PHYSICS 8 OPTICS DIPLOMA. ①

Optics is the branch of light which deals with study of light.

- Light is a form of energy. It is very essential for life.
- Plants prepare their food in presence of sun light on which most of the lives depend.

Use of light →

- Light travels in st. line
- Velocity 3×10^8 m/s
- When light enter into eyes - they cause sensation of vision.

Rays & Beams

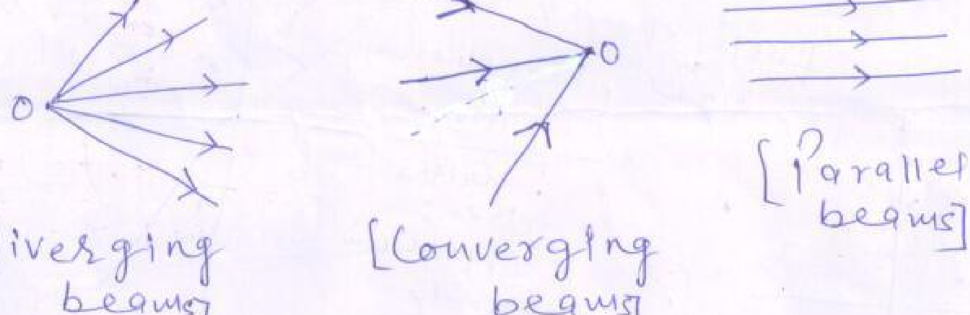
"A ray is a direction of the path taken by light."

It is denoted by '⟶' (In diagram) [Line with arrows on them]

" A beam is a stream of light energy."

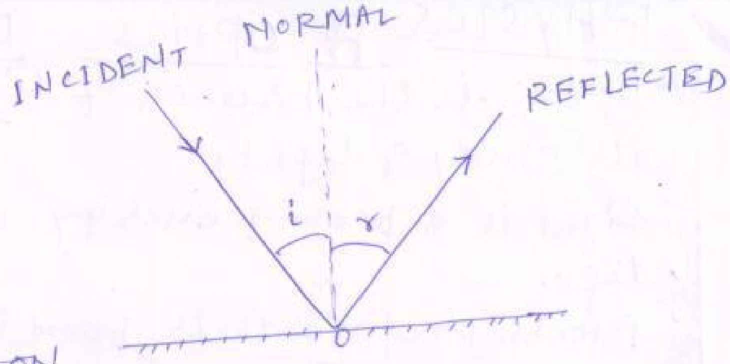
It is represented by no. of rays.

These rays may be either diverging, converging or parallel.



[diverging beams] [Converging beams] [Parallel beams].

② Reflection



LAWS OF REFLECTION

The laws of reflection are:-

(i) The incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane.

(ii) The angle of incidence is equal to the angle of reflection.

Refraction of Light :-

The phenomenon of deviation or bending of light rays from their original path while passing from one medium to another is called refraction.

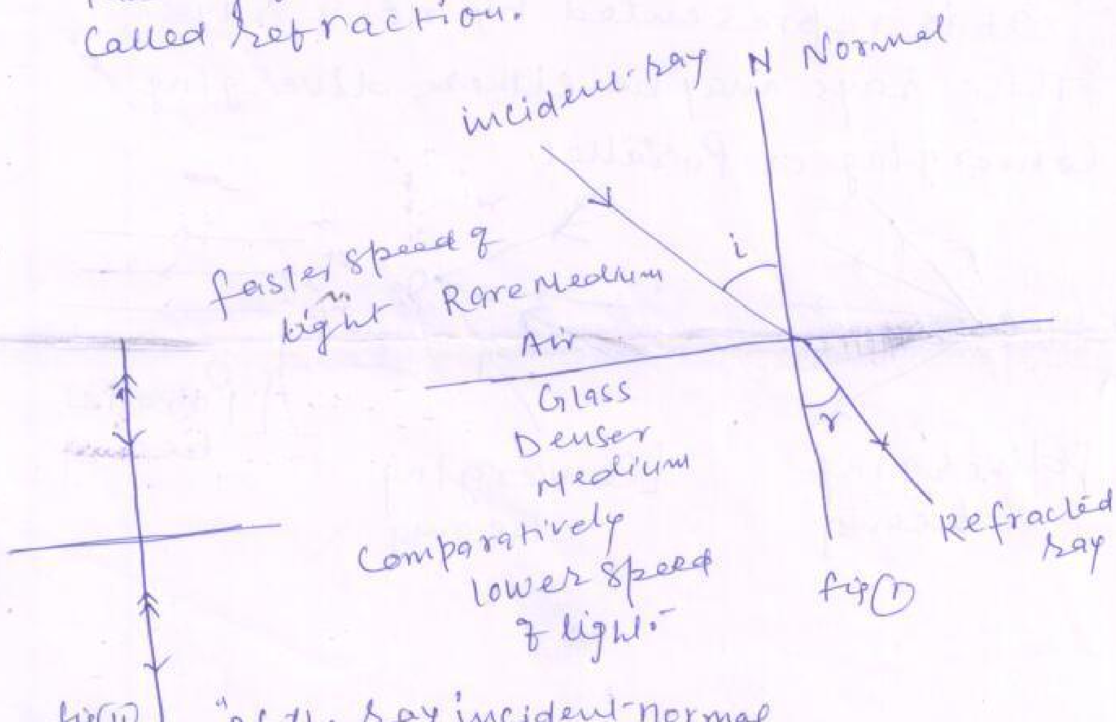


fig (II) "If the ray incident normal then there is no bending of light."

Laws of Reflection

(1) The incident ray and refracted ray are on opposite sides of the normal at the point of incidence and all three are in the same plane.

ii> The ratio of sine of the angle of incidence to the sine of the angle of refraction is a constant for a given pair of media

This law is also known as SNELL'S law.

Mathematically,

$$\frac{\sin i}{\sin r} = {}_a\mu_g$$

where ${}_a\mu_g$ = refractive index of glass w.r.t. air

i.e. when light goes from air to glass (ordinary).

also, $\boxed{{}_a\mu_g = 1.5}$

$$\boxed{{}_g\mu_a = \frac{1}{1.5} = 0.67}$$

Refractive index

Refractive index on the basis of velocity of light in the two media.

$$1.5 = {}_a\mu_g = \frac{\text{Velocity of light in air}}{\text{Velocity of light in glass}}$$

- The refractive indices of various media w.r.t air are often different.
- The index increases with increase in the optical density. i.e. diamond has refractive index upto 2.6

↓

Max^m incident rays

reflector thus has more brightness.

Lens formula

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

where

v = image distance.

u = object distance.

f = focal length.

formula are same for Concave & Convex lens.

④ # Power of a lens

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

i.e. Power (P) is the reciprocal of the focal-length (f) measured in metre.

The unit of power of lens is dioptre (D).

For example →

If $P = \frac{1}{0.25\,m} = 4.0\,m^{-1} = \underline{4.0\,D}$

f = (+)ve for convex lens ⇒ P = (+)ve

f = (−)ve for concave lens ⇒ P = (−)ve
↓ power

If two thin lenses are placed in contact with each other then the power of the equivalent lens is

$$\boxed{P = P_1 + P_2} \qquad \left[\because \frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}\right.$$

Thus when two lenses are placed in contact, their powers are added up.

Q: Two lenses, one of focal length 20 cm (convex lens) and another of focal length −15 cm (concave lens) are placed in contact. What is the focal length & power of the combination.

Soln
$f_1 = +20\,cm = +0.2\,m$
$f_2 = -15\,cm = -0.15\,m$

$\therefore P_1 = \frac{1}{0.2\,m} = 5\,D$

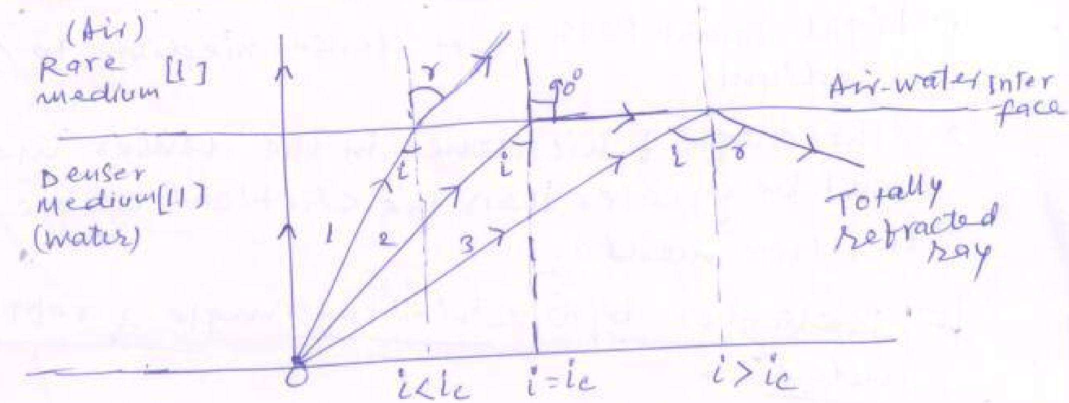
$P_2 = \frac{1}{-0.15\,m} = -6.67\,D$

∴ Power of combination
$P = P_1 + P_2$
$= 5 - 6.67 = -1.67\,D$

Also, focal length of the combination,
$F = \frac{1}{P} = \frac{1}{-1.67}\,m \quad \left[\because P = \frac{1}{f(m)}\right.$
$= -0.599\,m$
$= -59.9\,cm$

Negative sign shows combination act as Concave lens

Total Internal Reflection:→



[Total Internal reflection]

[ic = critical angle; i = angle of incidence]

- If the light passes through denser medium to rare medium

then at the interface, the light is partly reflected back into denser medium, & partly refracted to the rare medium.

This reflection is called Internal reflection.

for ray 1 This ray travels at a small angle of incidence from denser to rare medium, the ray bends away from the normal. So that

∠ refraction > the ∠ incident

i.e. $\angle r > \angle i$

for ray 2. For a certain angle of incidence, the angle of refraction becomes 90°. (i.e. along the surface of separation)

The angle of incidence in the denser medium for which the angle of refraction in the rare medium is 90° is called critical angle of the denser medium and is denoted by i_c.

for ray 3 If the angle of incidence is increased beyond i_c, no light is refracted into the rare medium, but whole of it is reflected back into the denser medium. This phenomenon is known as T.I.R.

(6) # Conditions for Total Internal Reflection

1. Light must pass from denser medium to rare medium.
2. The angle of incidence in the denser medium must be greater than the critical angle for the two media.

Relation b/w critical angle & refractive index.

From Snell's law.

$$\frac{\sin i}{\sin r} = {}^2\mu_1 = \frac{1}{{}^1\mu_2}$$ [${}^2\mu_1$ = r. I. of Med 1 w.r.to med 2.]

from snell's law

$${}^1\mu_2 = \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{\mu_2}{\mu_1}$$

If $i = i_c$
$r = 90°$

$$\therefore \frac{\sin I_c}{\sin 90°} = \frac{1}{{}^1\mu_2}$$

or. $$\frac{\sin I_c}{1} = \frac{1}{{}^1\mu_2} \Rightarrow \frac{1}{\sin I_c} = {}^1\mu_2 = \frac{\mu_2}{\mu_1}$$

If $\mu_1 = 1$ for air
& $\mu_2 = \mu$

$$\therefore \frac{1}{\sin I_c} = \mu \Rightarrow \boxed{\mu = \frac{1}{\sin I_c}}$$

Thus, the refractive Index of any medium is equal to the reciprocal of the sine of its critical angle.

Applications of T.I.R.

(I) sparkling of diamond.
(II) Mirage.
(III) Totally reflecting prism.
(IV) optical fibres.

MICROSCOPE

A microscope is an optical instrument which enables us to see the small objects in a better way.

There are two types of microscopes.

(I) Simple microscope
(II) Compound microscope.

TELESCOPE

A telescope is an optical instrument designed to show clearly the distant objects.

There are three types of telescope.

(a) Astronomical telescope :—
An astronomical telescope is an optical device used to see distant objects (astronomical bodies such as planets, stars etc).

(b) Terrestrial telescope.

(c) Galilian telescope.

USES OF MICROSCOPE & TELESCOPE

(a) Uses of Microscope.

- Microscope is used to see very small & near objects while telescope show far objects more clearly by farming their image at least distance of distinct vision.
- A microscope creats magnified image at near point, while telescope gather for more light to observe with greater magnification & better resolution.
- Biological scientists use microscopes in research.
- Microscopes are also used in schools & colleges by students

(8) · Microscopes are also used by forensic-science technicians to analyze evidences collected by law enforcement officers.

· Gemological microscopes are used by Jewellers to see the details of pieces they are working with.

· Geologists, geochemists & geophysicists use microscope to test the composition of different types of rocks.

· Similarly oceanographers, hydrologists & environmental science technicians use microscope to test water & soil samples for the presence of pollutions.

(b) Telescope uses :→

Astronomers use telescope to see or find astronomical objects and their motion & behaviour.

The best known & largest orbiting optical telescope is Hubble Space Telescope used for examining various characteristics of distant bodies.

Telescopes are used in laboratories to perform different expts. and finding values of diff. quantities.

Spectrometry uses telescopes to find wavelength of light & other optical effects like bandwidth etc.