CLASS 11 PHYSICS — FORMULA SHEET

Chapter 10 : Thermal Properties of Matter (NCERT)

10.1 Temperature & Thermal Expansion

Concept	Formula
Celsius–Fahrenheit	$(F - 32)/9 = C/5$; also $C/100 = (F-32)/180$
Celsius–Kelvin	$K = C + 273.15$
Linear expansion	$\Delta L = \alpha L \Delta T$; $L = L_0(1 + \alpha \Delta T)$
Area (superficial) expansion	$\Delta A = \beta A \Delta T$; $\beta = 2\alpha$
Volume (cubical) expansion	$\Delta V = \gamma V \Delta T$; $\gamma = 3\alpha$
Relation	$\alpha : \beta : \gamma = 1 : 2 : 3$
Thermal stress (rod fixed)	Stress $= Y \alpha \Delta T$

10.2 Specific Heat & Calorimetry

Concept	Formula
Heat absorbed/released	$Q = m c \Delta T$ (c = specific heat capacity)
Molar specific heat	$Q = n C \Delta T$
Specific heat of water	$c = 4186 \text{ J kg}^{-1} \text{K}^{-1} = 1 \text{ cal g}^{-1} \text{°C}^{-1}$
Principle of calorimetry	Heat lost by hot body = heat gained by cold body
Water equivalent	$W = m c \div c_{water}$ (mass of water needing same heat)
1 calorie	= 4.186 J

10.3 Latent Heat & Change of State

Concept	Formula / Value
Latent heat	$Q = m L$ (heat for phase change at constant T)
Latent heat of fusion (ice)	$L_f = 3.34 \times 10^5$ J/kg = 80 cal/g
Latent heat of vaporisation (water)	$L_v = 22.6 \times 10^5$ J/kg = 540 cal/g
Melting	Solid → liquid (absorbs heat, T constant)
Vaporisation	Liquid → gas (absorbs heat, T constant)
Sublimation	Solid → gas directly
Effect of pressure	↑ pressure → m.p. of ice falls, b.p. of water rises

10.4 Heat Transfer — Conduction

Concept	Formula
Rate of heat flow (conduction)	$Q/t = K A (T_1 - T_2) \div L$
Thermal conductivity	K (unit: $\text{W m}^{-1} \text{K}^{-1}$)

Concept	Formula
Thermal resistance	$R = L \div (KA)$
Temperature gradient	$= (T_1 - T_2) \div L$
Series combination	$R_{eq} = R_1 + R_2$ (resistances add)
Parallel combination	$1/R_{eq} = 1/R_1 + 1/R_2$

10.5 Convection, Radiation & Laws

Concept	Formula / Statement
Convection	Heat transfer by actual movement of fluid (no formula required)
Stefan–Boltzmann law	$E = \sigma T^4$; $\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}
Power radiated by a body	$P = e \sigma A T^4$ (e = emissivity)
Net radiated power	$P = e \sigma A (T^4 - T_0^4)$
Wien's displacement law	$\lambda_m T = b$; $b = 2.9 \times 10^{-3}$ m·K
Newton's law of cooling	Rate of cooling $\propto (T - T_0)$ (small temperature difference)
Cooling expression	$dT/dt = -k(T - T_0)$
Kirchhoff's law (radiation)	Good absorbers are good emitters (a = e)

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Expansion ratio	$\alpha : \beta : \gamma = 1 : 2 : 3$. $\beta = 2\alpha$ (area), $\gamma = 3\alpha$ (volume).
Temperature scales	$K = C + 273.15$; $C/5 = (F-32)/9$.
Calorimetry	Heat lost = heat gained. Mix problems balance the two sides.
Latent heat	$Q = mL$. Ice: 80 cal/g (fusion) ; Water: 540 cal/g (vaporisation).
Conduction	$Q/t = KA\Delta T/L$. Like Ohm's law: heat current = ΔT / thermal resistance.
Stefan's law	$E \propto T^4$ — doubling temperature raises radiated power 16×.
Wien's law	λ_m T = constant. Hotter body → shorter peak wavelength (bluer).
Newton's cooling	Rate $\propto$ temperature difference (valid for small ΔT only).