

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

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

Decay: $N = N_0 e^{\frac{-t}{\tau}}$

Basic Physics: $v = \frac{d}{t}$ $A_{circle} = \pi r^2$

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

Diffraction Grating: $d \sin \theta = m\lambda$

Power: $P = \frac{E}{t}$

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

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

Saturated Gain: $g_{sat} = \frac{g_0}{1 + \frac{2\rho}{\rho_{sat}}}$ $g_{sat} = \frac{g_0}{\sqrt{1 + \frac{2\rho}{\rho_{sat}}}}$

Snell's Law: $\left(\frac{\sin \theta_1}{\sin \theta_2}\right) = \frac{n_2}{n_1}$

Gain Coefficient: $g = \Delta N \times \sigma_0$

Linewidth: $\Delta\nu = 2\nu_0 \sqrt{\frac{2kT \ln(2)}{Mc^2}}$

Atomic Mass: $M(g) = \frac{amu(g/mol)}{N_a (mol^{-1})}$

Cavity Optics: $g = 1 - \frac{L}{r}$

Threshold Gain: $g_{th} = \gamma + \frac{1}{2x} \ln\left(\frac{1}{R_1 R_2}\right)$
(Simplified)

Re-absorption Loss: $\gamma_{thermal} = N_{LLL-Volumetric} \times \sigma_0$

Interferometer Mode Spacing: $FSR = \frac{c}{2nt}$

Etalon Angle: $N\lambda = 2nt \cos\left(\frac{\theta}{n}\right)$
(Small Angle approx)

Half-wave Voltage: $\frac{V_{\frac{1}{2}-\lambda_1}}{V_{\frac{1}{2}-\lambda_2}} = \frac{\lambda_1}{\lambda_2}$

Bragg Diffraction: $\theta_B = \frac{\lambda f}{2v}$

Acoustic Wavelength: $\Lambda = \frac{v_{acoustic}}{f}$

Diffraction Efficiency: $DE = \frac{P_{1st_Order_RF_ON}}{P_{0th_Order_RF_OFF}}$

Insertion Loss: $IL = \frac{P_{INPUT}}{P_{0th_Order_RF_OFF}}$

Time-B/W (Gaussian): $Time(s) \times BW(Hz) = 0.44$

Time-B/W (Sech²): $Time(s) \times Bandwidth(Hz) = 0.32$

Bandwidth: $BW(m) = BW(Hz) \times \frac{\lambda^2}{c}$

Optical Density: $OD = -\log_{10}\left(\frac{P_{OUT}}{P_{IN}}\right)$

Constants and Conversions:

1eV = 1.602E⁻¹⁹J

k = Boltzmann's constant (1.38 * 10⁻²³ J/K)

σ = Stefan-Boltzmann constant (5.67*10⁻⁸ Wm⁻²K⁻⁴)

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

Indices of Refraction: Quartz = 1.46, Glass = 1.51

Acoustic Speed: Quartz = 3760 m/s

0°C = 273.15 K

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

c = Speed of Light (3*10⁸ m/s)

ε₀ = permittivity (8.85*10⁻¹² F/m)

Dilated Pupil = 0.4cm²

Atomic masses: Neon = 20 amu, Argon = 38 amu, Helium = 4 amu, Cadmium=112 amu, CO₂ = 44 amu