

$h = 6.625 \times 10^{-34}$  J·s,  $q = 1.6 \times 10^{-19}$  C,  $k = 1.38 \times 10^{-23}$  J/K,  $c = 3 \times 10^8$  m/s  
 $1 \text{ nW} = 10^{-9}$  W,  $1 \mu \text{ W} = 10^{-6}$  W

$$E = hf, \quad f = c/\lambda, \quad d = v \cdot t$$

$$Q \text{ [dB]} = 10 \log(Q), \quad \log(A \cdot B/C) = \log(A) + \log(B) - \log(C)$$

$$P = V \cdot I, \quad V = R \cdot I$$

$$p = \frac{P_t}{4\pi d^2}, \quad P_r = p \cdot A_{er} = \frac{(EIRP)A_{er}}{4\pi d^2}$$

$$\text{beamwidth} = \frac{k\lambda}{L}$$

$$G = 4\pi\eta \frac{A_e}{\lambda^2}, \quad P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2}$$

$$P = kTB, \quad S(f) = \frac{N_0}{2}, \quad S_y(f) = |H(f)|^2 S_x(f), \quad P_y = \int_{-\infty}^{\infty} S_y(f) df$$

$$\langle v^2 \rangle = \lim_{T \rightarrow \infty} \frac{1}{T} \int_{T/2}^{T/2} v^2(t) dt, \quad v_{rms} = \sqrt{\langle v^2 \rangle}, \quad kTB = \langle v^2 \rangle / 4R, \quad \langle v^2 \rangle = 4kTRB = 4N_0RB$$

$$P_{ao} = G_0 \cdot N_0 \cdot B = \frac{N_0}{2} \int_{-\infty}^{\infty} G(f) df, \quad G(f) = \frac{1}{1 + (f/f_{3dB})^{2n}}, \quad B = \frac{\frac{\pi}{2} f_{3dB}}{n \sin(\frac{\pi}{2n})}$$

$$P_{ao} = G_0 N_0 B F = kTB G_0 F = k(T_0 + T_e) B G_0, \quad F = 1 + \frac{T_e}{T_0}, \quad T_e = T_0(F - 1)$$

$$F = F_1 + \frac{F_2 - 1}{G_{01}} + \frac{F_3 - 1}{G_{01} G_{02}}, \quad T_e = T_{e1} + \frac{T_{e1}}{G_{01}} + \frac{T_{e3}}{G_{01} G_{02}}$$

$$P_r \approx \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 L_{sys}} \left( \frac{4\pi h_t h_r}{\lambda} \right)^2 \frac{1}{d^4}$$