

## I. PROBLEM SESSION 8

### A. Problem 8.1

- a) Write down the expression for the electron energy levels in one dimension.
- b) Recall 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.  
How does the heat capacity of a metal depend on temperature.
- f) Why is the electrical resistance of an electron gas finite? How does it depend on temperature?
- g) How does the presence of a magnetic field modify the motion of an electron? What is the reason for the Hall effect?

### B. Problem 8.2

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 8.3

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 electron concentration. The result may be written as  $pV = \frac{2}{3} U_0$ .
- b) Show that the bulk modulus  $B = -V \frac{\partial p}{\partial V}$  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.