FORMULAE

BLACKBODY RADIATION

Planck's Blackbody Distribution:

$$u(\lambda, T) = \frac{8\pi h c}{\lambda^5} \cdot \frac{1}{e^{hc/\lambda k_B T} - 1}$$

$$\boxed{\mathcal{E} = h\nu = \frac{hc}{\lambda}}$$

(Energy quantum)

$$u(\lambda, T) = \frac{4}{c} \mathcal{E}_\lambda(\lambda, T)$$

Wien's Displacement Law:

$$\frac{d\mathcal{E}_\lambda}{d\lambda} = 0$$

$$\Rightarrow \lambda_{max} T = \frac{hc}{5k_B} \times \frac{1}{1 - e^{-hc/\lambda k_B T}}$$

$\lambda \to \lambda_{max}$

$$\Rightarrow \lambda_{max} T \simeq b \quad (b = 2.898 \times 10^{-3}\ mK)$$

Stefan-Boltzmann Law:

$$\mathcal{E} = \int_0^\infty \mathcal{E}_\lambda(\lambda, T)\, d\lambda = \sigma T^4$$

$$\Rightarrow \mathcal{E} = \sigma T^4, \quad \sigma = \frac{2}{15} \times \frac{\pi^5 k_B^4}{c^2 h^3} \simeq 5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$$

$W = \sigma A T^4$, $A \to$ surface area of black body.

Rayleigh-Jeans Law:

When $\lambda \to \infty$, $\frac{hc}{\lambda k_B T} \to 0$

$$\therefore u(\lambda, T) \simeq \frac{8\pi k_B T}{\lambda^4}$$

Wien's Blackbody Distribution:

When $\lambda \to 0$,

$$\frac{hc}{\lambda k_B T} \to \infty \Rightarrow u(\lambda, T) \simeq \frac{8\pi h c}{\lambda^5} \cdot e^{-hc/\lambda k_B T}$$