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Lasers Formulas

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List of 12 Lasers Formulas

Lasers

1) Absorption Co-Efficient

Open Calculator

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

ex $$9.7E\hat{}\text{-}41/m = \frac{24}{12} \cdot (1.85 electrons/m^3 - 1.502 electrons/m^3) \cdot \frac{1.52 m^3 \cdot [hP] \cdot 41 Hz \cdot 1.01}{[c]}$$

2) Half Wave Voltage

Open Calculator

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

ex $$0.166224V = \frac{3.939m}{23m \cdot (1.01)^3}$$

3) Intensity of Signal at Distance

Open Calculator

fx $$I_x = I_o \cdot \exp(-ad_c \cdot x)$$

ex $$2.717638 W/m^2 = 3.5 W/m^2 \cdot \exp(-2.3 \cdot 0.11m)$$

4) Irradiance

Open Calculator

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

ex $$1.510116 W/m^2 = 1.51 W/m^2 \cdot \exp(1.502 \cdot 51\mu m)$$

5) Plane of Polarizer

Open Calculator

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

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

6) Plane of Transmission of Analyzer

Open Calculator

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

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

7) Ratio of Rate of Spontaneous and Stimulated Emission

Open Calculator

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

$$0.367879 = \exp\left(\left(\frac{[hP] \cdot 57\text{Hz}}{[BoltZ] \cdot 293\text{K}}\right) - 1\right)$$

8) Round Trip Gain

Open Calculator

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

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

9) Single Pinhole

Open Calculator

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

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

10) Small Signal Gain Coefficient

Open Calculator

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

$$1.502 = 1.502\text{electrons/m}^3 - \left(\frac{24}{12}\right) \cdot (1.85\text{electrons/m}^3) \cdot \frac{1.52\text{m}^3 \cdot [hP] \cdot 41\text{Hz} \cdot 1.01}{[c]}$$

11) Transmittance

Open Calculator

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

$$0.852309 = \left(\sin\left(\frac{\pi}{3.939\text{m}} \cdot (1.01)^3 \cdot 23\text{m} \cdot 1.6\text{V}\right)\right)^2$$

12) Variable Refractive Index of The GRIN Lens

Open Calculator

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

$$1.453125 = 1.5 \cdot \left(1 - \frac{10000 \cdot (0.0025\text{m})^2}{2}\right)$$

Variables Used

- **A** Apex Angle *(Degree)*
- **A_{con}** Positive Constant
- **ad_c** Decay Constant
- **B_{21}** 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
- **g_1** Degeneracy of Initial State
- **g_2** 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)*
- **n_1** Refractive Index of Medium 1
- **N_1** Density of Atoms Initial State *(Electrons per Cubic Meter)*
- **N_2** 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)*
- **R_1** Reflectances
- **R_2** Reflectances Separated by L
- **R_{lens}** Radius of Lens *(Meter)*

- R_S Ratio of Rate of Spontaneous to Stimulus Emission
- S Single Pinhole
- t Transmittance
- T_o Temperature *(Kelvin)*
- v_{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)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[BoltZ]**, 1.38064852E-23
  Boltzmann constant
- Constant: **[c]**, 299792458.0
  Light speed in vacuum
- Constant: **[hP]**, 6.626070040E-34
  Planck constant
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **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.
- Function: **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 (m^3)
  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)
  Intensity Unit Conversion
- Measurement: **Irradiation** in Watt per Square Meter (W/m²)
  Irradiation Unit Conversion
- Measurement: **Electron Density** in Electrons per Cubic Meter (electrons/m³)
  Electron Density Unit Conversion

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