1. Define 'power of a lens'.

Ans:

The power of a lens is the reciprocal of its focal length in metre. It may also be defined as the power of convergence or divergence of a lens. If f is the focal length of a lens in metre and P is the power of the lens. Then:

$$P = \frac{1}{f\ (\text{in metre})}$$

2. An object of height 3 cm is placed at a distance of 24 cm from a convex lens of focal length 10cm, when an image is formed on the screen on the other side of the lens. Calculate

(a) The distance of the screen from the lens.

(b) The size of image

(c) The characteristics of image.

Ans

Height of object = 3cm

u= -24cm

v=?

f=10cm

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

$$\frac{1}{10} = \frac{1}{24} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{24 - 10}{240} = \frac{14}{240}$$

v = 17.14 cm

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

$$\frac{\text{Height of image}}{3} = \frac{17.14}{24}$$

Height of image = 2.1425cm

The image is real, inverted and diminished.

3. A concave lens forms 4 times diminished and virtual image when an object is placed at a distance of 80 cm. Calculate

   (a) The position of the image

   (b) The focal length of the lens.

Ans

Distance of the object from the lens (u) = -80cm

[∴u is always -ve]

Focal length of the lens (f) = ? [To be calculated]

Distance of the image from the lens (v) = ? [To be calculated]

Applying, $4 = \frac{v}{u}$

$v = 4 \times -80 = -240$

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

$\Rightarrow \frac{1}{-240} + \frac{1}{-80} = \frac{1}{f}$

$\Rightarrow \frac{1}{f} = -\frac{4}{240}$

$\Rightarrow f = -\frac{240}{4} = -60 \text{ cm}$

4. The number of the glasses of a person is +0.75D. What is the nature of the lens and what is its focal length?

Ans

(i) As the power is +0.75 D, therefore the lens is convex.

(ii) Applying,

$P = \frac{100}{f(\text{in cm})}$

$0.75 = \frac{100}{f}$

$\therefore f(\text{in cm}) = \frac{100}{0.75} = 133.33\text{cm}$

5. A virtual, diminished image is formed when an object is placed between the optical centre and the principal focus of a lens.

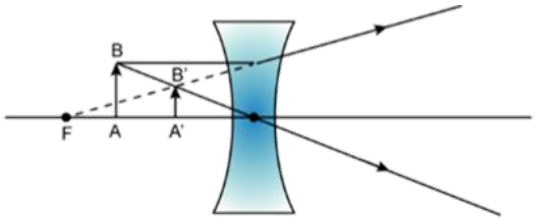
   (i) Name the type of lens which forms the above image.

(ii) Draw a ray diagram to show the formation of the image with the above stated characteristics.

Ans

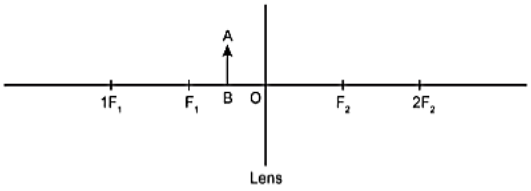
(i) Concave lens

(ii)



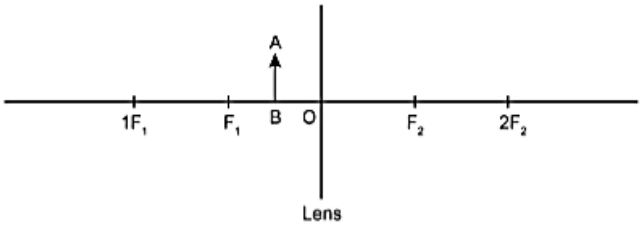
6. An object AB is placed between O and F_1 on the principal axis of a converging lens as shown in the diagram.

Copy the diagram and by using three standard rays starting from point A, obtain an image of the object AB.

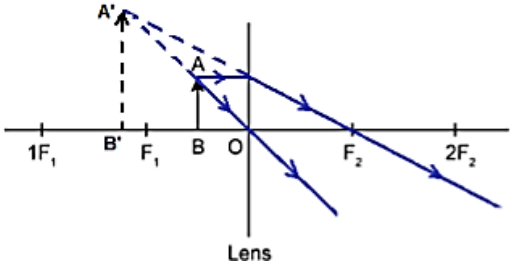


Ans

An object AB is placed between O and F_1 on the principal axis of a converging lens as shown in the diagram.



Using three standard rays starting from point A, obtain an image of the object AB.



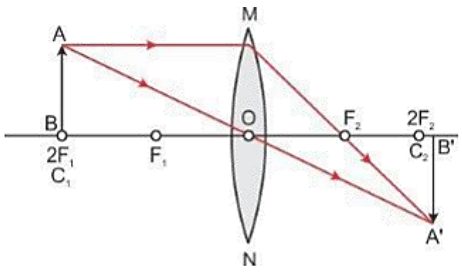
7. (i) Where should an object be placed so that a real and inverted image of the same size as the object is obtained using a convex lens?

(ii) Draw a ray diagram to show the formation of the image as specified in the part a(i).

Ans

(i) When an object is placed at $2F_1$ of a convex lens, a real and inverted image of the same size as that of the object is formed at $2F_2$.

(ii) The ray diagram for the same is as shown below:



8. An object 1 cm high is placed at a distance of 4 cm from a convex lens of focal length 6 cm. Calculate (a) The position of the image (b) Size of a image.

Ans

Height of the object (h_0)=1cm

Distance of the object from the lens (u) = 4cm

[∴u is always -ve]

Focal length of the lens (f) = +6 cm

[f is always +ve for a convex lens]

Distance of image from the lens (v) = ? [To be calculated]

Size of the image h_i=? [To be calculated]

(a) Applying, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\Rightarrow \frac{1}{v}-\frac{1}{-4}=\frac{1}{6}$

$\Rightarrow \frac{1}{v}=\frac{1}{6}-\frac{1}{4}$

$\Rightarrow \frac{1}{v}=\frac{4-6}{24}$

$\Rightarrow \frac{1}{v}=-\frac{2}{24}$

$\Rightarrow v = -12\text{cm}$

Thus , the image is formed at a distance of 40 cm from the lens, on the same side as the object.

(b)Applying, $\frac{h_i}{h_0}=\frac{v}{u}$

$\Rightarrow \frac{h_i}{1}=\frac{12}{4}$

$\Rightarrow h_i = 3\text{ cm}$

Thus, the height of the image is 3 cm

9. (i) What is the power of a converging lens of focal length 0.25 m?

   (ii) What is the focal length of lens of power –5D?

   (iii) If lenses (i) and (ii) are put together, what is the power of this combination?

Ans

(i) Power of the lens is given by

$$p = \frac{1}{F(metre)}$$

$$\therefore p = \frac{1}{0.25} = 4D$$

(ii) Focal length of the lens is given as

$$F = \frac{1}{p} = \frac{1}{5}$$

$$F = 0.2m$$

(iii) If both lenses are put together, then the focus will be

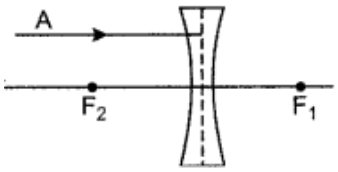
$$\frac{1}{F} = \frac{1}{F_1} + \frac{1}{F_2}$$

But as one of the lenses is diverging, it will have a negative focal length.

F=100cm

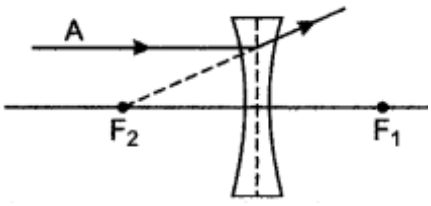
Now the power will be $P = \frac{1}{F(incm)} = \frac{100}{100} = -1D$

10. In figure give below of thin concave lens, F_1 and F_2 are its foci, complete the path of the given ray of light after it emerges out of the lens.



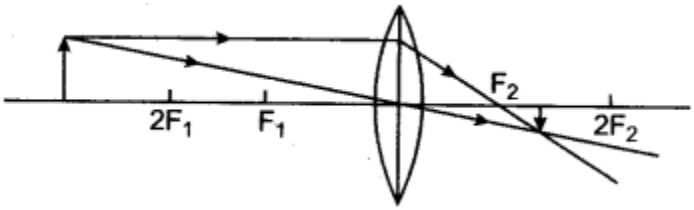
Ans:

See figure



11. Draw the ray diagrams of a converging lens, when the object is placed at a distance greater than twice the focal length of the lens.

Ans:



Object placed beyond 2F.

Image Nature: Real and inverted.

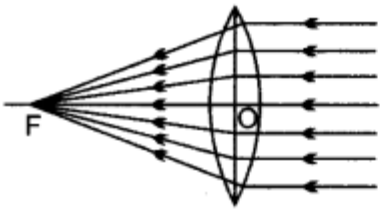
Size: Diminished.

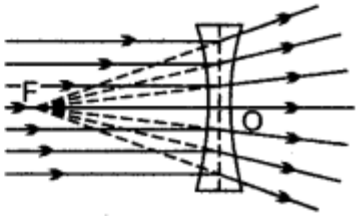
Position: Between F and 2F.

12. Define the Principal focus of a (i) Convex lens and (ii) Concave lens.

Ans:

(i) For a convex lens, principal focus is a point on the principal axis of a convex lens at which the rays of light originally parallel and close to the principal axis of the lens pass through it after refraction by the lens.

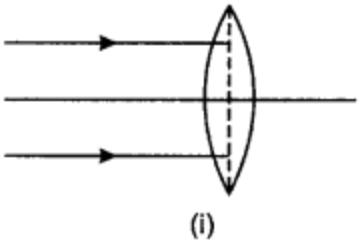


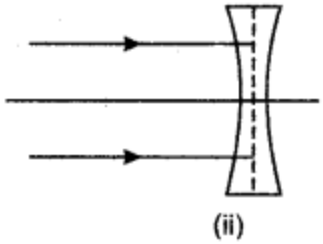


(ii) For a concave lens, principal focus is a point on its principal axis at which the rays of light originally parallel to the principal axis, appear to come from it after refraction by the lens.

13. (i) Copy and complete the following ray diagrams.

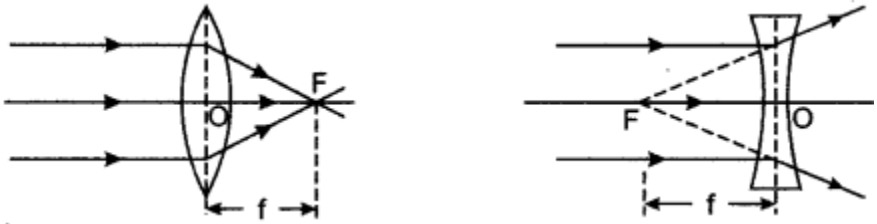
(ii) Define focal length.





Ans:

(i) See figure.



(ii) Focal length: It is the distance of the principal focus of the lens from its centre.

14. A concave mirror and convex lens are held in water. What changes, if any, do you expect in their focal length?

Ans:

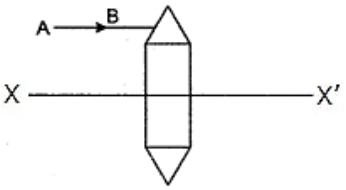
The focal lengths of a mirror does not depend upon the nature of the medium in which it is placed whereas the focal length of a lens depends upon the medium in which it is placed. Thus there will be no change in the focal length of the concave mirror whereas the focal length of the convex lens will change.

15. Point out difference between a convex lens and a concave lens.

Ans:

Convex Lens	Concave Lens
1. It is thicker at the centre and thin at the ends.	1. It is thinner at the centre and thick at the ends.
2. It converges rays of light.	2. It diverges rays of light.
3. It has a real focus.	3 . It has a virtual focus.

16. The diagram shown a lens as a combinations of one glass block and two prisms. Complete the ray diagram and show the part of the incident ray AB after passing through the lens.



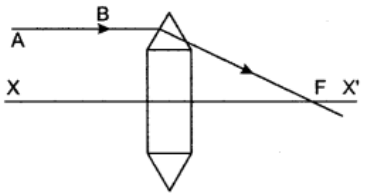
(i) Name of the lens formed by the combination.

(ii) What is the line XX' called?

(iii) Mark the focus F.

Ans

The completed ray diagram is shown.



(i) The lens formed by the combination is the convex lens.

(ii) The line XX' is called the principal axis.

(iii) The focus has been marked by the letter F in the diagram.