Important Devices with Optical Components Formulas PDF

Formulas
Examples
with Units

List of 14
Important Devices with Optical Components Formulas

1) Angle of Rotation of Plane of Polarization Formula

Evaluate Formula

Formula

$$\theta = 1.8 \cdot B \cdot L_m$$

Example with Units

$$19.53\,\text{rad} = 1.8 \cdot 0.35\,\text{T} \cdot 31\,\text{m}$$

2) Apex Angle Formula

Evaluate Formula

Formula

$$A = \tan(\alpha)$$

Example with Units

$$8.1673° = \tan(-3)$$

3) Brewsters Angle Formula

Evaluate Formula

Formula

$$\theta_B = \arctan\left(\frac{n_1}{n_{ri}}\right)$$

Example with Units

$$56.0463° = \arctan\left(\frac{1.5}{1.01}\right)$$

4) Current Due to Optically Generated Carrier Formula

Evaluate Formula

Formula

$$i_{opt} = q \cdot A_{pn} \cdot g_{op} \cdot \left(W + L_{dif} + L_p\right)$$

Example with Units

$$0.6\,\text{mA} = 0.3\,\text{C} \cdot 4.8\,\mu\text{m}^2 \cdot 2.9\text{e}13 \cdot \left(6.79\,\mu\text{m} + 5.477816\,\mu\text{m} + 2.1\,\mu\text{m}\right)$$

5) Diffraction using Fresnel-Kirchoff Formula Formula

Evaluate Formula

Formula

$$\theta_{dif} = a\sin\left(1.22 \cdot \frac{\lambda_{vis}}{D}\right)$$

Example with Units

$$0.0061\,\text{rad} = a\sin\left(1.22 \cdot \frac{500\,\text{nm}}{0.1\,\text{mm}}\right)$$

6) Diffusion Coefficient of Electron Formula

Evaluate Formula

Formula

$$D_E = \mu_e \cdot [BoltZ] \cdot \frac{T}{[Charge\text{-}e]}$$

Example with Units

$$0.0034\,m^2/s = 1000\,cm^2/V*s \cdot 1.4E\text{-}23\,J/K \cdot \frac{393\,K}{1.6E\text{-}19\,C}$$

7) Diffusion Length of Transition Region Formula

Evaluate Formula

Formula

$$L_{dif} = \frac{i_{opt}}{q \cdot A_{pn} \cdot g_{op}} - \left(W + L_p \right)$$

Example with Units

$$5.4778\,\mu m = \frac{0.60\,mA}{0.3\,C \cdot 4.8\,\mu m^2 \cdot 2.9e13} - \left(6.79\,\mu m + 2.1\,\mu m \right)$$

8) Effective Density of States in Conduction Band Formula

Evaluate Formula

Formula

$$N_{eff} = 2 \cdot \left(2 \cdot \pi \cdot m_{eff} \cdot [BoltZ] \cdot \frac{T}{[hP]^2} \right)^{\frac{3}{2}}$$

Example with Units

$$3.9E{+}24 = 2 \cdot \left(2 \cdot 3.1416 \cdot 0.2e\text{-}30\,kg \cdot 1.4E\text{-}23\,J/K \cdot \frac{393\,K}{6.6E\text{-}34^2} \right)^{\frac{3}{2}}$$

9) Electron Concentration under Unbalanced Condition Formula

Evaluate Formula

Formula

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

Example with Units

$$0.3392\,electrons/m^3 = 3.6\,electrons/m^3 \cdot \exp\left(\frac{3.7\,eV - 3.78\,eV}{1.4E\text{-}23\,J/K \cdot 393\,K} \right)$$

10) Excitation Energy Formula

Evaluate Formula

Formula

$$E_{exc} = 1.6 \cdot 10^{-19} \cdot 13.6 \cdot \left(\frac{m_{eff}}{[Mass\text{-}e]} \right) \cdot \left(\frac{1}{[Permitivity\text{-}silicon]^2} \right)$$

Example with Units

$$0.0218\,eV = 1.6 \cdot 10^{-19} \cdot 13.6 \cdot \left(\frac{0.2e\text{-}30\,kg}{9.1E\text{-}31\,kg} \right) \cdot \left(\frac{1}{11.7^2} \right)$$

11) Fringe Spacing given Apex Angle Formula

Evaluate Formula

Formula

$$S_{fri} = \frac{\lambda_{vis}}{2 \cdot \tan\left(\alpha_{opto} \right)}$$

Example with Units

$$1.4178\,\mu = \frac{500\,nm}{2 \cdot \tan\left(10° \right)}$$

12) Maximum Acceptance Angle of Compound Lens Formula

Evaluate Formula

Formula

$$\theta_{acc} = asin\left(n_1 \cdot R_{lens} \cdot \sqrt{A_{con}} \right)$$

Example with Units

$$22.0243° = asin\left(1.5 \cdot 0.0025\,m \cdot \sqrt{10000} \right)$$

13) Peak Retardation Formula

Evaluate Formula

Formula

$$\Phi_m = \frac{2 \cdot \pi}{\lambda_o} \cdot r \cdot n_{ri}^3 \cdot V_m$$

Example with Units

$$80.1349\,rad = \frac{2 \cdot 3.1416}{3.939\,m} \cdot 23\,m \cdot 1.01^3 \cdot 2.12\,V$$

14) PN Junction Capacitance Formula

Evaluate Formula

Formula

$$C_j = \frac{A_{pn}}{2} \cdot \sqrt{\frac{2 \cdot [Charge\text{-}e] \cdot \varepsilon_r \cdot [Permitivity\text{-}silicon]}{V_0 - \left(V \right)} \cdot \left(\frac{N_A \cdot N_D}{N_A + N_D} \right)}$$

Example with Units

$$1.9E{+}6\,fF = \frac{4.8\,\mu m^2}{2} \cdot \sqrt{\frac{2 \cdot 1.6E\text{-}19\,C \cdot 78\,F/m \cdot 11.7}{0.6\,V - \left(-4\,V \right)} \cdot \left(\frac{1e{+}22\,1/m^3 \cdot 1e{+}24\,1/m^3}{1e{+}22\,1/m^3 + 1e{+}24\,1/m^3} \right)}$$

Variables used in list of Devices with Optical Components Formulas above

- **A** Apex Angle *(Degree)*
- A_{con} Positive Constant
- A_{pn} PN Junction Area *(Square Micrometer)*
- **B** Magnetic Flux Density *(Tesla)*
- C_j Junction Capacitance *(Femtofarad)*
- **D** Diameter of Aperture *(Millimeter)*
- D_E Electron Diffusion Coefficient *(Square Meter Per Second)*
- E_{exc} Excitation Energy *(Electron-Volt)*
- E_i Intrinsic Energy Level of Semiconductor *(Electron-Volt)*
- F_n Quasi Fermi Level of Electrons *(Electron-Volt)*
- g_{op} Optical Generation Rate
- i_{opt} Optical Current *(Milliampere)*
- L_{dif} Diffusion Length of Transition Region *(Micrometer)*
- L_m Length of Medium *(Meter)*
- L_p Length of P-Side Junction *(Micrometer)*
- m_{eff} Effective Mass of Electron *(Kilogram)*
- n_1 Refractive Index of Medium 1
- N_A Acceptor Concentration *(1 per Cubic Meter)*
- N_D Donor Concentration *(1 per Cubic Meter)*
- n_e Electron Concentration *(Electrons per Cubic Meter)*
- N_{eff} Effective Density of States
- n_i Intrinsic Electron Concentration *(Electrons per Cubic Meter)*
- n_{ri} Refractive Index
- **q** Charge *(Coulomb)*
- **r** Length of Fiber *(Meter)*
- R_{lens} Radius of Lens *(Meter)*
- S_{fri} Fringe Space *(Micron)*

Constants, Functions, Measurements used in list of Devices with Optical Components Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **[BoltZ]**, 1.38064852E-23 *Boltzmann constant*
- constant(s): **[Charge-e]**, 1.60217662E-19 *Charge of electron*
- constant(s): **[Mass-e]**, 9.10938356E-31 *Mass of electron*
- constant(s): **[Permitivity-silicon]**, 11.7 *Permittivity of silicon*
- constant(s): **[hP]**, 6.626070040E-34 *Planck constant*
- Functions: **arctan**, arctan(Number) *Inverse trigonometric functions are usually accompanied by the prefix - arc. Mathematically, we represent arctan or the inverse tangent function as tan-1 x or arctan(x).*
- Functions: **asin**, asin(Number) *The inverse sine function, is a trigonometric function that takes a ratio of two sides of a right triangle and outputs the angle opposite the side with the given ratio.*
- Functions: **ctan**, ctan(Angle) *Cotangent is a trigonometric function that is defined as the ratio of the adjacent side to the opposite side in a right 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.*
- Functions: **sqrt**, sqrt(Number) *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- Functions: **tan**, tan(Angle) *The tangent of an angle is a trigonometric ratio of*

- **T** Absolute Temperature *(Kelvin)*
- **V** Reverse Bias Voltage *(Volt)*
- V_0 Voltage Across PN Junction *(Volt)*
- V_m Modulation Voltage *(Volt)*
- **W** Transition Width *(Micrometer)*
- **α** Alpha
- α_{opto} Angle of Interference *(Degree)*
- ε_r Relative Permittivity *(Farad per Meter)*
- **θ** Angle of Rotation *(Radian)*
- θ_{acc} Acceptance Angle *(Degree)*
- θ_B Brewster's Angle *(Degree)*
- θ_{dif} Diffraction Angle *(Radian)*
- λ_o Wavelength of Light *(Meter)*
- λ_{vis} Wavelength of Visible Light *(Nanometer)*
- μ_e Mobility of Electron *(Square Centimeter per Volt Second)*
- Φ_m Peak Retardation *(Radian)*

the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.

- Measurement: **Length** in Meter (m), Micrometer (µm), Nanometer (nm), Millimeter (mm), Micron (µ)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Micrometer (µm²)
  Area Unit Conversion
- Measurement: **Energy** in Electron-Volt (eV)
  Energy Unit Conversion
- Measurement: **Electric Charge** in Coulomb (C)
  Electric Charge Unit Conversion
- Measurement: **Angle** in Radian (rad), Degree (°)
  Angle Unit Conversion
- Measurement: **Capacitance** in Femtofarad (fF)
  Capacitance Unit Conversion
- Measurement: **Magnetic Flux Density** in Tesla (T)
  Magnetic Flux 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: **Mobility** in Square Centimeter per Volt Second (cm²/V*s)
  Mobility Unit Conversion
- Measurement: **Carrier Concentration** in 1 per Cubic Meter (1/m³)
  Carrier Concentration Unit Conversion
- Measurement: **Permittivity** in Farad per Meter (F/m)
  Permittivity Unit Conversion
- Measurement: **Electron Density** in Electrons per Cubic Meter (electrons/m³)
  Electron Density Unit Conversion

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