

Bhartiya Vidya Bhavan's Shri Ishvarlal L. P. Arts-Science and J. Shah Commerce College, Dakor Dakor - 388225, Dist. – Kheda, Gujarat

B.Sc. (semester -3)

Subject : Physics

Course : USO3CPHY21 OPTICS

UNIT 1: Geometrical Optics/ Part -2

By

Dr. Sahajkumar A. Gandhi



Unit:1 Geometrical Optics

- Revision – 1st lecture
- Cardinal points and planes of lens system :
 - Two Principal points and principal planes (Last Lecture)
 - Two focal points and focal planes
 - Two nodal points and nodal planes

Text Book:

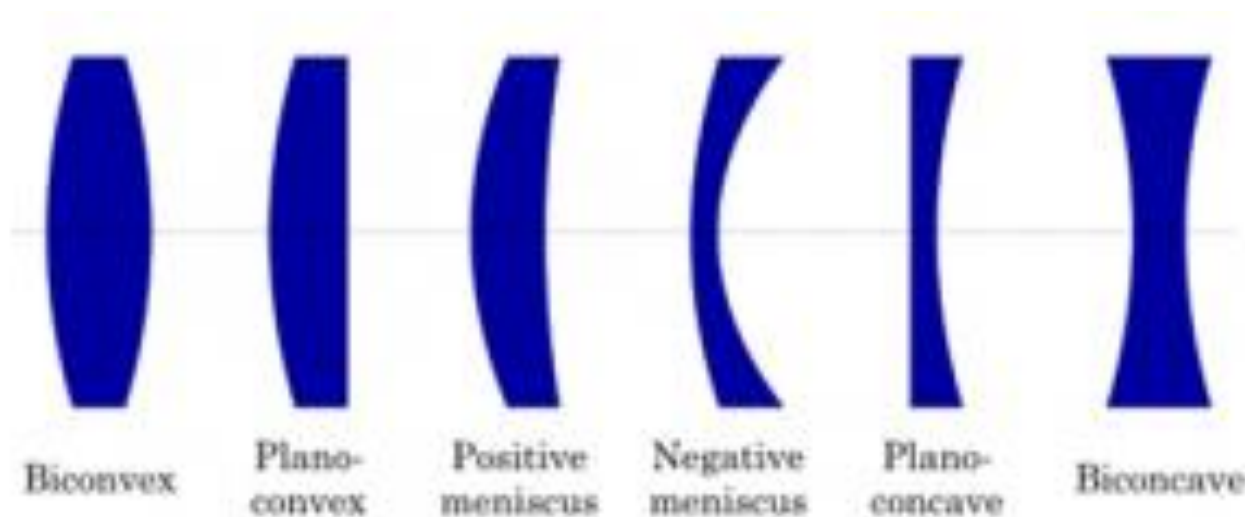
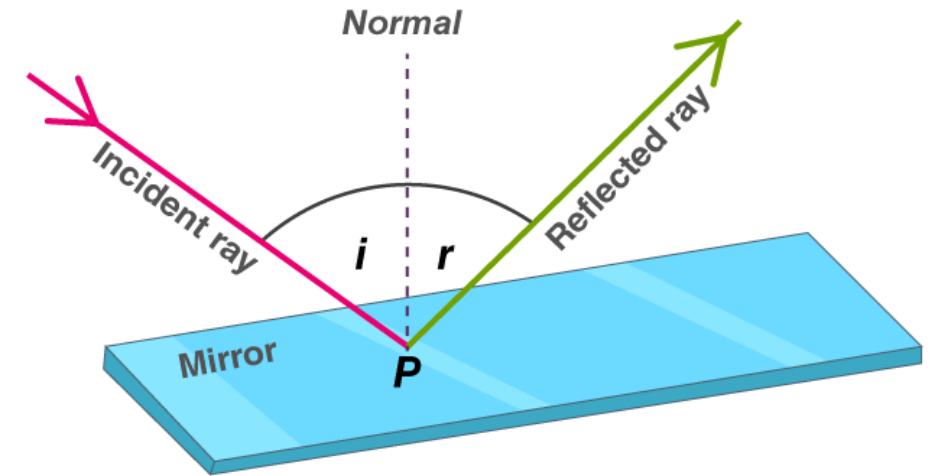
1. A Textbook of Optics

Subrahmanyam, Brij Lal and Avadhnulu

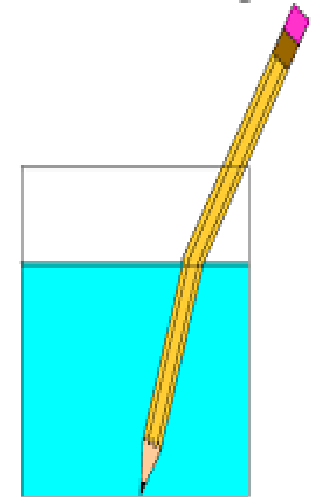
S Chand Publication (24th Revised addition 2010)

Revision...

- What is Reflection of Light?
- What is Refraction ?
- What is Total internal reflection ?
- What are Lenses?



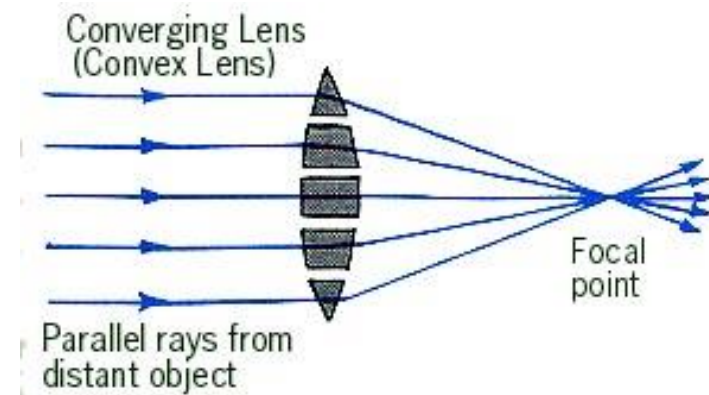
Refraction of Light



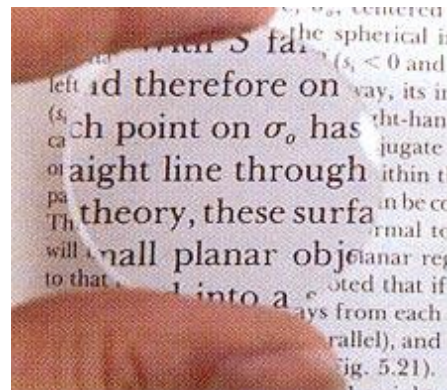
Light bends inwards because the speed of light is slower in water

Convex Lenses

- Thicker in the center than edges.
- Lens that converges (brings together) light rays.
- Forms real images and virtual images depending on position of the object

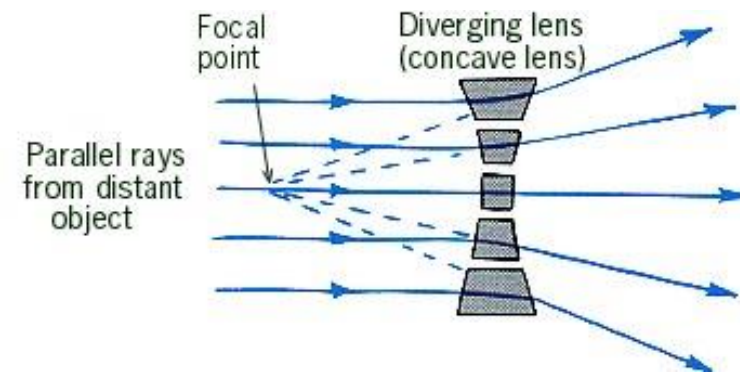


The Magnifier



Concave Lenses

- Lenses that are thicker at the edges and thinner in the center.
- Diverges light rays
- All images are erect and reduced.



The De-Magnifier



Cardinal points and planes of lens system :

How to ask in the exam ?

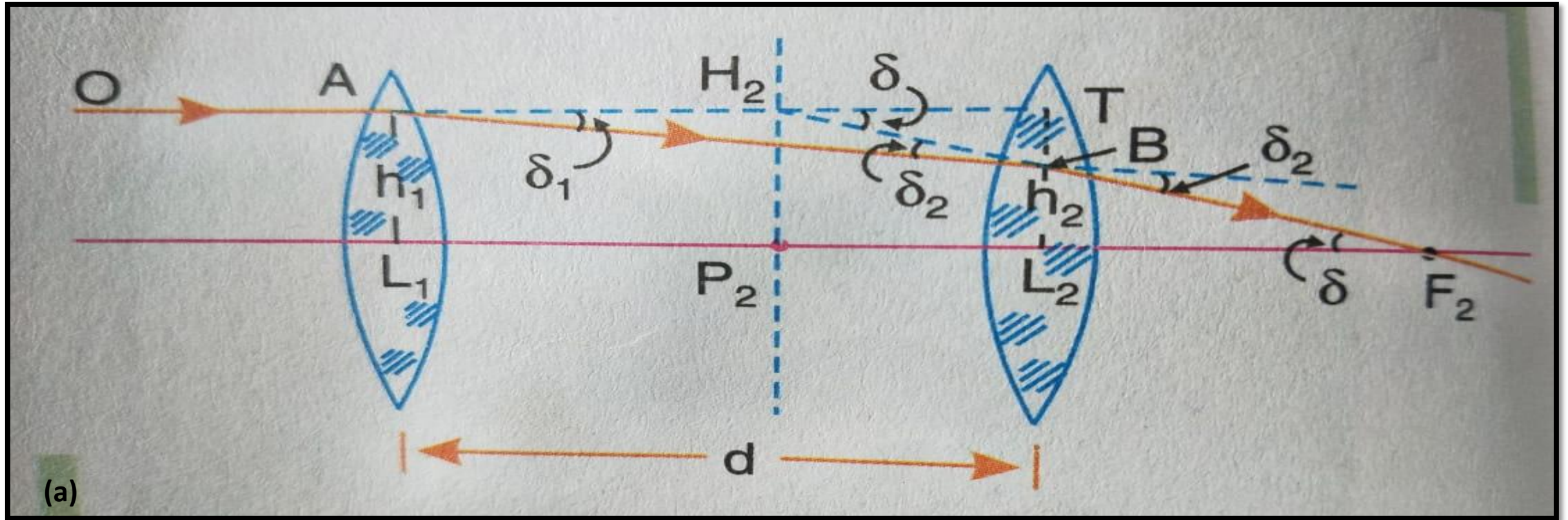
Explain cardinal points and planes of co-axial lens system with suitable diagram.

OR

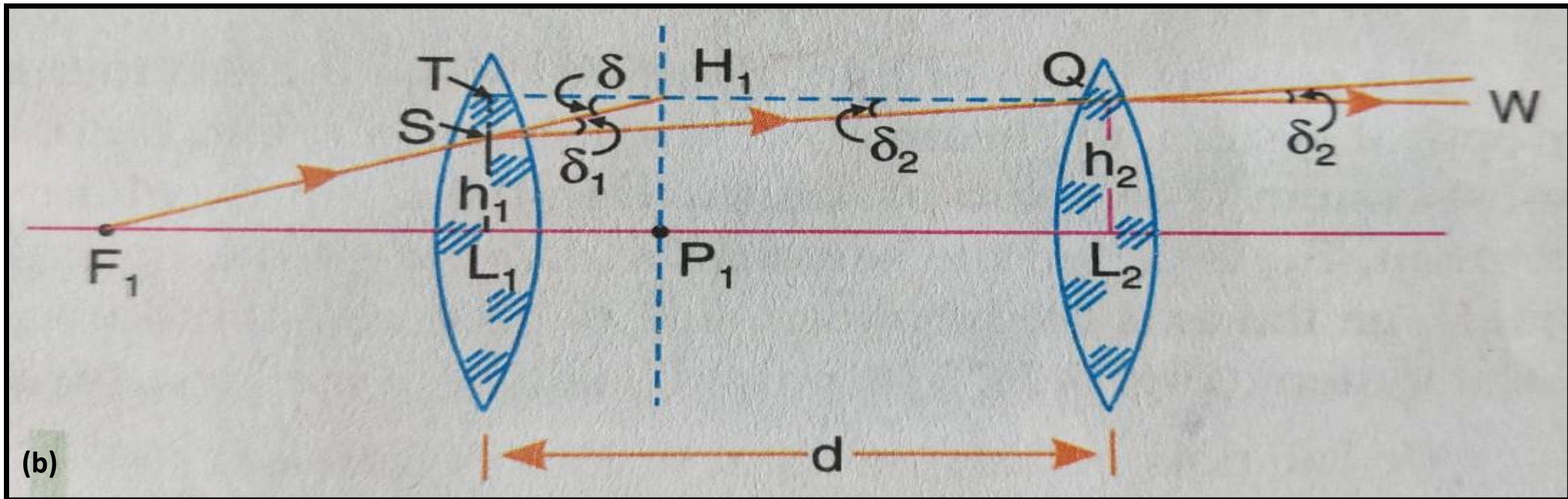
For a co-axial lens system, enlist the cardinal points and discuss them in detail.

10 Marks

1. Principal points and principal planes



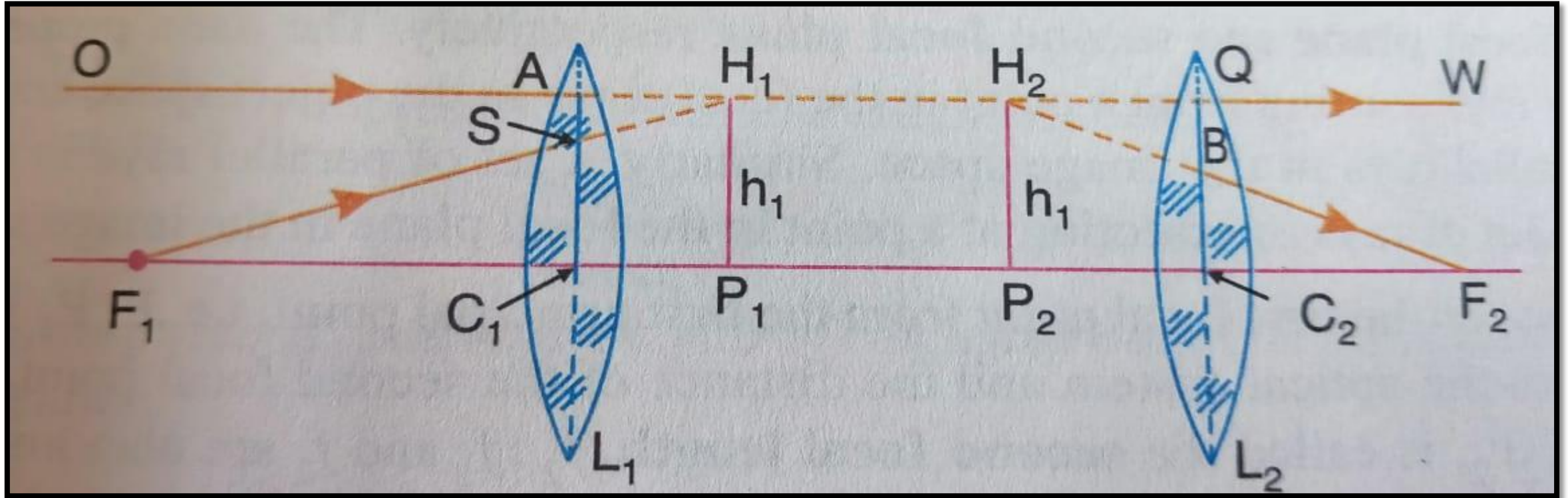
- A ray OA travelling parallel to the principle axis and incident at A is brought to focus at F_2 in the **image space** of the optical system as shown in above Figure.
- A plane drawn through the point H_2 and perpendicular to the axis may be regarded as the surface at which refraction take place. This plane is called the principal plane of the optical system.
- H_2P_2 is the principal plane in the image space and is called the second principal plane.
- The point P_2 at which the second principal plane intersects the axis is called the second principal point.



- We can locate the principal plane H_1P_1 and principal point P_1 in the **object space**.
- A plane perpendicular to the axis and passing through H_1 is called the first principal plane.
- The point of intersection, P_1 of the first principal plane with the axis is called the first principal point.
- It seen from above figure, that two incidents ray are directed towards H_1 and after refraction seem to come from H_2 .
- Therefore H_2 is image of H_1 Thus H_1 and H_2 are the conjugate points and the planes H_1P_1 and H_2P_2 are a pair of conjugate planes . It is also seen that

$$H_2P_2 = H_1P_1$$

FOCAL POINTS AND FOCAL PLANE



- If a parallel beam of light travelling from the left to the right (in object space) is incident on the optical system, the beam comes together at a point, F_2 on the other side (in image space) of the optical system.
- The beam passes through the point F_2 whatever may be its path inside the system. The point F_2 , is called the second focal point of the optical system.
- A beam of light passing the point F_1 , on the axis of the object side is rendered parallel to the axis after emergence through the optical system (Fig. 5.2). The point F_1 , is called the first focal point.

FOCAL POINTS AND FOCAL PLANE (continue)

We can now define the focal points as follows:

First focal point:

The first focal point is a point on the principal axis of optical system such that a beam of light passing through it is rendered parallel to the principal axis after refraction through the optical system.

Second focal point:

The second focal point is a point on the principal axis of the optical system such that a beam of light travelling parallel to the principal axis of the optical system, after refraction through the system, passes through it.

The planes passing through the principal focal points F_1 and F_2 and perpendicular to the axis are called **first focal plane** and **second focal plane** respectively. The main property of the focal planes is that the rays starting from a point in the focal plane in the object space correspond to a set of conjugate parallel rays in the image space. Similarly, a set of parallel rays in the object space corresponds to a set of rays intersecting at a point in the focal plane in the image space.

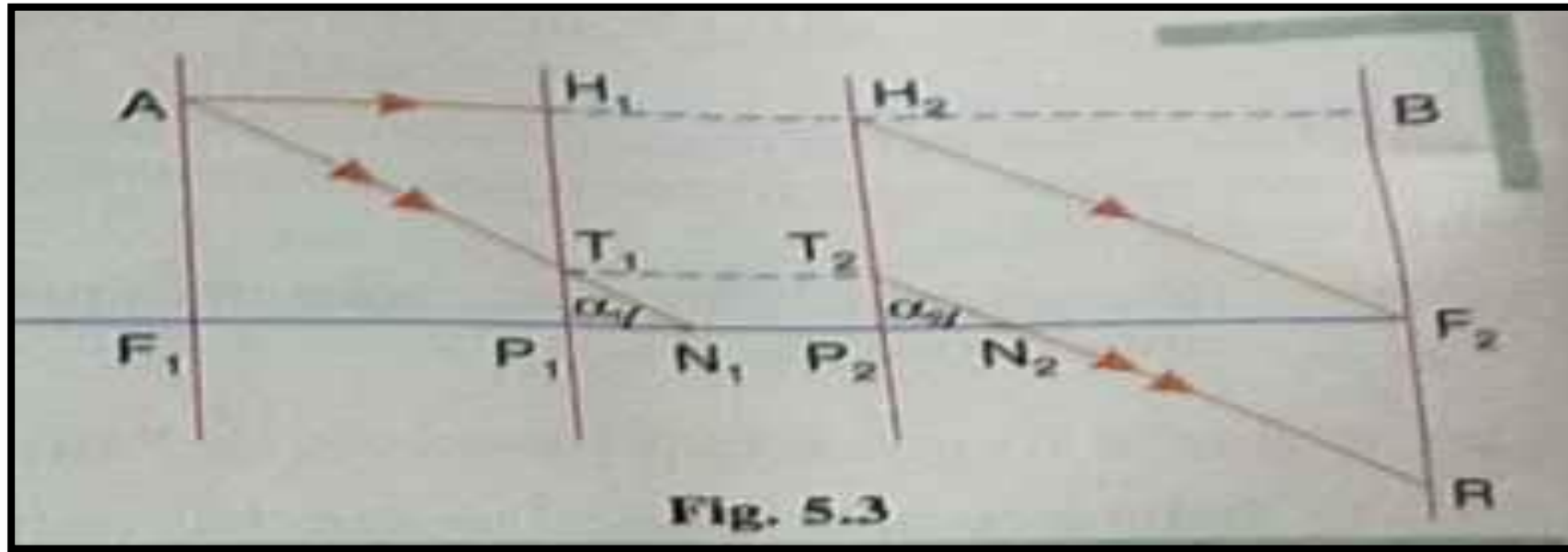
The distance of the first focal point from the first principal point, i.e., F_1P_1 is called the **first focal length**, f_1 of the optical system and the distance of the second focal point from the second principal point, F_2P_2 is called the second focal length, f_2 .

f_1 and f_2 are also known as the focal lengths in object space and image space respectively.

When the medium is same on the two sides of the optical system, $f_1 = f_2$ (numerically).

NODAL POINTS AND NODAL PLANES

- Nodal points are points on the principal axis of the optical system where light rays, **without refraction**, intersect the optic axis.
- In a thin lens the nodal point is the center of the lens. Light passing through the center of a thin lens does not deviate. In an optical system the center separates into two nodal points.
- The planes passing through the nodal points and perpendicular to the principal axis are called the **nodal planes**.
- Whereas the principal planes are planes where all refraction are assumed to occur, the nodal planes are planes where refraction does not take place.



- Fig. 5.3 represents an optical system with the help of its cardinal planes.
- From the Fig 5.3, that a ray of light, AN_1 directed towards one of the nodal points N_1 , after refraction through the optical system, along N_1N_2 , emerges out from the second nodal point, N_2 in a direction, N_2R . parallel to the incident ray.
- The distances of the nodal points are measured from the focal points.

Do you have Any Questions

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Thank you



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