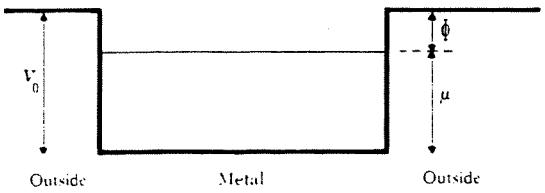
B5) A simple model for the conduction electrons in a metal is to take them to be independent particles moving in a potential determined by the other electrons and ions. In this model, the lowest possible energy of a conduction electron in the metal is $-V_0$ below the energy of a free electron at infinity. The conduction electrons have a Fermi energy (or chemical potential) μ. The minimum energy required to remove an electron from the metal is then $\Phi = V_0 - \mu$; Φ is the work function of the metal. The figure illustrates these relations in a diagram of energy versus spatial location of an electron.



Consider the electron gas outside the metal in thermal equilibrium with the electrons in the metal at the temperature T. The density of electrons outside the metal is quite small at all temperatures where $kT << \Phi$, as we assume is the case here.

(10 points) Determine the electron density n outside the metal. Express n in terms of m_e, T, Φ and basic constants of quantum statistical mechanics.