Chemical potential, μ

- The chemical potential varies with temperature, but for T << Fermi Temperature the variation is very weak

$$\mu(T) \approx E_F[1-(\pi^2/12)(T/T_F)^2]$$

For $T \ll T_F$

We usually just consider μ to be E_F For $T \ll T_F$

Properties of metal

- This theory of free electrons in metals is very powerful
- It is successfully used to model, e.g.
  - Electrical conduction
  - electron heat capacity
  - free electron paramagnetism
  - emission of electrons (thermionic and photoelectric)

Typical values of the Fermi energy

- For electrons in metals, N/V is given by the atomic spacing. Typically

$$N/V = 5 \times 10^{28} m^{-3}$$

With one conduction electron per atom one gets

$$E_F \approx 5\,eV$$

$$T_F \approx 5 \times 10^4\,K$$

$$V_F \approx 10^6\,m/s$$

High electron energies

- Electron energies can be high, even at T=0 (the Pauli exclusion principal forces them into high energy states)
- The Fermi energy is the energy of the topmost occupied energy level at T=0