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Charge Carrier Characteristics Formulas

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List of 17 Charge Carrier Characteristics Formulas

Charge Carrier Characteristics

1) Conductivity in Metals

$$fx \quad \sigma = N_e \cdot [\text{Charge-e}] \cdot \mu_n$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$ex \quad 0.865175\text{S/m} = 3e16/\text{m}^3 \cdot [\text{Charge-e}] \cdot 180\text{m}^2/\text{V*s}$$

2) Convection Current Density

$$fx \quad J_{cv} = \rho \cdot v$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$ex \quad 36\text{A/m}^2 = 3\text{C/m}^3 \cdot 12\text{m/s}$$

3) Current Density due to Electrons

$$fx \quad J_n = [\text{Charge-e}] \cdot N_e \cdot \mu_n \cdot E$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$ex \quad 2.965821\text{A/m}^2 = [\text{Charge-e}] \cdot 3e16/\text{m}^3 \cdot 180\text{m}^2/\text{V*s} \cdot 3.428\text{V/m}$$

4) Current Density due to Holes

$$fx \quad J_p = [\text{Charge-e}] \cdot N_p \cdot \mu_p \cdot E$$

[Open Calculator !\[\]\(83bbbd261710c59db0214aa27b2edc0d_img.jpg\)](#)

$$ex \quad 1.647678\text{A/m}^2 = [\text{Charge-e}] \cdot 2e16/\text{m}^3 \cdot 150\text{m}^2/\text{V*s} \cdot 3.428\text{V/m}$$



5) Diffusion Constant of Holes 

$$fx \quad D_p = \mu_p \cdot \left(\frac{[BoltZ] \cdot T}{[Charge-e]} \right)$$

Open Calculator 

$$ex \quad 37485.39 \text{cm}^2/\text{s} = 150 \text{m}^2/\text{V}^* \text{s} \cdot \left(\frac{[BoltZ] \cdot 290\text{K}}{[Charge-e]} \right)$$

6) Electrons Diffusion Constant 

$$fx \quad D_n = \mu_n \cdot \left(\frac{[BoltZ] \cdot T}{[Charge-e]} \right)$$

Open Calculator 


$$ex \quad 44982.46 \text{cm}^2/\text{s} = 180 \text{m}^2/\text{V}^* \text{s} \cdot \left(\frac{[BoltZ] \cdot 290\text{K}}{[Charge-e]} \right)$$

7) Electrostatic Deflection Sensitivity of CRT 

$$fx \quad S_e = \frac{d \cdot L}{2 \cdot \delta \cdot V_e}$$

Open Calculator 

$$ex \quad 1.1\text{E}^{-7} \text{m}/\text{V} = \frac{2.5\text{mm} \cdot 50\text{mm}}{2 \cdot 1.15\text{mm} \cdot 501509\text{m}/\text{s}}$$

8) Force on Current Element in Magnetic Field 

$$fx \quad F = i_L \cdot B \cdot \sin(\theta)$$

Open Calculator 

$$ex \quad 0.678823\text{N} = 0.48\text{m} \cdot 2\text{Wb}/\text{m}^2 \cdot \sin(45^\circ)$$



9) Hole Diffusion Length

$$fx \quad L_p = \sqrt{D_p \cdot \tau_p}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$ex \quad 0.362214m = \sqrt{37485.39cm^2/s \cdot 0.035s}$$

10) Holes Diffusion Constant

$$fx \quad D_p = \mu_p \cdot \left(\frac{[BoltZ] \cdot T}{[Charge-e]} \right)$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 37485.39cm^2/s = 150m^2/V*s \cdot \left(\frac{[BoltZ] \cdot 290K}{[Charge-e]} \right)$$

11) Intrinsic Carrier Concentration under Non-Equilibrium Conditions

$$fx \quad n_i = \sqrt{n_0 \cdot p_0}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 1E^8/m^3 = \sqrt{1.1e8/m^3 \cdot 9.1e7/m^3}$$


12) Intrinsic Concentration

$$fx \quad n_i = \sqrt{N_c \cdot N_v} \cdot e^{\frac{-E_g}{2 \cdot [BoltZ] \cdot T}}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 1.3E^8/m^3 = \sqrt{1.02e18/m^3 \cdot 0.5e18/m^3} \cdot e^{\frac{-1.12eV}{2 \cdot [BoltZ] \cdot 290K}}$$




13) Thermal Voltage 

$$fx \quad V_t = [\text{BoltZ}] \cdot \frac{T}{[\text{Charge-e}]}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)


$$ex \quad 0.02499V = [\text{BoltZ}] \cdot \frac{290K}{[\text{Charge-e}]}$$

14) Thermal Voltage using Einstein's Equation 

$$fx \quad V_t = \frac{D_n}{\mu_n}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 0.02499V = \frac{44982.46\text{cm}^2/\text{s}}{180\text{m}^2/\text{V}^*\text{s}}$$

15) Time Period of Electron 

$$fx \quad t_c = \frac{2 \cdot 3.14 \cdot [\text{Mass-e}]}{H \cdot [\text{Charge-e}]}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 0.155242\text{ns} = \frac{2 \cdot 3.14 \cdot [\text{Mass-e}]}{0.23\text{A}/\text{m} \cdot [\text{Charge-e}]}$$



16) Velocity of Electron [Open Calculator](#) 

fx

$$V_v = \sqrt{\frac{2 \cdot [\text{Charge-e}] \cdot V}{[\text{Mass-e}]}}$$

ex

$$501509\text{m/s} = \sqrt{\frac{2 \cdot [\text{Charge-e}] \cdot 0.715\text{V}}{[\text{Mass-e}]}}$$

17) Velocity of Electron in Force Fields [Open Calculator](#) 

fx

$$V_{ef} = \frac{E}{H}$$

ex

$$14.90435\text{m/s} = \frac{3.428\text{V/m}}{0.23\text{A/m}}$$



Variables Used








- **B** Magnetic Flux Density (*Weber per Square Meter*)
- **d** Distance between Deflecting Plates (*Millimeter*)
- **D_n** Electron Diffusion Constant (*Square Centimeter Per Second*)
- **D_p** Holes Diffusion Constant (*Square Centimeter Per Second*)
- **E** Electric Field Intensity (*Volt per Meter*)
- **E_g** Temperature Dependence of Energy Band Gap (*Electron-Volt*)
- **F** Force (*Newton*)
- **H** Magnetic Field Strength (*Ampere per Meter*)
- **i_L** Current Element (*Meter*)
- **J_{CV}** Convection Current Density (*Ampere per Square Meter*)
- **J_n** Electron Current Density (*Ampere per Square Meter*)
- **J_p** Holes Current Density (*Ampere per Square Meter*)
- **L** Screen and Deflecting Plates Distance (*Millimeter*)
- **L_p** Holes Diffusion Length (*Meter*)
- **n₀** Majority Carrier Concentration (*1 per Cubic Meter*)
- **N_C** Effective Density in Valence Band (*1 per Cubic Meter*)
- **N_e** Electron Concentration (*1 per Cubic Meter*)
- **n_i** Intrinsic Carrier Concentration (*1 per Cubic Meter*)
- **N_p** Holes Concentration (*1 per Cubic Meter*)
- **N_V** Effective Density in Conduction Band (*1 per Cubic Meter*)
- **p₀** Minority Carrier Concentration (*1 per Cubic Meter*)














- S_e Electrostatic Deflection Sensitivity (Meter per Volt)
- T Temperature (Kelvin)
- t_c Period of Particle Circular Path (Nanosecond)
- v Charge Velocity (Meter per Second)
- V Voltage (Volt)
- V_e Electron Velocity (Meter per Second)
- V_{ef} Velocity of Electron in Force Fields (Meter per Second)
- V_t Thermal Voltage (Volt)
- V_v Velocity due to Voltage (Meter per Second)
- δ Deflection of Beam (Millimeter)
- θ Angle between Planes (Degree)
- μ_n Mobility of Electron (Square Meter per Volt per Second)
- μ_p Mobility of Holes (Square Meter per Volt per Second)
- ρ Charge Density (Coulomb per Cubic Meter)
- σ Conductivity (Siemens per Meter)
- T_p Hole Carrier Lifetime (Second)



Constants, Functions, Measurements used






- **Constant:** [**BoltZ**], 1.38064852E-23 Joule/Kelvin
Boltzmann constant
- **Constant:** [**Charge-e**], 1.60217662E-19 Coulomb
Charge of electron
- **Constant:** [**Mass-e**], 9.10938356E-31 Kilogram
Mass of electron
- **Constant:** **e**, 2.71828182845904523536028747135266249
Napier's constant
- **Function:** **sin**, sin(Angle)
Trigonometric sine function
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Millimeter (mm), Meter (m)
Length Unit Conversion 
- **Measurement:** **Time** in Second (s), Nanosecond (ns)
Time Unit Conversion 
- **Measurement:** **Temperature** in Kelvin (K)
Temperature Unit Conversion 
- **Measurement:** **Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement:** **Energy** in Electron-Volt (eV)
Energy Unit Conversion 
- **Measurement:** **Force** in Newton (N)
Force Unit Conversion 
- **Measurement:** **Angle** in Degree (°)
Angle Unit Conversion 



- **Measurement: Magnetic Flux Density** in Weber per Square Meter (Wb/m^2)
Magnetic Flux Density Unit Conversion 
- **Measurement: Magnetic Field Strength** in Ampere per Meter (A/m)
Magnetic Field Strength Unit Conversion 
- **Measurement: Volume Charge Density** in Coulomb per Cubic Meter (C/m^3)
Volume Charge Density Unit Conversion 
- **Measurement: Surface Current Density** in Ampere per Square Meter (A/m^2)
Surface Current Density Unit Conversion 
- **Measurement: Electric Field Strength** in Volt per Meter (V/m)
Electric Field Strength Unit Conversion 
- **Measurement: Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement: Electric Conductivity** in Siemens per Meter (S/m)
Electric Conductivity Unit Conversion 
- **Measurement: Diffusivity** in Square Centimeter Per Second (cm^2/s)
Diffusivity Unit Conversion 
- **Measurement: Mobility** in Square Meter per Volt per Second ($\text{m}^2/\text{V}^*\text{s}$)
Mobility Unit Conversion 
- **Measurement: Deflection Sensitivity** in Meter per Volt (m/V)
Deflection Sensitivity Unit Conversion 
- **Measurement: Carrier Concentration** in 1 per Cubic Meter ($1/\text{m}^3$)
Carrier Concentration Unit Conversion 



Check other formula lists

- [Charge Carrier Characteristics Formulas](#) 
- [Diode Characteristics Formulas](#) 
- [Electrostatic Parameters Formulas](#) 
- [Semiconductor Characteristics Formulas](#) 
- [Transistor Operating Parameters Formulas](#) 

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