CLASS 12 PHYSICS — FORMULA SHEET

Chapter 9 : Ray Optics and Optical Instruments (NCERT)

9.1 Reflection & Spherical Mirrors

Concept	Formula
Laws of reflection	Angle of incidence = angle of reflection ; rays & normal coplanar
Focal length relation	f = R ÷ 2 (R = radius of curvature)
Mirror formula	1/v + 1/u = 1/f
Magnification	m = −v ÷ u = h_i ÷ h_o
Sign convention	Distances measured from pole ; +ve along incident light direction
Concave mirror	f negative (converging)
Convex mirror	f positive (diverging) ; always virtual, erect, diminished image

9.2 Refraction & Snell's Law

Concept	Formula
Snell's law	$n_1 \sin i = n_2 \sin r$; or $_1n_2 = \sin i \div \sin r$
Refractive index	n = c ÷ v (speed in vacuum ÷ speed in medium)
Relative refractive index	$_1n_2 = n_2 \div n_1 = v_1 \div v_2$
Real & apparent depth	n = Real depth ÷ Apparent depth
Apparent shift	Shift = t(1 − 1/n)
Lateral shift (slab)	d = t sin(i − r) ÷ cos r

9.3 Total Internal Reflection (TIR)

Concept	Formula / Condition
Conditions for TIR	Light goes from denser to rarer + angle > critical angle
Critical angle	$\sin C = n_{rarer} \div n_{denser} = 1 \div n$ (for medium-air)
Relation	n = 1 ÷ sin C
Applications	Optical fibres, sparkling diamonds, mirage, prisms in binoculars

9.4 Refraction at Spherical Surfaces & Lens Maker

Concept	Formula
Refraction at single surface	$n_2/v - n_1/u = (n_2 - n_1) \div R$
Lens maker's formula	$1/f = (n - 1)(1/R_1 - 1/R_2)$
Thin lens formula	1/v − 1/u = 1/f
Magnification (lens)	m = v ÷ u = h_i ÷ h_o
Power of lens	P = 1 ÷ f (in metres) ; unit dioptre (D)

Concept	Formula
Convex lens	f positive (converging) ; Concave lens: f negative (diverging)

9.5 Combination of Lenses & Prism

Concept	Formula
Lenses in contact	$1/f = 1/f_1 + 1/f_2 + \ldots$; $P = P_1 + P_2 + \ldots$
Lenses separated by d	$1/f = 1/f_1 + 1/f_2 - d/(f_1 f_2)$
Magnification (combination)	$m = m_1 \times m_2 \times \ldots$
Prism: angle relation	$A + \delta = i + e$ (A = prism angle, δ = deviation)
Prism: refraction	$A = r_1 + r_2$
Minimum deviation	$n = \sin[(A + \delta_m)/2] \div \sin(A/2)$
Thin prism deviation	$\delta = (n - 1)A$

9.6 Optical Instruments

Instrument	Magnification Formula
Simple microscope (near point)	$m = 1 + D/f$
Simple microscope (far point)	$m = D/f$
Compound microscope	$m = (L/f_o)(D/f_e)$ (approx, near point)
Compound microscope (general)	$m = m_o \times m_e = (v_o/u_o)(D/f_e)$
Telescope (normal adjustment)	$m = f_o \div f_e$
Telescope tube length	$L = f_o + f_e$ (normal adjustment)
Telescope (near point)	$m = (f_o/f_e)(1 + f_e/D)$

★ QUICK MEMORY AIDS & TRICKS

Mirror & lens formula	Mirror: 1/v + 1/u = 1/f. Lens: 1/v − 1/u = 1/f. Note the sign difference!
Magnification	Mirror: m = −v/u ; Lens: m = v/u. +m → erect, −m → inverted.
Sign convention	Measure from pole/optical centre ; against incident light is negative.
Critical angle	sinC = 1/n. Denser medium → smaller critical angle.
Lens maker	$1/f = (n-1)(1/R_1 - 1/R_2)$. Power P = 1/f (in metres), unit dioptre.
Lenses in contact	Add the powers: $P = P_1 + P_2$. Focal lengths add as reciprocals.
Prism deviation	Thin prism: $\delta = (n-1)A$. At min deviation, $r_1 = r_2 = A/2$.
Telescope vs microscope	Telescope: $m = f_0/fe$ (big objective f). Microscope: small f_0.