

Answer on Question #46460-Physics-Solid State Physics

Calculate the Debye specific heat of copper at $T = 300\text{ K}$, given that its Debye frequency is $\omega_D = 4.11 \cdot 10^{13}\text{ rads}^{-1}$.

Solution

$$C_V = \left(\frac{12}{5}\right) \pi^4 \frac{R}{M_{\text{copper}}} \left(\frac{T}{\theta_D}\right)^3.$$

$$\theta_D = \frac{h\nu_D}{k} = \frac{\hbar\omega_D}{k}.$$

$$C_V = \left(\frac{12}{5}\right) \pi^4 \frac{R}{M_{\text{copper}}} \left(\frac{kT}{\hbar\omega_D}\right)^3.$$

$$C_V = \left(\frac{12}{5}\right) \pi^4 \cdot \frac{8.31}{63.5 \cdot 10^{-3}} \left(\frac{1.38 \cdot 10^{-23} \cdot 300}{1.05 \cdot 10^{-34} \cdot 4.11 \cdot 10^{13}}\right)^3 = 27.0 \cdot 10^3 \frac{J}{kgK}.$$

Answer: $27.0 \cdot 10^3 \frac{J}{kgK}$.