1. Free electron gas in two dimensions.
   (a) What is the relation between the electron density n and k_F in two dimensions?
   (b) Derive the density of states $D(\epsilon)$.
   (c) What is the relation between the chemical potential μ and the Fermi energy E_F?

2. Deduce the temperature dependence of the chemical potential at low temperatures discussed in class.

$$\mu \approx \epsilon_F \left[1 - \frac{1}{3}\left(\frac{\pi k_B T}{2\epsilon_F}\right)^2\right]$$

3. Thermodynamics of the free electron gas (Read Problem A&M 2.2)] Deduce the following relations for entropy density $s = S/V$ and pressure P of the free electron gas using the thermodynamic identities

$$c_v = \left(\frac{\partial u}{\partial T}\right)_n = T\left(\frac{\partial s}{\partial T}\right)_n$$

   (a)

$$s = -k_B \int \frac{dk}{4\pi_3}\left[f ln f + (1-f) ln(1-f)\right]$$

   (b)

$$P = k_B T \int \frac{dk}{4\pi_3} ln\left(1 + exp\left[-\frac{(\hbar^2 k^2/2m) - \mu}{k_B T}\right]\right)$$