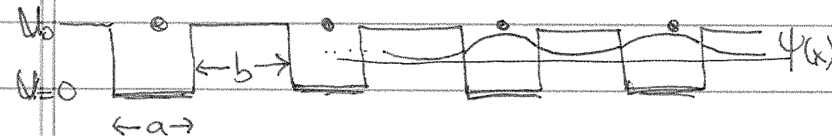
Band Structure – Conductors SemiConductors Insulators

$10^{-8}\,\Omega\cdot m$ $\qquad$ $10^{16}\,\Omega\cdot m$

* 2 methods of solving
Schrödinger equation for lattices.

A) Kronig-Penney Model – periodic potential.

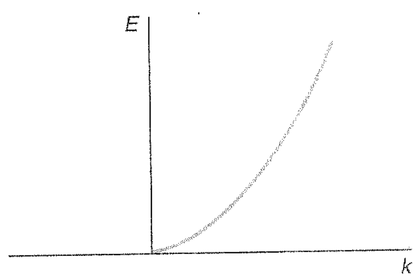


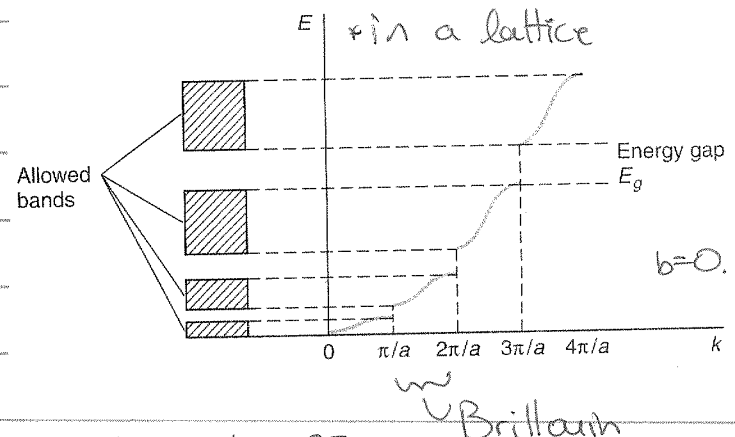
$\psi_a(x) = e^{ik'x}$ $\qquad E = \frac{\hbar^2 k'^2}{2m}$ $\qquad$ note: difference between k' and k

$\psi_b(x) = e^{-\alpha x}$ $\qquad U_0 - E = \frac{\hbar^2\alpha^2}{2m}$

solution: $\psi_k(x) = u_k(x)\cdot e^{ikx}$ for periodic $u(x)$

~~• free particle,~~ $\qquad$ • in a lattice





* effective mass m^* : $\frac{1}{m^*} = \frac{1}{\hbar^2}\frac{\partial^2 E}{\partial k^2}$
= curvature of dispersion relation
electrons appear really heavy near the band gaps

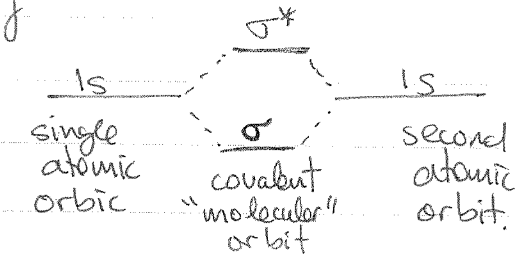
* interference as k (wavelength) approaches
the period of the lattice $\Rightarrow$ standing wave.

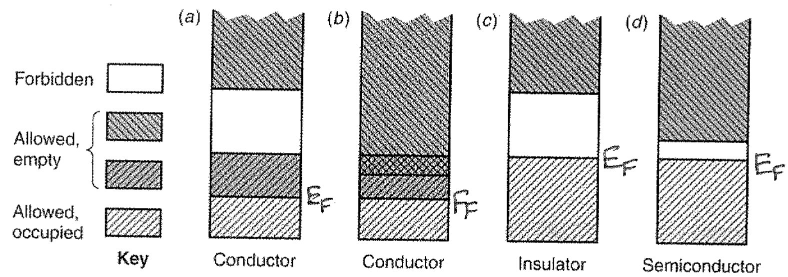
– energy levels of $N \sim 10^{23}$ atoms split into
infinitessimally close levels in a "band"

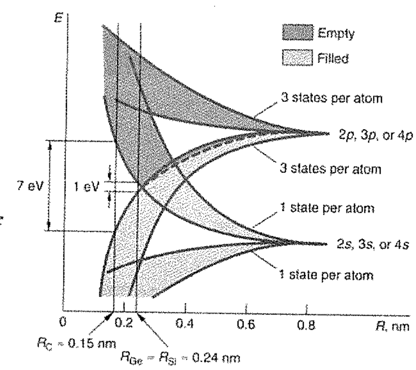
– quantization manifest as band gaps.

B) Variation of Lattice spacing

- similar to formation of a covalent bond
- now 10^{23} atoms! ⇒ bands.
  symmetric & antisymmetric

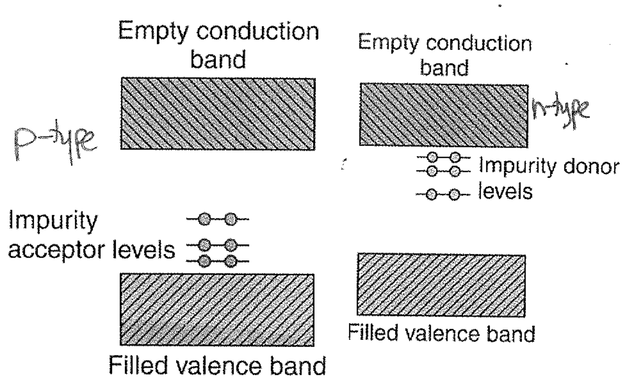


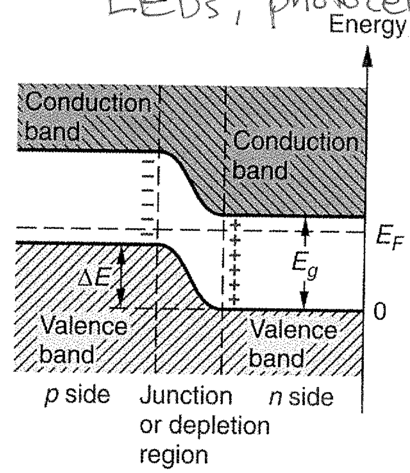




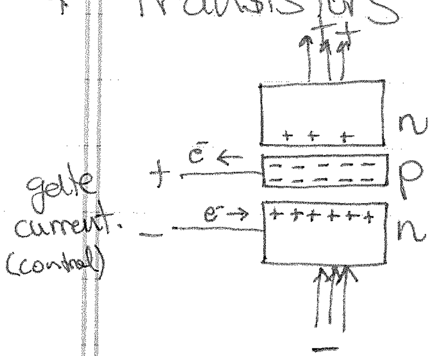
* Diodes pn-junction

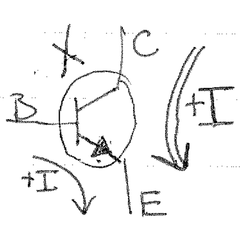
- surface barier detectors
- LED's, photocells

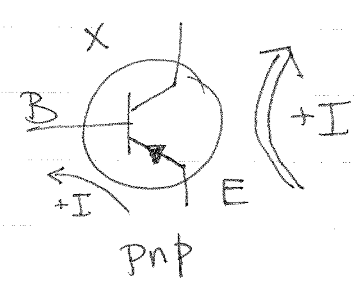




* Transistors pnp or npn (Bipolar Junction Transitor)







* MOSFET : base (gate) insullated, doesn't draw current.