SSP Exercise 3

To be handed in by 4 p.m. Thursday 2nd February

In *d* dimensions there are $(1/2\pi)^d$ different spatial quantum states, of wave function $\psi(r)$, per unit length/area/volume of real space *r,* per unit length/area/volume of *k* space.

Using the 3D free electron Fermi gas model show that the expression for the Fermi energy in terms of the free electron density, *n*, is given by

$$\varepsilon_F = \frac{\hbar^2}{2m}\left(3\pi^2 n\right)^{\frac{2}{3}},$$

where *m* is the electron mass. **[7]**

Calculate ε_F for:

(i) Copper, which has face centred cubic structure with lattice spacing *a*=0.361 nm and for which one atom contributes one free electron. **[6]**

(ii) A **two dimensiona**l solid containing 3×10^{15} m^{-2} free electrons. **[6]**

(iii) A **one dimensional** conductor whose unit cells each contribute one free electron and are 0.8 nm long. **[6]**