4. Refraction of Light at Curved Surfaces

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1 Mark Questions

Questions 1.
What is a lens?

Answer:
A lens is formed when a transparent material is bounded by two surfaces of which one (or) both surfaces are spherical.

Questions 2.
What is a double convex lens?

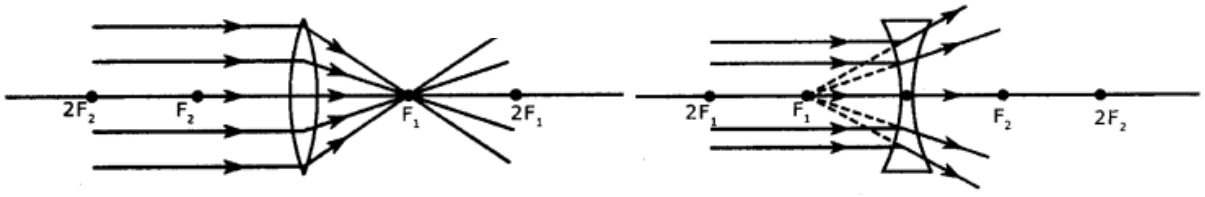
Answer:
A lens may have two spherical surfaces bulging outwards, such a lens is called double convex lens. It is thick at the middle as compared to edges.

Question 3.
What is a double concave lens?

Answer:
A double concave lens‘s bounded by two spherical surfaces curved inwards. It is thin at the middle and thicker at the edges and is called double concave lens.

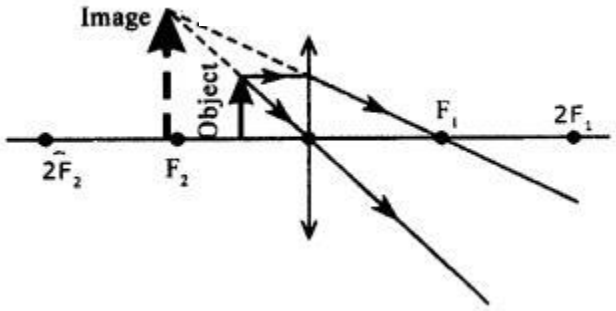
Question 4.
Define focal length of a lens.

Answer:
The point of convergence or the point from which rays seem to emanate after refraction in a lens is called focal point or focus (F). The distance between the focal point and optic centre is called focal length of lens, denoted by ‘f’.



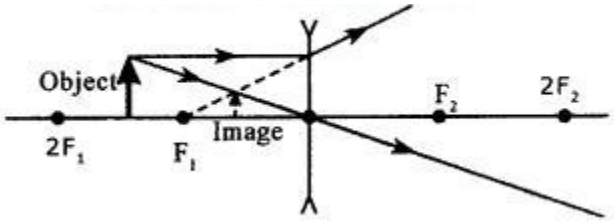
Question 5.
When do you get a virtual and magnified image with a convex lens?

Answer:
A magnified virtual image Is formed by a convex lens, when the object is at distance less than the focal length of the lens.



Question 6.
What Is the position and nature of the Image formed by a concave lens?

Answer:
Irrespective of the position of the object on the principal axis, we get an erect, virtual and Object diminished image in between the focal point and optic centre for a concave lens.



Question 7.
Write the lens formula.

Answer:
Lens formula: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

Here f – Focal length, v – Image distance, u – Object distance

Question 8.
What is the behaviour of convex lens when it is kept in another medium?

Answer:

1. The convex lens behaves as a convergence lens If It is kept in a medium with refractive index less than the refractive index of the lens.
2. It behaves as a diverging lens when it is kept In a transparent medium with greater refractive index than that of the lens.

Question 9.
What is lens maker formula?

Answer:

$$\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

Question 10.
What is power of lens?

Answer:
It Is the ability of a lens to converge (or) diverge a beam of light falling on it.

Question 11.
What are paraxial rays?

Answer:
The rays which move very close to the principal axis.

Question 12.
What ¡s absolute refractive index?

Answer:
It is the ratio of speed of light in air to speed of light In any medium.

Question 13.
Which mirror is similar to convex sens?

Answer:
Concave mirror.

Question 14.
Which mirror is similar to concave lens?

Answer:
Convex mirror.

Question 15.
Which lens will form both real and virtual images?

Answer:
Convex lens.

Question 16.
Give two uses of convex lens.

Answer:

1. used in projectors and
2. in cameras.

Question 17.
Which lens has a negative power?

Answer:
Concave lens.

Question 18.
Which lens has a positive power?

Answer:
Convex lens.

Question 19.
What type of lens behaviour will an air bubble inside water show?

Answer:
It will act as a concave lens.

Question 20.
What Is a double concave lens?

Answer:
It has two spherical surfaces curved inward is called a double concave lens.

Question 21.
Write about the thickness of concave lens.

Answer:
It has thin at the middle and thicker at the edges.

Question 22.
What is the mid-point of ens called?

Answer:
The mid-point of lens Is called pole (or) optical centre.

Question 23.
What happens If the ray passes through principal axis?

Answer:
It will be undeviated.

Question 24.
What ii the name given to line joining focal point, pole and centre of curvature?

Answer:
Principal axis.

Question 25.
What happens to a ray passing through pole?

Answer:
It will not deviated.

Question 26.
Where does light rays travelling to principal axis converge?

Answer:
They converge at focus.

Question 27.
What happens to light rays passing through focus?

Answer:
The path of the rays is parallel to principal axis after refraction.

Question 28.
There an object should be placed in front of a convex lens to get a real image of the size of object?

Answer:
At centre of curvature.

Question 29.
What is other names of convex lens?

Answer:
Converging lens (or) positive lens.

Question 30.
What is the other name of concave lens?

Answer:
Diverging lens (or) negative lens.

Question 31.
When do you get image at Infinity with a convex lens?

Answer:
The object is at the focal point.

Question 32.
When do you get a virtual Image with a convex lens?

Answer:
The object is placed between focus and pole.

Question 33.
The image formed by an en Is always erect and diminished. What is the nature of lens?

Answer:
It is a concave lens.

Question 34.
From which point of lens are all the distances measured?

Answer:
The optical centre of the lens.

Question 35.
Do only convex lens converge?

Answer:
No, a concave mirror also converge.

Question 36.
What happens to the Image formed by a convex lens If its lower part Is blackened?

Answer:
Every part of a lens forms a complete image. If the lower part of the lens is blackened the complete image will be formed but its intensity will be decreased.

Question 37.
Is it possible for a lens to act as a convergent lens In one medium and a divergent lens in another?

Answer:
Yes, a convergent lens is placed in a higher refractive index of medium the nature of the lens changes i.e., it acts as divergent lens.

Question 38.
Give mathematic expressIon for power of a lens and explain the terms in the formula.

Answer:
Power (P) = $\frac{1}{f}$

Where is focal length of lens.

Question 39.
Is focal length of a lens Is zero if not why?

Answer:
No, focal length of lens never equals to zero because it is the distance between focal point and optical centre.

Question 40.
If the size of Image Is same as object through a convex lens, then where Is the object placed?

Answer:
The object Is placed at the centre of curvature.

Question 41.
Ravi used a lens to burn a paper. What Is that lens?

Answer:
It is a convex lens.

Question 42.
How will you Identify a concave lens by touching it?

Answer:
A concave lens Is thinner at centre and thicker at edges.

Question 43.
How will you identify a convex lens by touching It?

Answer:
A convex lens is thicker at centre and thinner at edges.

Question 44.
Give use of concave lens.

Answer:
In spectacles, for Myopia.

Question 45.
Give the sign conventions for lenses with regard to the object and image distance.

Answer:
The distance measured In the direction of incident ray is taken as positive. The distance measured against the direction of incident ray is taken as negative.

Question 46.
Give the sign conventions for lenses with regard to the height of objects and images.

Answer:
All the heights of objects and images above principal axis are positive and below the axis are negative.

Question 47.
What type of lens does a drop of water behave like?

Answer:
It behaves as convex lens.

Question 48.
A thin lens has a focal length of 12 cm. Is It a convex lens or a concave lens?

Answer:
It Is a convex lens, because f is positive.

Question 49.
Does the lens formula change depending on the position of the object in front of the lens?

Answer:
No.

Question 50.
When light of two colours, A and B Is passes through a plane boundary, A is bent more than B. Which colour travels more slowly In the second medium?

Answer:
Colour A travels slowly.

Question 51.
What is a focal plane? (ASi)

Answer:
A plane which is perpendicular to principal axis at the focus is called focal plane.

Question 52.
On what factor does focal length of a lens depend?

Answer:
It depends on refractive index of the medium, object distance and image distance.

Question 53.
Write the list of materials required for the experiment to find the focal length of a convex lens.

Answer:
V-shaped stand, convex lens, screen, candle, meter scale.

2 Marks Questions

Question 1.
Find, the focal length of plane convex lens If Its radius of curvature is R and Its refractive Index is n.

Answer:
Given lens is plano-convex lens and radius of curvature Is = R
Refractive Index = n =

As the lens is kept In air. Lens' makers formula is $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Here $R_1 = \infty$ (for plano-convex lens)

$R_2 = R$ (for convex lens)

$$\frac{1}{f} = (n-1)\left(\frac{1}{\infty} - \left(\frac{1}{-R}\right)\right)$$

$$\frac{1}{f} = (n-1)\left(o + \frac{1}{R}\right) = (n-1)\left(\frac{1}{R}\right) \quad \left(\because \frac{1}{\infty} = 0\right)$$

$$\frac{1}{f} = \frac{n-1}{R} \Rightarrow f = \frac{R}{n-1}$$

$\therefore$ Required focal length is = $\frac{R}{n-1}$

Question 2.
Focal length of the lens depends on its surrounding medium. What happens, It we use a liquid as surrounding media of refractive index, equal to the refractive Index of lens?

Answer:

1. When the refractive index of surrounding media is equal to the refractive index of lens, the lens looses Its characteristics.
2. Lens do not diverge or converge the light.
3. Light do not get refracted when it passes through that lens.

Question 3.
Write the sign conventions for refraction through lenses.

Answer:

1. All distances are measured from the pole.
2. Distances measured along the direction of the incident light rays are taken as positive.
3. Distances measured opposite to the direction of the incident light rays are taken as negative.
4. The heights measured vertically above from the points on axis are taken as positive.
5. The heights measured vertically down from the points on axis are taken as negative.

Question 4.
Using the formula of refraction at curved surfaces, write the formula for plane surfaces.

Answer:
For curved surfaces the formula for refraction Is $n_2/v - n_1/u = (n_2 - n_1) / R$
For plane surface the radius of curvature (R) approaches infinity. Hence 1 /R becomes zero.
$n_2/v - n_1/u = 0 \Rightarrow n_2/v = n_1/u$

Question 5.
Explain, how a convex lens behaves on converging lens and diverging lens.

Answer:
The convex lens behaves as a converging lens, if it is kept In a medium with refractive index less than the refractive index of the lens. It behaves like a diverging lens when it is kept In transparent medium with greater, refractive index than that of lens. e.g.: Air bubble in water behaves like a diverging lens.

Question 6.
Write the differences between convex lens and concave lens.

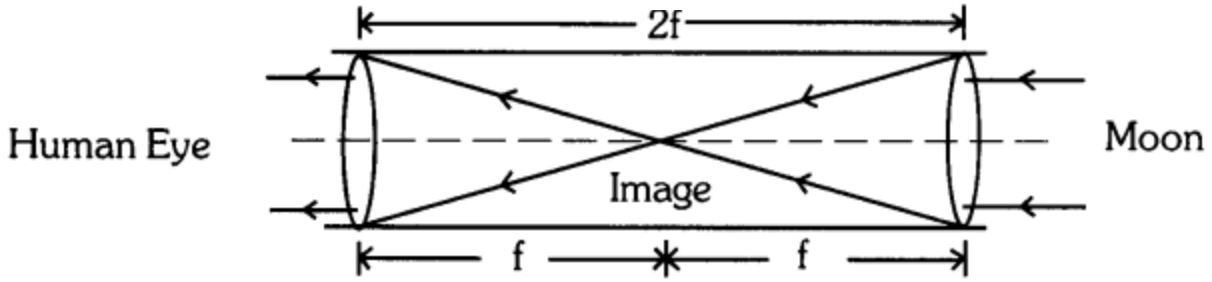
Answer:

Convex lens	Concave lens
1. Objects appear to be big through the lens.	1. Objects appear to be shnnk through the lens.
2. It generally forms real image. (except object is placed between optical centre and focal point)	2. It always forms virtual image.
3. Light rays tend to converge after refraction from lens.	3. LIght rays tend to diverge from lens after refraction.
4. The image due to convex lens may be enlarged or same size or diminished.	4. The image due to concave lens is always diminished.
5. The image due, to lens may be inverted or erect.	5. The Image is always erect.
6. It is used to correct hypermetropia.	6. It is used to correct Myopia.

Question 7.
Two convex lenses of same focal length are fixed In a PVC pipe at a distance double to their focal length. What happens If a boy sees the moon with that arrangement?

Answer:
He cannot be able to see the image of the moon.

1. Because here the image of the moon is formed at the focus of the eyepiece.
2. This image acts as an object for the eyepiece and the rays travels parallel after refraction. So, he cannot observe the image of the moon.



Question 8.
The refractive index of convex lens materials Is 1.46. The refractive index of Benzene and water is 1.5 and 1.0 respectively. How does the lens behaves when It Is kept In Benzene and water? Guess and write.

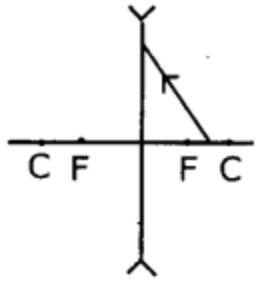
Answer:

1. When the convex lens with refractive index 1.46 is kept in Benzene with refractive index 1.5, then the lens acts as a diverging lens.
2. If the same lens Is kept in water whose refractive Index is 1, then it acts as a converging lens.

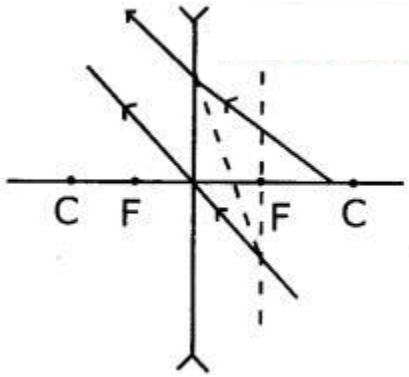
Question 9.
How will you explain twinkling of stars?

Answer:
The light from very distant stars undergoes refraction continuously before it reaches the earth. Due to this the apparent position of a star is slightly different than its actual position. Due to the variation in atmospheric conditions, this apparent position of the star constantly keeps on changing. The fluctuating
apparent positions to the star gives rise to the twinkling effect.

Question 10.
Complete the ray diagram given below.



Answer:



Question 11.
A thin converging lens has a focal length 'f' in air. If It is completely Immersed in a liquid, briefly explain how the focal length of the lens will vary? (ASI)

Answer:
The focal length of the lens in air is given by

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

if n^1 is the refractjve index of the material of the lens with respect to liquid, then the focal length of the lens, when placed in some liquid Is given by

$$\frac{1}{f^1} = \left(n^1 - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \Rightarrow \quad \frac{f^1}{f} = \frac{(n-1)}{(n^1-1)}$$

since $n^1 1$ > f i.e. focal length of the lens will increase on Immersing it in a liquid of lesser refractive index.

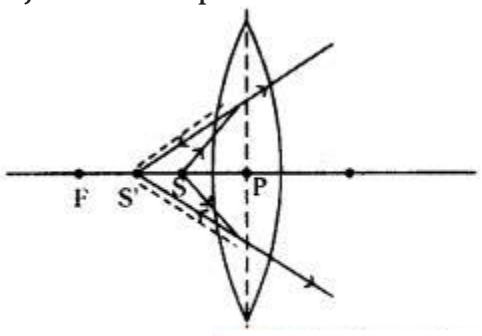
Question 12.
What changes In the focal length of a convex lens occur, when the Incident violet light on them Is replaced by red light?

Answer:
For a lens $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ Since $n_r < n_v$ the focal length of convex lens will increase on replacing violet light by red light.

4 Marks Questions

Question 1.
Using a biconvex lens, a point Image Is made on Its principal axis S. Let us assume that we know optical centre P and Its focus F. We also know PF> PS. Draw the ray diagram to identify the point source and give reasons.

Answer:
Given lens is biconvex lens and given condition is PF > PS' means image is formed between optic centre :
(P) and Focus (F). According to Snell's law this condition is possible when the object is also placed between P and F. Because reflected rays are divergent.



Question 2.
Radii of biconvex lens are equal. Let us keep an object at one of the centres of curvature. Refractive Index of lens is 'n'. Assume lens In the air. Let us take R as the radius of the curvature.
(a) How much is the focal length of the lens?
(b) What Is the Image distance?
(c) Discuss the nature of the image.

Answer:
Radii of curvatures (R) of biconvex lenses are equal, so $R_1 = R_2 = R$

(a) According to lens formula $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R} + \frac{1}{R}\right)$$

$$\frac{1}{f} = (n-1)\left(\frac{2}{R}\right)$$

$$\frac{1}{f} = \frac{2(n-1)}{R}$$

$\therefore$ Focal length of the lens = f = $\frac{R}{2(n-1)}$

b) We know that $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

Now replace $\frac{1}{f}$ in the lens formula

$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$$\frac{1}{u} + \frac{1}{v} = (n-1)\left(\frac{1}{R} + \frac{1}{R}\right)$$

$$\frac{1}{u} + \frac{1}{v} = (n-1)\left(\frac{2}{R}\right) = \frac{2n-2}{R} \Rightarrow \frac{1}{u} + \frac{1}{v} = \frac{2n-2}{R}$$

Object is placed at centre of curvature.

So, object distance = u = R

Let the image distance v = v

From above equabon $\frac{1}{v} = \frac{2n-2}{R} - \frac{1}{u} = \frac{2(n-1)}{R} - \frac{1}{R}$

$\frac{1}{v} = \frac{2n-2-1}{R} - = \frac{2n-3}{R}$

$\therefore$ Image distance $\frac{R}{2n-3}$

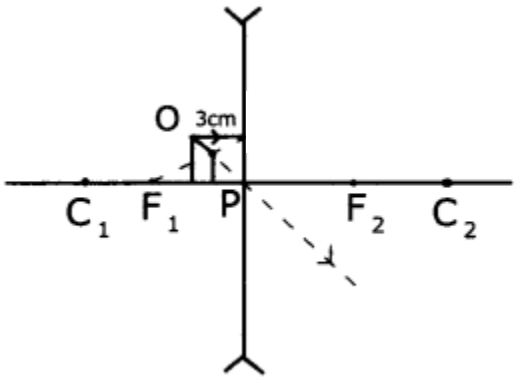
c) The nature of the image is inverted and v < u.

Question 3.

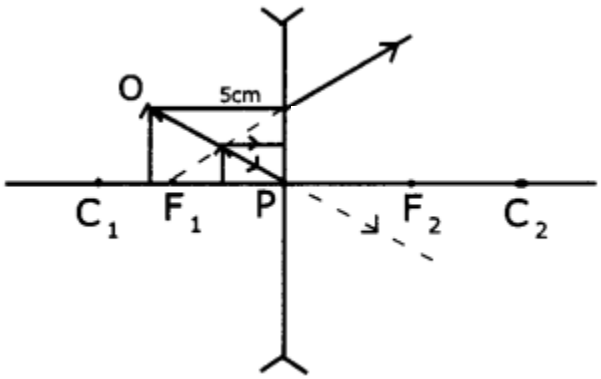
Draw ray diagrams for a double concave lens of focal length 4 cm, when objects are placed at 3 cm and 5 cm on principal axis. Write characteristics of images.

Answer:

(i)



(ii)

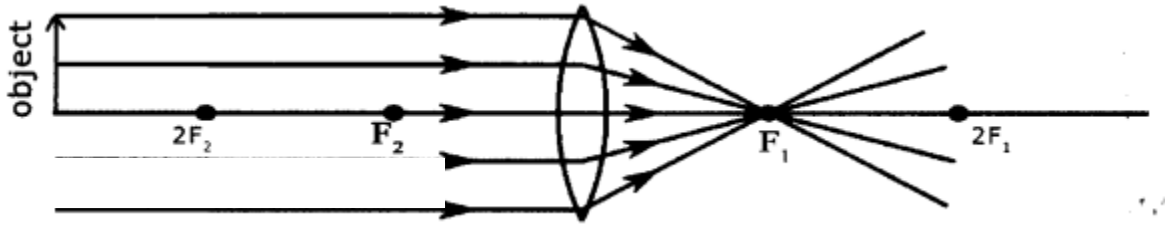


Characteristics of Images:

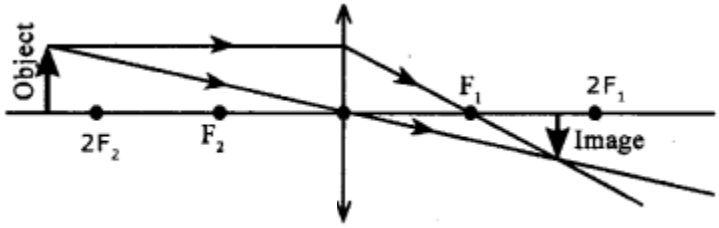
1. Image formed between P and F
2. DiminIshed Image
3. Erected Image
4. Virtual image

Question 4.
Describe the image formation by a convex lens for various positions of the object.

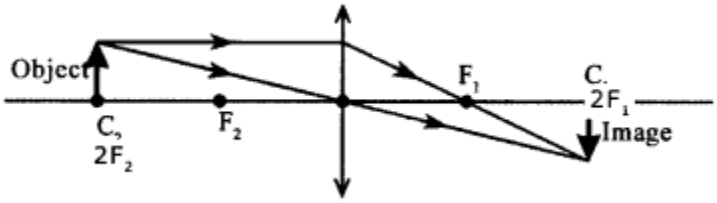
Answer:
1. Object at infinity: The rays coming from the object at infinity are parallel to principal axis and converge at the focal point after refraction. So, a point-sized image Is formed at the focal point.



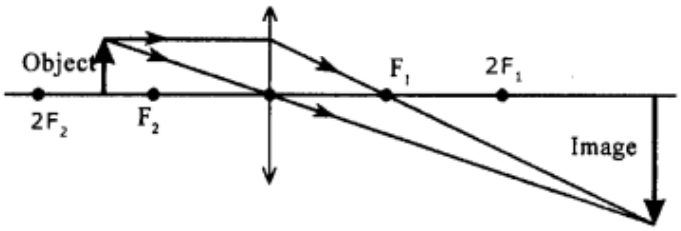
2. Object placed beyond the centre of curvature on the principal axis:
When an object is placed beyond $2F_2$, a real, inverted and diminished image is formed on the principal axis between F_1 and $2F_1$.



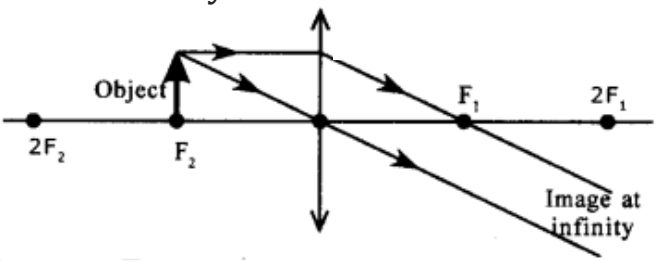
3) Object placed at the centre of curvature : When an object is placed at $2F_2$ on the principal axis, a real, inverted image Is formed at C_1 which Is of the same size as that of the object.



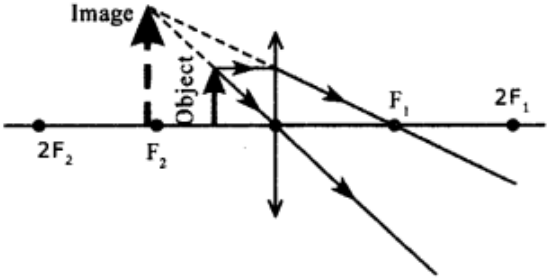
4) Object placed between the centre of curvature and focal point: When an object is placed between $2F_2$ and focus F_2, we will get an Image which is real, Inverted and magnified. This image will form beyond $2F_1$.



5) ObJect located at focal point: When an object Is placed at focus F_2, the Image will be at infinity.



6) Object placed between focal point and optic centre: If we place an object between focus and optic centre, we will get an image which in virtual, erect and magnified. On the same side of the object.

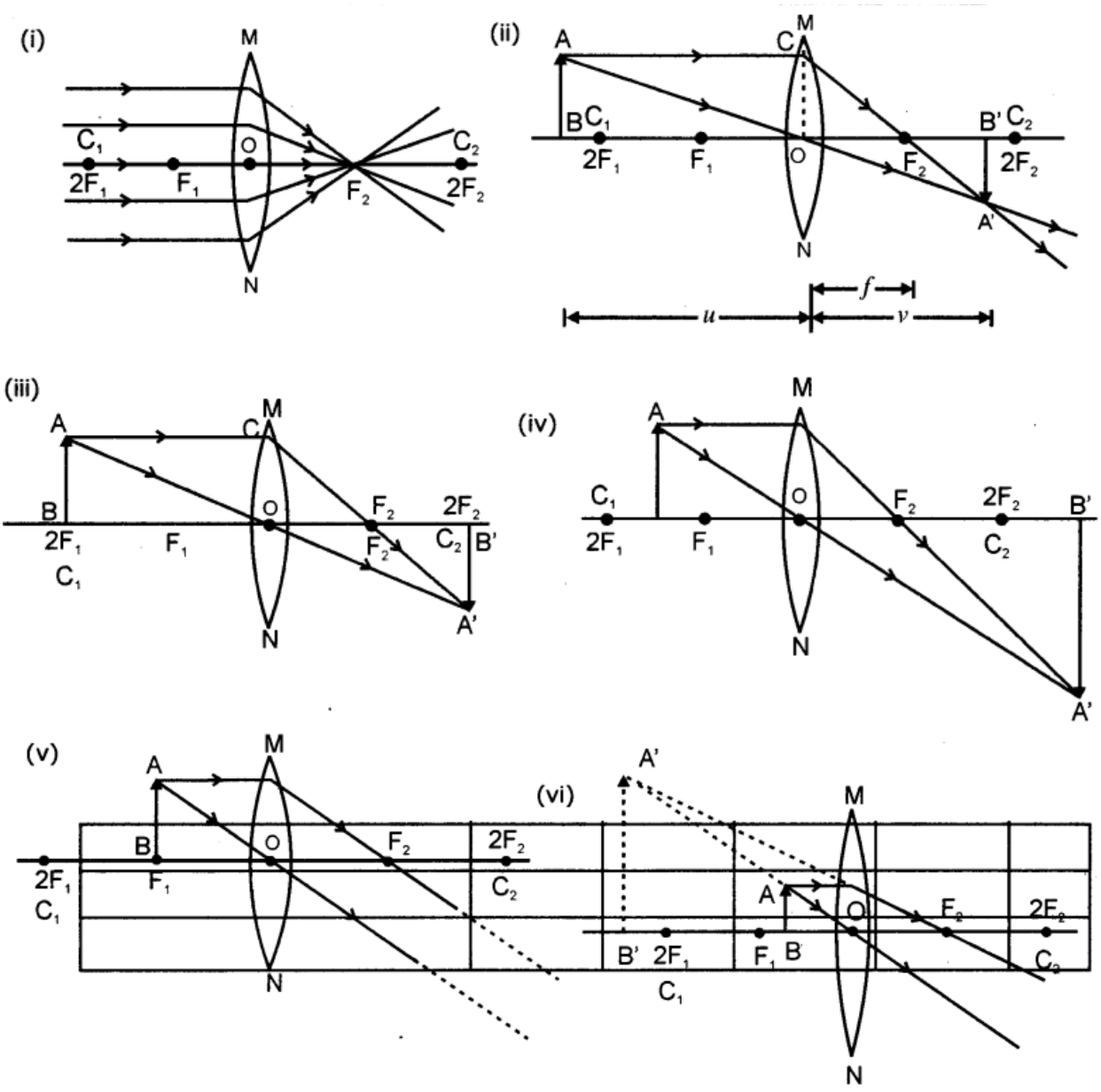


Question 5.

Write the nature, position and relative size of the Image formed by a convex lens for various positions of the object.

Answer:

S.No.	Position of the object	Position of the image	Relative size of the image	Nature of image
i.	At infinity	At focus F2 inverted point-sized	Highly diminished,	Real and inverted
ii.	Beyond 2F1	Between F2 and 2F2	Diminished	Real and inverted
iii.	At 2F1	At 2F2	Same size	Real and inverted
iv.	Between F1 and 2F1	Beyond 2F2	Enlarged	Real and inverted
v.	At focus F1	At infinity	Highly enlarged	Real and inverted
vi.	Between focus F1 and optical centre O	On the same side of the lens as the object	Enlarged	Virtual and erected



Question 6.

A student performed an experiment with biconvex lens and formulated a table as shown.

Object distance (u) (cm)	70	60	50	40	30
Image distance (v) (cm)	14.05	15.02	16.02	17	20

Focal lenth (f) (cm)	12.01	12.12	12.13	11.92	12

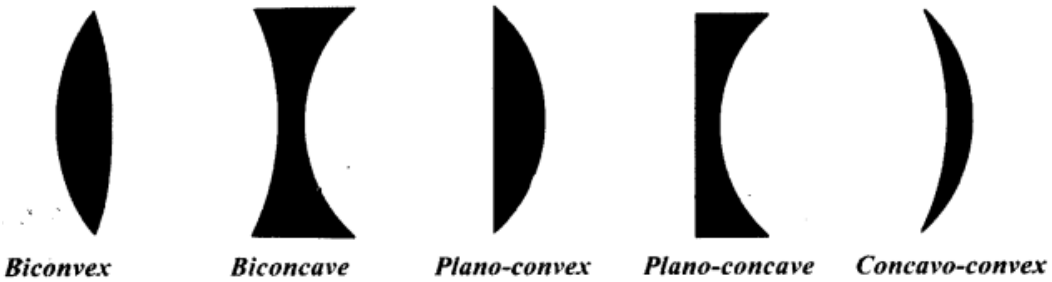
By observing above Information answer the following questions?
(a) What i your idea regarding different values of focal length?
(b) How you will decide the focal length of lens? What is that value?
(c) Can you able to measure the image distance by keeping object distance as 10 cm? Why?

Answer:
(a) Any experiment Is associated with errors. Error means difference In true value and measured value. Errors are due to instrument problems (or) Personal errors (or) Parallax errors. Due to systematic errors the values are obtained differently. To reduce the errors we have to Increase accuracy and precision.

(b) The focal length of the lens is decided by taking the arithmetic mean of five values as focal length (f) $= 12.01+12\times12+12\times13+11\times92+125$
$\therefore$ Focal length (f) $= 12.036$
(c) It is not possible to measure the Image distance when object distance Is u$=$ 10 cm
Here focal length of lens is nearly 12 cm.
u $<$ f i.e., object kept in between optic center and focus. So we will get a virtual image which can be seen with eye but cannot be caught on screen. Hence we cannot measure the image distance.

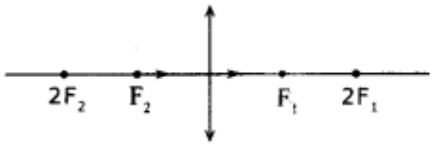
Question 7.
Draw diagrams of different lenses.

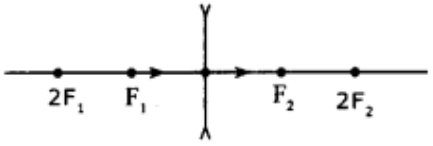
Answer:



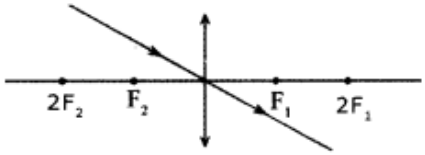
Question 8.
Explain the behaviour of certain light rays when they are incident on a lens, with neat ray diagrams.

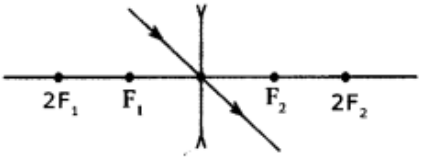
Answer:
a) Ray passing along the principal axis : Any ray passing along the principal axis is undeviated.



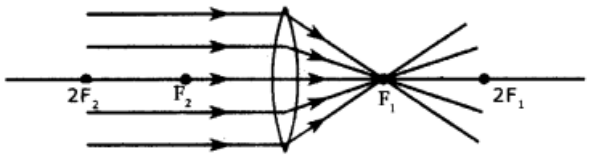


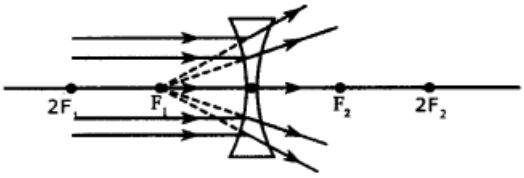
b) Ray passing through the optic centre: Any ray passing through the optic centre is also undefeated,



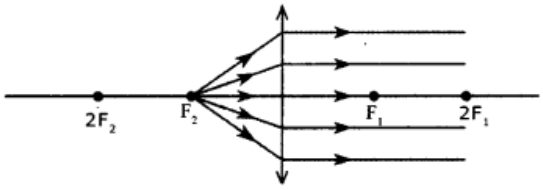


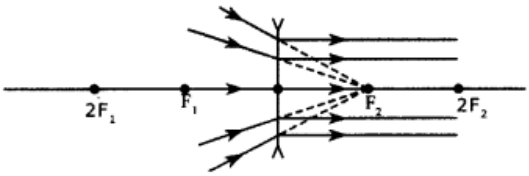
c) Rays travelling parallel to the principal axis: The rays passing parallel to the principal axis converge at the focus or appear to diverge from the focus.





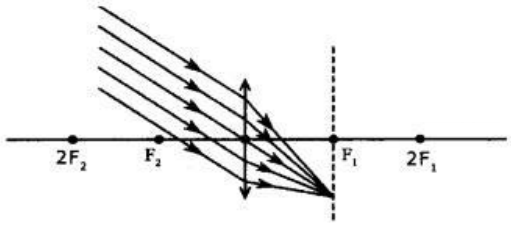
d) Ray passing through focus: The ray passing through the focus will take a path parallel to principal axis after refraction.

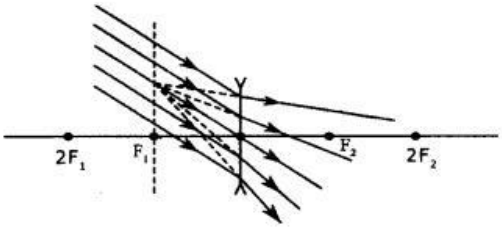




e) When parallel rays of light fall on a lens making some angle with the principal axis: When parallel rays, making an angle with principal axis, fall on a lens, the rays converge at a point or appear to diverge from a point lying on a

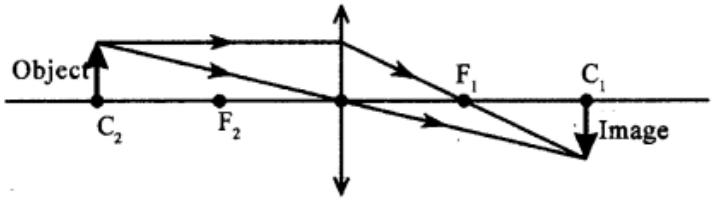
focal plane.



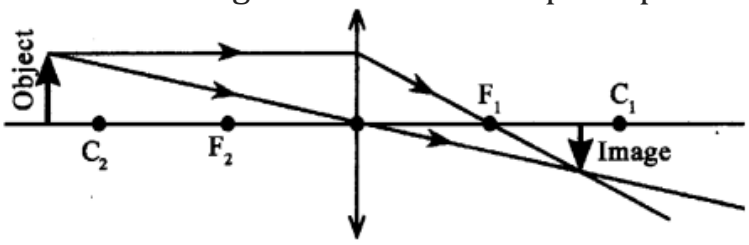


Question 9.
Draw the ray diagrams to find the images when an object is placed In front of the lens (i) at a distance of km, and (ii) at a distance of 10 cm on the principal axis of a convex lens whose focal length Is 4cm. Write the characteristics of Images In both the cases.

Answer:
(i) Object placed at the centre of curvature: When an object is placed at the centre of curvature (C_2) on the principal axis, a real, Inverted Image is formed at C_1 which is of the same size as that of the object.



(ii) Object placed beyond the centre of curvature on the principal axis:
When an object is placed beyond the centre of curvature, a real, inverted and diminished image is formed on the principal axis between f_1 and C_1.



Question 10.
A double concave lens with the refractive index (n) = 1.5 Is kept In the air. Its two spherical surfaces have radii $R_1 = 20$ cm and $R_2 = 60$ cm. Find the focal length of the lens. Write the characteristics of the lens.

Answer:
Refractive index (n) 1.5

Using sign convention for concave lens, we get R_1 = ... 30cm, R_2 = 60 cm

From Lens makers formula, $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$\frac{1}{f} = (1.5-1)\left(\frac{1}{-30} - \frac{1}{60}\right) = \frac{1}{f} = 0.5\left(\frac{-2-1}{60}\right) \qquad \frac{1}{f} = \frac{1}{2} \times \frac{-3}{60} 20$$

$$\frac{1}{f} = \frac{-1}{40}$$

Focal length of the lens = — 40 cm

Here minus Indicates that the characteristics of the lens is divergent. i.e divergent lens

Solved Problems

Question 1.

A convex retracting surface of radius of curvature 20cm separates two media of refractive indices 4/3 and 1.60. An object Is placed in the first medium n=4/3 at a distance of 200cm from the refracting surface. Calculate the position of the image formed.

Answer:

Formula: $\frac{-n_1}{u} + \frac{n_2}{v} = \frac{n_2 - n_1}{R}$

R= 20cm, n_1 = 4/3 , n_2 = 1.6, u = -200cm v=?

$$\frac{4/3}{-200} + \frac{1.60}{v} = \frac{1.60 - 4/3}{20}$$

$$\frac{4/3}{200} + \frac{1.60}{v} = \frac{1.60 - 4/3}{20} = \frac{4v/3 + (200 \times 1.6)}{200v}$$

$$= \frac{4.8 - 4}{3 \times 20} = \frac{4v + (4.8 \times 200)}{3 \times 200v} = \frac{0.8}{3 \times 20}$$

4v + 960 = 8v 8v – 4v= 960

4v = 960 v = 960/4 = 240 v = 240

The image is formed at a distance 240 cm. from lens

v = 240 cm in denser medium substitute 'v' value in above equation.

Question 2.

The radii of curvatures of a double convex lens are 15cm and 30cm and its refractive index is 1.5. Calculate its focal length.

Answer:

$R_1 = 15cm$, $R_2 = -30cm$, $n = 1.5$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow \frac{1}{f} = (1.5-1)\left(\frac{1}{15} - \frac{1}{-30}\right)$$

$$\Rightarrow \frac{1}{f} = (0.5)\left(\frac{-30-15}{-450}\right)$$

$$\Rightarrow \frac{1}{f} = (0.5)\left(\frac{1}{10}\right)$$

$\Rightarrow f = 20cm$

Question 3.

A plano-convex lens whose n=1.5 has a curved surface of radius 15cm. What is its focal length?

Answer:

$n = 1.5$, $R_1 = 15cm$, $R_2 = \infty$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \Rightarrow \quad \frac{1}{f} = (1.5-1)\left(\frac{1}{15} - \frac{1}{\infty}\right)$$

$$\frac{1}{f} = \frac{1}{2}\left(\frac{1}{15}\right)$$

because $\frac{1}{-\infty} = 0$

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

f = 30 cm

f = 30 cm

Question 4.

A 2.0 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 10 cm. The distance of the object from the lens is 15 cm. Find the nature, position and size of the Image.

Answer:
Height of the object $h_0 = +2.0$ cm;
Focal length f = + 10 cm;
object-distance u = -15 cm;
Image-distance v =?

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

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

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

v = 30 cm

V = 30 cm. The positive sign of y shows that the image is formed at a distance of 30 cm on the other side of the optical centre. The image is real and inverted.

Question 5.
An object 5 cm in length is held 25 cm away from a converging lens of focal length. 10cm. Find the position and nature of the Image formed.

Answer:
Given u = – 25 cm, I = 20 cm, v = ?
Lens formula

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

$$\frac{1}{10} = \frac{1}{v} - \frac{1}{-25}$$

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

$$v = \frac{50}{3} = 16.66 \text{ cm}$$

$$\frac{v}{u} = \frac{\text{Size of the image}}{\text{Size of the object}}$$

$$\frac{16.66}{25} = \frac{\text{Size of the image}}{5}$$

Size of the image = 3.332 cm
So image is diminished.
Because the image distance Is positive. So the Image Is real and lies between F_1 and C_1.
The image is inverted and diminished.

Question 6.
A concave lens of local length 15 cm forms an image 10 cm from the lens. How far Is the object placed from the lens?

Answer:
Given f = -15 cm, v = -10 cm, u =?
Lens formula

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

$$\frac{1}{-15} = \frac{1}{-10} - \frac{1}{u}$$

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

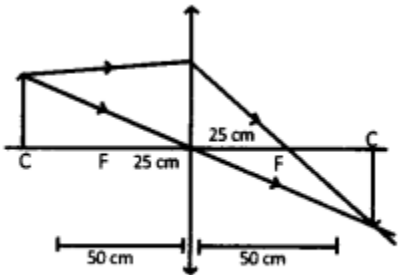
u = -30 cm

So the object should be placed 30 cm from the lens.

Question 7.
Write the characteristics of the images formed by a convex lens having focal length of 25 cm, when an object is kept on the principle axis at a distance of 50 cm and 75 cm.

Answer:
When the object is kept at 50 cm in front of the lens, the characteristics of image:

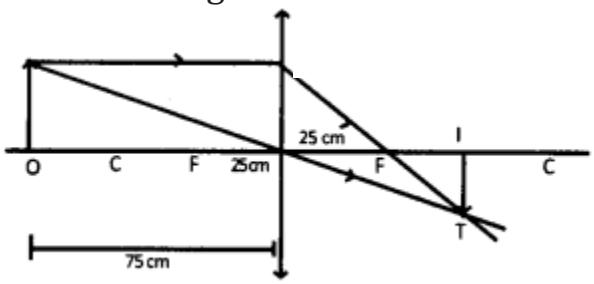
1. The image will form at 50 cm distance
2. Size of the image in equal of the size of the object F
3. Image is inverted
4. Image is real



When the object is kept at 75cm In front of the lens, the characteristics of Image:

1. Image will be formed between F and C (app.37.5cm)
2. Diminished image will be formed.

3. Imageisinverted
4. Image is real



Question 8.
A convex lens has a focal length of 25 cm. Calculate the distance of the object from the lens If the Image Is to be formed on the opposite side of the lens at a distance of 75 cm from the lens. What wIll be the nature of image?

Answer:
Given f=25 cm, v = 75 cm, u =?

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

We have $\frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{75} = \frac{1}{25} = \frac{1-3}{75} = \frac{-2}{75}$

Therefore u = -37.5

The image is real, inverted and magnified.

Question 9.
A 5cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 20cm. The distance of the object from the lens Is 30 cm. Find the (i) positive (ii) nature and (iii) size of the image formed.

Answer:
Given object size (h_0) = 5m
u= -30 cm
f = 20 cm, v = ?
Image size (h_i) =?

Using lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

We have $\frac{1}{v} = \frac{1}{u} + \frac{1}{f} = \frac{1}{-30} + \frac{1}{20} = \frac{-2+3}{60} = \frac{1}{60} \quad \Rightarrow \frac{1}{v} = \frac{1}{60}$

Therefore v = 60 cm

Magnification = $\frac{\text{Image size}}{\text{Object size}}$ = -2

$\frac{h_i}{h_o} = -2 \Rightarrow \frac{h_i}{5} = -2$

h_i = -2 × 5 = -10 cm

The image is real inverted and magnified.

Question 10.

An object 3.0 cm high is placed perpendicular to the principal axis of a concave lens of focal length 7.5 cm. The image Is formed at a distance of 5 cm from the lens. Calculate (i) distance at which object is placed and (ii) size and nature of image formed.

Answer:

Given h_0 > object size = 3 cm, f = – 7.5 cm,
v=-5 cm, u =?, I =?
[Assume 0 – object size, I – image size]

Using lens formula $\frac{1}{V} = \frac{1}{u} - \frac{1}{f}$

We have $\frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{-5} - \frac{1}{-7.5} = \frac{-3+2}{15} = \frac{-1}{15}$

∴ u = -15 cm

The object should be placed 15 cm from the concave lens.

m = $\frac{v}{u} = \frac{\text{Image size}}{\text{Object size}}$

Image size = $\frac{v}{u}$ x object size

I = $\frac{-5}{15} \times 3$ = 1 cm

The Image Is virtual and erect and has a size 1 cm.