Problem Sheet 4
Solid State Theory
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Problem 1) **(4 Points)**

Show that the kinetic energy of a three-dimensional gas of N free electrons at 0 K is

$$U_0 = \frac{3}{5} N \epsilon_F .$$

Problem 2) **(4 Points)**

The density of states of a three-dimensional system of fermions with anisotropic energy-wavevector-relation $E(\vec{k})$ can be computed from the formula

$$D(E) = \frac{V}{(2\pi)^3} \left| \frac{\mathrm{d}V_k}{\mathrm{d}E} \right| ,$$

where V is the volume of the system in real space while V_k is the volume in k-space enclosed by a surface of constant energy $E(\vec{k}) = E$. Compute from this the density of states for a system with energy-wavevector-relation

$$E(\vec{k}) = \frac{\hbar^2}{2} \left[\frac{k_x^2}{m_{11}} + \frac{k_y^2}{m_{22}} + \frac{k_z^2}{m_{33}} \right] .$$

Problem 3) **(4 Points)**

Prove that the Wannier-functions are orthogonal.