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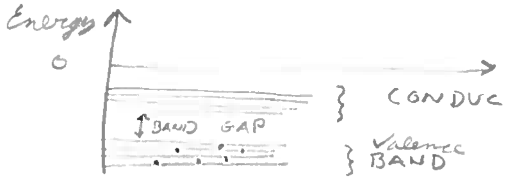
MODERN PHYSICS NOTES

Lattice of atoms who gave up electrons

If we solve the Schrodinger eq. because lattice repeats, energy LEVELS are closely spaced within bands



} CONDUCTANCE BAND : NOT completely filled w/ electrons
OR would be the Valence Band

- Most extreme case → is when Valence Band is completely full, conductance band is empty, and Band Gap LARGE ... Creates an insulator.

↳ Creates an insulator, because the electrons cannot reach the conducting band.

EXAMPLE: Diamonds

- The opposite example → when Valence Band is full, Conductance Band partially full, and/or Band Gap small.. creates a CONDUCTOR. and/or bands overlap

} Harmonic Oscillator = $(n + \frac{3}{2})\hbar\omega$

these traveling vibrations, can be quantized, called phonons.

↳ Some energy gets lost ~~when~~ from electrons ~~turn~~ to ~~into~~ phonons.

↳ also, these random vibrations ~~create~~ are! heat

• Intermediate case → Valence Band ||, conducting Band nearly empty, and band gap SMALL ...
Creates SEMICONDUCTORS

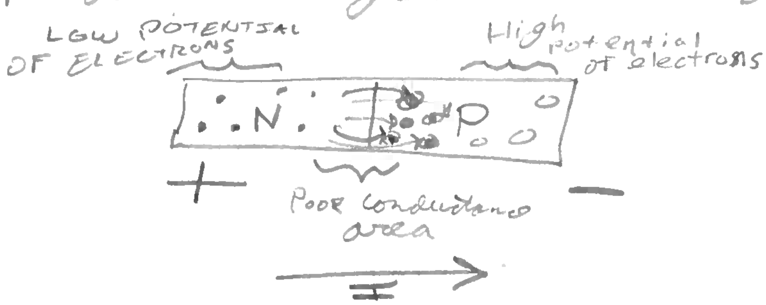
$n(E) \sim e^{-E/KT}$ = If temperature ≠ 0 & Small Energy gap there is some probability of electrons in upper band.

∴ ↑ Temperature creates more electrons in upper band
∴ Semiconductors create more current at high temperatu

→ Electron - Donor Impurities
↳ n - type doped semi - conductor

→ If you add electron - acceptor impurities → VALENCE BAND MIGHT HAVE holes
↳ Holes = missing electrons
∴ act like a + charge, but can move like an electron and thus creates → P - type Semiconductors

→ What happens if you connect a n & p type semiconduct
↳ some free electrons will end up in the p-type semiconductors. The point, electrons in the conductance band will fill in the holes & thus will not provide a good conductance.



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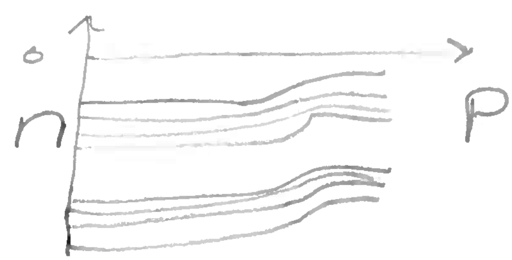

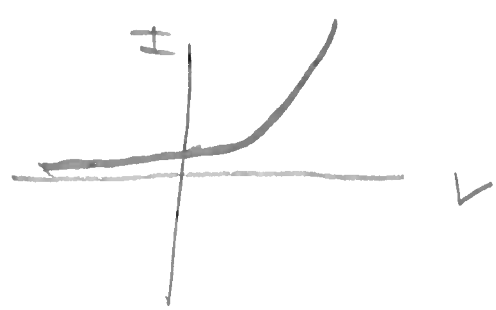

Diode

→ Superconductors would be the last ~~semiconductor~~. type of conductor

→ Thermophysics = if you have a system with a lot of particles there is no way to figure out what all the particle's motion will be; Resulting in probability becomes like certainty.

↳ THERMODYNAMICS
↳ Invented to improve thermo machines like the steam engine
- HEAT → MECHANICAL ENERGY
- came up w/ terms like:
  Temperature, Pressure, Density, entropy

$PV = n_{mol} R T$

$N_{molecules} = n_{mole} N_A$
Temperature IN KELVIN

↳ STATISTICAL PHYSICS
↳ fill up a tire... the air could stay on one side of tire... STATISTICAL PHYSICS says this will "never" happen.

KINETICS theory relates the two

Kinetic theory in STATISTICAL Physics:
assume $N = n_{mol} N_A$ how many particles will you find with energy E_i?

$$n(E_i) = C g(E_i) e^{-E_i/KT}$$

$$\sum_{i=1}^{\infty} n(E_i) = N = C \sum g(E_i) e^{-E_i/KT}$$

$$C = \frac{N}{\Sigma} = e^{-\alpha} = e^{-N/KT}$$

→ EX. H atom
$g(E_1) = 2$ (degeneracy) $\qquad g(E_2) = 8$

$$\to PV = nRT = N_{molecules} \left(\frac{R}{N_A}\right) T$$
($\frac{R}{N_A}$ = K)

↳ $(K)(290 \text{ Kelvin}) = .025 eV$ ✓

$$\frac{n(E_2)}{n(E_1)} = \frac{g(E_2)}{g(E_1)} e^{-\frac{(E_2 - E_1)}{KT}} \quad \text{\} Ratio}$$

- Average Energy = $\dfrac{\sum_{i=1}^{\infty} \varepsilon_n (s_i)}{\sum_{i=1}^{n} n(\varepsilon_i)}$
- $\langle \varepsilon \rangle = \frac{3}{2} KT$ = Average ENERGY
- If it could only move $\longleftrightarrow$ then $\frac{1}{2} KT$
- If 6 degrees of freedom = $3KT$