Suggested Units, Symbols and Defining Equations for Computer Graphics Global Illumination Based on ANSI/IES RP-16-1986

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Notes: The symbols for photometric quantities are the same as those for the corresponding radiometric quantities. When it is necessary to differentiate the the subscripts v and e respectively should be used, e.g., Q_v and Q_e.

Quantities may be restricted to a narrow wavelength band by adding the word spectral and indicating wavelength. The corresponding symbols are changed by adding a subscript λ, e.g., Q_λ for a spectral concentration or a λ in parentheses, e.g., $K(\lambda)$, for a function of wavelength.

Units for each quantity are given in SI units only.

Radiant energy: $Q(Q_e)$, joule (J).

Radiant energy density: $w(w_e)$, joule per cubic meter (J/m^3).

$$w = dQ/dV$$

Radiant flux: $\Phi(\Phi_e)$, watt,(W).

$$\Phi = dQ/dt$$

Radiant flux density at a surface: watt per square meter, (W/m^2).

Radiant exitance: $M(M_e)$.

$$M = d\Phi/dA$$

Irradiance: $E(E_e)$.

$$E = d\Phi/dA$$

Radiant intensity: $I(I_e)$, watt per steradian, (W/sr).

$$I = d\Phi/d\omega$$

(ω = solid angle through which flux from point source is radiated)

Radiance: $L(L_e)$, watt per steradian-square meter, $(W/sr\cdot m^2)$.

$$\begin{aligned} L &= d^2\Phi/[d\omega(dAcos\theta)] \\ &= dI/(dAcos\theta) \end{aligned}$$

θ is the angle between line of sight and normal to surface considered

Radiant fluence: $F(\Delta t)$, joule per square meter, (J/m^2).

$$F(\Delta t) = \int_{\Delta t}\int_{4\pi} L d\omega dt$$

Radiant fluence rate: F_t, watt per square meter, (W/m^2)

$$F_t = \int_{4\pi} L d\omega$$

Radiant sterisent: $L^*(x)$, watt per steradian-cubic meter, $(W/sr\cdot m^3)$.

$$L^*(x) = dL_g/dx$$

the subscript g denotes a generated quantity.

Luminous efficacy: K, lumen per watt (lm/W).

$$K = \Phi_v/\Phi_e$$

Luminous efficiency: V, dimensionless.

$$V = K/K_{maximum}$$

$K_{maximum}$ = maximum value of $K(\lambda)$ function.

Luminous energy: $Q(Q_v)$, lumen-second $(lm\cdot s)$.

$$Q_v = \int_{380}^{770} K(\lambda)Q_{e\lambda}d\lambda$$

Luminous energy density: $w(w_v)$, lumen-second per cubic meter, $(lm\cdot s/m^3)$.

Radiant flux: $\Phi(\Phi_v)$, lumen,(lm).

Luminous flux density at a surface: lumen per square meter, (lm/m^2).

Luminous exitance: $M(M_v)$.

Illuminance: $E(E_v)$.

Luminous intensity: $I(I_v)$, candela, (cd).

1 candela = 1 lumen per steradian

Luminance: $L(L_v)$, candela per square meter, (cd/m^2).

Absorptance: $\alpha, (\alpha_v, \alpha_e)$, dimensionless.

$$\begin{aligned} \alpha &= \Phi_a/\Phi_i \\ \Phi_a &= absorbed\,flux \\ \Phi_i &= incident\,flux \end{aligned}$$

Reflectance: $\rho, (\rho_v, \rho_e)$, dimensionless.

$$\begin{aligned} \rho &= \Phi_r/\Phi_i \\ \Phi_r &= reflected\,flux \end{aligned}$$

Transmittance: $\tau, (\tau_v, \tau_e)$, dimensionless.

$$\begin{aligned} \tau &= \Phi_t/\Phi_i \\ \Phi_t &= transmitted\,flux \end{aligned}$$

Bidirectional reflectance-distribution function (BRDF): f_r, (sr^{-1})

$$f_r(\theta_i, \phi_i, \theta_r, \phi_r) = dL_r(\theta_r, \phi_r)/dE_i(\theta_i, \phi_i)$$

Bidirectional transmittance-distribution function (BTDF): f_t, (sr^{-1})

$$f_t(\theta_i, \phi_i, \theta_t, \phi_t) = dL_t(\theta_t, \phi_t)/dE_i(\theta_i, \phi_i)$$

Coefficient of attenuation: μ, (m^{-1})

$$\Phi_x = \Phi_o exp[-\int_o^x \mu(x)dx]$$

Form factor: f_{1-2}, dimensionless.

$$f_{1-2} = (\Phi_{1\rightarrow 2})/(\Phi_1)$$

Configuration factor: C_{1-2}, dimensionless.

$$C_{1-2} = (d\Phi_{1\rightarrow 2})/(d\Phi_1)$$