Chapter - 10
Light-Reflection and Refraction

Multiple Choice Questions

1. Which of the following can make a parallel beam of light when light from a point 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° to each other
(d) Concave mirror as well as concave lens

Soln:

Answer is (d) Concave mirror as well as concave lens

Explanation:

When point source of a light is focused to a convex or concave mirror emergent rays make a parallel beam of light.

2. 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) – 30 cm
(b) – 20 cm
(c) – 40 cm
(d) – 60 cm

Soln:

Answer is (b) – 20 cm

Explanation:

Here, size of object = O = + 10.0 mm = + 1.0 cm (as, 1 cm = 10 mm)
Size of Image size = I = 5.0 mm = 0.5 cm
Image distance, v = − 30 cm   (as image is real)
Let, object distance = u
Focal length, f =?

Magnification m= $\underline{\text{I (Size of image)}}$
                    O(Size of image)

Magnification is given by m=$\frac{-v}{u}$

$\frac{I}{O}=\frac{-v}{u}$

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

U= -60cm

Focal length is given by $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\frac{1}{f} = \frac{1}{-30} + \frac{1}{-60}$$
$$= \frac{-2-1}{60}$$

$$= \frac{-3}{60}$$

F= -20cm

3. 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 centre of curvature
(d) When object is kept at a distance greater than its radius of curvature
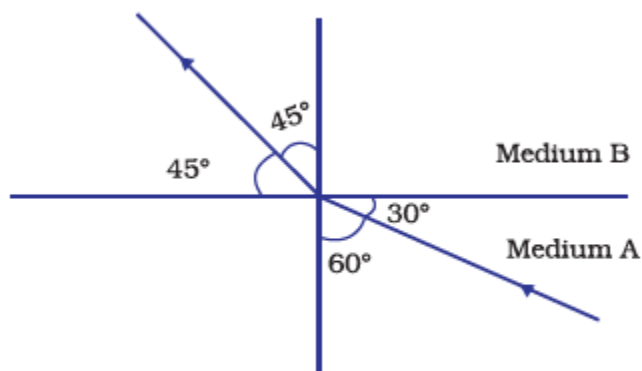
Soln:

Answer is (c) When object is placed between the focus and centre of curvature

Explanation:

When object is placed between F and C an enlarged image is formed beyond C.

4. Figure 10.1 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) 3 / 2
(b) 2 / 3
(c) 1/ 2
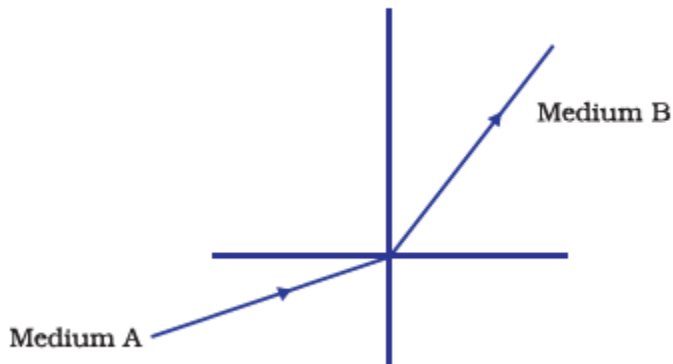**(d) 2**

Fig. 10.1

Soln:

Answer is (a) 3 / 2

Refractive Index of B with respect to A

$$= \frac{sin i}{sin r}$$

$$= \frac{sin 60}{sin 45}$$

$$= \frac{(\sqrt{3}/2)}{(1/\sqrt{2})}$$

$$= \sqrt{6}/2$$

$$= 1.225$$

5. A light ray enters from medium A to medium B as shown in Figure 10.2. 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**

Fig. 10.2

Soln:

Answer is (b) less than unity

Explanation:

Here the ray of light bends away from normal when it enters from medium A into medium B. This shows that medium B is optically rarer than medium A. Therefore, speed of light in medium B is more than speed of light in medium A. So, ratio of speed of light in medium A to speed of light in medium B will be less than one.

6. 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 Figure10.3. Which of the following could be inside the box?
(a) A rectangular glass slab
(b) A convex lens
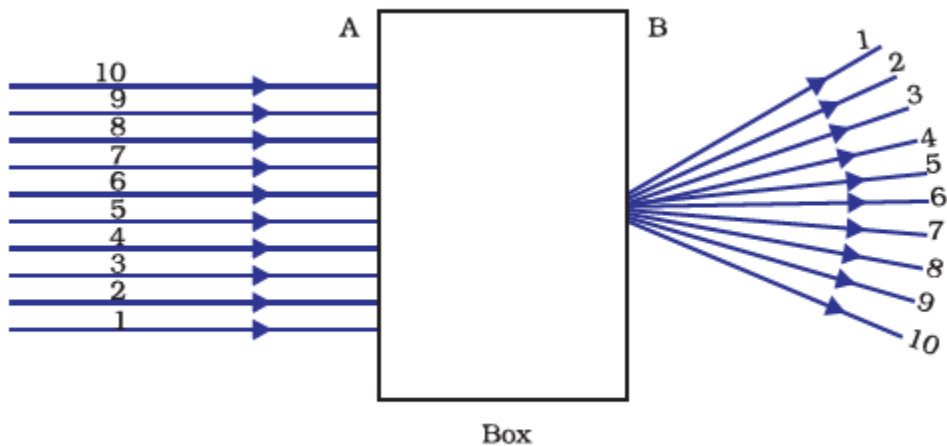(c) A concave lens
(d) A prism

Box
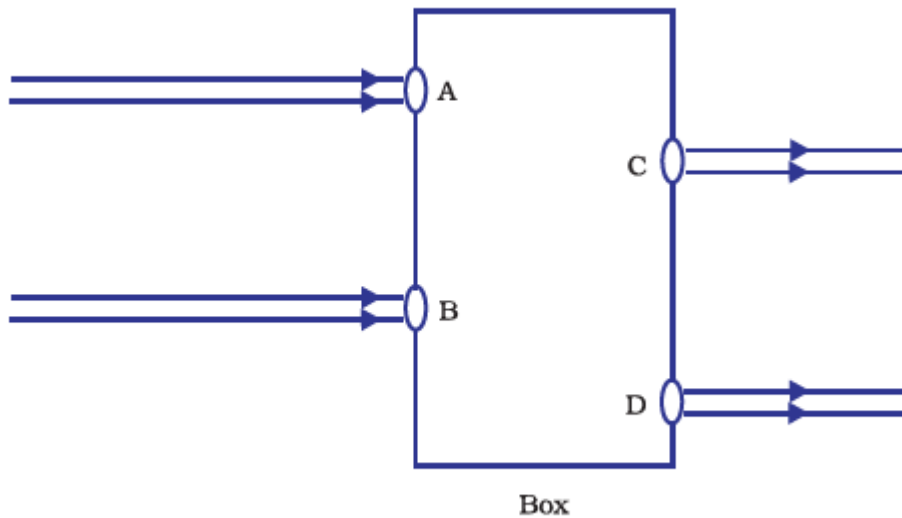
Fig. 10.3

Soln:

Answer is(a) A rectangular glass slab

Explanation:

When incident rays fall perpendicularly on the point of incidence. A rectangular glass slab would refract and then re-refract it.

7. 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 10.4. Which of the following could be inside the box?
(a) Concave lens
(b) Rectangular glass slab
(c) Prism
(d) Convex lens

A   B

10
9
8
7
6
5
4
3
2
1

1
2
3
4
5
6
7
8
9
10

Box

Fig. 10.4

Soln:

Answer is (a) Concave lens

Explanation:

Answer is concave lens because incident rays are parallel and emergent rays are diverging.

8. Which of the following statements is true?
(a) A convex lens has 4 dioptre power having a focal length 0.25 m
(b) A convex lens has –4 dioptre power having a focal length 0.25 m
(c) A concave lens has 4 dioptre power having a focal length 0.25 m
(d) A concave lens has –4 dioptre power having a focal length 0.25 m

Soln:

Answer is (a) A convex lens has 4 dioptre power having a focal length 0.25 m

Explanation:

Positive value for focal length indicates convex lens.

9. 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

Soln:

Answer is (a) is less than one

Explanation:

Convex mirror is used in rear view mirror. Convex mirror always give smaller image. Hence, magnification produced by rear view mirror is always less than 1.

10. 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

Soln:

Answer is (d) more than 30 cm in front of the mirror

Explanation:

Here f= 15,

Radius of curvature is double the focal length

hence c=30

When object is placed on c, its image is of the same size, inverted and is formed on c.

11. A full length image of a distant tall building can definitely be seen by using
(a) a concave mirror
(b) a convex mirror
(c) a plane mirror
(d) both concave as well as plane mirror

Soln:

Answer is (b) a convex mirror

Explanation:

Field of convex mirror is more than any type of mirror. Hence full length size of building can be seen by using a convex mirror.

12. 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 centre of curvature of the reflector
(d) at the centre of curvature of the reflector

Soln:

Answer is (b) very near to the focus of the reflector

Explanation:

Headlight reflectors and search lights are in the shape of concave mirror. When source of light is placed at the focus, reflected light appears like a beam.

13. The laws of reflection hold good for
(a) plane mirror only
(b) concave mirror only
(c) convex mirror only
(d) all mirrors irrespective of their shape

Soln:

Answer is (d) all mirrors irrespective of their shape

14. The path of a ray of light coming from air passing through a rectangular glass slab traced by four students are shown as A, B, C and D in Figure 10.5. Which one of them is correct?
(a) A
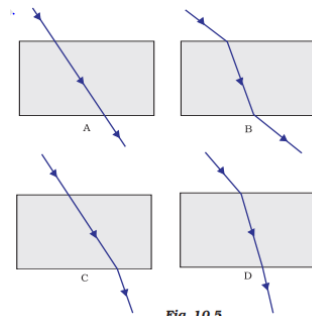**(b) B**
(c) C
(d) D

Soln:

Fig. 10.5

Soln:

Answer is b)B

Explanation:

Light bends towards normal when it passes from air to glass. Light bends away from normal when it passes from glass to air. This is appropriately shown in figure b).

15. You are given water, mustard oil, glycerine 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) Glycerine

Soln:

Answer is (d) Glycerine

Explanation:

Refractive indices

Water-1.33
Kerosene-1.44
Mustard oil-1.46
Glycerine-1.47

Hence Glycerine is optically dense hence ray of light bends more with glycerine.

16. Which of the following ray diagrams is correct for the ray of light incident on a concave mirror as shown in Figure 10.6?
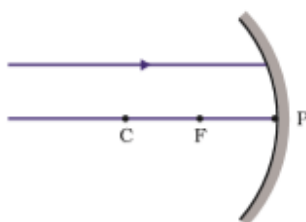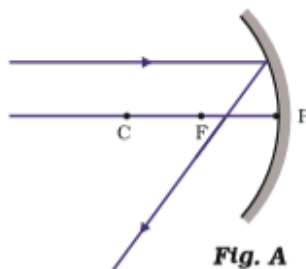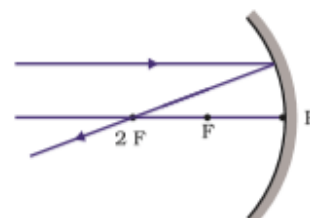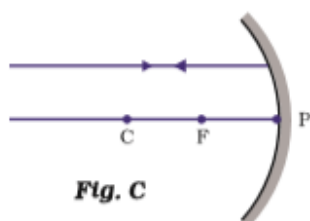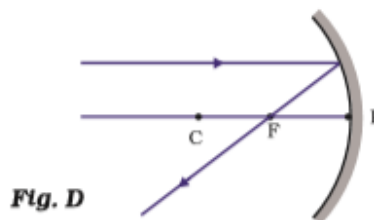

Fig. 10.6   Fig. A   Fig. B

Fig. C   Fig. D

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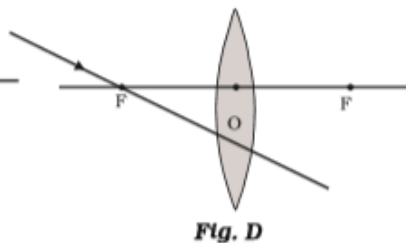
(a) Fig. A
(b) Fig. B
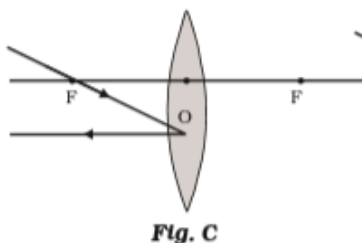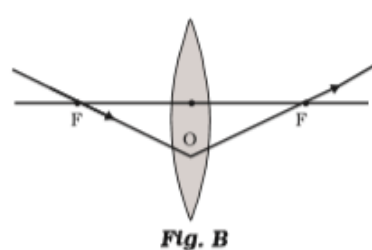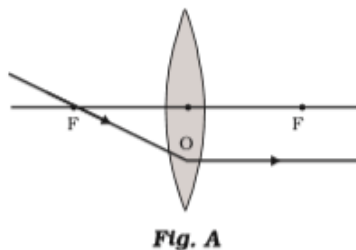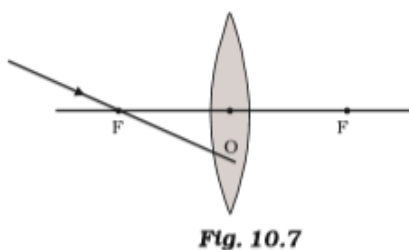(c) Fig. C
(d) Fig. D

Soln:

Answer is (d) Fig. D

Explanation:

In case of concave mirror, an incident ray is parallel to principal axis passes through F after reflection.

17. Which of the following ray diagrams is correct for the ray of light incident on a lens shown in Fig. 10.7?

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

Fig. 10.7   Fig. A   Fig. B

Fig. C   Fig. D

Soln:

Answer is (a) Fig. A.

Explanation:

In convex lens, incident ray passing through F goes parallel to the principal axis after refraction.

18. 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

Soln:

Answer is (c) Concave, plane and convex

Explanation:

When the object is between F and P of concave mirror enlarged image is formed behind the mirror. Hence child can see her head bigger in a concave mirror. She can see her body size of the same size because plane mirror gives image of original size. Convex mirror gives diminished images and babies legs appear smaller.

19. In which of the following, the image of an 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

Soln:

Answer is (d) Concave mirror, convex mirror, concave lens and convex lens

Short Answer Questions

20. 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 centre on the same side as that of the object.
(d) Object is placed between infinity and device, image formed is diminished and between pole and focus, behind it.

Soln:

a) Concave mirror
b) Convex lens
c) Concave lens
d) Convex mirror

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

Soln:

When light ray enters denser medium from rarer medium it bends towards the normal In this case extent of bending of ray at opposite parallel is same. Hence emergent ray is parallel to incident ray.

22. 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.

Soln:

Bending of light here is a function of refraction. Refraction is dependent on refractive indices. Refractive indices of kerosene or turpentine would not be same as water. Hence degree of bend would be different in different mediums.

23. 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?

Soln:

Refractive Index can be seen as the factor by which the speed and the wavelength of the radiation are reduced with respect to their vacuum values.

w=civ (where n:refractive index,c=speed of light,v:velocity of light in that medium)

Refractive index of one medium in relation to a second medium is given by ratio of speed of light In second medium to speed of light in first medium.

24. 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.

Soln:

Absolute RI of diamond= 1.6
Absolute RI of glass= 1.5
Multiplying them we get 2.4

25. 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?

Soln:

When an object is placed in F and F2 of a convex lens, we get inverted, enlarged and real image is formed beyond 2F2 which is on the other side of the lens. Hence we need to place the object between 20 and 40 cm of the lens.

When an object is placed between F and 0 of a convex lens, its enlarged, erect and virtual image is formed beyond FL i.e. on the same side of lens. So for this we need to place the object at a distance less than 20 cm from the lens.

26. 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?

Soln:

To obtain clear image of the building Sudha has to move the screen towards the elns. Focal length will be approximately 15 cm. The rays of light coming from distant object such as a tree (or a distant building or electricity pole) can be considered to be parallel to each other. When parallel rays of light are incident on a convex lens, the rays, after refraction, converge at focus on the other side of the lens.

27. 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?
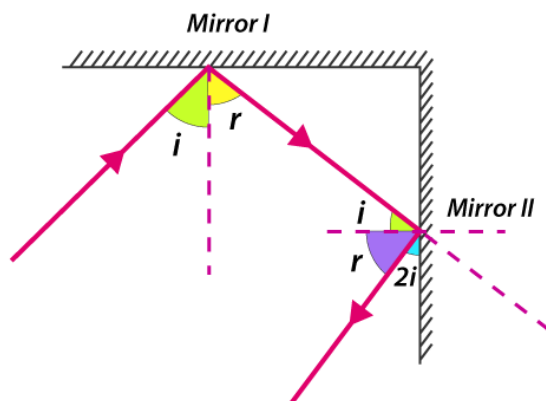
Soln:

Power of lens is inversely proportional to the focal length of the lens. Lens with focal length 20 has more power than lens with focal length 40 cm. Lens with higher power should be used to obtain more convergent light.

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

Soln:

If two plane mirrors are placed perpendicular to each other then Incident ray and reflected ray will always be parallel to each other.
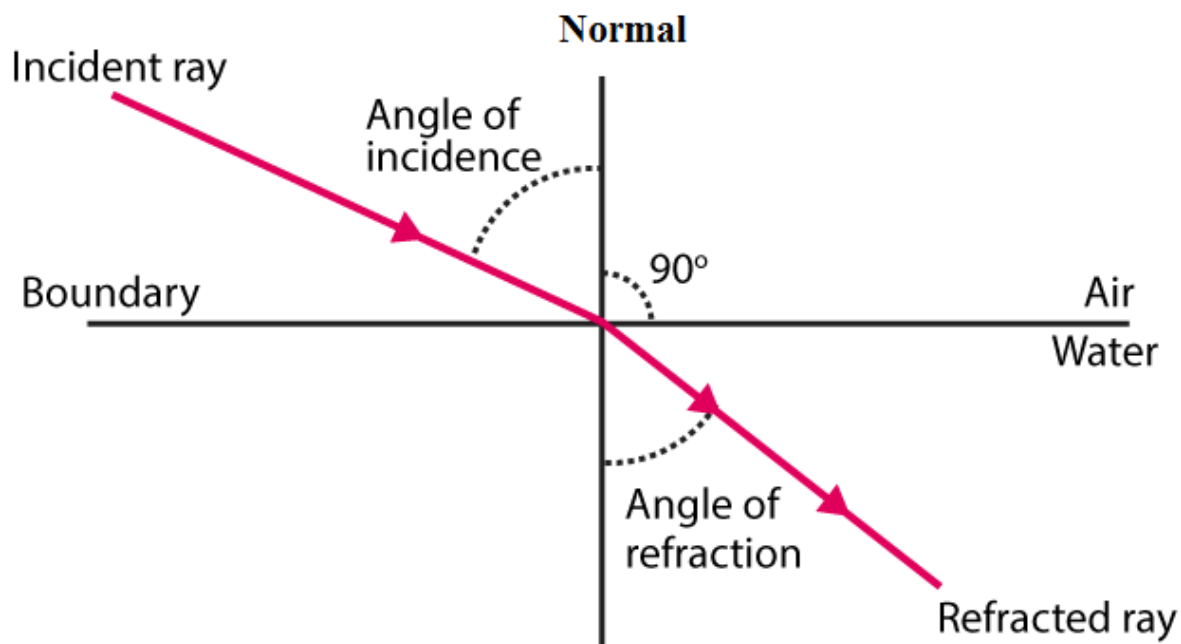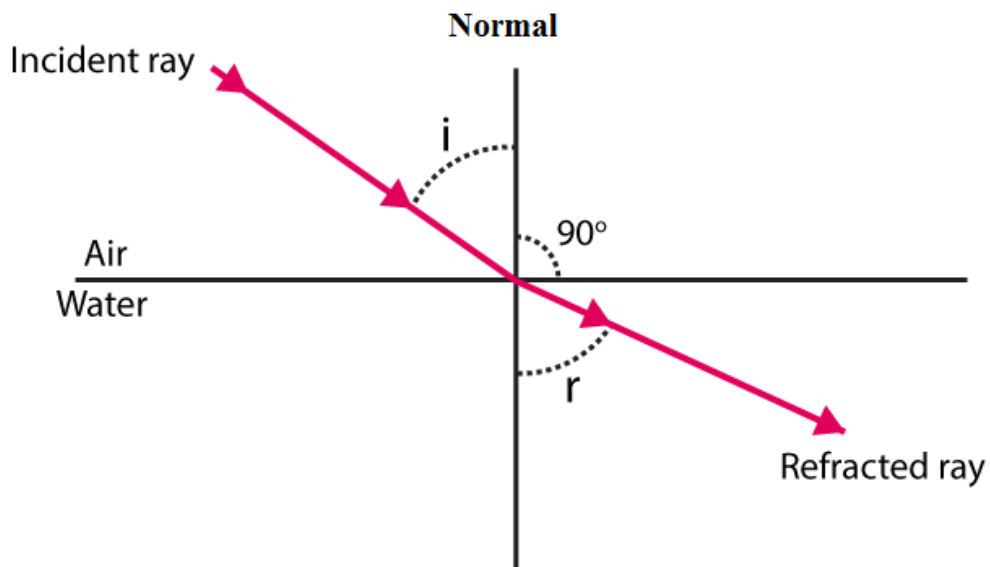
Mirror I

Mirror II

29. 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.

Soln:

Speed of light decreases when it passes from rarer medium to denser medium and also light rays bend towards normal.

When ray of light passes from denser medium to rarer medium light rays bends away from the normal.


Normal

Incident ray

Angle of incidence

90°

Boundary

Air
Water

Angle of refraction

Refracted ray

Normal

Incident ray

i

Air

Water

90°

r

Refracted ray

30. 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 centre of curvature of the mirror
(c) at centre of curvature of the mirror
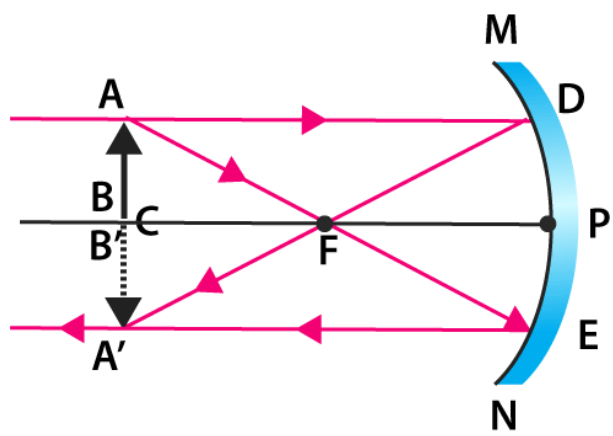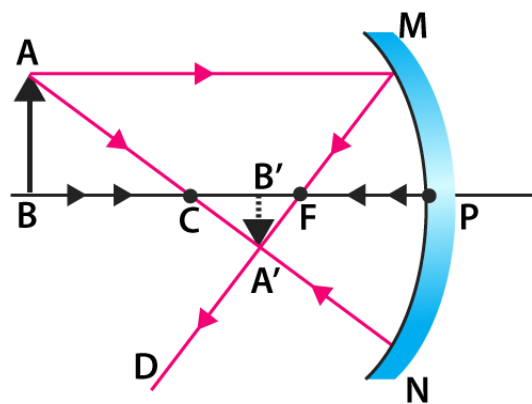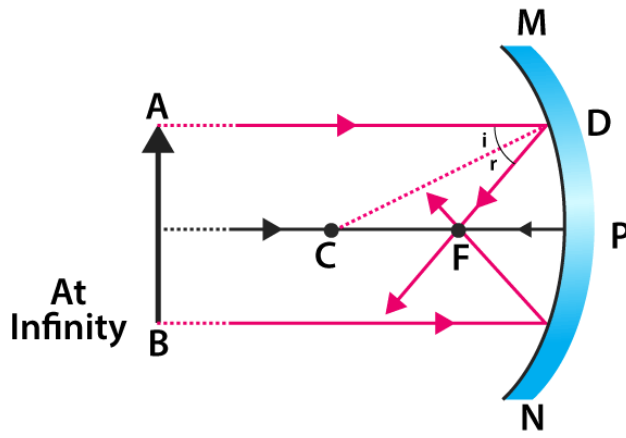**(d) a little beyond centre of curvature of the mirror**
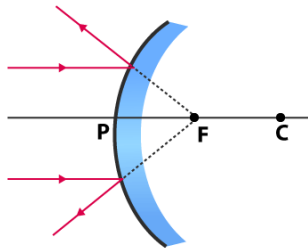**(e) at infinity**

Soln:

a)
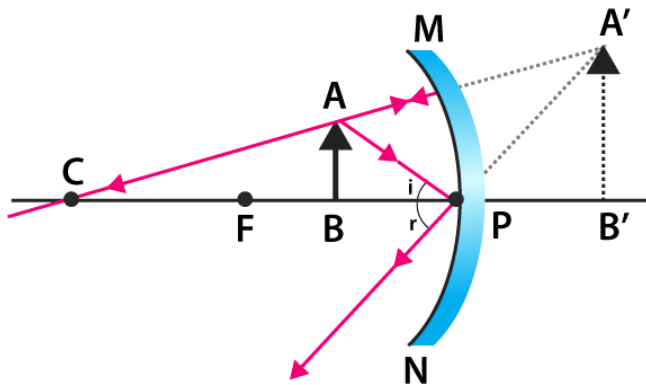
b)
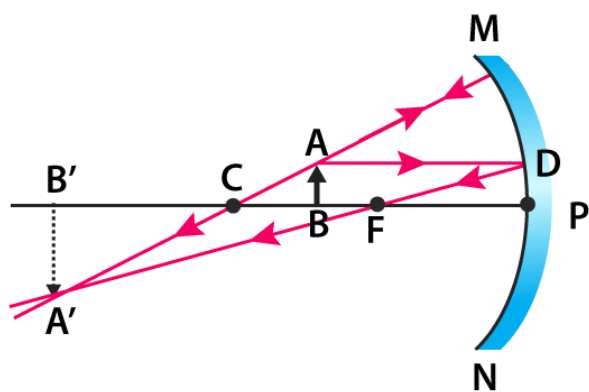
C)

d)

e)

31. Draw ray diagrams showing the image formation by a convex lens when an object is placed
(a) between optical centre 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
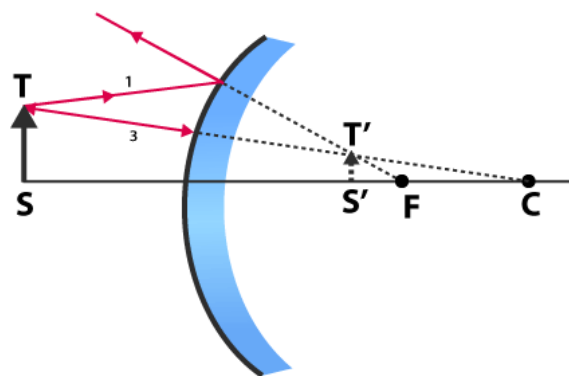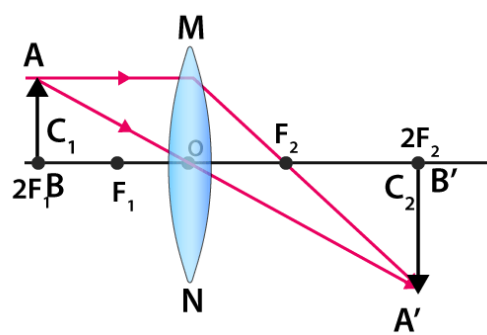**(d) at infinity (e) at the focus of the lens**
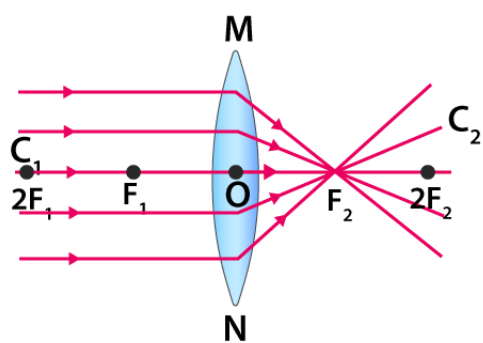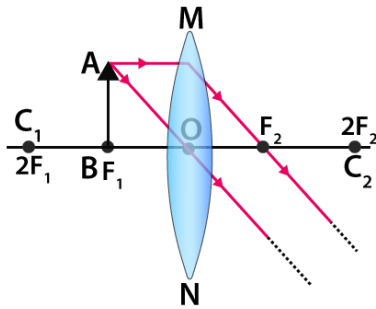
Soln:
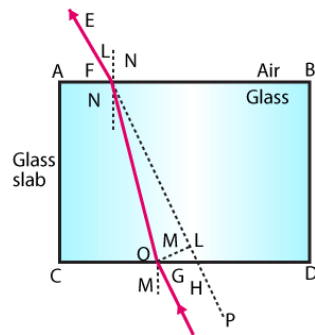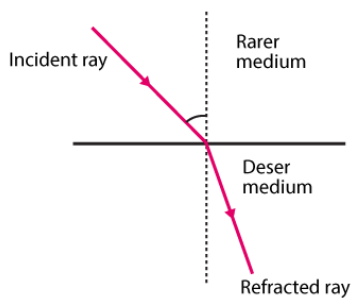
a)

b)

c)

d)

e)

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

Soln:

Laws of refraction

a) Incident ray, refracted ray and normal at the point of incidence lie in the same plane.

b) Ratio of sine of incidence and sine of refraction is constant for the given color and pair of media.

• ABCD is a glass slab.
EF is incident ray which is incident on point 0 on air-glass interface.
• NO is normal and _LEON = :I; which Is angle of incidence.
• NV is normal extended towards the glass slab and ..LV '00 = Zri; which is angle of refraction.
• 00' is refracted ray from surface AB. It behaves like Incident ray on surface CD.
• the ray EF bends when it enters the slab to become 00'.
• MO' and O'M' are normal on surface CD.
• GH is the emergent ray.
• ZOO' Al = Li,; which is angle of Incidence at surface CD.
• Z.110' H = Zr,; which Is angle of refraction at surface CD.
• It is observed that EF. NO and 00' lie in the same plane: which is in accordance to the first law of refraction.
• It is also observed that EF II GH; which means emergent ray is parallel to incident ray. This happens because the degree of bend at opposite surfaces of glass slab is same.

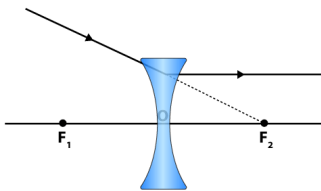**33. Draw ray diagrams showing the image formation by a concave lens when an object is placed**
(a) at the focus of the lens
(b) between focus and twice the focal length of the lens
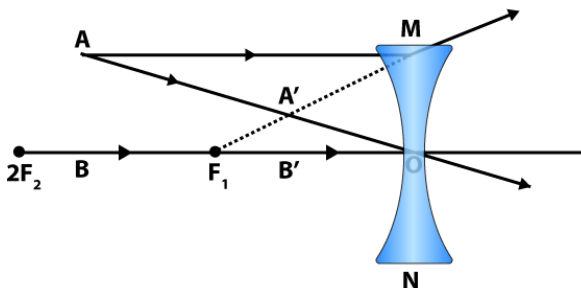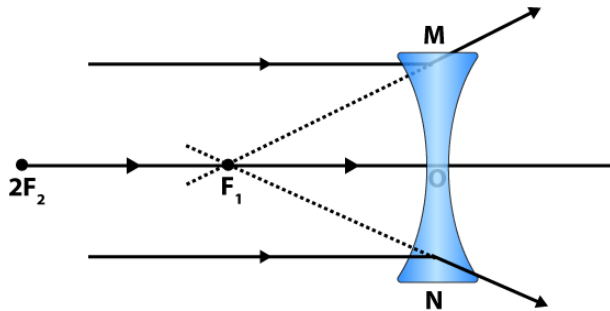**(c) beyond twice the focal length of the lens**

Soln:

(a) The ray diagram when the object is placed at the focus of the concave lens:

(b) The ray diagram when the object is placed between focus and twice the length of focal length of the lens:

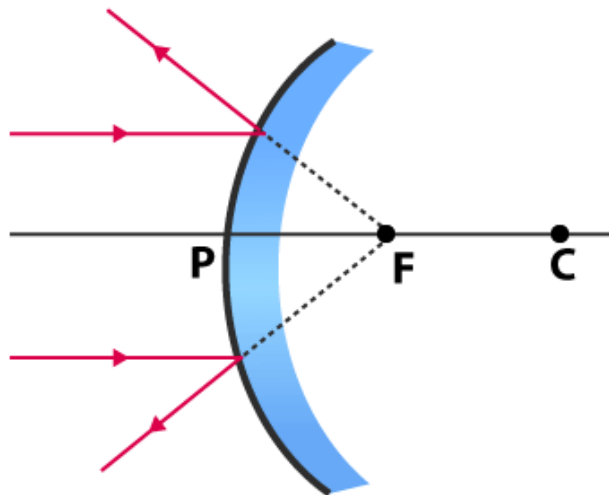(c) Ray diagram when the object is beyond twice the focal length of the concave lens:

34. Draw ray diagrams showing the image formation by a convex mirror when an object is placed
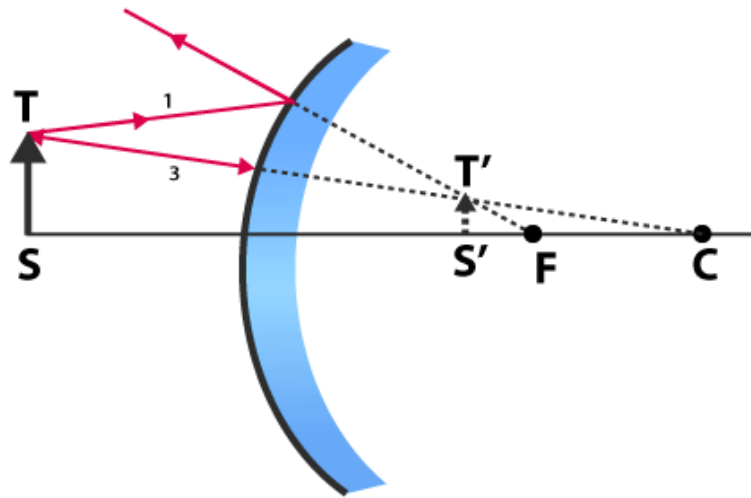**(a) at infinity**
(b) at finite distance from the mirror

Soln:

    a)   At Infinity

b) At infinite distance from the mirror

35. The image of a candle flame formed by a lens is obtained on a screen placed on the 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 from the lens? What is the nature of the image at a distance of 80 cm and the lens?

Soln:

As the image is obtained on the screen , it is real .

so,

Magnification , $m = -3$,

$v = 80$ cm

$u = ?$

As $m = v/u$

so,

$-3 = 80/u$,

$u = -80/3$ cm .

From

1/f = 1/v - 1/u

=1/80 + 3/80

= 4/80

= 1/20

1/f = 1/20cm

so,

f = 20 cm .

The lens is convex and image formed at 80 cm from the lens is real and inverted.

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

Soln:

$m = \dfrac{1}{3}$

Using $\dfrac{1}{v} + \dfrac{1}{u} = \dfrac{1}{f}$

Calculate u;u = – 80 cm.

Image is real and inverted. Mirror is concave.

37. 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 lens and its power used by each of them?

Soln:

Degree of convergence and divergence provided by a lens is called power of the lens. Unit of power of lens is Diopter D.

focal length of lens used by first student is in positive hence it is a convex lens. The lens of second student is a concave lens.

$p == \dfrac{1}{f} = \dfrac{1}{0.5} = 2$

Power of lens (first student) =+2
Power of lens (second student) =).2

38. A student focussed 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 (iii) as said above.**

Soln:

Position of the candle flame = 12.0cm

Position of the lens= 50.0 cm

Position of the screen=88.0 cm

i) u= 50-12= 38 cm.

Image distance v= 88-50= 38cm

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

f= 19cm

ii) Object distance u= 50-31= 19 cm

Here

Object distance = focal length

Hence the I mage is formed at infinity.

iii)

If he further shifts the candle towards the lens. The object comes between F and 0. In this case. Image is virtual, enlarged and erect and is formed on the same side of lens.

iv)