Ray Optics and Optical Instruments

Class 12 · Physics · Quick Revision · **chapternotes.in**

NEET: 3-4 Qs (~12-16 marks) | Boards: 8-10 marks

Scan: practise free

Light as rays: how mirrors and lenses bend it, when it gets trapped (TIR), how a prism splits it, and how microscopes & telescopes magnify – all run on one sign convention.

1. Reflection & Spherical Mirrors

One mirror formula plus the Cartesian sign convention solves every image.

$f = R/2$
focus midway between pole & C

$1/v + 1/u = 1/f$
mirror formula (note the +)

$m = h'/h = -v/u$
magnification (minus sign!)

MUST KNOW Sign convention: measure all distances from the pole; along incident ray = +, against = −. Real object ⇒ u negative.

MUST KNOW Concave: f, R negative. Convex: f, R positive. Convex mirror always gives a virtual, erect, diminished image (rear-view mirror).

- m positive ⇒ erect/virtual; m negative ⇒ inverted/real. Insert signs first, then solve.

2. Refraction & Total Internal Reflection

Light bends crossing media; past the critical angle it is trapped.

$\mu = \sin i / \sin r$ ($n_1 \sin i = n_2 \sin r$)
Snell's law, angles from normal

$\mu = c/v$
denser medium ⇒ higher μ, slower light

μ = real depth / apparent depth
object appears raised

$\sin i_c = 1/\mu$
critical angle (rarer = air)

MUST KNOW TIR needs BOTH: light going denser → rarer AND i > critical angle i_c.

MUST KNOW Higher μ ⇒ smaller critical angle (diamond μ≈2.42, i_c≈24° → sparkle). Used in optical fibres & total-reflecting prisms.

- Apparent depth is always less than real depth. Frequency stays fixed across a boundary; speed and λ change.

3. Refraction at Spherical Surfaces & Lens Maker

Single-surface refraction applied twice gives the lens maker's formula.

$\mu_2/v - \mu_1/u = (\mu_2 - \mu_1)/R$
single spherical surface

$1/f = (\mu-1)(1/R_1 - 1/R_2)$
lens maker (thin lens in air)

MUST KNOW μ here is the lens index RELATIVE to its surroundings. In a liquid use μ_lens/μ_medium, not the bare glass value.

MUST KNOW If μ_lens = μ_medium ⇒ 1/f = 0: the lens vanishes optically. In a denser medium a convex lens can DIVERGE.

- Equiconvex lens: R_1 positive, R_2 negative; a flat face has R = ∞ so its 1/R term is zero.

4. Thin Lens Formula, Magnification & Power

Lens equation and power; lenses in contact add powers.

$1/v - 1/u = 1/f$
thin lens (note the −, unlike mirror)

$m = v/u = h'/h$
lens magnification (NO minus sign)

P = 1/f (in dioptres, f in metres)
convex P > 0, concave P < 0

$P = P_1 + P_2 + \ldots$ (lenses in contact)
$1/f = 1/f_1 + 1/f_2$

$P = P_1 + P_2 - d \cdot P_1 P_2$
separated by distance d (in m)

MUST KNOW Lens m = +v/u (no minus); mirror m = −v/u. Mixing the two is the classic slip.

MUST KNOW Convex lens, object inside F ⇒ virtual, erect, magnified (magnifying glass). f must be in METRES for power.

- Lenses in contact: add powers (or 1/f), never the focal lengths directly.

5. Prism & Dispersion

A prism deviates light and fans white light into colours.

$$A = r_1 + r_2\ ,\ \delta = i + e - A$$

geometry of a prism

$$\mu = \sin((A + \delta_m)/2)\ /\ \sin(A/2)$$

at minimum deviation, $i = e$, $r_1 = r_2 = A/2$

$$\delta = (\mu - 1)A$$

thin (small-angle) prism

$$\theta = \delta_V - \delta_R = (\mu_V - \mu_R)A$$

angular dispersion

$$\omega = (\mu_V - \mu_R)/(\mu_y - 1)$$

dispersive power (material only)

MUST KNOW Violet deviates most ($\mu_V > \mu_R$), red least. Dispersive power depends only on the material, not on A or prism size.

- Combine prisms for dispersion without deviation (direct-vision spectroscope) or deviation without dispersion (achromatic).

6. Optical Instruments: Microscope & Telescope

Instruments magnify the ANGLE an object subtends at the eye.

Simple microscope: $M = 1 + D/f$ **(image at** $D = 25$ **cm)**

$M = D/f$ if image at infinity

Compound microscope: $M = (L/f_o)(1 + D/f_e)$

L = tube length

Telescope (normal adj.): $M = f_o/f_e$

objective on top

Telescope tube length: $L = f_o + f_e$

MUST KNOW Microscope wants SMALL f_o and small f_e. Telescope wants LARGE f_o and small f_e - opposite objectives.

MUST KNOW Telescope objective is also wide (large aperture) to gather more light and resolve finer detail.

- Don't use $L = f_o + f_e$ for a microscope - that tube relation belongs to the telescope.

Concave vs Convex Lens

	Convex (converging)	Concave (diverging)
f & P	positive	negative
Real image?	Yes (object beyond F)	Never
Object inside F	Virtual, erect, magnified	Virtual, erect, diminished
Use	Magnifier, camera	Spectacles for myopia

Microscope vs Telescope

	Compound Microscope	Astronomical Telescope
Object	Near, tiny	Far (≈ infinity)
Objective f_o	Very small	Large
Eyepiece f_e	Small	Small
Magnification	$(L/f_o)(1 + D/f_e)$	f_o/f_e
Final image	Virtual, inverted	Virtual, inverted

Mnemonic - Order of dispersion: Violet has highest μ (shortest λ), red lowest

VIBGYOR - Violet bends MOST, Red bends LEAST

Common traps

- Sign convention is everything: real object ⇒ u negative; concave mirror/diverging lens ⇒ f negative. Insert signs BEFORE solving.
- Mirror $m = -v/u$ BUT lens $m = +v/u$. Don't borrow the minus sign for lenses.
- Mirror formula uses $1/v + 1/u$; lens formula uses $1/v - 1/u$. Easy to swap under exam pressure.
- Lens maker μ is RELATIVE to the medium: in a liquid use μ_{lens}/μ_{medium}, never the bare glass index.
- For power, f MUST be in metres - leaving it in cm makes the answer 100× too big.

Most asked in NEET » Mirror/lens numericals with sign convention · Critical angle & TIR (denser→rarer) · Real vs apparent depth · Lens in a medium (f changes / vanishes) · Prism: minimum deviation & μ · Dispersion without deviation (achromatic) · Microscope vs telescope magnifying power

Practise this chapter free

10+ real NEET PYQs with worked solutions, flashcards & a gamified app — all free at **chapternotes.in**