Metals 11/29/2016

Metal ions that have lost their electrons arranged in a crystal or some other structure have a binding effect. The net effect is zero outside the system.

The electrons have a negative potential -> they are bound; however they are free to move inside the metal freely. There is the electron potential and an ion potential. To write the Hamiltonian for the full metal requires the Hamiltonian for all the electrons plus the hamiltonian for all the positive ions. Any potential at equilibrium can be approximated as an harmonic oscillator.

$$E_{ion} = \frac{1}{2}, \bar{h}w, \frac{3}{2}\bar{h}w....$$

Phonon = elementary excitations of “wiggling” ions.

The Schröder's equation can be examined in parts to conceptualize and predict that there are only certain energy potentials that can exist. A maximum energy is reached for a set of states then there is a gap then there is another set of energy eigenstates this is called a band. For **ONE** dimension, the number of states in the band is equal to N / 2. The top most band is the Conduction band the next one is the Valence band. The Valence band is nearly or completely full.

3 Cases

1st case Valence is full - Conduction is empty - Big gap between the two

Electrons are free to move in the insulator; however the gap between the conduction band and valence is too large. This is an **Insulator**

2nd case Either conduction band or valence is partially filled and or gap is 0 or negative

This is a **Conductor**

3rd case The gap is “smallish” When temp is close to zero becomes an insulator. As temp increases so does conductivity.This is a **Semi-Conductor**

$$E_{d.o.f} = \frac{1}{2}kt$$

Semi-conductor can be improved to conduct better by doping with and electron donor. When the donor has excess electrons this is called n-type doping. Atoms can be added that have less electrons also improve conductivity. The deficiency in the valence band effectively makes it the conduction band, this is called p-type.