

## I. PROBLEM SESSION 7

### A. Problem 7.1

- a) Write down the expression for the electron energy levels in one dimension.
- b) Recall the meaning of the Fermi energy of the one dimensional electron gas.
- c) What is the relationship between the chemical potential and the Fermi energy.
- d) Recall the expression for the electron density of states in the 3d electron gas. How does the Fermi energy depend on the electron concentration in this case.
- e) How does the heat capacity of a metal depend on temperature.

### B. Problem 7.2

Kinetic energy of the electron gas: Show that the kinetic energy of a three-dimensional electron gas of  $N$  free electrons at zero temperature is

$$U_0 = \frac{3}{5}N\epsilon_F. \quad (1)$$

### C. Problem 7.3

Pressure and bulk modulus of an electron gas: a) Derive a relation connecting the pressure and the volume of an electron gas at 0K. Hint: Use the result of the previous problem and the relation between the Fermi energy and the electron density. The result may be written as  $pV = \frac{2}{3}U_0$

- b) Show that the bulk modulus  $B = -V \frac{\delta p}{\delta V}$  of an electron gas at 0K is

$$B = \frac{5p}{3} = \frac{10U_0}{9V}. \quad (2)$$

- c) Estimate for potassium the value of the electron gas contribution to B. Use the table on page 139 in the book.