

PHY 491, Fall 2024 - Homework 10

DUE: Friday 11/22/24, 11:59pm

Problem 5.1 The thermodynamic properties of Li are governed by acoustic phonon modes for temperatures higher than a few Kelvin. Li crystallizes in a BCC structure with lattice constant $a = 3.5\text{\AA}$.

5.1.1 Sketch the heat capacity of Li as a function of temperature. Indicate explicitly the value at large temperature. (5 points)

5.1.2 If the sound velocity at low frequency is $v = 6 \cdot 10^5 \text{ cm/sec}$, what is the value of the Debye frequency ω_D and Debye temperature T_D ? (6 points)

Problem 5.2 Given a mono-atomic lattice in one dimension at temperatures small compared with the Debye temperature, $T_D = \frac{\hbar \pi v}{k_B a}$, with sound velocity v and lattice constant a .

5.2.1 Use the Debye model to calculate the heat capacity of the chain. (9 points)

Useful integral: $\int_0^\infty \frac{x}{(e^x - 1)} dx = \frac{\pi^2}{6}$