

Useful Formulae:

Wein's Law: $\lambda_{\max} T = 2.897 \times 10^{-3} \text{ mK}$

Gain: $g = \Delta N \sigma_0$

Planck's Relationship: $E = h\nu = \frac{hc}{\lambda}$

Threshold Gain:
(simple configuration) $g_{\text{threshold}} = \gamma + \frac{1}{2x} \ln\left(\frac{1}{R_1 R_2}\right)$

Fresnel equation: $R = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2$

ULL Rate Equation: $\frac{dN_{ULL}}{dt} = \frac{\Delta N}{\tau}$

Minimum Pump Power: $P_{\text{Minimum}} = \frac{dN_{ULL}}{dt} V h \nu_{MP}$

Re-absorption loss: $\gamma_{\text{THERMAL}} = \sigma_0 N_{LLL} = \sigma_0 f_L N_0$

Rigrod Solution: $I_2 = \frac{I_{\text{SAT}} (g_0 x_g + \ln(\sqrt{R_1 R_2}))}{1 + \sqrt{\frac{R_2}{R_1}} - R_2 - \sqrt{R_1 R_2}}$

Saturation Intensity: $I_{\text{sat}} = \frac{h\nu}{\sigma_0 \tau}$

Boltzmann's Law: $N = N_0 e^{\frac{-E}{kT}}$

Saturated Gain: $g_{\text{sat}} = \frac{g_0}{1 + \frac{\rho}{\rho_{\text{sat}}}}$

Mode Spacing: $\Delta\nu = \frac{c}{2nL}$

Recombination Rate: $\frac{dN_{ULL}}{dt} = \frac{J}{q \times t}$

Level Lifetime: $\tau = \frac{1}{\sum A_i}$

Partition Function: $f_L = \frac{g_x e^{\frac{-E_x}{kT}}}{\sum_i g_i e^{\frac{-E_i}{kT}}}$

Constants and Conversions:

1eV = 1.602E⁻¹⁹J

k = Boltzmann's constant (1.381 * 10⁻²³ J/K)

c = Speed of Light (3*10⁸ m/s)

1 mole (Avogadro's number) = 6.02*10²³ atoms/molecules

Indices of Refraction: Quartz = 1.46, Glass = 1.51

0 C = 273.15 K

h = Planck's constant (6.626 * 10⁻³⁴ Js)