Important Advanced Illumination Formulas PDF

Formulas
Examples
with Units

List of 16
Important Advanced Illumination Formulas

1) Beer-Lambert Law Formula

Evaluate Formula

Formula

$$I_t = I_o \cdot \exp(-\beta \cdot c \cdot x)$$

Example with Units

$$21.7232\,\text{cd} = 700\,\text{cd} \cdot \exp(-1.21 \cdot 0.41 \cdot 7\,\text{m})$$

2) Fresnel's Law of Reflection Formula

Evaluate Formula

Formula

$$r_\lambda = \frac{(n_2 - n_1)^2}{(n_2 + n_1)^2}$$

Example

$$0.0432 = \frac{(1.54 - 1.01)^2}{(1.54 + 1.01)^2}$$

3) Illumination by Lambert Cosine Law Formula

Evaluate Formula

Formula

$$E_v = \frac{I_v \cdot \cos(\theta)}{L^2}$$

Example with Units

$$0.4427\,\text{lx} = \frac{4.62\,\text{cd} \cdot \cos(65°)}{2.1\,\text{m}^2}$$

4) Incident Angle using Snell's Law Formula

Evaluate Formula

Formula

$$\theta_i = \operatorname{arcsinh}\left(\frac{n_2 \cdot \sin(\theta_r)}{n_1}\right)$$

Example with Units

$$30.6613° = \operatorname{arcsinh}\left(\frac{1.54 \cdot \sin(21.59°)}{1.01}\right)$$

5) Intensity of Light Transmitted Formula

Evaluate Formula

Formula

$$I_t = I_o \cdot \exp(-\alpha \cdot x)$$

Example with Units

$$21.1234\,\text{cd} = 700\,\text{cd} \cdot \exp(-0.5001 \cdot 7\,\text{m})$$

6) Inverse Square Law Formula

Evaluate Formula

Formula

$$L_v = \frac{I_t}{d^2}$$

Example with Units

$$0.2651\,\text{cd*sr/m}^2 = \frac{21\,\text{cd}}{8.9\,\text{m}^2}$$

7) Lambert's Cosine Law Formula

Evaluate Formula

Formula

$$E_\theta = E_v \cdot \cos\left(\theta_i\right)$$

Example with Units

$$0.8833\,\text{lx} = 1.02\,\text{lx} \cdot \cos\left(30°\right)$$

8) Luminance for Lambertian Surfaces Formula

Evaluate Formula

Formula

$$L_v = \frac{E_v}{\pi}$$

Example with Units

$$0.3247\,\text{cd*sr/m}^2 = \frac{1.02\,\text{lx}}{3.1416}$$

9) Luminous Intensity Formula

Evaluate Formula

Formula

$$I_v = \frac{Lm}{\omega}$$

Example with Units

$$1.55\,\text{cd} = \frac{41.85\,\text{cd*sr}}{27\,\text{sr}}$$

10) Number of Floodlighting Units Formula

Evaluate Formula

Formula

$$N = \frac{A_{light} \cdot E_v}{0.7 \cdot \Phi_B}$$

Example with Units

$$1.7103 = \frac{8.98\,\text{m}^2 \cdot 1.02\,\text{lx}}{0.7 \cdot 7.651\,\text{lm}}$$

11) Refracted Angle using Snell's Law Formula

Evaluate Formula

Formula

$$\theta_r = \operatorname{arcsinh}\left(\frac{n_1 \cdot \sin\left(\theta_i\right)}{n_2}\right)$$

Example with Units

$$18.4671° = \operatorname{arcsinh}\left(\frac{1.01 \cdot \sin\left(30°\right)}{1.54}\right)$$

12) Specific Consumption Formula

Evaluate Formula

Formula

$$S.C. = \frac{2 \cdot P_{in}}{CP}$$

Example with Units

$$374.1935 = \frac{2 \cdot 290\,\text{W}}{1.55\,\text{cd}}$$

13) Spectral Luminous Efficacy Formula

Evaluate Formula

Formula

$$K_\lambda = K_m \cdot V_\lambda$$

Example with Units

$$2561.22\,\text{lm/W} = 55.8\,\text{lm/W} \cdot 45.9$$

14) Spectral Reflection Factor Formula

Evaluate Formula

Formula

$$P_\lambda = \frac{J_\lambda}{G_\lambda}$$

Example

$$1.3043 = \frac{4.5}{3.45}$$

15) Spectral Transmission Factor Formula

Evaluate Formula

Formula

$$T_\lambda = \frac{J_\lambda'}{G_\lambda}$$

Example

$$1.1275 = \frac{3.89}{3.45}$$

16) Utilization Factor of Electrical Energy Formula

Evaluate Formula

Formula

$$UF = \frac{L_r}{L_e}$$

Example with Units

$$0.1579 = \frac{6\,\text{cd}}{38\,\text{cd}}$$

Variables used in list of Advanced Illumination Formulas above

- A_{light} Area to be Lighted *(Square Meter)*
- **c** Concentration of Absorption Material
- **CP** Candle Power *(Candela)*
- **d** Distance *(Meter)*
- E_v Illumination Intensity *(Lux)*
- E_θ Illuminance at Angle of Incidence
- G_λ Spectral Irradiation
- I_o Intensity of Light Entering the Material *(Candela)*
- I_t Intensity of Transmitted Light *(Candela)*
- I_v Luminous Intensity *(Candela)*
- J_λ Reflected Spectral Emission
- J_λ' Transmitted Spectral Emission
- K_m Maximum Sensitivity *(Lumen Per Watt)*
- K_λ Spectral Luminous Efficacy *(Lumen Per Watt)*
- **L** Length of Illumination *(Meter)*
- L_e Lumen Emitting from Source *(Candela)*
- L_r Lumen Reaching Working Plane *(Candela)*
- L_v Luminance *(Candela Steradian per Sq Meter)*
- **Lm** Lumen *(Candela Steradian)*
- **N** Number of Floodlighting Units
- n_1 Refractive Index of Medium 1
- n_2 Refractive Index of Medium 2
- P_{in} Input Power *(Watt)*
- P_λ Spectral Reflection Factor
- r_λ Reflection Loss
- **S.C.** Specific Consumption
- T_λ Spectral Transmission Factor
- **UF** Utilization Factor
- V_λ Photopic Efficiency Value
- **x** Path Length *(Meter)*
- **α** Absorption Coefficient

Constants, Functions, Measurements used in list of Advanced Illumination Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **arcsinh**, arcsinh(Number) *The inverse hyperbolic sine function, also known as the arcsinh function, is the inverse function of the hyperbolic sine function.*
- Functions: **cos**, cos(Angle) *Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the 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: **sinh**, sinh(Number) *The hyperbolic sine function, also known as the sinh function, is a mathematical function that is defined as the hyperbolic analogue of the sine function.*
- Measurement: **Length** in Meter (m) *Length Unit Conversion*
- Measurement: **Luminous Intensity** in Candela (cd) *Luminous Intensity Unit Conversion*
- Measurement: **Area** in Square Meter (m²) *Area Unit Conversion*
- Measurement: **Illuminance** in Lux (lx), Candela Steradian per Sq Meter (cd*sr/m²) *Illuminance Unit Conversion*
- Measurement: **Power** in Watt (W) *Power Unit Conversion*
- Measurement: **Angle** in Degree (°) *Angle Unit Conversion*
- Measurement: **Luminous Flux** in Candela Steradian (cd*sr), Lumen (lm) *Luminous Flux Unit Conversion*

- β Absorption per Concentration Coefficient
- θ Illumination Angle *(Degree)*
- θ_i Incident Angle *(Degree)*
- θ_r Refracted Angle *(Degree)*
- Φ_B Lumen Flux *(Lumen)*
- ω Solid Angle *(Steradian)*

- Measurement: **Luminous Efficacy** in Lumen Per Watt (lm/W)
  Luminous Efficacy Unit Conversion
- Measurement: **Solid Angle** in Steradian (sr)
  Solid Angle Unit Conversion

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