Metallic Bonding -> delocalised valence electrons. These are why there is high electrical and thermal conductivity in metals.

Metallic Bonding allows high malleability and ductility because the atoms roll over each other.

The sea of delocalized electrons around the metal cation are free to move, therefore when a current is pushed through the negative side, they come out at the same right out the positive side.

Band Theory;

When multiple atoms in a system come closer than r_i (interactive radius), then their shells begin to combine. However, due to Pauli's exclusion principle, they can not merge into the same shell, therefore they begin to combine to form bands. These bands later split due to the interatomic distance amongst atoms decreasing, therefore forming Bonding and Antibonding bands => Valence Band and Conduction Band. The distance between these two is known as E_g, or the Forbidden Energy Gap. $E_g = E_C - E_V$. The distance between the Valence and Conduction band, or the E_g is the determinant of whether a material is an insulator, semiconductor, or a conductor. Insulators, Semiconductors, Conductors; >5.4, <1.8, 0 (overlapping).

Free Electron Model;

Metal atom in a vacuum. Fills from the bottom whilst considering Aufbau's Principle, and Pauli's Exclusion. Highest level of energy (valence) is the Fermi Energy E_F. The work function (φ) is the energy required to remove an electron from the Fermi Level, and take it to x = infinity from the level. It's like ionization energy of an atom.

Aufbau:
https://www.khanacademy.org/science/ap-chemistry-beta/x2eef969c74e0d802:atomic-structure-and-properties/x2eef969c74e0d802:atomic-structure-and-electron-configuration/v/the-aufbau-principle

Pauli's Exclusion
https://www.youtube.com/watch?v=TIzs5C33ONg

Particle in a box;

The walls of the box have infinite potential, and as the particle always seeks to move to lower potential, it can be concluded that the particle is always moving towards lower entropy which is the center of the atom. We can also determine in what approximate region the particle is due to Heisenberg's Uncertainty Principle. However, the position and the momentum can't both be known at the same time.

E-K Diagram; **CONFUSING PART -- STUDY THIS**

Brillouin zones because of Bragg's law = basically like total internal reflection. At the boundaries of the zones there is no energy, therefore there is a discontinuity in the E-k diagram. Equations are just further simplifications and substitutions. Check page 4 of notebook.

Free Electron Theory;

Energy Levels increase with increasing energy. At temperatures ABOVE absolute zero (Kelvin), electrons jump up to higher energy levels. Some next to the E_F are half occupied, and that's why there is good conductivity in metals. Nearly Free Electron Theory is kinda like that, except it is periodic and NOT constant. Look at the diagram on Page 5. It moves in a regularly repeating fashion, as a function of the interatomic distance r.

Chemical theory;

Band Theory;

https://www.khanacademy.org/science/in-in-class-12th-physics-india/in-in-semiconductors/in-in-band-theory-of-solids/v/band-theory-of-solids-class-12-india-physics-khan-academy

Why it splits;

https://www.youtube.com/watch?v=FVc1S2CO4qg

Even = n/2 bonding, n/2 antibonding
Odd = (n-1)/2 bonding, 1 nonbonding, (n-1)/2 antibonding

Diamond;

4sp3 is when one s and 3 p orbitals combine, usually as p + sp + p and form a tetrahedral geometry. This is the case for diamond. These 4 orbitals split into 2 bonding and 2 antibonding = valence, conduction. As it fills from the bottom, valence is full, and conduction is empty. And the E_g is 5.4 eV. So conduction is basically impossible. Look at the last slide on the presentation. The permeability of waves through a material is dependent on the eV of the wave, and the E_G of the material in eV. Less than = can go through, else = no.