

$$\frac{9N}{\omega_0^3} \int_0^{\omega_0} \frac{\cancel{h} \omega}{e^{\frac{\cancel{h} \omega}{kT}} - 1} \omega^2 d\omega$$

$$x = \frac{\cancel{h} \omega}{kT} \quad \frac{dx}{d\omega} = \frac{\cancel{h}}{kT}$$

$$d\omega = dx \frac{kT}{\cancel{h}}$$

$$\rightarrow \frac{9N}{\omega_0^3} \int_0^{x_0} \frac{kT}{\cancel{h}} \frac{\cancel{h} \omega^3}{e^x - 1} dx$$

$$\rightarrow \frac{9N}{\omega_0^3} \int_0^{x_0} \frac{x^3}{e^x - 1} dx \cdot \left(\frac{kT}{\cancel{h}}\right)^3$$

$$k \Theta_0 = \cancel{h} \omega_0$$

$$\rightarrow \left(\frac{k}{\cancel{h}}\right)^3 = \frac{\omega_0^3}{\Theta_0^3} \quad \checkmark$$