

NORTHERN ILLINOIS UNIVERSITY

PHYSICS DEPARTMENT

Physics 580 – Solid State Physics

Fall 2020

Problem Set #3

Problem Set Due: Thurs., Sept. 22, 2020

Read Kittel: Chapter 3

1. Go through Equations (1) through (9) in Chapter 3 in Kittel (pages 53-56). In particular:

- a) derive Eq. (3)
- b) make the substitutions in Eq. (5) and derive Eq. (7)
- c) and derive Eq. (9).

2.

1. **Quantum solid.** In a quantum solid the dominant repulsive energy is the zero-point energy of the atoms. Consider a crude one-dimensional model of crystalline He^4 with each He atom confined to a line segment of length L . In the ground state the wave function within each segment is taken as a half wavelength of a free particle. (a) Find the zero-point kinetic energy per particle. (b) Find an expression for the force needed to keep the line from expanding. (c) In equilibrium the expansive tendency of the kinetic energy is balanced by the van der Waals (vdW) interaction. The vdW energy between nearest neighbors is given very roughly by $U(L) = -1.6 L^{-6} 10^{-60}$ erg, where L is in cm. Find the equilibrium value of L .