NCERT Solutions for Class 10 Science: Chapter 10 Light Reflection and Refraction

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NCERT Solutions for Class 10 Science: Chapter 10 - Light Reflection and Refraction

Class 10: Science Chapter 10 solutions. Complete Class 10 Science Chapter 10 Notes.

NCERT Solutions for Class 10 Science: Chapter 10 - Light Reflection and Refraction

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1. Define the principal focus of a concave mirror.

Answer

Light rays that are parallel to the principal axis of a concave mirror converge at a specific point on its principal axis after reflecting from the mirror. This point is known as the principal focus of the concave mirror.

2. The radius of curvature of a spherical mirror is 20 cm. What is its focal length?

Answer

Radius of curvature, R= 20 cm

Radius of curvature of a spherical mirror = 2 × Focal length (f)R= 2f

f= R/2 = 20 / 2 = 10

Hence, the focal length of the given spherical mirror is 10 cm.

3. Name the mirror that can give an erect and enlarged image of an object.

► Concave Mirror.

4. Why do we prefer a convex mirror as a rear-view mirror in vehicles?

Answer

We prefer a convex mirror as a rear-view mirror in vehicles because it gives a wider field of view, which allows the driver to see most of the traffic behind him. Convex mirrors always form a virtual, erect, and diminished image of the objects placed in front of it.

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1. Find the focal length of a convex mirror whose radius of curvature is 32 cm.

Answer

Radius of curvature, R= 32 cm

Radius of curvature = 2 × Focal length (f)

R= 2$f$$f$= R/2 = 32/2 = 16

Hence, the focal length of the given convex mirror is 16 cm.

2. A concave mirror produces three times magnified (enlarged) real image of object placed at 10 cm in front of it. Where is the image located?

Answer

Magnification produced by a spherical mirror is given by the relation,

$$m = \frac{Height\ of\ the\ Image}{Height\ of\ the\ Object} = -\frac{Image\ Distance}{Object\ Distance}$$

$$m = \frac{h_1}{h_0} = -\frac{u}{v}$$

Let the height of the object, h_o= h

Then, height of the image, h_1= -3h (Image formed is real)

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

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

Object distance, u= - 10 cm

v = 3 × (- 10) = - 30 cm

Here, the negative sign indicates that an inverted image is formed at a distance of

30 cm in front of the given concave mirror.

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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?

Answer

The ray of light bends towards the normal. When a ray of light enters from an optically rarer medium (having low refractive index) to an optically denser medium (having high refractive index), its speed slows down and it bends towards the normal. Since water is optically denser than air, a ray of light entering from air into water will bend towards the normal.

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}.

Answer

Refractive index of a medium, n_m = Speed of light in vacuum/Speed of light in the medium

Speed of light in vacuum, $c = 3 \times 10^8\ ms^{-1}$

Refractive index of glass, $n_g = 1.50$

Speed of light in the glass, v = Speed of light in vacuum/ Refractive index of glass

$= c/n_g$

$= 3 \times 10^8/1.50 = 2 \times 10^8\ ms^{-1}$.

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

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

Answer

Highest optical density = Diamond

Lowest optical density = Air

Optical density of a medium is directly related with the refractive index of that medium. A medium which has the highest refractive index will have the highest optical density and vice-versa.

It can be observed from table 10.3 that diamond and air respectively have the highest and lowest refractive index. Therefore, diamond has the highest optical density and air has the lowest optical

density.

4. You are given kerosene, turpentine and water. In which of these does the light travel fastest? Use the information given in Table.

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

Answer

In water light travel faster as compare to kerosene and turpentine because the refractive index of water is lower than that of kerosene and turpentine. The speed of light is inversely proportional to the refractive index.

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

Answer

The refractive index of diamond is 2.42. This means that the speed of light in diamond will reduce by a factor of 2.42 as compared to its speed in air.

In other words, the speed of light in diamond is 1/2.42 times the speed of light in vacuum.

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1. Define 1 dioptre of power of a lens.

Answer

The SI unit of power of lens is dioptre which is denoted by the letter D. 1 dioptre is defined as the power of a lens of focal length 1 metre.

2. 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.

Answer

Since the image is real and same size. The position of image should be at 2*F*.

It is given that the image of the needle is formed at a distance of 50 cm from the convex lens. Hence, the needle is placed in front of the lens at a distance of 50 cm.

Object distance, *u*= - 50 cm

Image distance, *v*= 50 cm

Focal length = *f*

According to the lens formula,

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

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

$$= \frac{1}{50} + \frac{1}{50} = \frac{1}{25}$$

f= 25 cm =0.25 m

Power of lens, $P = \frac{1}{f\ (in\ metres)} = \frac{1}{0.25} = +4D$

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

Answer

Focal length of concave lens, f = 2 mPower of lens, P= 1/*f* = 1/(-2)= -0.5D

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Exercise

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

(a) Water

(b) Glass

(c) Plastic

(d) Clay

► (d) Clay

2. The image formed by a concave mirror is observed to be virtual, erect and larger than the object. Where should be the position of the object?

(a) Between the principal focus and the centre of curvature

(b) At the centre of curvature

(c) Beyond the centre of curvature

(d) Between the pole of the mirror and its principal focus.

► (d) Between the pole of the mirror and its principal focus.

3. 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.

► (b) At twice the focal length

4. 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

► (a) both concave

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5. No matter how far you stand from a mirror, your image appears erect. The mirror is likely to be

(a) plane

(b) concave

(c) convex

(d) either plane or convex

► (d) either plane or convex

6. 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

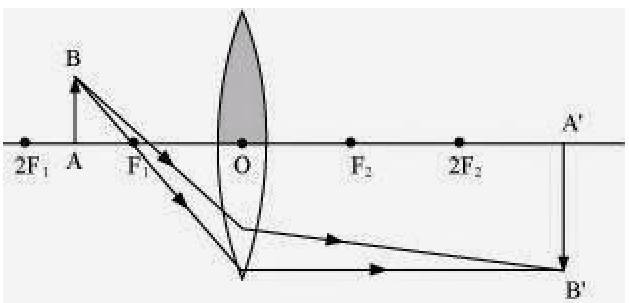
► (c) A convex lens of focal length 5 cm

7. We wish to obtain an erect image of an object, using a concave mirror of focal length 15 cm. What should be the range of distance of the object from the mirror? What is the nature of the image? Is the image larger or smaller than the object? Draw a ray diagram to show the image formation in this case.

Answer

Range of the distance of the object = 0 to 15 cm from the pole of the mirror.

Nature of the image = virtual, erect and larger than the object.



8. Name the type of mirror used in the following situations.

(a) Headlights of a car

(b) Side/rear-view mirror of a vehicle

(c) Solar furnace

Support your answer with reason.

Answer

(a) Concave Mirror: This is because concave mirrors can produce powerful parallel beam of light when the light source is placed at their principal focus.

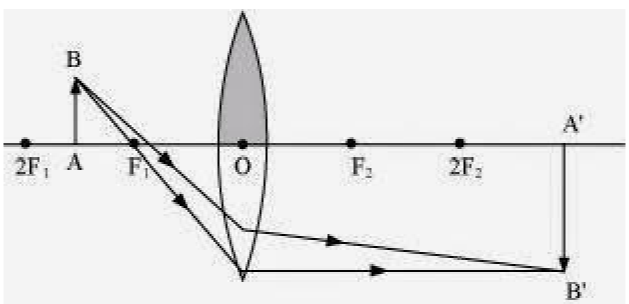
(b) Convex Mirror: This is because of its largest field of view.

(c) Concave Mirror: This is because it concentrates the parallel rays of sun at principal focus.

9. 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.

Answer

The convex lens will form complete image of an object, even if its one half is covered with black paper. It can be understood by the following two cases.Case I



When the upper half of the lens is covered

In this case, a ray of light coming from the object will be refracted by the lower half of the lens. These rays meet at the other side of the lens to form the image of the given object, as shown in the above figure.

Case II

Height of the Object, h_0 = 5 cm

Distance of the object from converging lens, u = – 25 cm

Focal length of converging lens, f = 10 cm

Using lens formula,

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

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} - \frac{1}{25} = \frac{15}{250}$$

$$v = \frac{250}{15} = 16.66 \text{ cm}$$

Also, for a converging lens, $\frac{h_i}{h_0} = \frac{v}{u}$

$$h_i = \frac{v}{u} \times h_0 \; \frac{50 \times 5}{3 \times (-25)} = \frac{10}{-3} = -3.3 \text{ cm}$$

Thus, the image is inverted and formed at a distance of 16.7 cm behind the lens and measures 3.3 cm. The ray diagram is shown below.

When the lower half of the lens is covered

In this case, a ray of light coming from the object is refracted by the upper half of the lens. These rays meet at the other side of the lens to form the image of the given object, as shown in the above figure.

10. 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.

Answer

Height of the Object, h_0 = 5 cm

Distance of the object from converging lens, u = – 25 cm

Focal length of converging lens, f = 10 cm

Using lens formula,

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

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} - \frac{1}{25} = \frac{15}{250}$$

$$v = \frac{250}{15} = 16.66 \text{ cm}$$

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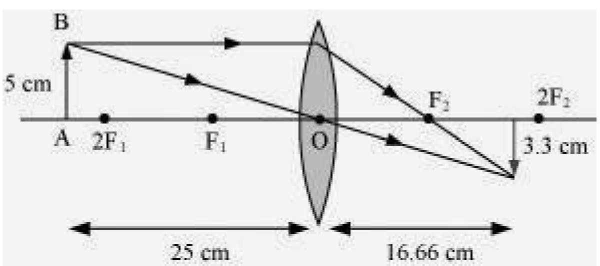


11. A concave lens of focal length 15 cm forms an image 10 cm from the lens. How far is the object placed from the lens? Draw the ray diagram.

Answer

Focal length of concave lens (OF_1), f = - 15 cm

Image distance, v= - 10 cm

According to the lens formula,

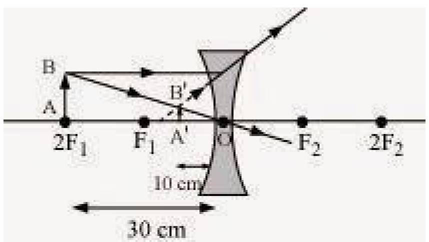
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

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

$$= \frac{-1}{10} - \frac{1}{-15} = \frac{-1}{10} + \frac{1}{15} = \frac{-5}{150}$$

u = -30 cm

The negative value of *u* indicates that the object is placed 30 cm in front of the lens. This is shown in the following ray diagram.



12. An object is placed at a distance of 10 cm from a convex mirror of focal length 15 cm. Find the position and nature of the image.

Answer

Focal length of convex mirror, *f*= +15 cm

Object distance, *u*= - 10 cm

According to the mirror formula,

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

$$\Rightarrow \frac{1}{v} = \frac{1}{15} - \frac{1}{(-10)}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{15} + \frac{1}{10}$$

$$\Rightarrow \frac{1}{v} = \frac{2+3}{30}$$

$$\Rightarrow \frac{1}{v} = \frac{5}{30}$$

$$\Rightarrow v = 6\ cm$$

$$\text{Magnification} = \frac{-v}{u} = \frac{-6}{-10} = 0.6$$

The image is located at a distance 6 cm from the mirror on the other side of the mirror.

The positive and value less than 1 of magnification indicates that the image formed is virtual and erect and diminished.

13. The magnification produced by a plane mirror is +1. What does this mean?

Answer

The positive sign means image formed by a plane mirror is virtual and erect. Since the magnification is 1 it means that the size of the image is equal to the size of the object.

14. An object 5 cm is placed at a distance of 20 cm in front of a convex mirror of radius of curvature 30 cm. Find the position, nature and size of the image.

Answer

Object distance, u= - 20 cm

Object height, h= 5 cm

Radius of curvature, R= 30 cm

Radius of curvature = 2 × Focal length

R= 2f

f= 15 cm

According to the mirror formula,

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

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

$$= \frac{1}{15} + \frac{1}{20} = \frac{4+3}{60} = \frac{7}{60}$$

v = 8.57 cm

The positive value of v indicates that the image is formed behind the mirror.

Magnification, $m = -\frac{Image\ DIstance}{Object\ Distance} = \frac{-8.57}{-20} = 0.428$

The positive value magnification indicates that the image formed is virtual.

Magnification, $m = \frac{Height\ of\ the\ Image}{Height\ of\ the\ Object} = \frac{h'}{h}$

$h' = m \times h = 0.428 \times 5 = 2.14$ cm

The positive value of image height indicates that the image formed is erect.

Therefore, the image formed is virtual, erect, and smaller in size.

15. An object of size 7.0 cm is placed at 27 cm in front of a concave mirror of focal length 18 cm. At what distance from the mirror should a screen be placed, so that a sharp focused image can be obtained? Find the size and the nature of the image.

Answer

Object distance, u= - 27 cm

Object height, h= 7 cm

Focal length, f = - 18 cm

According to the mirror formula,

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

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

$$= \frac{-1}{18} + \frac{1}{27} = \frac{-1}{54}$$

v = -54 cm

The screen should be placed at a distance of 54 cm in front of the given mirror.

Magnification, $m = -\frac{Image\ DIstance}{Object\ Distance} = \frac{-54}{27}$ = -2

The negative value of magnification indicates that the image formed is real.

Magnification, $m = \frac{Height\ of\ the\ Image}{Height\ of\ the\ Object} = \frac{h\prime}{h}$

h' = 7 x (-2) = -14 cm

The negative value of image height indicates that the image formed is inverted.

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

Answer

Power of lens, *P*= 1/*f*

P= -2D

f= -1/2 = -0.5 m

A concave lens has a negative focal length. Hence, it is a concave 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?

Answer

Power of lens, $P = 1/f$

$P = 1.5D$

$f = 1/1.5 = 10/15 = 0.66$ m

A convex lens has a positive focal length. Hence, it is a convex lens or a converging lens.

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Chapterwise NCERT Solutions for Class 10 Science :

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