Class 10 Science Chapter 7 – Lenses

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Question 1:

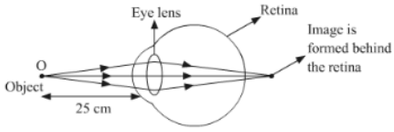
Match the columns in the following table and explain them.

Column 1	Column 2	Column 3
Farsightedness	Nearby object can be seen clearly	Bifocal lens
Presbyopia	Far away object can be seen clearly	Concave lens
Nearsightedness	Problem of old age	Concave lens

ANSWER:

Column 1	Column 2	Column 3
Farsightedness	Far away object can be seen clearly	Convex lens
Presbyopia	Problem of old age	Bifocal lens
Nearsightedness	Nearby object can be seen clearly	Concave lens

Farsightedness: This defect is also known as Hypermetropia. It is an eye defect in which a person is unable to see nearby objects clearly but can see the far away objects clearly.

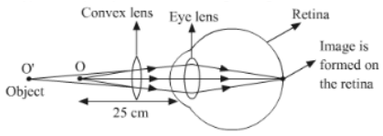


It is caused due to

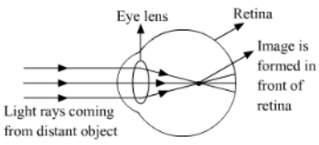
i. reduction in the curvature of the lens

ii. decrease in the size of the eyeball

Since a convex lens has the ability to converge incoming rays, it can be used to correct this defect of vision, as you already have seen in the animation. The ray diagram for the corrective measure for a hypermetropic eye is shown in the given figure.



Nearsightedness: This defect is also known as Myopia. It is a defect of vision in which a person clearly sees all the nearby objects, but is unable to see the distant objects comfortably and his eye is known as a myopic eye. A myopic eye has its far point nearer than infinity. It forms the image of a distant object in front of its retina as shown in the figure.

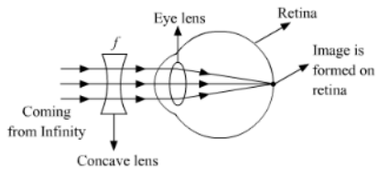


It is caused by

i. increase in curvature of the lens

ii. increase in length of the eyeball

Since a concave lens has an ability to diverge incoming rays, it is used to correct this defect of vision. The image is allowed to form at the retina by using a concave lens of suitable power as shown in the given figure.



Presbyopia: This is a common defect of vision, which generally occurs at old age. A person suffering from this type of defect of vision cannot see nearby objects clearly and distinctively. A presbyopic eye has its near point greater than 25 cm and it gradually increases as the eye becomes older.

Presbyopia is caused by the

i. weakening of the ciliary muscles

ii. reduction in the flexibility of the eye lens

It can be corrected using bifocal lens.

Question 2:

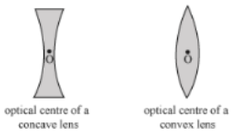
Draw a figure explaining various terms related to a lens.

ANSWER:

Terms Associated with Lenses:

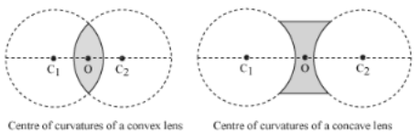
Optical centre

Optical centre is a point at the centre of the lens. It always lies inside the lens and not on the surface. It is denoted by **'O'**.



Centre of curvature

It is the centre point of arcs of the two spheres from which the given spherical lens (concave or convex) is made. Since a lens constitutes two spherical surfaces, it has two centers of curvature.

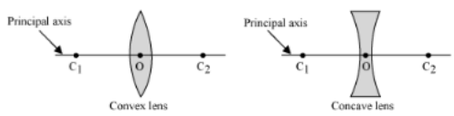


Radius of curvature

The distance of the optical centre from either of the centre of curvatures is termed as the **radius of curvature**.

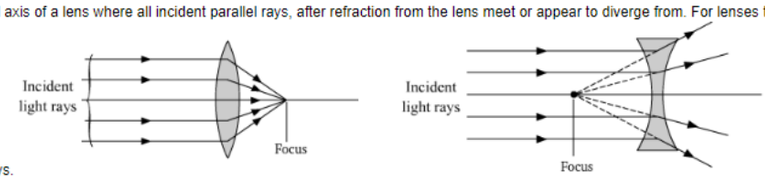
Principal axis

The imaginary straight line joining the two centers of curvature and the optical centre **(O)** is called the **principal axis** of the lens.



Focus

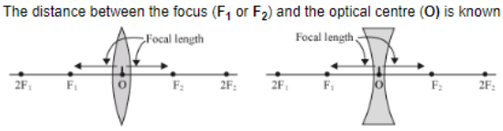
The focus **(F)** is the point on the principal axis of a lens where all incident parallel rays, after refraction from the lens meet or appear to diverge from. For lenses there are two foci (F_1 and F_2)



depending on the direction of incident rays.

Focal length

The distance between the focus (F_1 or F_2) and the optical centre (O) is known as the **focal length** of the lens.



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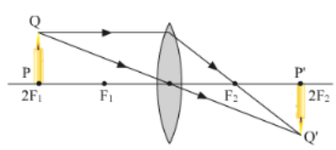
Question 3:

At which position will you keep an object in front of a convex lens so as to get a real image of the same size as the object? Draw a figure.

ANSWER:

When an object is placed at the centre of curvature $2F_1$ of a convex lens, we will get a real image of the same size as the object.



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Question 4:

Give scientific resons:
a. Simple microscope is used for watch repairs.
b. One can sense colours only in bright light.
c. We cannot clearly see an object kept at a distance less than 25 cm from the eye.

ANSWER:

a. Simple microscope has convex lens which has the ability to produce 20 times larger as well as erect image of an object. This means the magnifying power of the microscope is very high. Thus, simple microscopes are used by watch makers to see the small parts and screws of the watch while repairing it.

b. The cells present on the retina and responsible for colour vision are known as cone cells. These cells become active only under bright light and remain inactive under dark. Thus, we are able sense only in bright light.

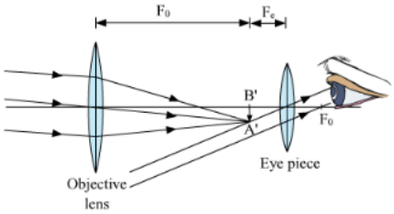
c. We cannot clearly see an object kept at a distance less than 25 cm from the eye. This is because ciliary muscles of our eyes are unable to contract beyond certain limit. If the object is placed at a distance less than 25 cm from the eye, then the object appears blurred because light rays coming from the object meet behind the retina.

Question 5:

Explain the working of an astronomical telescope using refraction of light.

ANSWER:

The astronomical telescope consists of two lenses: objective and eyepiece. Objective has larger focal length and diameter to accommodate maximum amount of light coming from the far away (astronomical) objects. A parallel beam of rays from an astronomical object is made to fall on the objective lens of the telescope. It forms a real, inverted and diminished image A'B' of the object. The eyepiece is so adjusted that A'B' lies just at the focus of the eye piece. Therefore, a highly magnified image of the object is formed at infinity. The same has been shown in the figure below.



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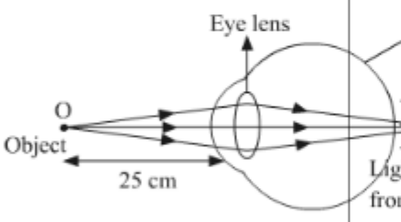
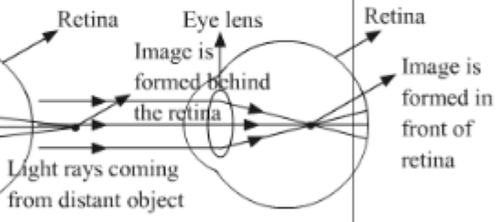
Question 6:

Distinguish between:
a. Farsightedness and Nearsightedness
b. Concave lens and Convex lens

ANSWER:

a.

Farsightedness	Nearsightedness
In this defect, person clearly sees all the far away objects, but is unable to see the nearby objects comfortably and clearly.	In this defect, person clearly sees all the nearby objects, but is unable to see the distant objects comfortably and clearly.
It is caused due to decrease in curvature of eye lens or decrease in length of eyeball.	It is caused due to increase in curvature of eye lens or increase in length of eyeball.
In this defect, image is formed behind the retina. 	In this defect, image is formed in front of the retina. 
It is corrected using convex lens.	It is corrected using concave lens.

b.

Concave lens	Convex lens
It is a diverging lens because it diverges the rays falling on it.	It is a converging lens because it converges the rays falling on it.
It is thin at the center and bulged at the edge.	It is thin at the edge and bulged at the centre.
The image formed by concave lens is always diminished and virtual.	The image formed by convex lens can be real as well as virtual. Also, the image formed can be diminished as well as magnified.
It has a virtual focus.	It has a real focus.

Question 7:

What is the function of iris and the muscles connected to the lens in human eye?

ANSWER:

Function of Iris: The iris is a muscular diaphragm that controls the size of the pupil, which, in turn, controls the amount of light entering the eye. It also gives colour to the eye.

Function of ciliary muscles: The eye lens is held in position by the ciliary muscles. The focal length of the eye lens is adjusted by the expansion and contraction of the ciliary muscles.

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Question 8:

Solve the following examples.
i. Doctor has prescribed a lens having power +1.5 D. What will be the focal length of the lens? What is the type of the lens and what must be the defect of vision?
ii. 5 cm high object is placed at a distance of 25 cm from a converging lens of focal length of 10 cm. Determine the position, size and type of the image.
iii. Three lenses having power 2, 2.5 and 1.7 D are kept touching in a row. What is the total power of the lens combination?
iv. An object kept 60 cm from a lens gives a virtual image 20 cm in front of the lens. What is the focal length of the lens? Is it a converging lens or diverging lens?

ANSWER:

i. Given:
Power of lens, P = +1.5 D
Now, focal length of lens, $f = \frac{1}{P} = +\frac{1}{1.5} = +0.67\ \mathrm{m}$.
Since, the focal length is positive, the lens prescribed for correction is convex lens. Thus, the defect of vision is farsightedness or hypermetropia.

ii. Given:
Height of object, h_o = 5 cm
Object distance, $u = -25$ cm
Since the lens is converging, thus it is a convex lens.
Focal length of the lens, f = 10 cm
Using lens formula,
$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
$\Rightarrow \frac{1}{v} = \frac{1}{10} + \frac{1}{-25} = \frac{3}{50}$
$\Rightarrow v = \frac{50}{3} = 16.7\ \mathrm{cm}$
Thus, the image is formed $16.7\ \mathrm{cm}$ right of the lens.
Now, we know
$\frac{v}{u} = \frac{h_i}{h_o}$
$\Rightarrow h_i = \frac{50}{3\times -25} \times 5 = \frac{10}{3} = -3.3\ \mathrm{cm}$
Thus, the size of the image is 3.3 cm. Negative sign shows that the image formed is real and inverted. Hence, the image formed is real and inverted and diminished.

iii. Given:
P_1 = 2 D, P_2 = 2.5 D, P_3 = 1.7 D
Let the total power of the lens combination be P. Thus,
$P = P_1 + P_2 + P_3 = 2 + 2.5 + 1.7 = 6.6\ \mathrm{D}$

iv. Given:
Object distance, $u = -60$ cm
Image distance, $v = -20$ cm
Using lens formula,
$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
$\Rightarrow \frac{1}{f} = \frac{1}{-20} - \frac{1}{-60} = -\frac{1}{30}$
$\Rightarrow f = -30\ \mathrm{cm}$
Since, the focal length is negative, the lens is a diverging lens or a concave lens.