1. Gold has the same structure as copper. The velocity of sound in gold is 2100 m/s and that in copper is 3800 m/s. If the Debye temperature of copper is 348 K, determine the Debye temperature of gold. The densities of gold and copper are 1.93 X 10^4 kg/m^3 and 8960 kg/m^3 and their atomic weights are 197 and 63.54 amu respectively.

2. Consider a one-dimensional crystal of atoms of mass m with one atom per site. The interactions up to the next nearest neighbors are taken into account and are modelled by springs with the force constant for the nearest-neighbor interaction given by C_1 and that for the next-nearest-neighbor interaction given by C_2. Compute the equation of motion for an atom and the dispersion relation of the normal modes.

3. For phonons in two dimensions :
(a) Find the expression of density of state and Debye frequency for linear dispersion close to K=0.

(b) Find the expression for total energy (with integral). Next calculate its value in the low temperature limit using the integral $\int_0^\infty \frac{x^2}{e^x - 1} = 2.4$

4.

IONIC AND ELECTRONIC POLARIZABILITY Consider the CsCl crystal which has one Cs^+–Cl^- pair per unit cell and a lattice parameter a of 0.412 nm. The electronic polarizability of Cs^+ and Cl^- ions is 3.35×10^{-40} F m^2 and 3.40×10^{-40} F m^2, respectively, and the mean ionic polarizability per ion pair is 6×10^{-40} F m^2. What is the dielectric constant at low frequencies and that at optical frequencies?

5.

ELECTRONIC POLARIZABILITY OF A VAN DER WAALS SOLID The electronic polarizability of the Ar atom is 1.7×10^{-40} F m^2. What is the static dielectric constant of solid Ar (below 84 K) if its density is 1.8 g cm^{-3}?