NCERT – GRADE 10 CHEAT SHEET

Pumpa®

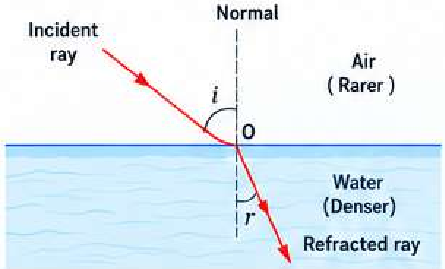
LIGHT REFRACTION & LENSES

PART 2 – REFRACTION AND LENSES

Key Concepts, Laws, Properties & Facts at a Glance

1 REFRACTION OF LIGHT

- The change in direction of light when it passes from one transparent medium to another is called refraction.
- It is due to the change in the speed of light in different media.



LAWS OF REFRACTION (SNELL'S LAW)

1. The incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.
2. For a given pair of media, $n_1 \sin i = n_2 \sin r$ = constant. This is Snell's law of refraction.

Key Points

- If the ray bends towards the normal ($r < i$), medium 2 is denser.
- If the ray bends away from the normal ($r > i$), medium 2 is rarer.

2 REFRACTIVE INDEX

- Refractive index (n) of medium 2 with respect to medium 1 is the ratio of speed of light in medium 1 to that in medium 2.

$$n_{21} = \frac{v_1}{v_2}$$

(n is always > 1 for denser medium)

Refractive index of some media (w.r.t. air)

Medium	Refractive Index (n)
Water	1.33
Alcohol	1.36
Glass	1.50
Diamond	2.42

Absolute Refractive Index

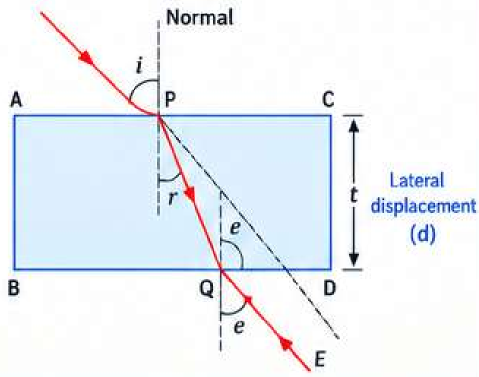
Refractive index of a medium with respect to vacuum.

$$n = \frac{c}{v}$$

Where, c = speed of light in vacuum
v = speed of light in the medium

3 REFRACTION THROUGH A GLASS SLAB

- A ray of light passing through a glass slab emerges parallel to the incident ray.
- There is a lateral displacement of the ray.

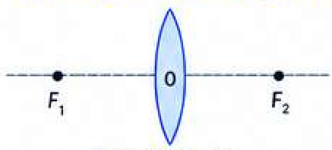


Factors affecting lateral displacement (d)

- Greater thickness (t) → more d
- Greater angle of incidence (i) → more d
- Greater refractive index (n) of slab → more d

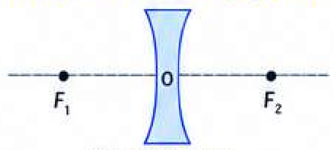
5 LENSES – TYPES AND PRINCIPAL RAYS

(i) Convex Lens (Converging Lens)



Thicker at centre, thinner at edges.

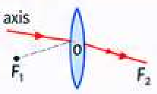
(ii) Concave Lens (Diverging Lens)



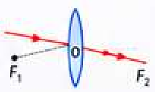
Thinner at centre, thicker at edges.

Principal Rays for Convex Lens

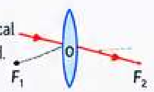
1. Ray parallel to principal axis refracts through F_2.



2. Ray passing through F_1 refracts parallel to principal axis.

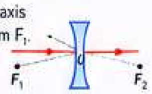


3. Ray passing through optical centre O goes undeviated.

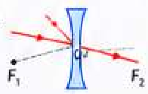


Principal Rays for Concave Lens

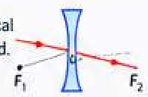
1. Ray parallel to principal axis refracts as if coming from F_1.



2. Ray directed towards F_2 refracts parallel to principal axis.



3. Ray passing through optical centre O goes undeviated.



6 IMAGE FORMATION BY LENSES

(i) Convex Lens (Converging Lens)

Position of Object	Position of Image	Nature of Image	Size of Image
1. At infinity	At F_2	Real, inverted	Highly diminished (point-sized)
2. Beyond $2F_1$	Between F_2 and $2F_2$	Real, inverted	Diminished
3. At $2F_1$	At $2F_2$	Real, inverted	Same size
4. Between F_1 and $2F_1$	Beyond $2F_2$	Real, inverted	Enlarged
5. At F_1	At infinity	Real, inverted	Highly enlarged
6. Between O and F_1	On same side of lens	Virtual, erect	Enlarged

(ii) Concave Lens (Diverging Lens)

Position of Object	Position of Image	Nature of Image	Size of Image
For all positions of object	Between O and F_1 (on same side)	Virtual, erect	Diminished

7 LENS FORMULA, MAGNIFICATION & POWER

Lens Formula

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

Where,
u = object distance (negative for real object)
v = image distance (positive for real image)
f = focal length (positive for convex, negative for concave)

Magnification (m)

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

Where,
h_i = height of image
h_o = height of object

Power of Lens (P)

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

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

- Convex lens → +ve power
- Concave lens → –ve power

Sign Convention (Cartesian)

- All distances are measured from the optical centre of the lens.
- Distances measured in the direction of incident light (left to right) are +ve.
- Distances measured opposite to the direction of incident light (right to left) are –ve.
- Heights above principal axis are +ve; below are –ve.

FORMULAE AT A GLANCE

- Snell's law: $n_1 \sin i = n_2 \sin r$
- Absolute RI: $n = \frac{c}{v}$
- Lens formula: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
- Magnification: $m = \frac{h_i}{h_o} = \frac{v}{u}$
- Power of lens: $P = \frac{1}{f}$ (in m)

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