

Important Lasers Formulas PDF



Formulas Examples with Units

List of 12 Important Lasers Formulas

1) Absorption Co-Efficient Formula ↻

Formula

$$\alpha_a = \frac{g_2}{g_1} \cdot (N_1 - N_2) \cdot \frac{B_{21} \cdot [h\nu] \cdot v_{21} \cdot n_{ri}}{[c]}$$

Evaluate Formula ↻

Example with Units

$$9.7E-41 \text{ 1/m} = \frac{24}{12} \cdot (1.85 \text{ electrons/m}^3 - 1.502 \text{ electrons/m}^3) \cdot \frac{1.52 \text{ m}^3 \cdot 6.6E-34 \cdot 41 \text{ Hz} \cdot 1.01}{3E+8 \text{ m/s}}$$

2) Half Wave Voltage Formula ↻

Formula

$$V_\pi = \frac{\lambda_0}{r \cdot n_{ri}^3}$$

Example with Units

$$0.1662 \text{ v} = \frac{3.939 \text{ m}}{23 \text{ m} \cdot 1.01^3}$$

Evaluate Formula ↻

3) Intensity of Signal at Distance Formula ↻

Formula

$$I_x = I_o \cdot \exp(-\text{ad}_c \cdot x)$$

Example with Units

$$2.7176 \text{ w/m}^2 = 3.5 \text{ w/m}^2 \cdot \exp(-2.3 \cdot 0.11 \text{ m})$$

Evaluate Formula ↻

4) Irradiance Formula ↻

Formula

$$I_t = E_o \cdot \exp(k_s \cdot x_l)$$

Example with Units

$$1.5101 \text{ w/m}^2 = 1.51 \text{ w/m}^2 \cdot \exp(1.502 \cdot 51 \mu\text{m})$$

Evaluate Formula ↻

5) Plane of Polarizer Formula ↻

Formula

$$P = P' \cdot (\cos(\theta))^2$$

Example with Units

$$1.995 = 2.66 \cdot (\cos(30^\circ))^2$$

Evaluate Formula ↻



6) Plane of Transmission of Analyzer Formula

Formula

$$P' = \frac{P}{(\cos(\theta))^2}$$

Example with Units

$$2.66 = \frac{1.995}{(\cos(30^\circ))^2}$$

Evaluate Formula 

7) Ratio of Rate of Spontaneous and Stimulated Emission Formula

Formula

$$R_s = \exp\left(\left(\frac{[hP] \cdot f_r}{[BoltZ] \cdot T_o}\right) - 1\right)$$

Example with Units

$$0.3679 = \exp\left(\left(\frac{6.6E-34 \cdot 57 \text{ Hz}}{1.4E-23 \text{ J/K} \cdot 293 \text{ K}}\right) - 1\right)$$

Evaluate Formula 

8) Round Trip Gain Formula

Formula

$$G = R_1 \cdot R_2 \cdot \left(\exp\left(2 \cdot (k_s - \gamma_{\text{eff}}) \cdot L_l\right)\right)$$

Example with Units

$$3E-16 = 2.41 \cdot 3.01 \cdot \left(\exp\left(2 \cdot (1.502 - 2.4) \cdot 21 \text{ m}\right)\right)$$

Evaluate Formula 

9) Single Pinhole Formula

Formula

$$S = \frac{F_w}{\left(A \cdot \left(\frac{180}{\pi}\right)\right) \cdot 2}$$

Example with Units

$$24.5098 = \frac{400 \text{ m}}{\left(8.16^\circ \cdot \left(\frac{180}{3.1416}\right)\right) \cdot 2}$$

Evaluate Formula 

10) Small Signal Gain Coefficient Formula

Formula

$$k_s = N_2 \cdot \left(\frac{g_2}{g_1}\right) \cdot (N_1) \cdot \frac{B_{21} \cdot [hP] \cdot v_{21} \cdot n_{ri}}{[c]}$$

Example with Units

$$1.502 = 1.502 \text{ electrons/m}^3 \cdot \left(\frac{24}{12}\right) \cdot (1.85 \text{ electrons/m}^3) \cdot \frac{1.52 \text{ m}^3 \cdot 6.6E-34 \cdot 41 \text{ Hz} \cdot 1.01}{3E+8 \text{ m/s}}$$

Evaluate Formula 



11) Transmittance Formula

Formula

Evaluate Formula 

$$t = \left(\sin \left(\frac{\pi}{\lambda_o} \cdot (n_{ri})^3 \cdot r \cdot V_{cc} \right) \right)^2$$

Example with Units

$$0.8523 = \left(\sin \left(\frac{3.1416}{3.939_m} \cdot (1.01)^3 \cdot 23_m \cdot 1.6_v \right) \right)^2$$

12) Variable Refractive Index of The GRIN Lens Formula

Formula

Example with Units

Evaluate Formula 

$$n_r = n_1 \cdot \left(1 - \frac{A_{con} \cdot R_{lens}^2}{2} \right)$$

$$1.4531 = 1.5 \cdot \left(1 - \frac{10000 \cdot 0.0025_m^2}{2} \right)$$



Variables used in list of Lasers Formulas above

- **A** Apex Angle (Degree)
- **A_{con}** Positive Constant
- **ad_c** Decay Constant
- **B₂₁** Einstein Coefficient for Stimulated Absorption (Cubic Meter)
- **E_o** Irradiation of Light Incident (Watt per Square Meter)
- **f_r** Frequency of Radiation (Hertz)
- **F_w** Wavelength of Wave (Meter)
- **G** Round Trip Gain
- **g₁** Degeneracy of Initial State
- **g₂** Degeneracy of Final State
- **I_o** Initial Intensity (Watt per Square Meter)
- **I_t** Irridance of Transmitted Beam (Watt per Square Meter)
- **I_x** Intensity of Signal at Distance (Watt per Square Meter)
- **k_s** Signal Gain Coefficient
- **L_l** Length of Laser Cavity (Meter)
- **n₁** Refractive Index of Medium 1
- **N₁** Density of Atoms Initial State (Electrons per Cubic Meter)
- **N₂** Density of Atoms Final State (Electrons per Cubic Meter)
- **n_r** Apparent Refractive Index
- **n_{ri}** Refractive Index
- **P** Plane of Polarizer
- **P'** Plane of Transmission of Analyzer
- **r** Length of Fiber (Meter)
- **R₁** Reflectances
- **R₂** Reflectances Separated by L
- **R_{lens}** Radius of Lens (Meter)

Constants, Functions, Measurements used in list of Lasers Formulas above

- **constant(s):** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **constant(s):** **[BoltZ]**, 1.38064852E-23
Boltzmann constant
- **constant(s):** **[c]**, 299792458.0
Light speed in vacuum
- **constant(s):** **[hP]**, 6.626070040E-34
Planck constant
- **Functions:** **cos**, cos(Angle)
Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- **Functions:** **exp**, exp(Number)
n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- **Functions:** **sin**, sin(Angle)
Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- **Measurement:** **Length** in Meter (m), Micrometer (μm)
Length Unit Conversion 
- **Measurement:** **Temperature** in Kelvin (K)
Temperature Unit Conversion 
- **Measurement:** **Volume** in Cubic Meter (m³)
Volume Unit Conversion 
- **Measurement:** **Angle** in Degree (°)
Angle Unit Conversion 
- **Measurement:** **Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement:** **Wavelength** in Meter (m)
Wavelength Unit Conversion 
- **Measurement:** **Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement:** **Wave Number** in 1 per Meter (1/m)
Wave Number Unit Conversion 
- **Measurement:** **Intensity** in Watt per Square Meter (W/m²)



- R_s Ratio of Rate of Spontaneous to Stimulus Emission
- S Single Pinhole
- t Transmittance
- T_o Temperature (Kelvin)
- ν_{21} Frequency of Transition (Hertz)
- V_{cc} Supply Voltage (Volt)
- V_{π} Half Wave Voltage (Volt)
- x Distance of Measuring (Meter)
- x_l Distance Travelled by Laser Beam (Micrometer)
- α_a Absorption Coefficient (1 per Meter)
- γ_{eff} Effective Loss Coefficient
- θ Theta (Degree)
- λ_o Wavelength of Light (Meter)

Intensity Unit Conversion 

- **Measurement: Irradiation** in Watt per Square Meter (W/m^2)

Irradiation Unit Conversion 

- **Measurement: Electron Density** in Electrons per Cubic Meter (electrons/ m^3)

Electron Density Unit Conversion 



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