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Photonics Devices Formulas

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List of 13 Photonics Devices Formulas

Photonics Devices

1) Contact Potential Difference

Open Calculator

fx $$V_0 = \frac{[BoltZ] \cdot T}{[Charge\text{-}e]} \cdot \ln\left(\frac{N_A \cdot N_D}{(n1_i)^2}\right)$$

ex $$0.623837V = \frac{[BoltZ] \cdot 393K}{[Charge\text{-}e]} \cdot \ln\left(\frac{1e{+}22/m^3 \cdot 1e{+}24/m^3}{(1e{+}19/m^3)^2}\right)$$

2) Energy Density given Einstein Co-Efficients

Open Calculator

fx $$u = \frac{8 \cdot [hP] \cdot f_r^3}{[c]^3} \cdot \left(\frac{1}{\exp\left(\frac{h_p \cdot f_r}{[BoltZ] \cdot T_o}\right) - 1}\right)$$

ex $$3.9E\hat{}\text{-}42J/m^3 = \frac{8 \cdot [hP] \cdot (57Hz)^3}{[c]^3} \cdot \left(\frac{1}{\exp\left(\frac{6.626E\hat{}\text{-}34 \cdot 57Hz}{[BoltZ] \cdot 293K}\right) - 1}\right)$$

3) Length of Cavity

Open Calculator

fx $$L_c = \frac{\lambda \cdot m}{2}$$

ex $$7.878m = \frac{3.9m \cdot 4.04}{2}$$

4) Mode Number

Open Calculator

fx $$m = \frac{2 \cdot L_c \cdot n_{ri}}{\lambda}$$

ex $$4.029641 = \frac{2 \cdot 7.78m \cdot 1.01}{3.9m}$$

5) Net Phase Shift

Open Calculator

$$\Delta\Phi = \frac{\pi}{\lambda_o} \cdot (n_{ri})^3 \cdot r \cdot V_{cc}$$

$$30.23959\text{rad} = \frac{\pi}{3.939\text{m}} \cdot (1.01)^3 \cdot 23\text{m} \cdot 1.6\text{V}$$

6) Optical Power Radiated

Open Calculator

$$P_{opt} = \varepsilon_{opto} \cdot [\text{Stefan-BoltZ}] \cdot A_s \cdot T_o^4$$

$$0.001815\text{W} = 0.85 \cdot [\text{Stefan-BoltZ}] \cdot 5.11\text{mm}^2 \cdot (293\text{K})^4$$

7) Proton Concentration under Unbalanced Condition

Open Calculator

$$p_c = n_i \cdot \exp\left(\frac{E_i - F_n}{[\text{BoltZ}] \cdot T}\right)$$

$$38.21311\text{electrons/m}^3 = 3.6\text{electrons/m}^3 \cdot \exp\left(\frac{3.78\text{eV} - 3.7\text{eV}}{[\text{BoltZ}] \cdot 393\text{K}}\right)$$

8) Relative Population

Open Calculator

$$n_{rel} = \exp\left(-\frac{[\text{hP}] \cdot \nu_{rel}}{[\text{BoltZ}] \cdot T}\right)$$

$$1 = \exp\left(-\frac{[\text{hP}] \cdot 8.9\text{Hz}}{[\text{BoltZ}] \cdot 393\text{K}}\right)$$

9) Saturation Current Density

Open Calculator

$$J_0 = [\text{Charge-e}] \cdot \left(\frac{D_h}{L_h} \cdot p_n + \frac{D_E}{L_e} \cdot n_p\right)$$

$$1.6\text{E^-7A/m}^2 = [\text{Charge-e}] \cdot \left(\frac{1.2\text{e-3m}^2/\text{s}}{0.35\text{mm}} \cdot 2.56\text{e+11/m}^3 + \frac{0.003387\text{m}^2/\text{s}}{0.71\text{mm}} \cdot 2.55\text{e+10/m}^3\right)$$

10) Spectral Radiant Emittance

Open Calculator

fx $$W_{sre} = \frac{2 \cdot \pi \cdot [hP] \cdot [c]^3}{\lambda_{vis}^5} \cdot \frac{1}{\exp\left(\frac{[hP] \cdot [c]}{\lambda_{vis} \cdot [BoltZ] \cdot T}\right) - 1}$$

ex $$5.7E\hat{}\text{-}8W/(m^2*Hz) = \frac{2 \cdot \pi \cdot [hP] \cdot [c]^3}{(500nm)^5} \cdot \frac{1}{\exp\left(\frac{[hP] \cdot [c]}{500nm \cdot [BoltZ] \cdot 393K}\right) - 1}$$

11) Total Current Density

Open Calculator

fx $$J = J_0 \cdot \left(\exp\left(\frac{[Charge\text{-}e] \cdot V_0}{[BoltZ] \cdot T}\right) - 1\right)$$

ex $$7.914809C/m^2 = 1.6E\hat{}\text{-}7A/m^2 \cdot \left(\exp\left(\frac{[Charge\text{-}e] \cdot 0.6V}{[BoltZ] \cdot 393K}\right) - 1\right)$$

12) Wavelength of Output Light

Open Calculator

fx $$\lambda_o = n_{ri} \cdot \lambda$$

ex $$3.939m = 1.01 \cdot 3.9m$$

13) Wavelength of Radiation in Vaccum

Open Calculator

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

ex $$399.84m = 8.16^\circ \cdot \left(\frac{180}{\pi}\right) \cdot 2 \cdot 24.5$$

Variables Used

- **A** Apex Angle *(Degree)*
- A_s Area of Source *(Square Millimeter)*
- D_E Electron Diffusion Coefficient *(Square Meter Per Second)*
- D_h Diffusion Coefficient of Hole *(Square Meter Per Second)*
- E_i Intrinsic Energy Level of Semiconductor *(Electron-Volt)*
- F_n Quasi Fermi Level of Electrons *(Electron-Volt)*
- f_r Frequency of Radiation *(Hertz)*
- F_w Wavelength of Wave *(Meter)*
- h_p Planck's Constant
- **J** Total Current Density *(Coulomb per Square Meter)*
- J_0 Saturation Current Density *(Ampere per Square Meter)*
- L_c Length of Cavity *(Meter)*
- L_e Diffusion Length of Electron *(Millimeter)*
- L_h Diffusion Length of Hole *(Millimeter)*
- **m** Mode Number
- N_A Acceptor Concentration *(1 per Cubic Meter)*
- N_D Donor Concentration *(1 per Cubic Meter)*
- n_i Intrinsic Electron Concentration *(Electrons per Cubic Meter)*
- n_p Electron Concentration in p-Region *(1 per Cubic Meter)*
- n_{rel} Relative Population
- n_{ri} Refractive Index
- $n1_i$ Intrinsic Carrier Concentration *(1 per Cubic Meter)*
- p_c Proton Concentration *(Electrons per Cubic Meter)*
- p_n Hole Concentration in n-Region *(1 per Cubic Meter)*
- P_{opt} Optical Power Radiated *(Watt)*
- **r** Length of Fiber *(Meter)*
- **S** Single Pinhole

- **T** Absolute Temperature *(Kelvin)*
- T_o Temperature *(Kelvin)*
- **u** Energy Density *(Joule per Cubic Meter)*
- V_0 Voltage Across PN Junction *(Volt)*
- V_{cc} Supply Voltage *(Volt)*
- W_{sre} Spectral Radiant Emittance *(Watt per Square Meter per Hertz)*
- $\Delta\Phi$ Net Phase Shift *(Radian)*
- ε_{opto} Emissivity
- λ Photon Wavelength *(Meter)*
- λ_o Wavelength of Light *(Meter)*
- λ_{vis} Wavelength of Visible Light *(Nanometer)*
- v_{rel} Relative Frequency *(Hertz)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[BoltZ]**, 1.38064852E-23
  Boltzmann constant
- Constant: **[Charge-e]**, 1.60217662E-19
  Charge of electron
- Constant: **[c]**, 299792458.0
  Light speed in vacuum
- Constant: **[hP]**, 6.626070040E-34
  Planck constant
- Constant: **[Stefan-BoltZ]**, 5.670367E-8
  Stefan-Boltzmann Constant
- 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: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Measurement: **Length** in Meter (m), Millimeter (mm), Nanometer (nm)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Energy** in Electron-Volt (eV)
  Energy Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Angle** in Radian (rad), Degree (°)
  Angle Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Wavelength** in Meter (m)
  Wavelength Unit Conversion

- Measurement: **Surface Charge Density** in Coulomb per Square Meter (C/m²)
  Surface Charge Density Unit Conversion
- Measurement: **Surface Current Density** in Ampere per Square Meter (A/m²)
  Surface Current Density Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Diffusivity** in Square Meter Per Second (m²/s)
  Diffusivity Unit Conversion
- Measurement: **Carrier Concentration** in 1 per Cubic Meter (1/m³)
  Carrier Concentration Unit Conversion
- Measurement: **Energy Density** in Joule per Cubic Meter (J/m³)
  Energy Density Unit Conversion
- Measurement: **Spectral Exitance Per Unit Frequency** in Watt per Square Meter per Hertz (W/(m²*Hz))
  Spectral Exitance Per Unit Frequency Unit Conversion
- Measurement: **Electron Density** in Electrons per Cubic Meter (electrons/m³)
  Electron Density Unit Conversion

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