AcadPrime
ACADEMY OF EXCELLENCE

Chapter – 10 Light: Reflection and Refraction

Multiple Choice Questions

Q1. Which of the following can make a parallel beam of light when light from appoint source is incident on it?

a) **Concave mirror as well as convex lens**
b) **Convex mirror as well as concave lens**
c) **Two plane mirrors placed at 90^o to each other**
d) **Concave mirror as well as concave lens**

Answer: Option a)

A ray passing via the principal focus of a convex lens or concave mirror, after reflection/refraction, will emerge parallel to the principal axis.

Q2. A 10 mm long awl pin is placed vertically in front of a concave mirror. A 5 mm long image of the awl pin is formed at 30 cm in front of the mirror. The focal length of this mirror is

a) $\boldsymbol{-30\ cm}$
b) $\boldsymbol{-20\ cm}$
c) $\boldsymbol{-40\ cm}$
d) $\boldsymbol{-60\ cm}$

Answer: Option b)

Object size given is,

$$h = +10.0\ mm$$
$$= +1.0\ cm$$

Image size, $h' = 5.0\ mm = 0.5\ cm$

Image distance, $v = -30\ cm$

Focal length, $f = ?$

Magnification,

$$m = \frac{h'}{h}\ \frac{(image\ size)}{(object\ size)}$$

Again, magnification,

$$m = \frac{-v}{u} \Rightarrow \frac{h'}{h} = \frac{-v}{u}$$

$$\frac{0.5}{1} = \frac{-30}{u}$$

$$u = -60\ cm$$

Using mirror formula,

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

$$\frac{1}{f} = \frac{1}{-30} - \frac{1}{60}$$

$$\frac{1}{f} = \frac{-2-1}{60} = \frac{-3}{60}$$

$$f = -20\ cm$$

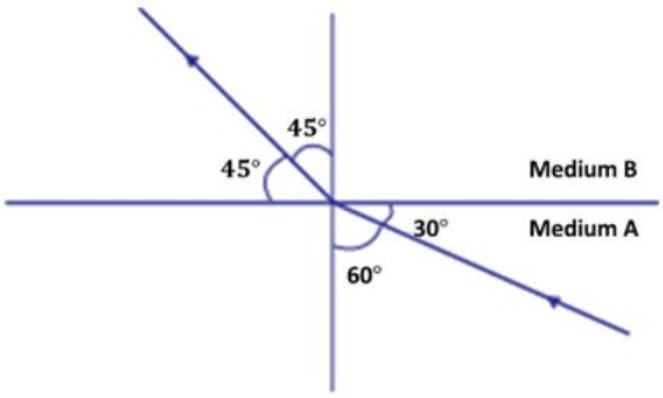
Q3. Under which of the following conditions, a concave mirror can form an image larger than the actual object?

a) **When the object is kept at a distance equal to its radius of curvature.**
b) **When object is kept at a distance less than its focal length.**
c) **When object is placed between the focus and center of curvature.**
d) **When object is kept at a distance greater than its radius of curvature.**

Answer: Option c)

A concave mirror can form an enlarged image, which is real and inverted compared to the actual object, beyond center of curvature (C) on placing the object between the center of curvature and focus (F).

Q4. Figure shows a ray of light as it travels from medium A to medium B. Refractive index of the medium B relative to medium A is



a) $\frac{\sqrt{3}}{2}$

b) $\frac{\sqrt{2}}{\sqrt{3}}$

c) $\frac{1}{\sqrt{2}}$

d) $\sqrt{2}$

Answer: Option a)

Given,

Angle of incidence, $i = 60^o$

Angle of refraction, $r = 45^o$

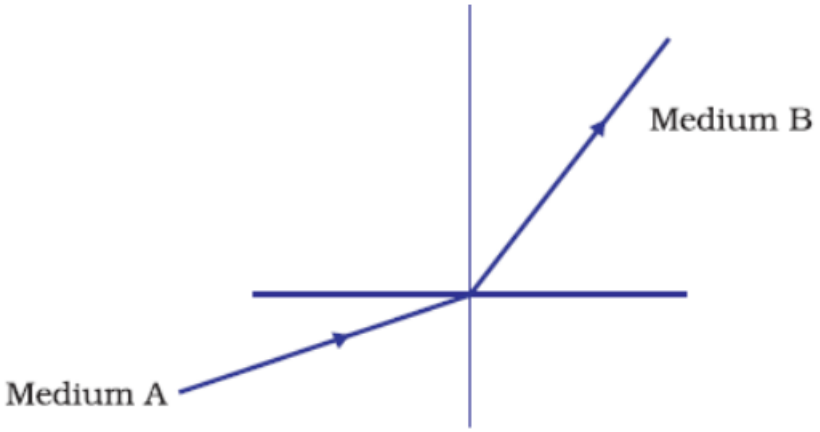
The refractive index of the medium B relative to medium A,

$$\mu_{BA} = \frac{\sin i}{\sin r} = \frac{\sin 60^o}{\sin 45^o}$$

$$\mu_{BA} = \frac{\frac{\sqrt{3}}{2}}{\frac{1}{\sqrt{2}}}$$

$$\mu_{BA} = \frac{\sqrt{3}}{\sqrt{2}}$$

Q5. A light ray enters from medium A to medium B as shown in the figure. The refractive index of medium B relative to A will be



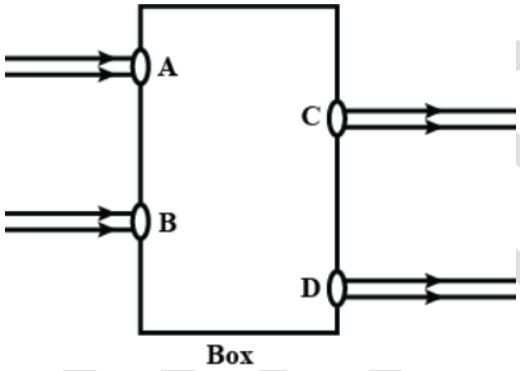
a) **Greater than unity**
b) **Less than unity**
c) **Equal to unity**

d) Zero

Answer: Option a)

As the light ray in the medium B goes towards the normal. So, it will have greater refractive index and lesser velocity of light with respect to medium A. Hence the refractive index of medium B with respect to medium A is greater than unity.

Q6. Beams of light are incident through the holes A and B and emerge out of box through the holes C and D respectively as shown in the figure. Which of the following could be inside the box?

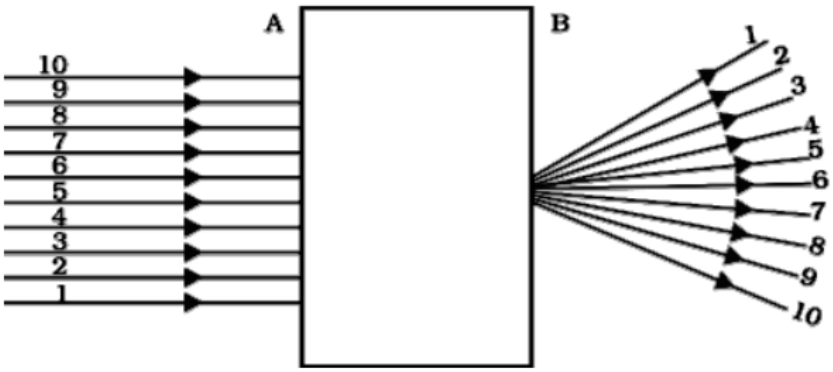


a) A rectangle glass slab
b) A convex lens
c) A concave lens
d) A prism

Answer: Option a)

The emergent rays are parallel to the incident ray. So, a rectangular glass slab is inside the box as the bending of ray at the opposite parallel faces AB and CD of the rectangular glass slab are equal and opposite.

Q7. A beam of light is incident through the holes on side A and emerges out of the holes on the other face of the box as shown in the figure. Which of the following could be inside the box?



a) **Concave lens**
b) **Rectangular glass slab**
c) **Prism**
d) **Convex lens**

Answer: Option d)

Inside the box it has to be a convex lens since the parallel rays are converging at a point.

Q8. Which of the following statements is true?

a) **A convex lens has 4 diopter power having a focal length $0.25\ m$**
b) **A convex lens has 4 diopter power having a focal length $-0.25\ m$**
c) **A concave lens has 4 diopter power having a focal length $0.25\ m$**
d) **A concave lens has 4 diopter power having a focal length $-0.25\ m$**

Answer: Option a)

The power P of a lens of focal length f is given as,

$$P = \frac{1}{f}$$

Where f is the focal length in meter and power in diopter.

So,

$$f = \frac{1}{P} = \frac{1}{4} = 0.25\ m$$

Q9. Magnification produced by a rear-view mirror fitted in vehicles

a) **Is less than one**
b) **Is more than one**

c) **Is equal to one**
d) **Can be more than or less than one depending upon the position of the object in front of it.**

Answer: Option a)

The convex mirror will produce the virtual, erect and diminished image of the object also the rear-view mirror will form some image. Hence, magnification produced by a rear-view mirror fitted in vehicle is less than unity, that is m < 1.

Q10. Rays from sun converge at a point 15 cm in front of a concave mirror. Where should an object be placed so that size of its image is equal to the size of the object?

a) **15 cm in front of the mirror.**
b) **30 cm in front of the mirror.**
c) **Between 15 cm and 30 cm in front of the mirror.**
d) **More than 30 cm in front of the mirror.**

Answer: Option b)

The rays which are coming from infinity are parallel to the principal axis after reflection converge at a point, called as focus. The focal length of concave mirror is 15 cm. Also, concave mirror will produce same size, real and inverted image, when the object is placed at focus 2F so to form by same size image object will be placed at $15 \times 2 = 30\ cm$.

Q11. A full-length image of a distant tall building can definitely by seen by using

a) **A concave mirror**
b) **A convex mirror**
c) **A plane mirror**
d) **Both concave as well as plane mirror**

Answer: Option b)

A convex mirror forms virtual, erect and diminished image of the objects. Hence, it can form full length image of distant tall building.

Q12. In torches, search lights and headlights of vehicles, the bulb is placed

a) **Between the pole and the focus of the reflector.**
b) **Very near to the focus of the reflector.**
c) **Between the focus and center of curvature of the reflector.**
d) **At the center of curvature of the reflector.**

Answer: Option b)

Concave mirror is used in torches, search lights and vehicles headlights for parallel beams of lights. So, bulb near the focus of reflector, as incident rays passes through the focus of concave mirror, after reflection become parallel to the principal axis of the mirror.

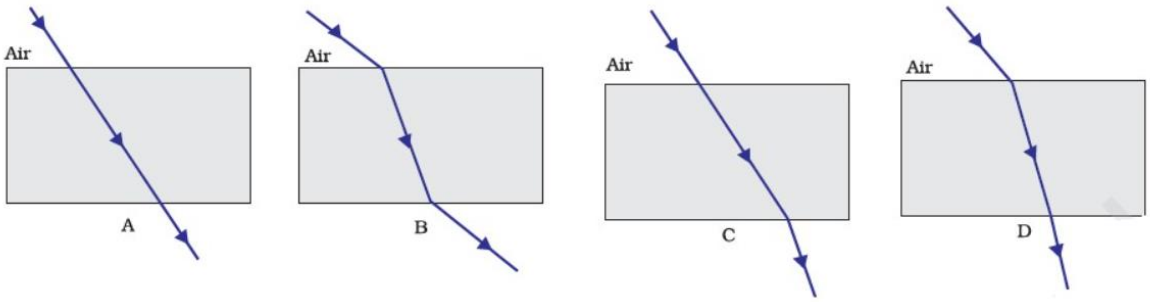
Q13. The laws of reflection hold good for

a) **Plane mirror only**
b) **Concave mirror only**
c) **Convex mirror only**
d) **All mirror irrespective of their shape**

Answer: Option d)

The laws of reflection hold good for light reflected from any smooth surface, that is, all mirror regardless of its shape.

Q14. The path of a ray light coming from air passing through rectangular glass slab traced by four students as shown as A, B, C and D in the figure. Which one of them is correct?



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

Answer: Option b)

In a rectangular glass slab, the rays which are emerging are parallel to the direction of the incident ray, because of the lateral deviation of bending of the ray of light at the opposite parallel faces and of the rectangular glass slab are equal and opposite.

Q15. You are given water, mustard oil, glycerin and kerosene. In which of these media, a ray of light incident obliquely at same angle would bend the most?

a) **Kerosene**
b) **Water**
c) **Mustard oil**
d) **Glycerin**

Answer: Option d)

Kerosene has refractive index is 1.44 and water has 1.33, mustard oil has 1.46 and glycerin has 1.74. So, glycerin is the denser and have the largest refractive index. Hence, ray of light bend most in glycerin.

Q16. Which of the following ray diagram ray diagrams is correct for the ray of light incident on a concave mirror as shown in figure?

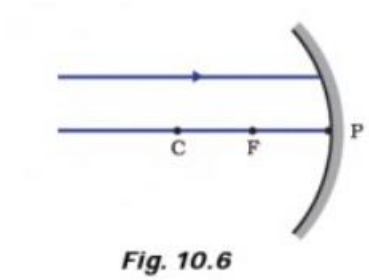


Fig. 10.6

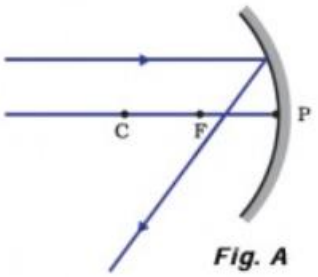


Fig. A

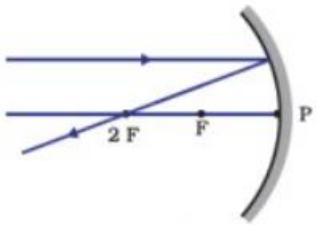


Fig. B

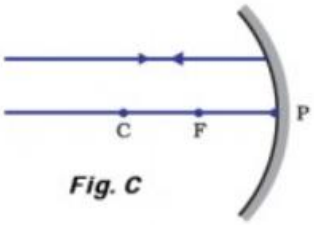


Fig. C

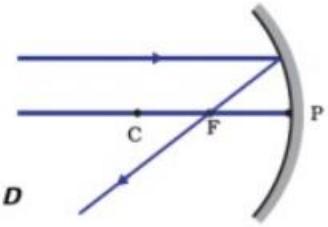


Fig. D

(a) Fig. A
(b) Fig. B
(c) Fig. C
(d) Fig. D

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

Answer: Option d)

A ray which is parallel to the principal axis, after the reflection will pass through the principal focus in case of a concave mirror.

Q17. Which of the following ray diagrams is correct for the ray of light incident on a lens shown in figure?

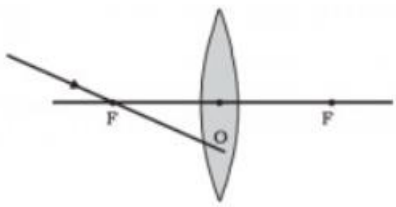


Fig. 10.7

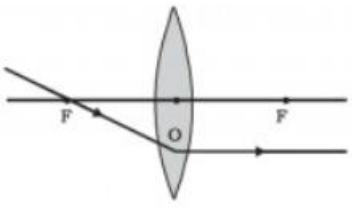


Fig. A

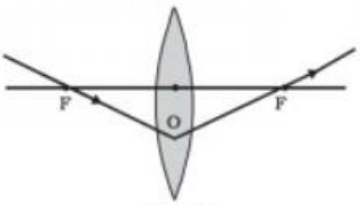


Fig. B

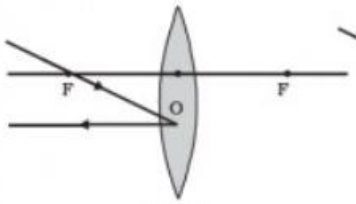


Fig. C

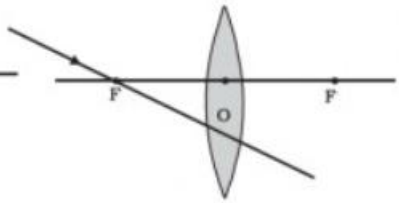


Fig. D

(a) Fig. A.
(b) Fig. B.
(c) Fig. C.
(d) Fig. D.

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

Answer: Option a)

The ray of light which is passing through the principal focus of a convex lens after refraction from a convex lens, it will emerge parallel to the principal axis.

Q18. A child is standing in front of a magic mirror. She finds the image of her head bigger, the middle portion of her body of the same size and that of the legs smaller. The following is the order of combinations for the magic mirror from the top.

a) Plane, convex and concave
b) Convex, concave and plane
c) Concave, plane and convex
d) Convex, plane and concave

Answer: Option c)

Concave mirror can be used to see a bigger imager of the head, plane mirror for middle portion is used to see the child's body of the same and convex mirror to see the diminished image of leg.

Q19. In which of the following, the image of the object placed at infinity will be highly diminished and point sized?

a) Concave mirror only
b) Convex mirror only

c) **Convex lens only**
d) **Concave mirror, convex mirror, concave lens and convex lens**

Answer: Option d)

The incident rays from an object placed at infinity is parallel and the rays parallel to the principal axis, after reflection by concave, convex mirrors or by convex or concave lens pass through principal focus.

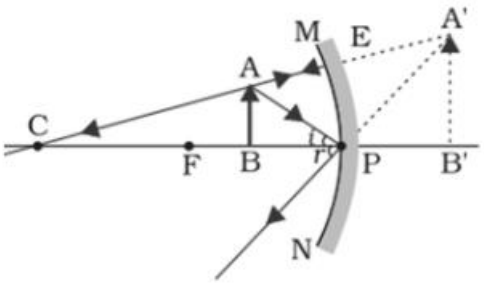
Short Answer Type Questions

Q20. Identify the device used as a spherical mirror or lens in following cases, when the image formed is virtual and erect in each case.

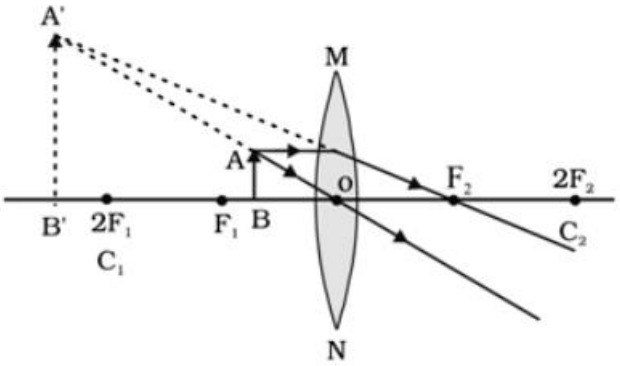
a) **Object is placed between device and its focus, image formed is enlarged and behind it**
b) **Object is placed between the focus and device, image formed is enlarged and on the same side as that of the object**
c) **Object is placed between infinity and device, image formed is diminished and between focus and optical center on the same side as that of the object**
d) **Object is placed between infinity and device**

Answer:

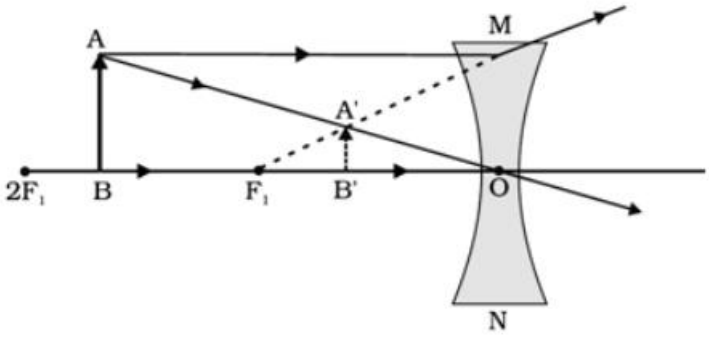
a) The spherical mirror is used as Concave mirror.



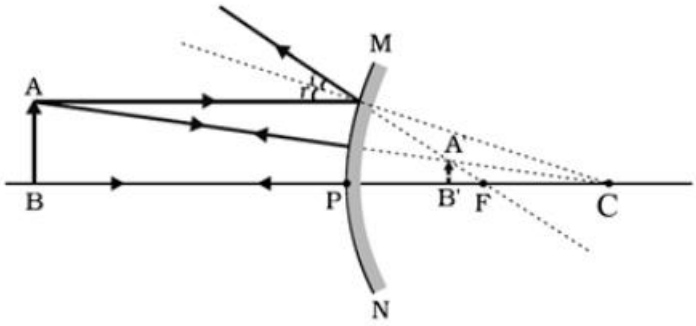
b) The spherical lens is used as Convex lens.



c) The spherical lens is used as concave lens.

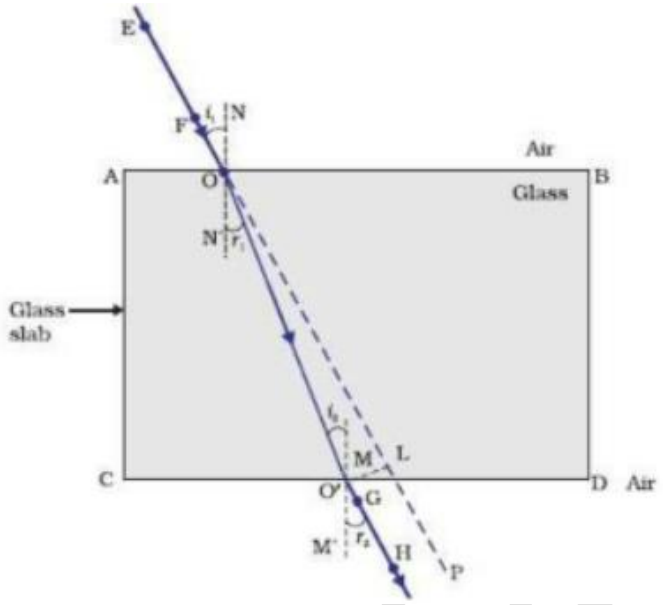


d) The spherical mirror is used as convex mirror.



Q21. Why does light ray incident on a rectangular glass slab immersed in any medium emerges parallel to itself? Explain using a diagram.

Answer:



In the above diagram, EO is the incident ray, OO' is the reflected ray and O'H is the emergent ray.

The extension of bending of the ray of light at the air-glass interface, that is, at AB and glass-air surface, that is, CD of the rectangular glass slab is equal to opposite.

Hence, the ray emerges parallel to the incident ray on a rectangular glass slab. Also, we can see the slight shift of the light ray.

When we immerse the glass slab in any medium, then the AB and CD glass medium will be equal and opposite so, the emergent ray will always be parallel to the incident ray.

Q22. A pencil when dipped in water in a glass tumbler appears to be bent at the interface of air and water. Will the pencil appear to be bent to the same extent, if instead of water we use liquids like, kerosene or turpentine? Support your answer with reason.

Answer:

When the pencil is partly immersed in water in a glass tumbler, it appears to be displaced at the interface of the air and water, it is due to phenomenon of refraction of light.

If the pencil is being dipped inside the kerosene or turpentine, then their refractive indices are different which produces deviation from incident ray by different extent.

Q23. How is the refractive index of a medium related to the speed of light? Obtain an expression for refractive index of a medium with respect to another in terms of speed of light in these two media?

Answer:

The refractive index is "the ratio of speed of light in vacuum to the speed of light in the medium.

$$Refractive\ index, \mu = \frac{speed\ of\ light\ in\ vacuum, c}{speed\ of\ light\ in\ medium, v}$$

$\mu_1 = refractive\ index\ of\ first\ medium$

$\mu_2 = refractive\ index\ of\ second\ medium$

$v_1 = velocity\ in\ first\ medium$

$v_2 = velocity\ in\ second\ medium$

Medium – 1,

$$\mu_1 = \frac{c}{v_1}$$

Medium – 2,

$$\mu_2 = \frac{c}{v_2}$$

Therefore,

$$\mu_{21} = \frac{\mu_2}{\mu_1}$$

$$\mu_{21} = \frac{\frac{c}{v_2}}{\frac{c}{v_1}} = \frac{v_1}{v_2}$$

Q24. Refractive index of diamond with respect to glass is 1.6 and absolute refractive index of glass is 1.5. Find out the absolute refractive index of diamond.

Answer:

The refractive index of diamond with respect of glass,

$$\mu_d = 1.6 = \frac{\mu_d}{\mu_g}$$

Absolute refractive index of glass,

$$\mu_g = 1.5 = \frac{\mu_g}{\mu_a}$$

Absolute refractive index of diamond,

$$\mu_d\ of\ diamond = \frac{\mu_d\ of\ glass}{\mu_a} = ?$$

$$\mu_d\ of\ glass = \frac{\mu_d\ of\ diamond}{\mu_g}$$

$$\mu_d\ of\ diamond = \mu_d\ of\ glass\ \times\ \mu_g$$

$$= 1.6 \times 1.5 = 2.4$$

Therefore, the absolute refractive index of diamond, $\mu_d = 2.4$

Q25. A convex lens of focal length 20 cm can produce a magnified virtual as well as real image. Is this a correct statement? If yes, where shall the object be placed in each case for obtaining these images?

Answer:

Yes, the convex lens of focal length of 20 cm can produce a magnified, virtual as well as real image.

For that object should be placed: -

i) In between the focus F_1 and optical center O for magnified, virtual and erect image.
ii) In between F_1 and $2F_1$ for real, inverted and enlarged image.

Q26. Sudha finds out that the sharp image of the window pane of her science laboratory is formed at a distance of 15 cm from the lens. She now tries to focus the building visible to her outside the window instead of the window pane without disturbing the lens. In which direction will she move the screen to obtain a sharp image of the building? What is the approximate focal length of this lens?

Answer:

Sudha move the screen towards the lens to obtain a sharp image of the building since window pane was beyond the focus of 2F or center of curvature and convex lens forms its image.

If Sudha focus the building between focus F and 2F then lens form the image of building at a distance of focal length. The approximate focal length of this lens would be 15 cm.

Q27. How are power and focal length of a lens related? You are provided with two lenses of focal length 20 cm and 40 cm, respectively. Which lens will you use to obtain more convergent light?

Answer:

The power of a lens is related to its focal length as –

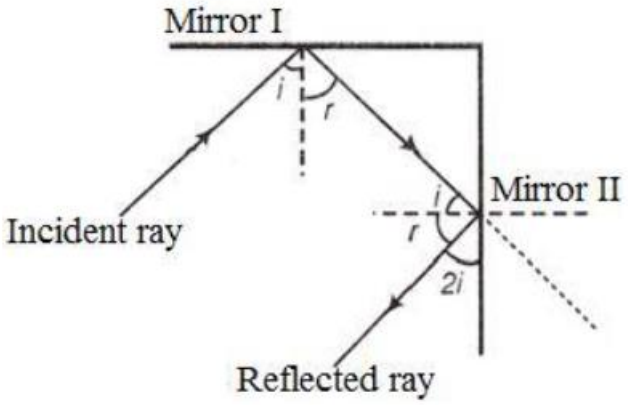
$$P = \frac{1}{f}$$

To have a greater convergent of light, the lens of higher power and smaller focal length is required, that is, the lens of focal length 20 cm is needed for the same.

Q28. Under what condition in an arrangement of two plane mirrors, incident ray will always be parallel to each other, whatever may be angle of incidence. Show the same with the help of diagram.

Answer:

The incident ray and reflected ray is parallel to each other when two plane mirrors are at right angle to each other, irrespective of the angle of incidence.

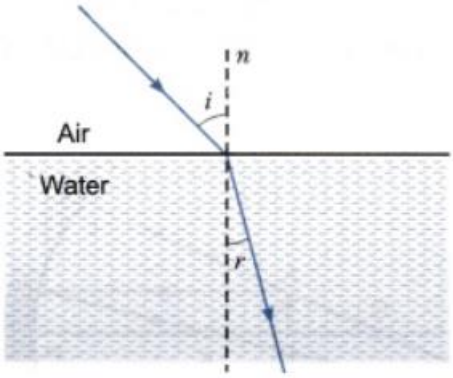


Q29. Draw a ray diagram showing the path of rays of light when it enters with oblique incidence (i) from air into water; (ii) from water into air.

Answer:

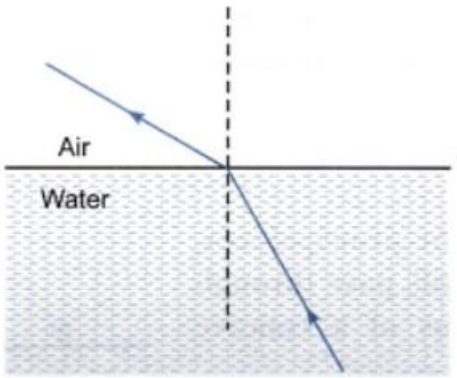
(i) Whenever a light ray is passing from air to water medium with oblique incidence, it goes from optical rarer medium to optical denser medium and velocity of light also decreases, which will bend the incident light towards the normal.

$$i > r$$



(ii) Whenever a light ray enters from water to air medium with oblique incidence, it then goes from optical denser medium to optical rarer medium and velocity of light also increases which bends the incidence light away from the normal.

$$i < r$$



Long Answer Type Questions

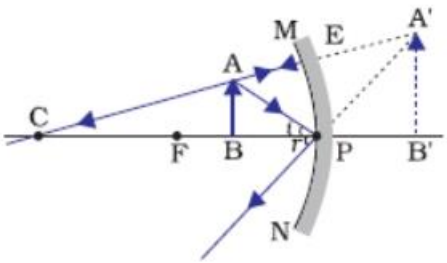
Q30. Draw ray diagrams showing the image formation by a concave mirror when an object is placed.

a) **Between pole and focus of the mirror**
b) **Between focus and center of curvature of the mirror**
c) **At center of curvature of the mirror**
d) **A little beyond center of curvature of the mirror**

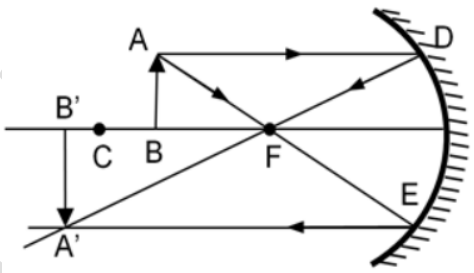
e) **At infinity**

Answer:

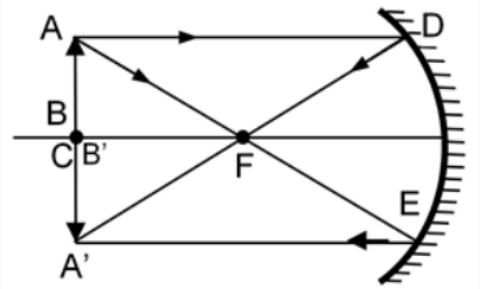
a) An enlarged, virtual and erect image is formed behind the mirror, when object is placed between pole and focus of the mirror.



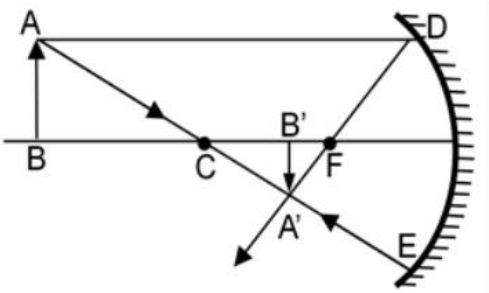
b) An enlarged, real and inverted image is formed beyond the center of curvature if the object is between focus and center of curvature .



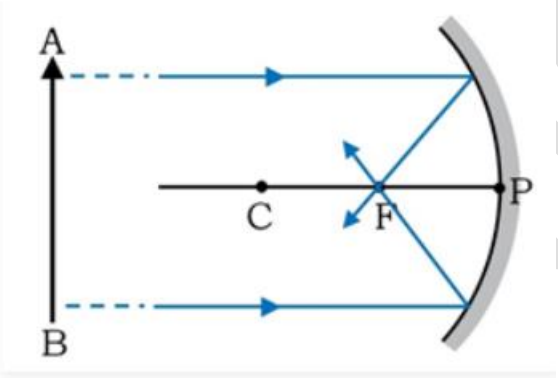
c) The real and inverted image is equal to the size of object formed at the center of curvature when the object is placed at the center of curvature .



d) The diminished, real and inverted image formed between center of curvature and focus, if the object is a little beyond center of curvature .



e) The real, inverted and reduced image formed at focus F, if the object is placed at infinity.

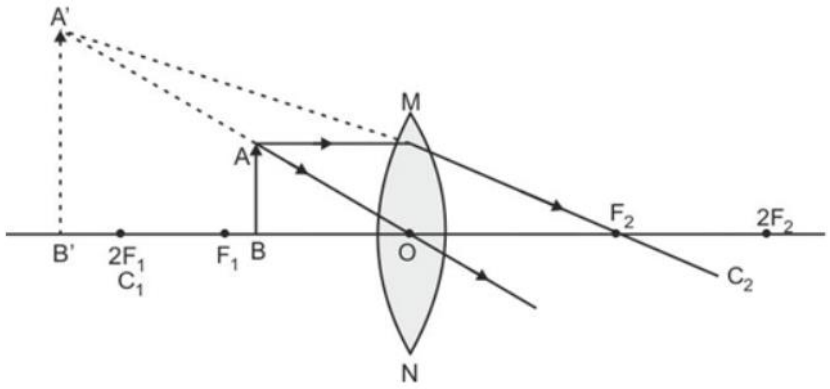


Q31. Draw ray diagram showing the image formation by a convex lens when an object is placed

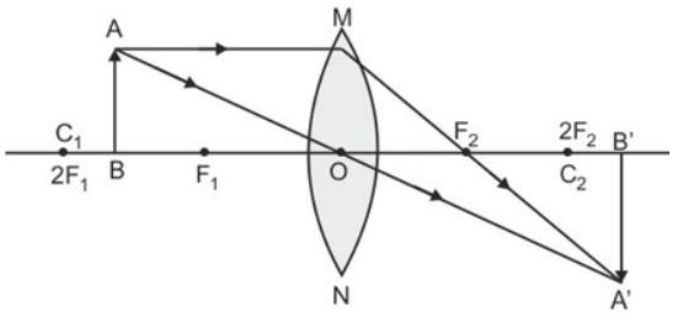
a) Between optical center and focus of the lens
b) Between focus and twice the focal length of the lens
c) At twice the focal length of the lens
d) At infinity
e) At the focus of the lens

Answers:

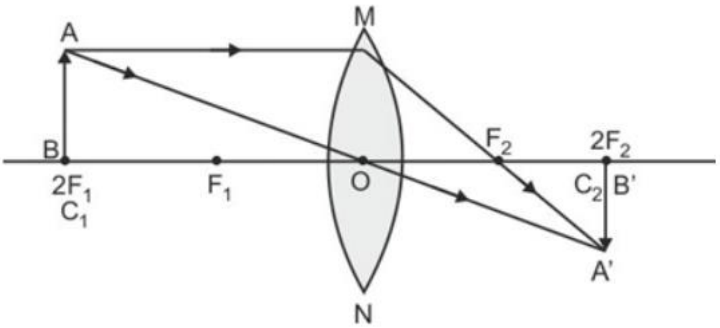
a) The enlarged virtual and erect image formed beyond $2F_1$ at the same side of the object when the object is between optical center and focus F_1 of lens.



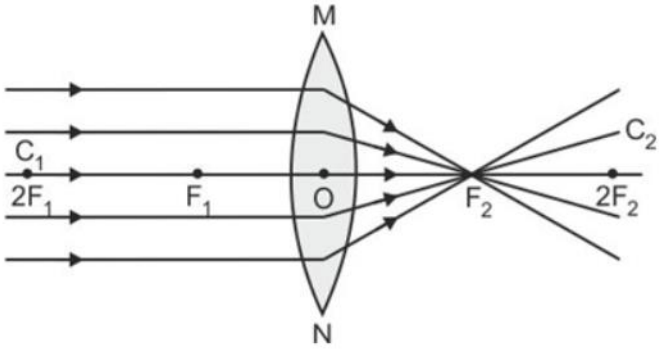
b) The enlarged real and inverted image formed beyond focus $2F_1$ on the other side of the object when the object is placed between focus and twice the focal length .



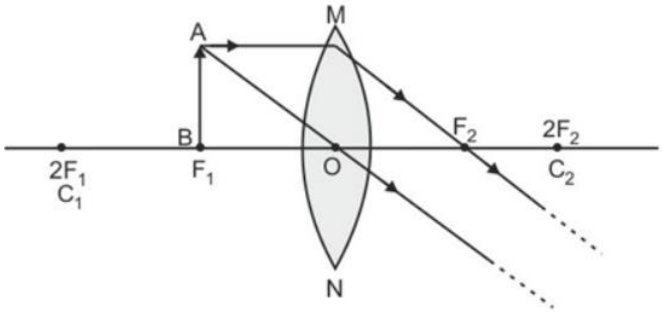
c) The real and inverted image of equal to the size of object formed and focus $2F_1$ on the other side of the object when the object is placed at twice the focal length .



d) The real inverted and highly reduced image formed at the focus F_1 on the other side of the object when the object is placed at infinity.



e) The real, inverted and magnified image formed at infinity on the other side of the object when the object is placed at the focus .



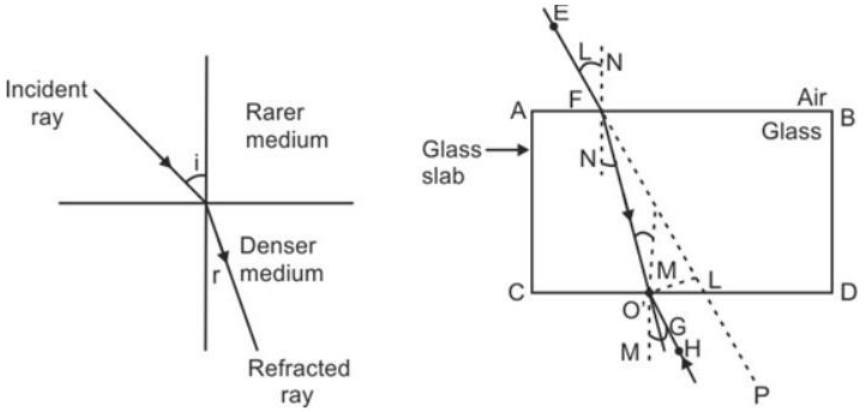
Q32. Write laws of refraction. Explain the same with the help of ray diagram, when a ray of light passes through a rectangular glass slab.

Answer:

The laws of refraction of light are as follows: -

i) The incident ray, the refracted ray and the normal to the interface of two transparent medium, all of them lie in the same plane.

ii) The ratio of the sine of angle of incidence to the sine of angle of refraction is constant called Snell's law of refraction.



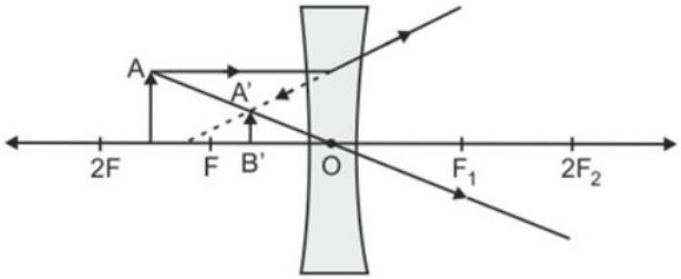
In rectangular glass slab, the emerging rays are parallel to the incident ray because the bending of ray of light at the opposite face of rectangular glass slab are equal and opposite so emergent ray is parallel to incident ray.

Q33. Draw ray diagram shown the image formation by concave lens when an object is placed

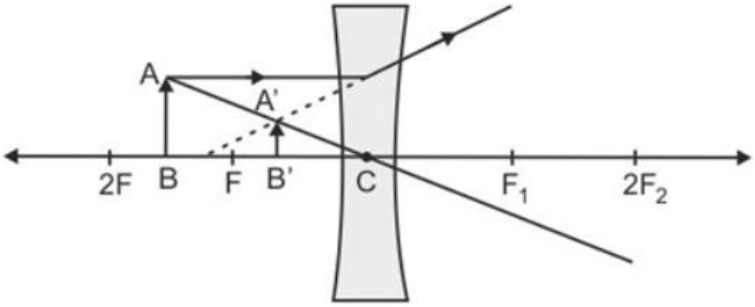
a) **At the focus of the lens**
b) **Between focus and twice the focal length of the lens**
c) **Beyond twice the focal length of the lens**

Answer:

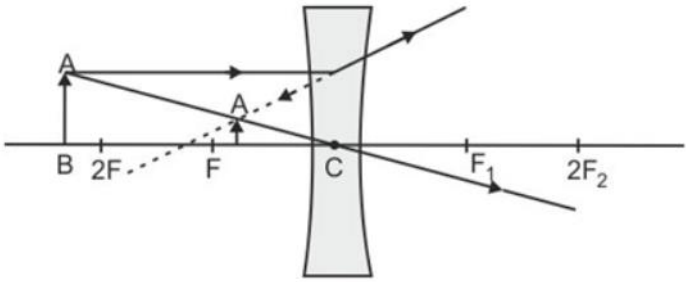
a) The image formed is virtual, erect diminished in size and between F when the object is at focus



b) The image formed is virtual, erect diminished in size and between optical center and focus F when the object is placed between focus and twice the focal length .



c) The image is virtual, erect diminished in size and between optical center and focus F when the object is placed beyond twice the focal length .

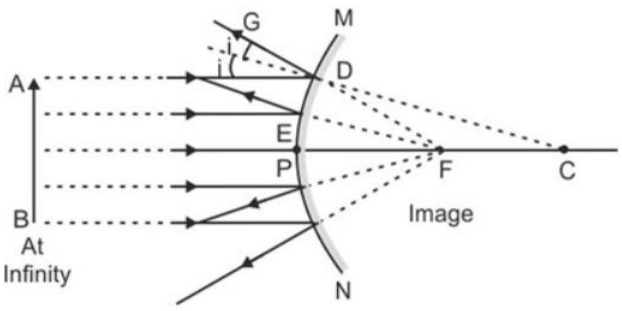


Q34. Draw the diagram showing the image formation by a convex mirror when an object is placed

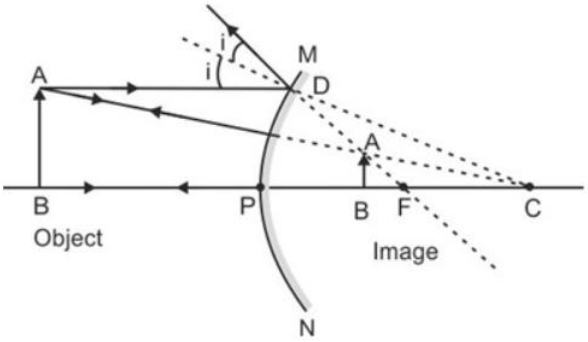
a) At infinity
b) At finite distance from the mirror

Answer:

a) The virtual erect and diminished image of the object formed at focus F behind the mirror when the object is placed at infinity.



b) The virtual, erect and diminished image formed between focus F and pole P behind the mirror when the object is placed at finite distance .



Q35. The image of a candle flame formed by a lens is obtained on a screen placed on other side of the lens. If the image is three times the size of the flame and the distance between lens and image is 80 cm, at what distance should the candle be placed form the lens? What is the nature of the image at a distance of 80 cm and the lens?

Answer:

The image is real as it can be taken on screen.

So, image distance $v = +80\ cm$

Magnification, $m = -3$

Object distance, $u =$?

Magnification is given as,

$$m = \frac{v}{u}$$

$$-3 = \frac{80}{u}$$

$$u = \frac{-80}{3}\ cm$$

Q36. Size of image of an object ny a mirror having a focal length of 20 cm is observed to be reduced to 1/3rd to its size. At what distance, the object has been placed from the mirror? What is the nature of the image and the mirror?

Answer:

First, we will consider the concave mirror –

Focal length, $f = -20\ cm$

Magnification,

$$m = -\frac{1}{3}$$

We know magnification is,

$$m = -\frac{u}{v}$$

Therefore, magnification,

$$m = -\frac{1}{3} = -\frac{v}{u}$$

$$v = \frac{u}{3}$$

Using mirror formula, we have

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

$$\frac{1}{f} = \frac{1}{u} + \frac{3}{u} = \frac{4}{u}$$

$$u = 4f = 4(-20) = -80\ cm$$

Now, we can say that the object should be placed at a distance of 80 cm from the concave mirror.

Now, considering the convex mirror,

Focal length, $f = +20\ cm$

Magnification,

$$m = +\frac{1}{3}$$

So, magnification,

$$m = -\frac{v}{u}$$

Therefore, magnification,1

$$m = \frac{1}{3} = -\frac{v}{u}$$

$$v = -\frac{u}{3}$$

Using mirror formula,

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

$$\frac{1}{f}=\frac{-3}{u}+\frac{1}{u}=\frac{-2}{u}$$

$$u=-2f$$

$$u=-2f=-2(20)=-40\ cm$$

So, the object should be placed at a distance of 40 cm from the convex mirror to form virtual erect and diminished image.

Q37. Define power of a lens. What is its unit? One student uses a lens of focal length 50 cm and another of $-50\ cm$. What is the nature of the length and its power used by each of them?

Answer:

Power of lens: - the ability of a lens to bend the rays of light. It is given as the reciprocal of focal length in meter. Its unit is dioptre.

For focal length, $f=50\ cm$

$$P=\frac{100}{f}=\frac{100}{50}=2D$$

So, the lens is convex.

For focal length, $f=-50\ cm$

$$P=\frac{100}{f}=\frac{100}{-50}=-2D$$

So, the lens is concave.

Q38. A student focused the image of a candle flame on a white screen using a convex lens. He noted down the position of the candle, screen and the lens as under

Position of candle $=12.0\ cm$

Position of convex lens $=50.0\ cm$

Position of the screen $=88.0\ cm$

i) **What is the focal length of the convex lens?**
ii) **Where will the image be formed, if he shifts the candle towards the lens at a position of 31.0 cm?**

iii) What will be the nature of the image formed, if he further shifts the candle towards the lens?

iv) Draw a ray diagram to show the formation of the image in case as said above.

Answer:

Distance of the object, $u =$ Position of the convex lens – Position of candle

$$= 50 - 12 = 38\ cm$$

Using the sign convention,

$$u = -38\ cm$$

Distance of the image, $v =$ position of the screen – Position of convex lens

$$= 88 - 50 = 38\ cm$$

Using sign convention,

$$v = +38\ cm$$

i) By lens formula,

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

$$\frac{1}{f} = \frac{1}{38} - \frac{1}{-38}$$

$$\frac{1}{f} = \frac{2}{38} = \frac{1}{19}$$

$$\frac{1}{f} = 19\ cm$$

Thus focal length is 19 cm.

ii) Shifting the candle to the lens at 31.0 cm, then

Distance object, $u =$ position of convex lens – position of candle

$$u = 50 - 31 = 19$$

Using sign convention,

$$u = -19\ cm$$

Focal length of convex lens is 19 cm. Hence, candle lies at the focus of lens, so, its image forms at infinity.

iii) If students shift the candle towards the lens, that is, candle will lie between optical center and focus of convex lens, then the image formed by the lens will be enlarged, virtual and erect image of the candle.

iv) The ray diagram showing the formed image: -