

Week 4 Worksheet

Free Electron Gas

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Exercise 1. Suppose you have N electrons in a box of side length L .

a) Show that the Fermi energy is

$$E_F = \frac{\hbar^2}{2m} \left(\frac{3N\pi^2}{L^3} \right)^{2/3}.$$

b) Find the total energy of the electrons in terms of E_F .

Exercise 2. Now, consider a free electron gas in two dimensions, confined to a square of side length L .

a) **Griffiths 5.30.** Find the Fermi energy in terms of N and L , and show that the average energy of the particles is $E_F/2$.

b) Let $g(E) dE$ be the number of particles with energy E in the interval dE . $g(E)$ is called the **density of states** and is useful in various problems in quantum statistical mechanics. Calculate $g(E)$ for the particles. Your formula should be constant, i.e. independent of E .