

Potentially Useful Formulae and Constants:

Speed of light, $c = 3 \times 10^8 \text{ ms}^{-1}$

Charge of the Electron, $e = 1.6 \times 10^{-19} \text{ C}$

Planck's Constant, $h = 6.6 \times 10^{-34} \text{ J s}$

Boltzmann's constant, $k = 1.38 \times 10^{-23} \text{ J K}^{-1}$

Earth-Moon distance, $r = 384,000 \text{ km}$

(The symbols below should be interpreted with their usual meaning)

Energy of a photon , $E = h\nu$

Resonator g factors: $g_1 = 1 - L/R_1$, $g_2 = 1 - L/R_2$

Ray matrices for a curved mirror, thin lens, propagation, and a spherical dielectric interface:

$$\begin{bmatrix} 1 & 0 \\ -2/R & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ -1/f & 1 \end{bmatrix} \begin{bmatrix} 1 & d \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \frac{n_2 - n_1}{n_2 R} & n_1/n_2 \end{bmatrix}$$

Finesse of a resonator with no loss apart from that associated with the finite reflectivity of the two mirrors. The mirror reflectivity is expressed in terms of its amplitude reflectivity:

$$F = \frac{\pi \sqrt{r_1 r_2}}{1 - r_1 r_2}$$

Planck's radiation law: $u = \frac{8\pi h\nu^3}{c^3 (e^{h\nu/(kT)} - 1)}$

Definition of the complex radius of curvature: $\frac{1}{q(z)} = \frac{1}{R(z)} - j \frac{\lambda}{\pi w(z)^2}$

Ratio of population densities in two levels separated by ΔE in energy: $n_2 / n_1 = e^{-\Delta E/(kT)}$

Q of a cavity resonance mode: $Q_c = \nu_0 / \Delta\nu$ or $Q_c = 2\pi\nu_0 [E / (dE/dt)]$ or $Q_c = 2\pi [E/E']$ where E is the stored energy, dE/dt is the energy dissipated per second and E' is the energy dissipated per cycle.

Gain coefficient for a 4 level scheme in terms of population differences: $\kappa = \frac{c^2 g(\nu_r) A}{8\pi\nu_r^2} (n_3 - n_2)$

where c is the speed of light in the material and the rest of the symbols are interpreted as usual.

Population inversion at threshold for a 4 level laser scheme: $(n_3 - n_2) / N = W_{41} / (W_{41} + A_{32})$