NCERT QUESTIONS WITH SOLUTIONS

1. A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal? Why?

Solution

The light ray bends towards the normal. This is because it enters from rarer (air) medium to denser (water) medium.

2. Light enters from air to glass having refractive index 1.50. What is the speed of light in the glass? The speed of light in vacuum is 3×10^8 ms^{-1}.

Solution

We know that, absolute refractive index (n) of a medium is given by,

$$n = \frac{c}{v} \text{ or } v = \frac{c}{n}$$

Thus, $v_{glass} = \frac{c}{n_{glass}} = \frac{3\times10^8}{1.5}$ = **2 × 10⁸ m/s**

3. Find out, from Table given below, the medium having highest optical density. Also find the medium with lowest optical density.

Material medium	Refractive index
Vacuum	1.00
Air	1.0003
Ice	1.31
Water	1.33
Alcohol	1.36
Kerosene	1.44
Fused quartz	1.46
Turpentine oil	1.47
Glycerine	1.47
Benzene	1.50
Crown glass	1.52
Canada Balsam	1.53
Rock salt	1.54
Carbon disulphide	1.63
Dense flint glass	1.65
Ruby	1.71
Sapphire	1.77
Diamond	2.42

Solution

Among the media given in the above table, diamond has highest optical density as its refractive index is maximum among the given media. Air has least optical density as its refractive index is minimum among the given media.

4. You are given kerosene, turpentine and water. Using the table given in question 3, find in which of these does the light travel fastest.

Solution

The light travels fastest in water as its refractive index is least ($v \propto 1/n$), among the three given substances.

5. The refractive index of diamond is 2.42. What is the meaning of this statement?

Solution

We know that, absolute refractive index (n) of a medium is given by,

$$n = \frac{c}{v} \text{ or } v = \frac{c}{n} \text{ i.e., } v \propto \frac{1}{n}$$

Since, the refractive index of diamond is 2.42, this suggests that the speed of light in diamond will reduce by a factor 2.42 compared to its speed in air.

6. Define 1 dioptre of power of a lens.

Solution

1 dioptre is defined as the power of a lens of focal length 1 metre.

7. A convex lens forms a real and inverted image of a needle at a distance of 50 cm from it. Where is the needle placed in front of the convex lens if the image is equal to the size of the object? Also, find the power of the lens.

Solution

Given, v = + 50 cm (positive sign is taken because real image in convex lens is formed on the right side).

Since, the image is real and size of the image is equal to the size of object.

$\therefore$ Magnification, m = –1

Now, $m = +\frac{v}{u}$ or $-1 = +\frac{v}{u}$

or u = – v = – (+50) = **– 50 cm**

By lens equation,

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

$$\frac{1}{(+50)} - \frac{1}{(-50)} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{2}{50} = \frac{1}{25}$$

or f = + 25 cm = + 0.25 m

Power, $P = \frac{1}{f} = \frac{1}{+0.25}$

= **+ 4 Diopter**

8. Find the power of a concave lens of focal length 2 m.

Solution

Given, focal length = – 2 m (focal length of concave lens is negative).

Power, $P = \frac{1}{f} = \frac{1}{-2.0}$

or P = **– 0.5 Diopter**

9. Which one of the following materials cannot be used to make a lens?

(a) Water (b)Glass

(c) Plastic (d) Clay

Solution

(d) Clay is not transparent; therefore, it cannot be used for making lens.

10. Where should an object be placed in front of a convex lens to get a real image of the size of the object?

(a) At the principal focus of the lens

(b) At twice the focal length

(c) At infinity

(d) Between the optical centre of the lens and its principal focus.

Solution

When an object is placed at $2F_1$ in front of a convex lens, its image is formed at $2F_2$ on the other side of the lens. The image formed is real, inverted, and of the same size as the object.

Thus, option (b) is correct i.e., the object should be placed at twice the focal length from the optical centre of the lens.

11. A spherical mirror and a thin spherical lens have each a focal length of –15 cm. The mirror and the lens are likely to be

(a) both concave

(b) both convex

(c) the mirror is concave and the lens is convex

(d) the mirror is convex, but the lens is concave

Solution

Option (a) is correct i.e., a concave mirror as well as concave lens both have negative focal length.

12. Which of the following lenses would you prefer to use while reading small letters found in a dictionary?

(a) A convex lens of focal length 50 cm

(b) A concave lens of focal length 50 cm

(c) A convex lens of focal length 5 cm

(d) A concave lens of focal length 5 cm

Solution

Option (c) is correct.

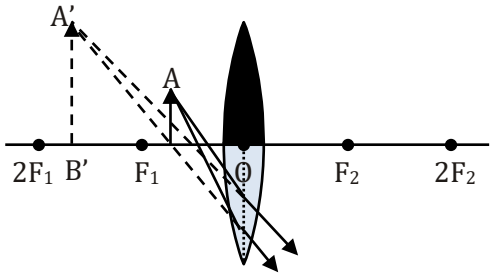
For reading small letters in a dictionary, a convex lens of small focal length is used as it is kept quite close to the page of the dictionary.

13. One-half of a convex lens is covered with a black paper. Will this lens produce a complete image of the object? Verify your answer experimentally. Explain your observations.

Solution

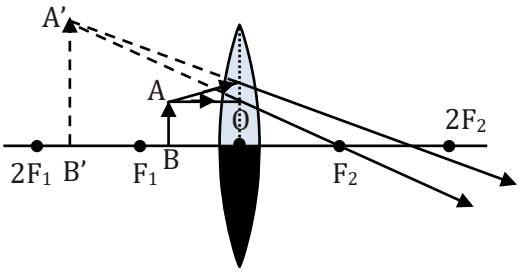
The convex lens will form complete image of an object, even if its one half is covered with black paper. Only the brightness of the image will reduce, in this case it will be half of the brightness of original image. It can be understood by the following two cases:

(a) Let the upper half of the lens be covered and an object be placed between optical centre and the focus F_1. The light rays from the object falling on the lower half of the lens form a virtual, erect and magnified image [see figure(a)]



(a)

(b) Let the lower half of the lens be covered and an object be placed between optical centre and the focus F_1. The light rays from the object falling on the upper half of the lens form a virtual, erect and magnified image [see figure(b)]



(b)

14. An object 5 cm in length is held 25 cm away from a converging lens of focal length 10 cm. Draw the ray diagram and find the position, size and the nature of the image formed.

Solution

Given, $h_1 = +5$ cm; $u = -25$ cm; $f = +10$ cm

By lens equation,

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \quad \text{or} \quad \frac{1}{v}-\frac{1}{(-25)}=\frac{1}{+10}$$

$$\text{or} \quad \frac{1}{v}+\frac{1}{25}=\frac{1}{+10}$$

$$\text{or} \quad \frac{1}{v}=\frac{1}{10}-\frac{1}{25}=\frac{5-2}{50}=\frac{3}{50}$$

or $v = +50/3 =$ **+ 16.67 cm**

Magnification,

$$m = +\frac{v}{u} = \frac{+(50/3)}{(-25)} = -\frac{2}{3}$$

Now, $m = \frac{h_2}{h_1}$ or $-\frac{2}{3} = \frac{h_2}{h_1}$

or $h_2 = -\frac{2}{3} h_1 = -\frac{2}{3} \times 5 = -\frac{10}{3}$

or h_2 = **–3.33 cm**

The image is real, inverted and diminished.

15. A concave lens of focal length 15 cm forms an image 10 cm from the lens. How far is the object placed from the lens? Draw the ray diagram.

Solution

Given, f = – 15 cm,

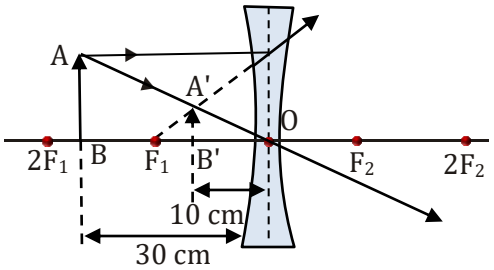
v = – 10 cm (negative sign is taken because the image formed in concave lens is always towards left)

By lens equation,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad \text{or} \quad \frac{1}{(-10)} - \frac{1}{u} = \frac{1}{-15}$$

or $\frac{-1}{10} + \frac{1}{15} = \frac{1}{u}$ or $\frac{1}{u} = \frac{-3+2}{30} = -\frac{1}{30}$

or u = **– 30 cm**



16. Find the focal length of a lens of power –2.0 D. What type of lens is this?

Solution

Given, power, P = –2.0 D

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

or $f = \frac{1}{P} = \frac{1}{-2}$ = **– 0.5 m**

= **– 50 cm**

The lens is a concave (or diverging) lens.

17. A doctor has prescribed a corrective lens of power +1.5 D. Find the focal length of the lens. Is the prescribed lens diverging or converging?

Solution

Given, power, P = +1.5 D

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

or $f = \frac{1}{P} = \frac{1}{+1.5} = \frac{10}{15} = +\frac{2}{3}$

or f = +0.66 m = **+ 66 cm**

The lens is a convex (or converging) lens.