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Electrons & Holes Formulas

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List of 18 Electrons & Holes Formulas

Electrons & Holes

1) AC Conductance

Open Calculator

fx $$G_s = \left(\frac{[Charge\text{-}e]}{[BoltZ] \cdot T}\right) \cdot I$$

ex $$0.007736\mho = \left(\frac{[Charge\text{-}e]}{[BoltZ] \cdot 300K}\right) \cdot 0.2mA$$

2) Difference in Electron Concentration

Open Calculator

fx $$\Delta N = N_1 - N_2$$

ex $$8000/m^3 = 1.02e6/m^3 - 1.012e6/m^3$$

3) Electron Component

Open Calculator

fx $$i_{en} = \left(\frac{i_{ep}}{Y}\right) - i_{ep}$$

ex $$1.2675 = \left(\frac{5.07}{0.8}\right) - 5.07$$

4) Electron Current Density

Open Calculator

fx $J_e = J_T - J_h$

ex $0.03\text{A/m}^2 = 0.12\text{A/m}^2 - 0.09\text{A/m}^2$

5) Electron Flux Density

Open Calculator

fx $\Phi_n = \left(\frac{L_e}{2 \cdot t}\right) \cdot \Delta N$

ex $0.017718\text{Wb/m}^2 = \left(\frac{25.47\mu\text{m}}{2 \cdot 5.75\text{s}}\right) \cdot 8000/\text{m}^3$

6) Electron in Region

Open Calculator

fx $n_{in} = \frac{n_{out}}{M_n}$

ex $15 = \frac{60}{4}$

7) Electron Multiplication

Open Calculator

fx $M_n = \frac{n_{out}}{n_{in}}$

ex $4 = \frac{60}{15}$

8) Electron Out of Region

Open Calculator

fx $n_{out} = M_n \cdot n_{in}$

ex $60 = 4 \cdot 15$

9) Hole Component

Open Calculator

fx $i_{ep} = i_{en} \cdot \frac{Y}{1 - Y}$

ex $5.04 = 1.26 \cdot \frac{0.8}{1 - 0.8}$

10) Hole Current Density

Open Calculator

fx $J_h = J_T - J_e$

ex $0.09 A/m^2 = 0.12 A/m^2 - 0.03 A/m^2$

11) Mean Free Path

Open Calculator

fx $L_e = \left(\frac{\Phi_n}{\Delta N} \right) \cdot 2 \cdot t$

ex $24.4375 \mu m = \left(\frac{0.017 Wb/m^2}{8000/m^3} \right) \cdot 2 \cdot 5.75 s$

12) Mean Time Spend by Hole

Open Calculator

fx $\delta_p = g_{op} \cdot \tau_p$

ex $8120s = 2.9e19 \cdot 2.8e\text{-}16$

13) Order of Diffraction

Open Calculator

fx $m = \frac{2 \cdot d \cdot \sin(\theta_i)}{\lambda}$

ex $7.272727 = \frac{2 \cdot 160\mu m \cdot \sin(30^\circ)}{22\mu m}$

14) Phi-dependent Wave Function

Open Calculator

fx $\Phi_m = \left(\frac{1}{\sqrt{2 \cdot \pi}}\right) \cdot (\exp(n_e \cdot \theta))$

ex $6.1E\hat{}7 = \left(\frac{1}{\sqrt{2 \cdot \pi}}\right) \cdot (\exp(6 \cdot 180^\circ))$

15) Quantum State

Open Calculator

fx $E_n = \frac{n^2 \cdot \pi^2 \cdot [hP]^2}{2 \cdot M \cdot L^2}$

ex $8.2E\hat{}\text{-}24eV = \frac{(2)^2 \cdot \pi^2 \cdot [hP]^2}{2 \cdot 1.34e\text{-}5kg \cdot (7e\text{-}10)^2}$

16) Radius of Nth Orbit of Electron

Open Calculator

fx $$r_n = \frac{[\text{Coulomb}] \cdot n^2 \cdot [hP]^2}{M \cdot [\text{Charge-e}]^2}$$

ex $$4.6\text{E}\hat{}\text{-}8\mu\text{m} = \frac{[\text{Coulomb}] \cdot (2)^2 \cdot [hP]^2}{1.34\text{e-}5\text{kg} \cdot [\text{Charge-e}]^2}$$

17) Total Carrier Current Density

Open Calculator

fx $$J_T = J_e + J_h$$

ex $$0.12\text{A/m}^2 = 0.03\text{A/m}^2 + 0.09\text{A/m}^2$$

18) Wave Function Amplitude

Open Calculator

fx $$A_w = \sqrt{\frac{2}{L}}$$

ex $$53452.25 = \sqrt{\frac{2}{7\text{e-}10}}$$

Variables Used

- A_w Amplitude of Wave Function
- d Grafting Space *(Micrometer)*
- E_n Energy in Quantum State *(Electron-Volt)*
- g_{op} Optical Generation Rate
- G_s AC Conductance *(Mho)*
- I Electric Current *(Milliampere)*
- i_{en} Electron Component
- i_{ep} Hole Component
- J_e Electron Current Density *(Ampere per Square Meter)*
- J_h Hole Current Density *(Ampere per Square Meter)*
- J_T Total Carrier Current Density *(Ampere per Square Meter)*
- L Potential Well Length
- L_e Mean Free Path Electron *(Micrometer)*
- m Order of Diffraction
- M Mass of Particle *(Kilogram)*
- M_n Electron Multiplication
- n Quantum Number
- N_1 Electron Concentration 1 *(1 per Cubic Meter)*
- N_2 Electron Concentration 2 *(1 per Cubic Meter)*
- n_e Wave Quantum Number
- n_{in} Number of Electron in Region

- n_{out} Number of Electron Out of Region
- r_n Radius of nth Orbit of Electron *(Micrometer)*
- **t** Time *(Second)*
- **T** Temperature *(Kelvin)*
- **Y** Emitter Injection Efficiency
- δ_p Mean Time Spend by Hole *(Second)*
- **ΔN** Difference in Electron Concentration *(1 per Cubic Meter)*
- **θ** Wave Function Angle *(Degree)*
- θ_i Incident Angle *(Degree)*
- **λ** Wavelength of Ray *(Micrometer)*
- τ_p Majority Carrier Decay
- Φ_m Φ Dependent Wave Function
- Φ_n Electron Flux Density *(Weber per Square Meter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[BoltZ]**, 1.38064852E-23 Joule/Kelvin
  Boltzmann constant
- Constant: **[Charge-e]**, 1.60217662E-19 Coulomb
  Charge of electron
- Constant: **[Coulomb]**, 8.9875517923E9 Newton * Meter ^2 / Coulomb ^2
  Coulomb constant
- Constant: **[hP]**, 6.626070040E-34 Kilogram Meter² / Second
  Planck constant
- Function: **exp**, exp(Number)
  Exponential function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Micrometer (µm)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion

- Measurement: **Energy** in Electron-Volt (eV)
  Energy Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Electric Conductance** in Mho (℧)
  Electric Conductance Unit Conversion
- Measurement: **Magnetic Flux Density** in Weber per Square Meter (Wb/m²)
  Magnetic Flux Density Unit Conversion
- Measurement: **Surface Current Density** in Ampere per Square Meter (A/m²)
  Surface Current Density Unit Conversion
- Measurement: **Carrier Concentration** in 1 per Cubic Meter (1/m³)
  Carrier Concentration Unit Conversion

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- **Electrons & Holes Formulas**
- **Energy Band & Charge Carrier Formulas**
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