a prism depends on the refractive index of the material and the angle of incidence.

30. The focal length of a convex lens is:

a) Positive b) Negative c) Zero d) Infinite

Answer: a) Positive

Explanation: The focal length of a convex lens is positive because the lens converges light to a focal point.

31. Which of the following types of lens is thicker at the edges than in the middle?

a) Convex lens b) Concave lens c) Biconvex lens d) Plano-convex lens

Answer: b) Concave lens

Explanation: A concave lens is thicker at the edges than in the middle, causing it to diverge light rays.

32. Which of the following is the correct sequence of colors in the visible spectrum, from longest to shortest wavelength?

a) Violet, blue, green, yellow, orange, red
b) Red, orange, yellow, green, blue, violet
c) Green, yellow, orange, red, blue, violet
d) Red, green, blue, yellow, violet, orange

Answer: b) Red, orange, yellow, green, blue, violet

Explanation: The correct order of colors in the visible spectrum is red, orange, yellow, green, blue, and violet, from longest to shortest wavelength.

33. Lateral shift varies inversely to:

a) Wavelength b) Refractive index c) Incident angle d) None of these

Answer: A. Wavelength

34. The twinkling of stars is due to the effect of

a) Refraction b) Reflection c) Absorption d) All of these

Answer: Refraction

Section B

II. Fill in the blanks:

(a) Water is optically_____ than air.

(b) Air is optically _____ than glass.

(c) When a ray of light travels from water to air, it bends _____ the normal.

(d) When a ray of light travels from air to glass, it bends _____the normal.

(e) When white light passes through a prism, it _____.

(f) The splitting of white light into its constituent colors is called _____.

(g) A _____ mirror is obtained on silvering the outer surface of a part of a hollow glass sphere.

(h) Radius of curvature of a spherical mirror is _____its focal length.

(i) The angle of incidence for a ray of light passing through the center of curvature of a spherical mirror is _____.

(j) A _____ mirror always forms a virtual image.

(k) A concave mirror forms a virtual image for an object placed _____.

(l) Bouncing off of light in all directions after falling on an object is called _____.

(m) A rainbow in the sky is a result of the dispersion of light by the drops of water which act like_____

(n) _____ mirror can be used to see a much larger area than the area covered by a plane mirror.

(o) In astronomical telescopes, a larger_____ mirror is used to collect light from objects like stars and planets.

(p) A person 1 m in front of a plane mirror seems to be _____ m away from his image.

(q) If you touch your _____ ear with your right hand in front of a plane mirror, it will be seen in the mirror that your right ear is touched with _____.

Answer:

(a) denser (b) rarer (c) away from (d) towards (e) disperses

(f) dispersion (g) concave (h) two times (i) 0° (j) convex

(k) between pole and focus (l) Reflection (m) prism (n) Convex

(o) concave

(p) 2 meter

Reason: When a person stands in front of a plane mirror, their image appears to be as far behind the mirror as the person is in front of it.

So, when the person is 1 m away from the mirror. His image will be formed at 1 m from the mirror on the other side, hence, his image will be 1 + 1 = 2 m from the person himself.

(q) left, your left hand

Reason — The image formed by a mirror is laterally inverted hence, when we touch our left ear with our right hand in front of a plane mirror, it will be seen in the mirror that our right ear is touched with our left hand.

Section C

III. Short answer questions

Q1. How does the speed of light determine the optical density of a medium?

Answer: A medium is said to be denser if the speed of light in it decreases, while it is said to be rarer if the speed of light in it increases.

Q2. Which is optically denser: water or air? Give reason.

Answer: Water is optically denser than air because speed of light in water (2.25×10^8 m s^{-1}) is less than speed of light in air (3×10^8 m s^{-1}).

Q3. A ray of light falls normally on a glass slab. What is the angle of incidence?

Answer: When a ray of light falls normally on a glass slab the angle between incident ray and normal is 0°. So, the angle of incidence is 0°.

Q4. What is the spectrum and dispersion of light?

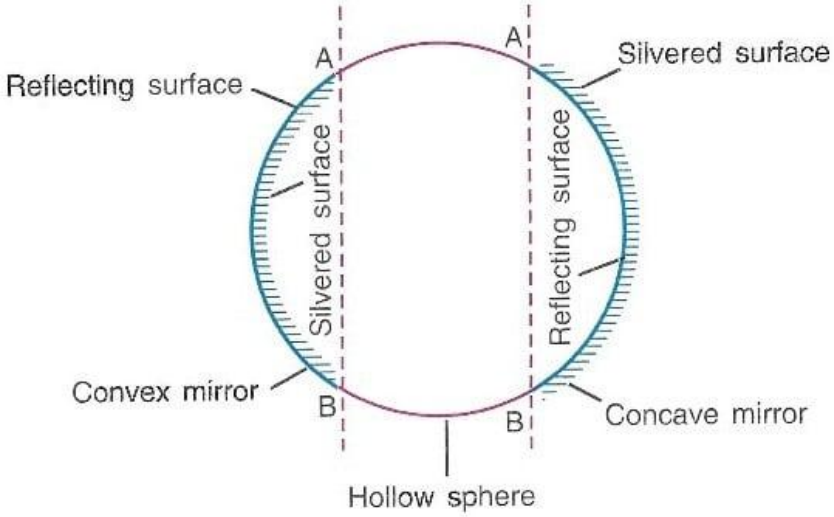
Answer:

Spectrum: When white light passes through a prism, it disperses into a band of seven different colors. This band of colors obtained from the dispersion of light is called a spectrum. Dispersion of light in a prism results in the formation of a spectrum. The various colors present in the spectrum of sunlight are violet, indigo, blue, green, yellow, orange, and red.

Dispersion of light: The splitting of white light into its seven constituent colors.

Q5. What is a spherical mirror?

Answer: A spherical mirror is made by silvering a part of a hollow glass sphere. The surface on which silvering is done is called the silvered surface and the reflection of light takes place from the other surface known as the reflecting surface.



Q6. How is the focal length of a spherical mirror related to its radius of curvature?

Answer: The focal length of a spherical mirror is half of its radius of curvature.

Focal length = $\frac{1}{2}$ x Radius of curvature

Q7. State two uses of a concave mirror.

Answer: The two uses of a concave mirror are:

1. It is used as a shaving mirror.
2. It is used as a doctor's head mirror.

Q8. State two uses of a convex mirror.

Answer: The two uses of a convex mirror are:

1. It is used as a rear-view mirror.
2. It is used as a reflector in street lamps.

Q9. Name the kind of mirror used to obtain:

(a) a real and enlarged image,

(b) a virtual and enlarged image,

(c) a real and diminished image, and

(d) a virtual and diminished image.

Answer:

(a) Concave mirror is used to obtain a real and enlarged image when object is placed between its centre of curvature and focus.

(b) Concave mirror is used to obtain a virtual and enlarged image when object is placed between its focus and pole.

(c) Concave mirror is used to obtain a real and diminished image when object is placed beyond its centre of curvature.

(d) Convex mirror produces a virtual and diminished image.

Q10. What is a real image? What are its characteristics.

Answer. When the rays of light diverging from a point of reflection or refraction actually converge at some other point the image so formed is called real image. Characteristics of real image:

(a) Real image is always inverted.

(b) Real image can be taken on screen.

(c) Real image may be magnified, diminished or be of the same size as the object.

Q11. What is a virtual image? What are its characteristics?

Answer. When the rays of light diverging from a point, after reflection or refraction, appear to diverge from some other point, the image so formed is called virtual image. Characteristics of virtual image:
(a) Virtual images are always erect.

(b) Virtual image cannot be taken on screen.

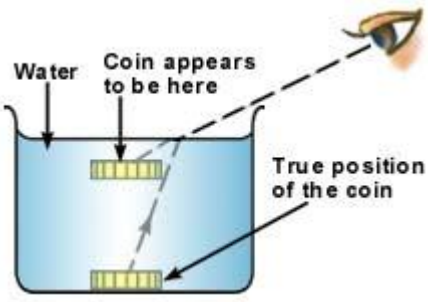
(c) Virtual image may be magnified or diminished or be of the same size as the object.

Q12. Convex Mirror Image Formation

1. **At infinity**
2. **Between infinity and pole of mirror**

Answer:

Position of Object	Position of Image	Size of Image	Nature of Image
At Infinity	At focus F, behind the mirror	Highly Diminished	Virtual and Erect
Between Infinity and Pole of Mirror	Between P and F, behind the mirror	Diminished	Virtual and Erect



Q13. Explain why a coin placed at the bottom of a beaker containing water appears raised.

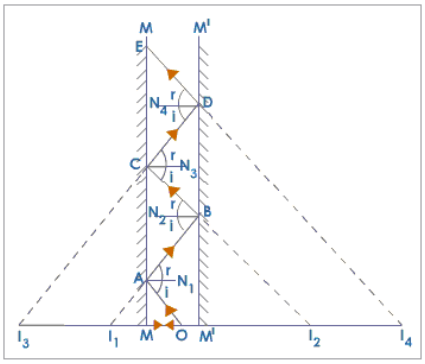
Answer: This occurs due to the phenomenon of refraction of light. Here, the ray of light from the coin travels from a denser medium to a rarer medium. In this process, it bends away from the normal. The point from which the refracted rays appear to come gives the apparent position of the coin.

Q14. Why does the sky at sunset and sunrise appear to be orange-red coloured?

Answer: Because red colour has the longest wavelength in the visible spectrum.

Q15. If we pass a monochromatic ray of light through a prism, will it undergo dispersion and split into constituent colours?

Answer: No, it will not disperse because it's a beam of single wavelength.



Q16. How many images of a candle will be formed if it is placed between two parallel plane mirrors separated by 40 cm?

Answer: When a candle is placed between two parallel plane mirrors, infinite images are formed due to repeated reflections between the mirrors.

Q17. Which type of reflection of light, regular reflection or diffuse reflection, leads to the formation of images?

Answer: Regular reflection leads to the formation of images because the rays are reflected in a particular direction and meet at a point to form an image.

Q18. How are the two plane mirrors in a periscope arranged?

(a) With respect to one another?

(b) With respect to the sides of the tube?

Answer:

(a) The two mirrors are parallel to each other

(b) They make 45 degrees with respect to the sides of the tube.

Q19. What type of lens (convex or concave) is present in the human eye?

Answer: A convex type lens is present in the human eye.

Q20. A wall reflects light and a mirror also reflects light. What difference is there in the way they reflect light?

Answer: The mirror will reflect the light with the same angle of incidence and reflection without any loss of intensity of light. Whereas, after reflecting from a wall, the angle of incidence will not be equal to the angle of reflection and there will be some loss in intensity of light. It will not be a perfect reflection.

Q21. How many images of an object will be formed when the object is placed between two plane mirrors that are inclined at the following angles to one another?

(a) 120° (b) 45° (c) 180° (d) 60° (e) 90°

Answer:

The formula to calculate the no. of images of an object placed between 2 plane mirrors – $(360/\theta) - 1$; where theta is the angle of inclination.

a- 2 (360/120) – 1 = 3 – 1 = 2

b- 7 (360/45) – 1 = 8 – 1 = 7

c- 1 (360/180) – 1 = 2 – 1 = 1

d- 5 (360/60) – 1 = 6 – 1 = 5

e- 3 (360/90) – 1 = 4 – 1 = 3

[The formula to calculate the number of images formed by two plane mirrors is:

- **n = 360/θ - 1**: If (360/θ) is an even integer
- **n = 360/θ**: If (360/θ) is an odd integer and the object is placed asymmetrically
- **n = 360/θ - 1**: If (360/θ) is an odd integer and the object is placed symmetrically
- **If (360/θ) is a fraction, the number of images formed is equal to its integral part**

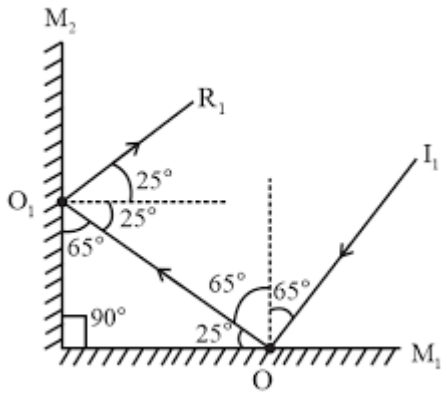
In the formula, θ is the angle between the two mirrors.

If the mirrors are parallel, then θ = 0°, and n = ∞]

Q22. Explain why, when an object is placed between two plane mirrors inclined at an angle, then multiple images are formed.

Answer: When an object is placed between two plane mirrors inclined at an angle, multiple images are formed because of multiple reflections between the mirrors.

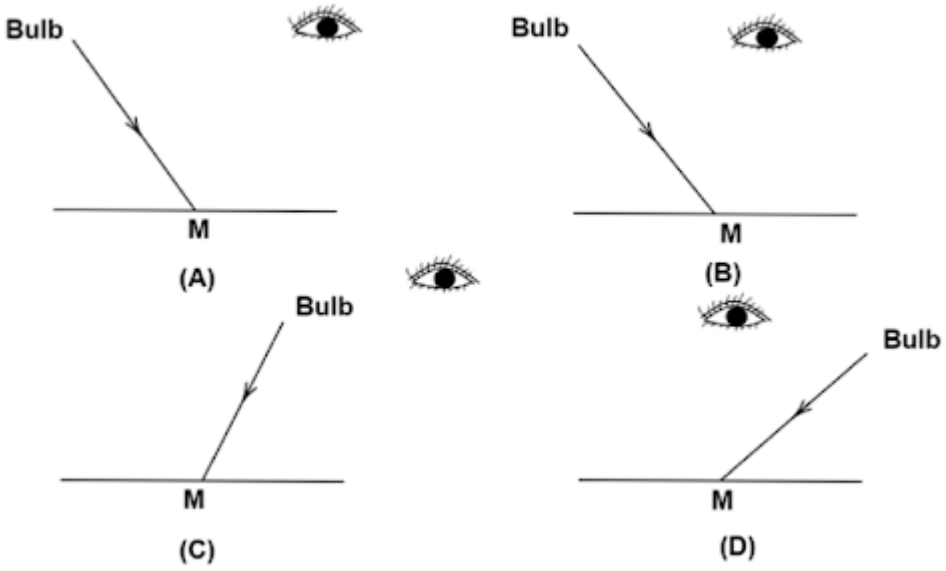
- [**Image formation**: When an object is placed between two mirrors, the image formed by the first mirror acts as an object for the second mirror. This process continues until no more reflection is possible.
- **Number of images**: The number of images formed depends on the angle between the mirrors and is not random.
- **Infinite images**: If two plane mirrors are parallel to each other, light bounces continuously, resulting in an infinite number of images.]



Q23. A ray of light strikes a plane mirror XY at an angle of incidence of 65°, is reflected from this plane mirror and then strikes a second plane mirror YZ placed at right angles to the first mirror. What is the angle of reflection for the mirror YZ?

Answer: Since mirrors XY and YZ are perpendicular, their normals are also perpendicular. Thus when the ray of light strikes off the mirror XY with an angle 65◦, it will incident wth angle 90◦ - 65◦ on mirror YZ, i.e., 25◦. Thus, the angle of reflection for mirror YZ will be 25◦.

Q24. A tiny mirror M is fixed on a piece of cardboard placed on a table. The cardboard is illuminated by light from a bulb. The position of the eye with respect to the position of the bulb is shown in Fig. 16.2 as A, B, C, and D. In which position will the mirror be visible?



Answer: According to the laws of reflection, angle of incidence is equal to the angle of reflection. Hence, option A is the correct answer.

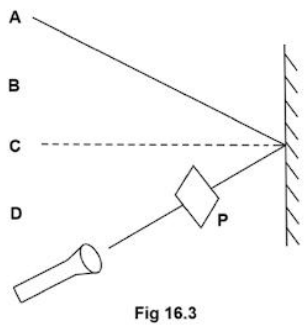
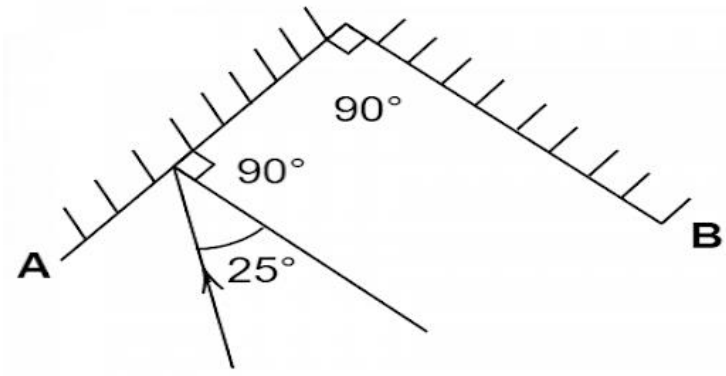


Fig 16.3

Q25. A small hole P is made in a piece of cardboard. The hole is illuminated by a torch as shown in Fig. 16.3. The pencil of light coming out of the hole falls on a mirror. At which point should the eye be placed so that the hole can be seen?

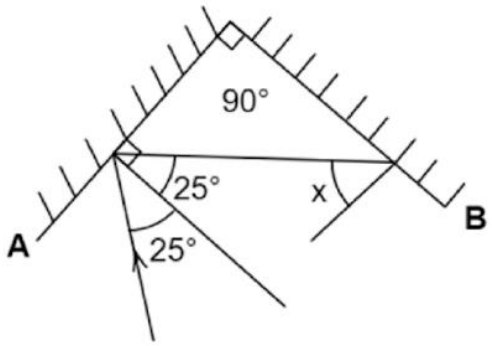
a) A b) B c) C d) D

Answer: The eye should be placed at position A as the angle of incidence is equal to the angle of reflection.



Q26. Two mirrors A and B are placed at right angles to each other as shown in Fig. 16.4. A ray of light incident on mirror A at an angle of 25° falls on mirror B after reflection. The angle of reflection for the ray reflected from mirror B would be

a) 25^0 b) 50^0 c) 65^0 d) 115^0



Answer: c) 65^0

Both the mirrors are inclined to each other at 90^0. This means that the normal of both the mirrors will also be perpendicular to each other. We know that the angle of incidence is equal to the angle of reflection. Hence, the angle made by a reflected ray with normal is 25^0.

Hence, $x + 25^0 = 90^0$

$X = 90^0 - 25^0 = 65^0$

Q27. The distance between the object and its image formed by a plane mirror appears to be 24 cm. What is the distance between the mirror and the object?

Answer: The distance between the object and the image includes the distance between the image and mirror and the distance between the object and mirror. In the case of a plane mirror, the distance between the plane mirror and the object is equal to the distance between the plane mirror and the image. Let the distance from the image to the mirror be x.

Then, the distance from the object to the mirror is also x.

So, x + x = 24cm

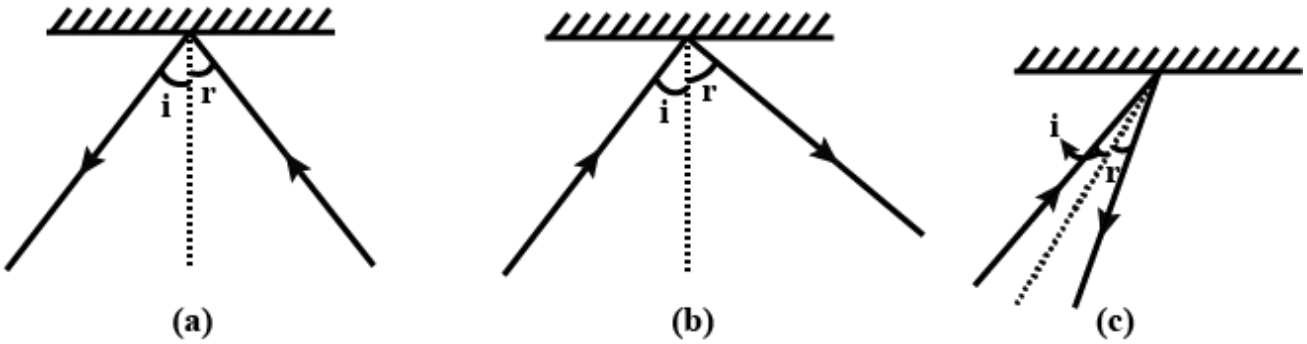
x = 12 cm

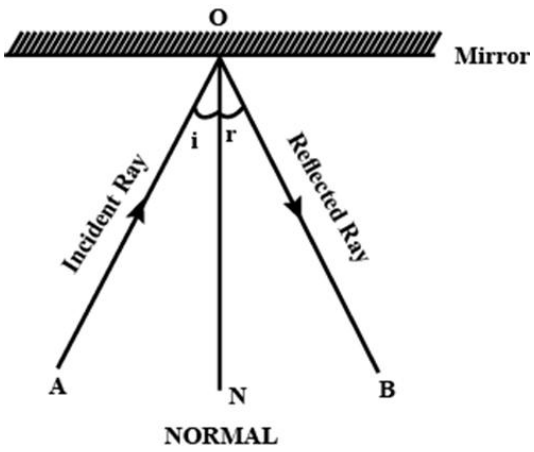
Hence, the distance between the mirror and the object is 12 cm.

Q28. Look at Fig. 16.7. Can the image of the child in it be obtained on a screen?

Answer: Images formed in a plane mirror are virtual. Virtual images cannot be obtained on a screen. Therefore, it is not possible to obtain the image of a child on a screen.

Q29. There is a mistake in each of the following ray diagrams given as Fig. 16.9 a, b, and c. Make the necessary correction(s).

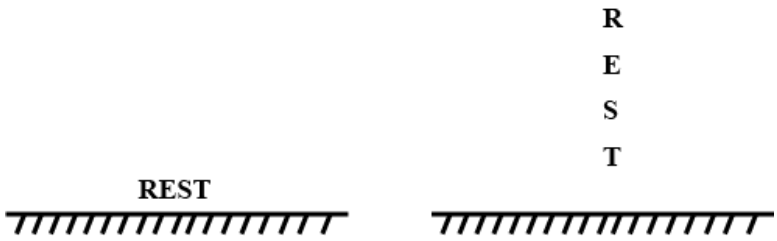




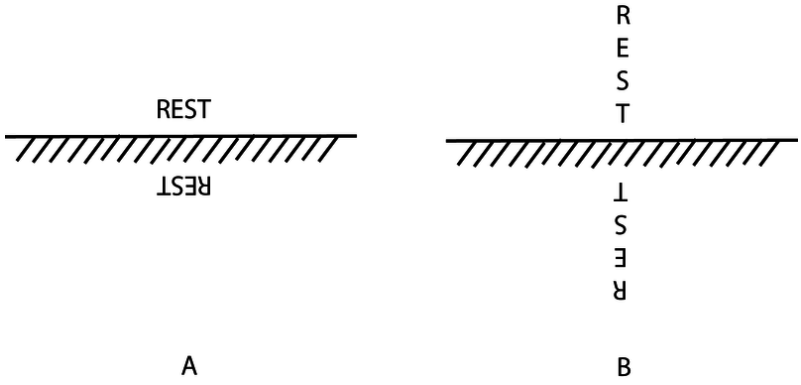
Answer: The angles are labelled wrongly in diagram (a). The angle of reflection is labelled as angle of incidence and vice versa. In diagram (b), the law of reflection is not followed as angle of reflection and angle of incidence are not equal in measure. The normal drawn is not perpendicular to the surface in diagram (c).

The corrected ray diagram is as shown below.

Q30. Fig. 16.10 shows the word REST written in two ways in front of a mirror. Show how the word would appear in the mirror.



Answer:



Section D

IV. Long Answer Question:

Q1. Concave Mirror Image Formation

1. When the object is placed at infinity

2. When the object is placed beyond C (centre of curvature)

3. When the object is placed at C

4. When the object is placed between C and F (principal focus)

5. When the object is placed at F

6. When the object is placed between F and P (pole)

Answer: Image Formation Tabular Data

Position of the Object	Position of the Image	Size of the Image	Nature of the Image
At infinity	At focus, F	Highly diminished and pointed in size	Inverted and real
Beyond C	Between F and C	Diminished	Inverted and real
At C	At C	Same size	Inverted and real
Between C and F	Beyond C	Enlarged	Inverted and real
At F	At infinity	Highly enlarged	Inverted and real
Between F and P	Behind the mirror	Enlarged	Erect and virtual

Q2. Give reasons for the following.

1. It is difficult to place a test-tube over an erect pencil looking at it through a glass slab.

2. Light bends towards the normal when it travels from air to water.

3. The dispersion of light occurs when it is passed through a prism

Answer

1. When a ray of light travels from one medium to another, it changes its path. So the correct position of the pencil is not seen through a glass slab. So it is difficult to place a test tube over an erect pencil while looking at it though a glass slab.

2. Since air is less dense than water, so light bends towards the normal when it travels from air to water.

3. The dispersion of light occurs when it passes through a prism because the different colours are refracted through different angles by a prism.

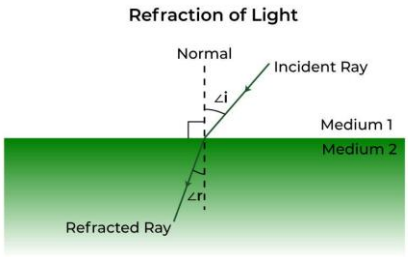
Q3. Differentiate between reflection of light and refraction of light.

Answer: The main difference between reflection and refraction of light is that reflection is when light bounces off a surface, while refraction is when light bends as it passes through a material:

- Reflection

Light bounces back when it hits a surface. This is why images appear in mirrors and other smooth, shiny surfaces. The color of an object is the wavelengths of light that are reflected, while the other wavelengths are absorbed.

- Refraction



Light changes direction, or bends, as it passes from one material to another. Refraction is often observed when light passes through transparent materials like water, glass, or lenses.

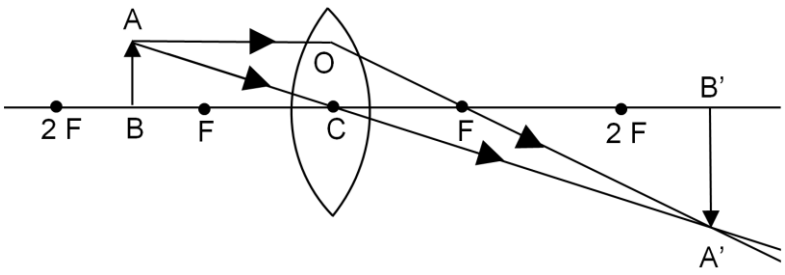
Q4. State the characteristics of an image and draw a neat diagram when:

(a) The object is between F and 2F in the case of a convex lens.

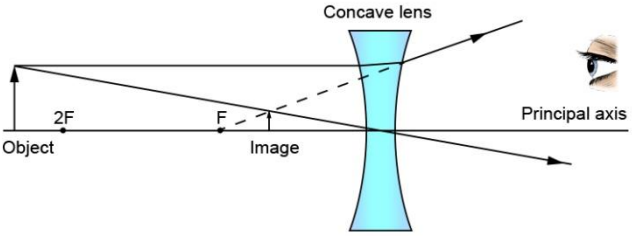
(b) Object is beyond 2F in the case of a concave lens.

Answer:

(a) The object is between F and 2F in the case of a convex lens.: Image is



1. Real
2. Magnified
3. Inverted
4. Formed beyond 2F on the other side of lens

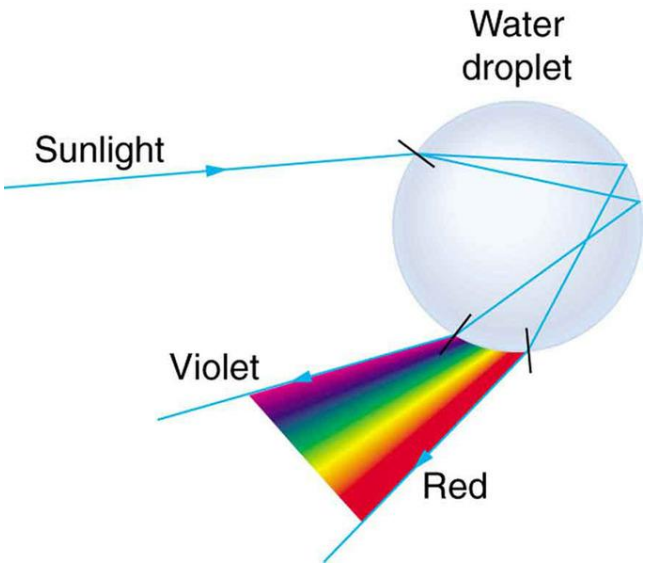


(b) Object is beyond 2F in case of concave lens. : Image is

1. Virtual

2. Diminished

3. Erect 4. Formed between O and F on the same side of the object



Q5. What information do you get about sunlight from the formation of a rainbow?

Answer: The information that we get about sunlight from the formation is about dispersion of light. The separation of white light into seven different colors is known as dispersion. Different colors of light have different wavelengths. Rainbows are formed when sunlight passes through water droplets in the atmosphere. The water droplets act like prisms, refracting and dispersing the sunlight. The light is then internally reflected and refracted again as it exits the raindrop.

Q6. A man stands 10 m in front of a large plane mirror. How far must he walk before he is 5 m away from his image?

Answer:

The object distance is equal to image distance in a plane mirror.

For the distance of man from his image to be 5m

The distance of man from mirror + distance of image from the mirror = 5m

Since object distance = image distance

Therefore, 2*distance of man from the mirror = 5m

Distance of man from the mirror = 5/2 = 2.5m

The man is 10m from the mirror at the starting, so he will have to walk 10 – 2.5 = 7.5m towards the mirror for being 5m away from his image.

Q7. A student makes a device P by using three long and narrow strips of plane mirrors inclined at 60° to one another which enables him to see beautiful patterns made by pieces of coloured glass bangles. On the other hand, another student makes a device Q by using two plane mirrors arranged parallel to each other which helps him to see a football match clearly even when some very tall persons are sitting in front of him in the ground. What are P and Q?

Answer:

P: Kaleidoscope

A Kaleidoscope is an optical instrument that consists of 3 plain mirror strips which are arranged inside a tube (cylinder) with colored glass pieces at one end and a glass to view on the other.

Q: Periscope

A periscope is an optical instrument that consists of a tube attached to a set of 2 mirrors arranged parallel to each other. A periscope is used to see over, through or around any object.

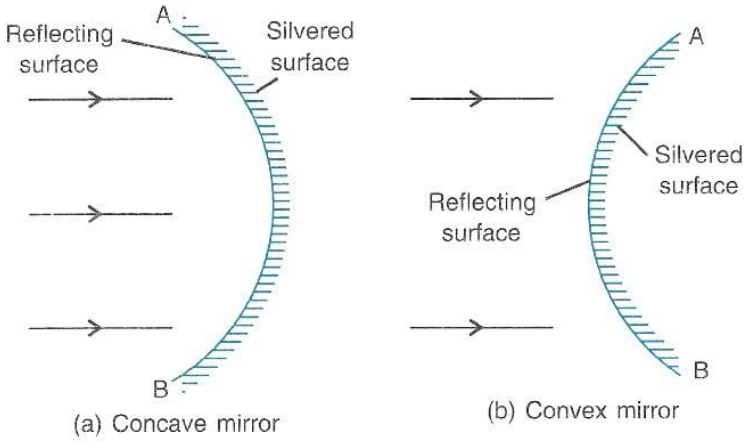
Q8. State the two kinds of spherical mirrors and distinguish them with the aid of proper diagrams.

Answer: The two kinds of spherical mirrors are:

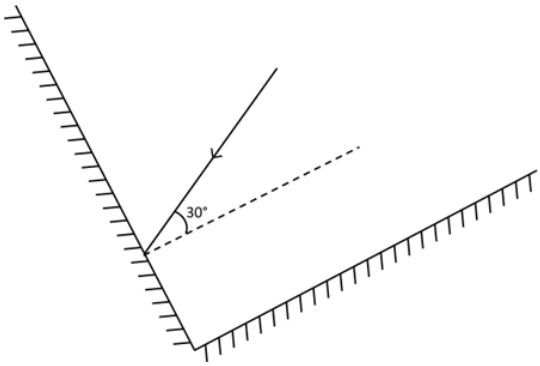
1. Concave mirror
2. Convex mirror

Sl. No.	Concave mirror	Convex mirror
1.	It is made by silvering the outer surface of the hollow sphere.	It is made by silvering the inner surface of the hollow sphere.
2.	The reflection takes place from the inner concave surface.	The reflection takes place from the outer bulged surface.

Figure of concave and convex mirror is shown below:



Q9. Two mirrors meet at right angles. A ray of light is incident on one at an angle of 30° as shown in Fig. 13.19. Draw the reflected ray from the second mirror.



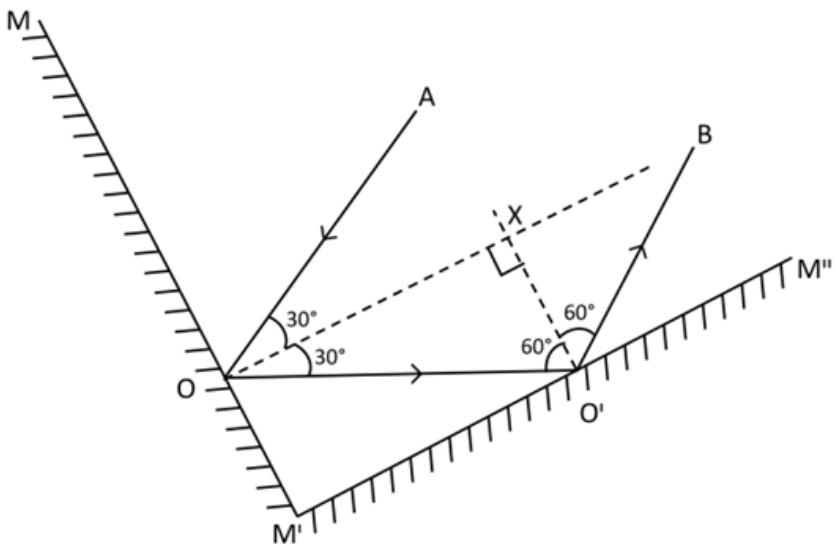
Answer:

Let MM' and M'M'' be the two plane mirrors at right angles.

The reflected ray from the second mirror is shown in the figure below:

Given that the ray is incident on mirror MM' at 30°,

∴ ∠AOX = 30°



According to the law of reflection,

∠i = ∠r

∴ ∠XOO' = ∠AOX = 30°

As OX ⊥ MM' and O'X ⊥ M'M''

∴ OX ⊥ O'X

∴ ∠OXO' = 90°

In ΔOXO', by angle sum property.

∠XOO' + ∠OXO' + ∠XO'O = 180°

⇒ 30° + 90° + ∠XO'O = 180°

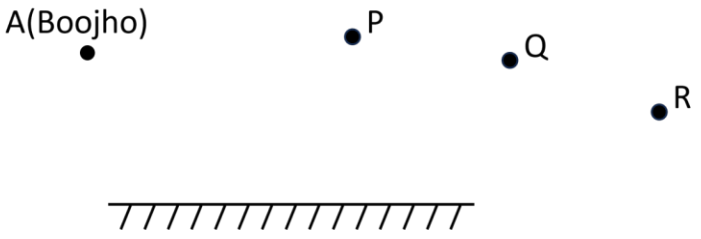
⇒ ∠XO'O = 180° - 90° - 30°

⇒ ∠XO'O = 60°

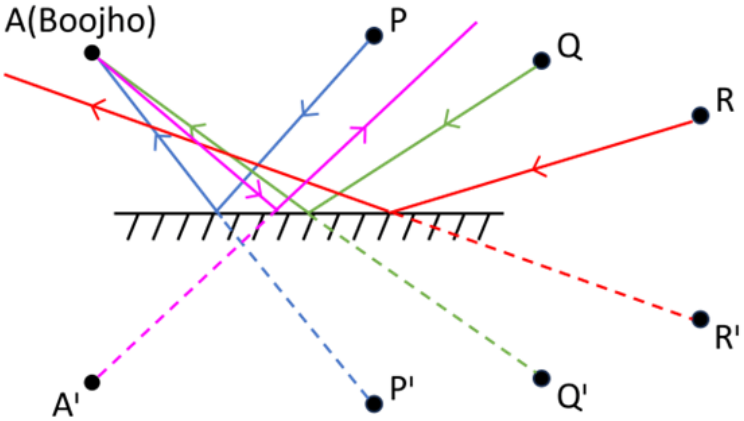
∴ Angle of incidence of the ray on M'M'' = 60°

∴ Angle of reflection of the ray from M'M'' = 60° [∵ ∠i = ∠r]

Q10. Boojho stands at A just on the side of a plane mirror, as shown in Fig. 13.20. Can he see himself in the mirror? Also, can he see the image of objects situated at P, Q and R?



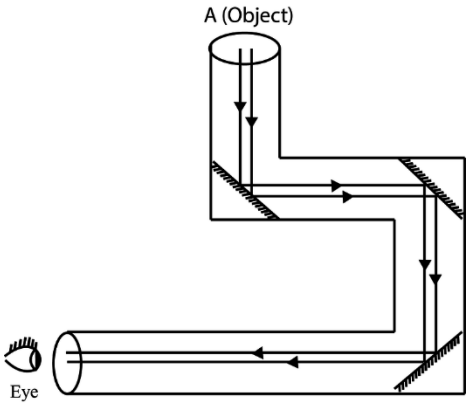
Answer: Boojho cannot see himself in the mirror because light rays originating from him do not reach his eyes after reflection.



He can see the image of objects situated at P and Q because the light rays coming from P and Q get reflected by the mirror and reach his eyes.

Boojho can't see the image of object situated at R because the light rays from object R do not reach his eyes after reflection.

Q11. Boojho planned an activity to observe object A through pipes as shown in Fig., so that he could see objects which he could not directly see.



(a) How many mirrors should he use to see the objects?

(b) Indicate the positions of the mirrors in the figure.

(c) What must be the angle with respect to the incident light at which he should place the mirrors? (d) Indicate the direction of the rays in the figure.

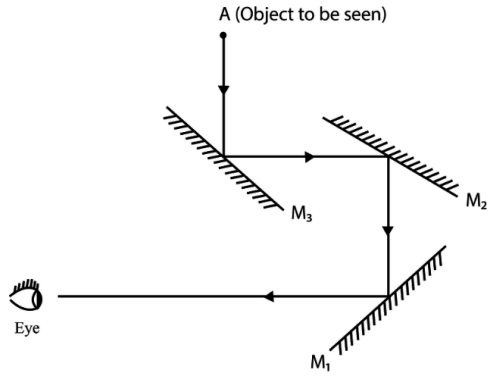
(e) If any of the mirrors are removed, will he be able to see the objects?

Answer:

(a) How many mirrors should he use to see the objects?

Answer: Three plane mirrors should be used by Boojho to see the objects.

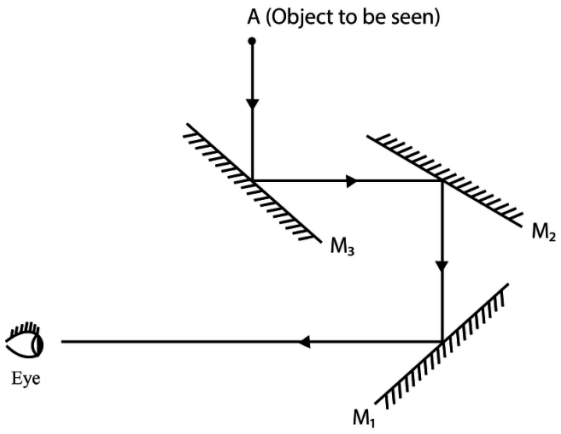
(b) Indicate the positions of the mirrors in the figure.



Ans: The positions of the mirrors as shown in the figure.

(c) What must be the angle with respect to the incident light at which he should place the mirrors?

Ans: 45^0

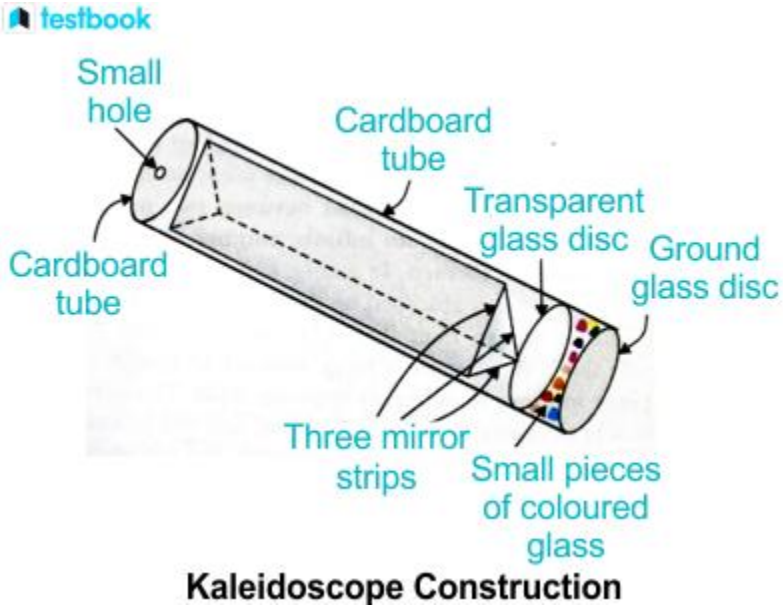


(d) Indicate the direction of rays in the figure.

Answer: The direction of rays is as shown in the figure.

(e) If any of the mirrors is removed, will he be able to see the objects?

Answer: No, Boojho won't be able to see the object if any of the mirrors is removed.



Kaleidoscope Construction

Q12. How is the phenomenon of reflection used in making a kaleidoscope? What are the applications of a kaleidoscope?

Answer: A kaleidoscope uses the phenomenon of reflection to create symmetrical images by multiple reflections of light:

- **How it works**: A kaleidoscope is a cylinder with mirrors that are placed at an angle to each other, usually 60°. The mirrors reflect light that enters the kaleidoscope, creating symmetrical patterns. The number of mirrors used depends on the desired pattern.

- **Applications**: Kaleidoscopes have many applications, including:
  - **Studying geometric patterns**: Kaleidoscopes are useful for studying geometrical patterns in mathematics.
  - **Toys**: Kaleidoscopes are used as toys for children.
  - **Design inspiration**: Kaleidoscopes are used by designers and artists to get ideas for new patterns for fabrics, jewelry, and wallpapers

Q13. Mention against each of the following whether regular or diffused reflection will take place when a beam of light strikes. Justify your answer in each case.

(a) Polished wooden table

(b) Chalk powder

(c) Cardboard surface

(d) Marble floor with water spread over it

(e) Mirror

(f) Piece of paper

Answer:

(a) **Polished wooden table - regular reflection**

A polished surface is an example of a smooth surface. Hence, reflections from the polished table will be regular.

(b) **Chalk powder - Diffused reflection**

Chalk power spread on a surface Is an example of an irregular surface. It is not smooth. Therefore, diffused reflection will take place

from chalk powder.

(c) **Cardboard surface - Diffused reflection**

Cardboard surface is also an example of an irregular surface. Hence, diffused reflection will take place from a cardboard surface.

(d) **Marble floor with water spread over it - Regular reflection**

Marble floor with water spread over it is an example of a regular surface. This is because water makes the marble surface smooth. Hence, regular reflection will take place from this surface.

(e) **Mirror - Regular reflection**

The mirror has a smooth surface. Therefore, it will give a regular reflection.

(f) **Piece of paper - Diffused reflection**

Although a piece of paper may look smooth, it has many irregularities on its surface. Due to this reason, it will give a diffused reflection.

Q14. Draw separate diagrams for the formation of virtual image of an object by

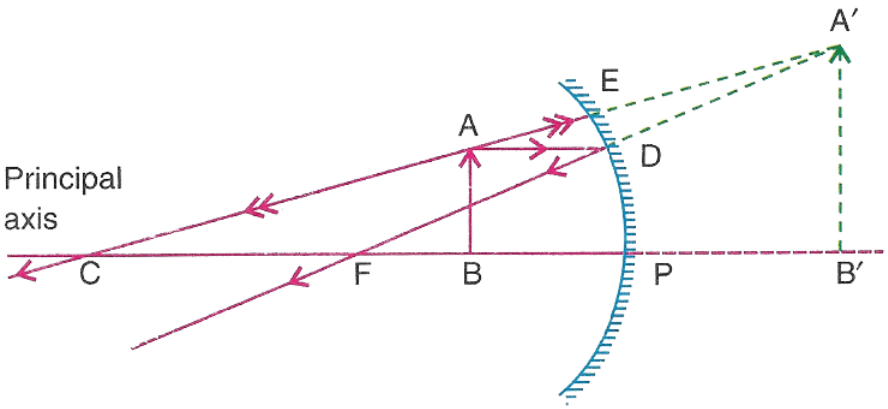
(a) a concave mirror and

(b) a convex mirror.

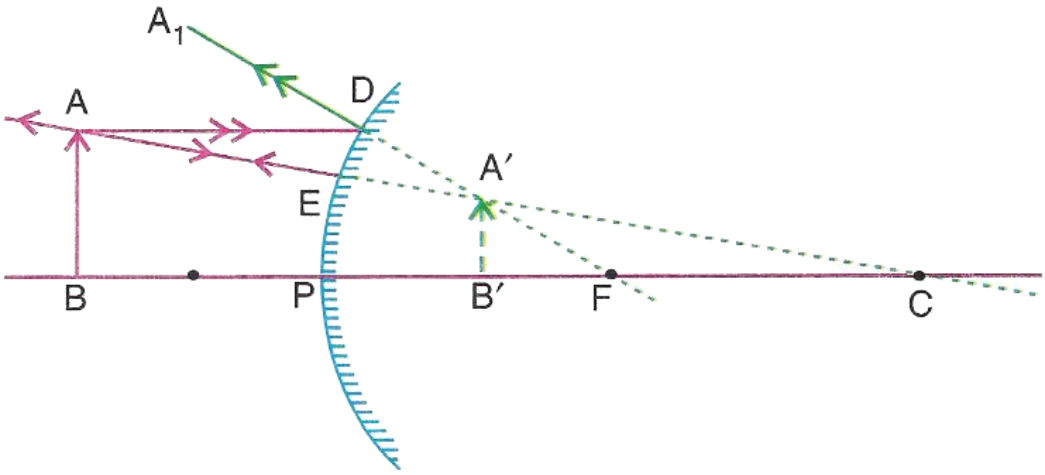
State the difference of the two images.

Answer:

(a) When an object is placed between the pole and focus of a concave mirror, the image is formed behind the mirror. A virtual, erect and enlarged image of the object is formed.



(b) In convex mirror for the object placed at finite distance, the image formed is always virtual, erect, diminished and it is formed between pole and focus of the mirror.



Sl. No.	Virtual Image of Concave mirror	Virtual Image of Convex mirror
1.	The image is enlarged.	Image is diminished and if the object is at infinity, then the image is diminished to a point.
2.	The image is formed behind the mirror between the pole and focus.	The image is formed between the pole and the focus. But if the object is at infinity, then the image is formed at the focus of the mirror.

Q15. The diagrams (Fig. 5.41) given below show two parallel rays 1 and 2 incident on:

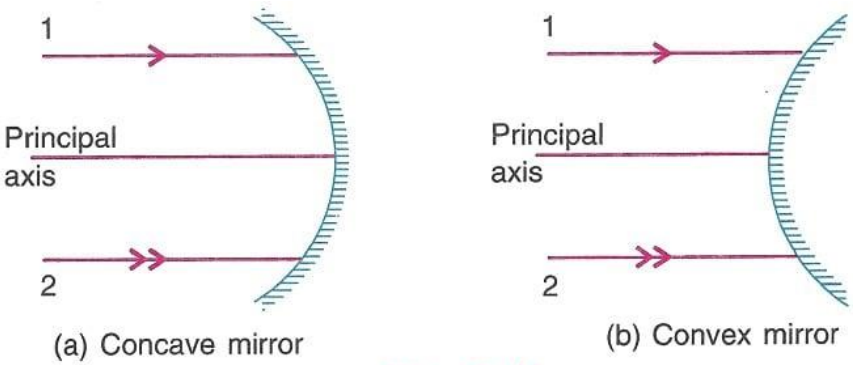


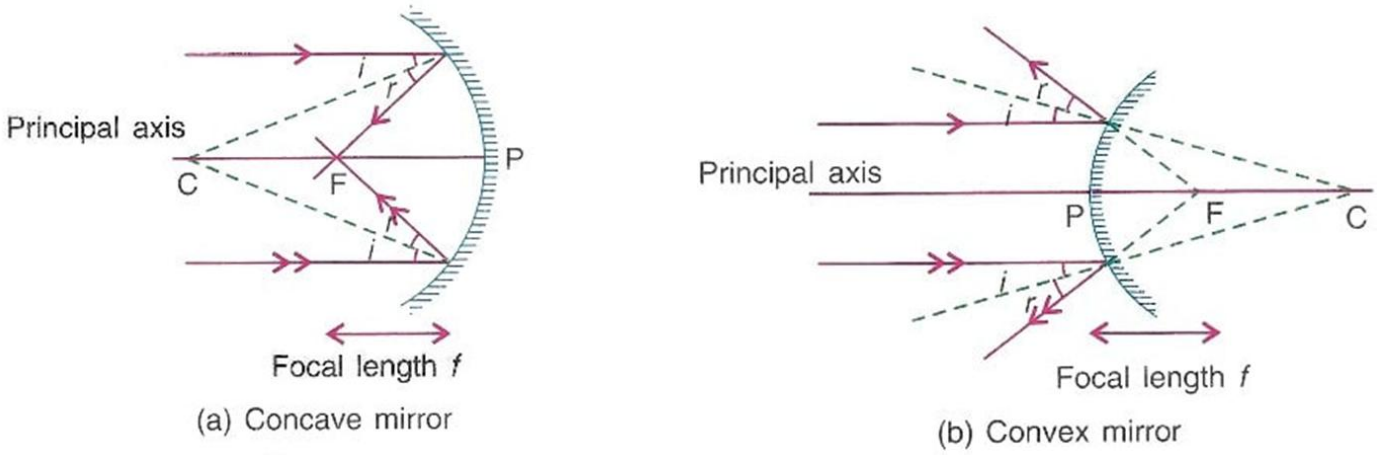
Fig. 5.41

(a) a concave mirror,

(b) a convex mirror.

Draw the reflected rays and mark the focus by the symbol F.

Answer: The completed diagrams with focus marked are shown below :



- C — Centre of curvature,
- F — Focus,
- P — Pole

Q16. Complete the following diagrams in Fig. 5.42 by drawing the reflected rays for the incident rays 1 and 2 if F is the focus and C is the centre of curvature.

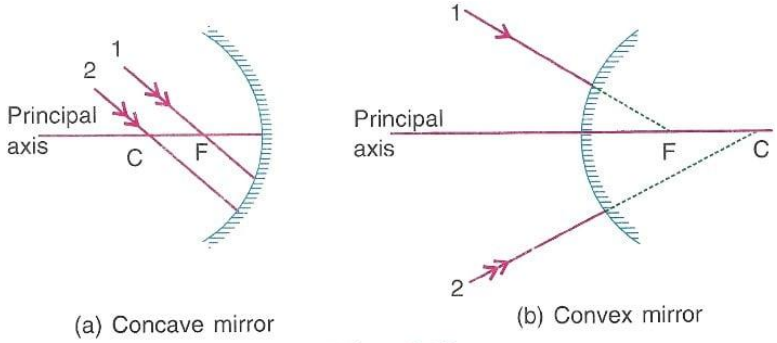
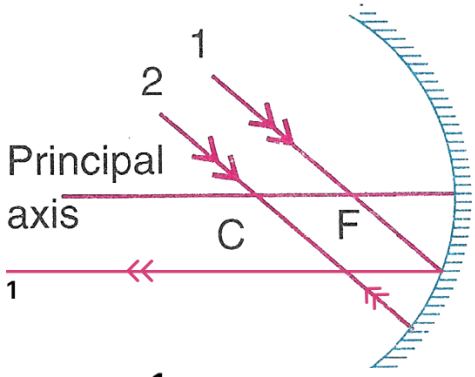


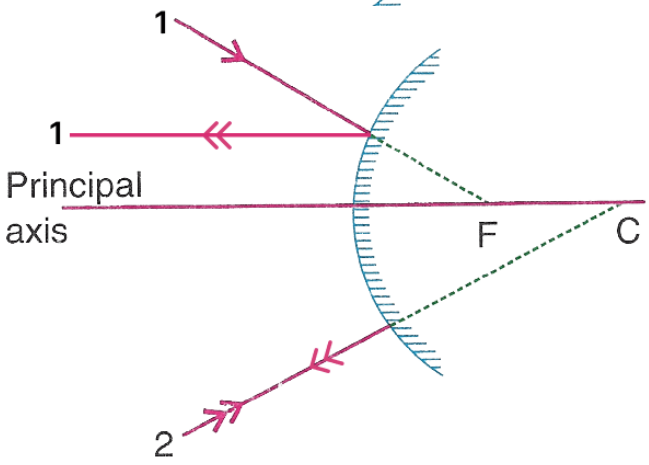
Fig. 5.42

Answer:



Ray 1 passing through the focus of a concave mirror gets reflected parallel to the principal axis.

Ray 2 passing through the centre of curvature of a concave mirror is reflected along its own path.



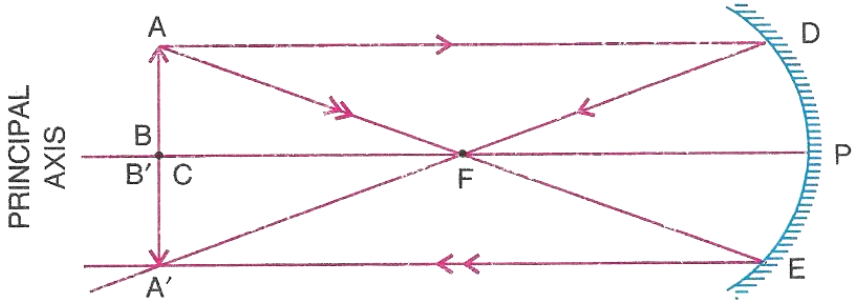
Ray 1 appearing to pass through the focus of a convex mirror gets reflected parallel to the principal axis.

Ray 2 directed in the direction of centre of curvature of a convex mirror is reflected along its own path.

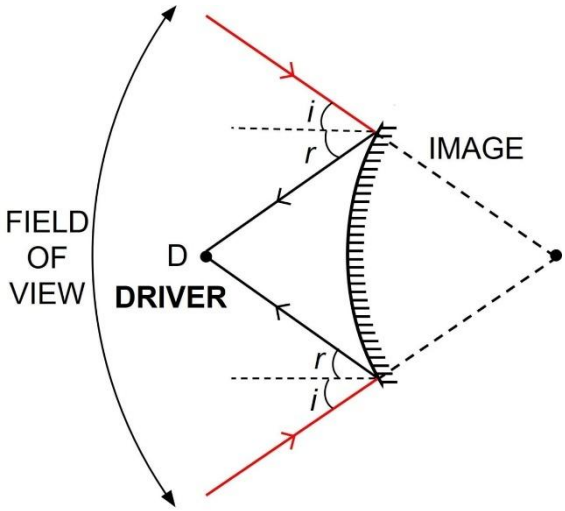
Q17. Draw a ray diagram to show the formation of the image of an object placed at the centre of curvature of a concave mirror. State the position, size and nature of the image.

Answer:

- Nature — Image is real and inverted.
- Position — The image is formed at the centre of curvature of the concave mirror.
- Size — The size of image and object is the same.



Q18. A driver uses a convex mirror as a rear view mirror. Explain the reason with the help of a ray diagram.

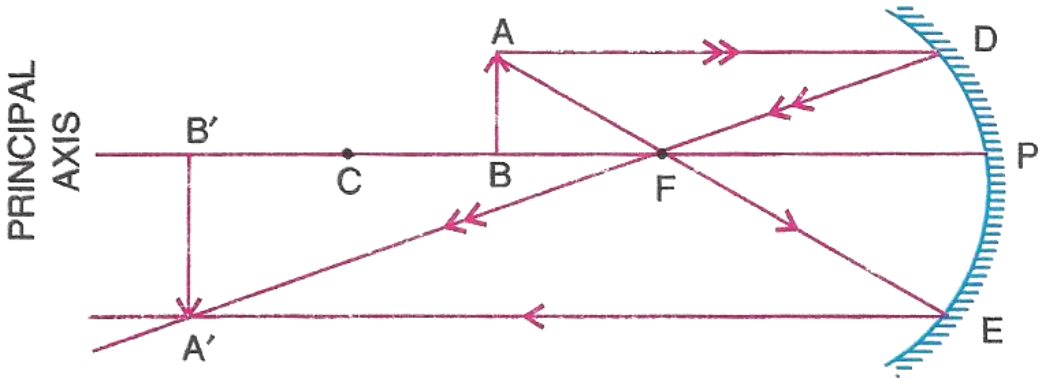


Answer: A convex mirror diverges the incident light rays and always form a small, erect image between its pole and focus. This enables the driver to use it as a rear view mirror so that he could able to see all the traffic behind him approaching the mirror. It has wider field of view than a plane mirror.

Q19. Draw a ray diagram to show the formation of image of an object placed between the focus and centre of curvature of a concave mirror. State the position, size and nature of the image.

Answer:

- Nature — Image is real and inverted.
- Position — The image is formed beyond centre of curvature of the mirror.
- Size — The size of image is bigger than that of object.



Q20. Draw a ray diagram to show the formation of the image of an object placed beyond the centre of curvature of a concave mirror. State the position, size and nature of the image.

Answer:

- Nature — Image is real and inverted.

- Position — The image is formed between the centre of curvature and focus of the concave mirror.
- Size — The size of the image is smaller than that of the object.