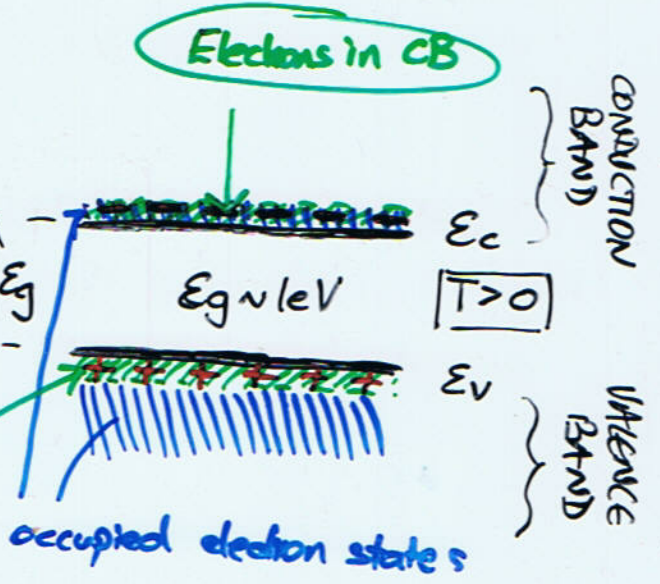
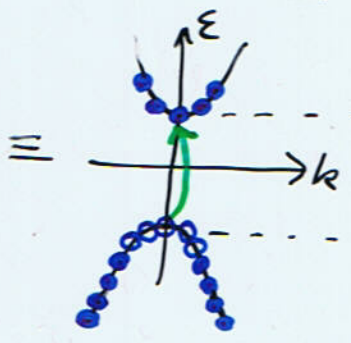
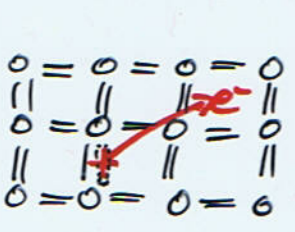


Semiconductors, electrons + holes

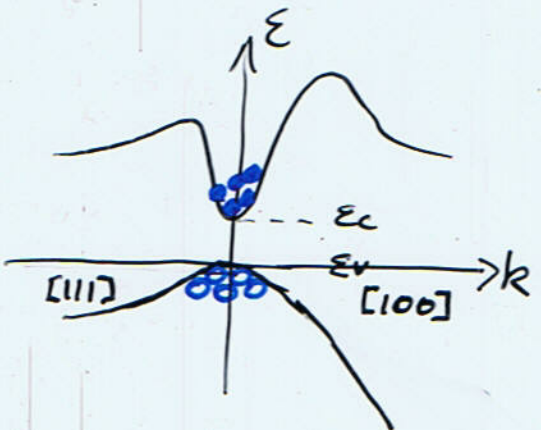


Electrons in nearly empty conduction band, and vacant states (holes) in nearly filled valence band are equally important charge carriers.

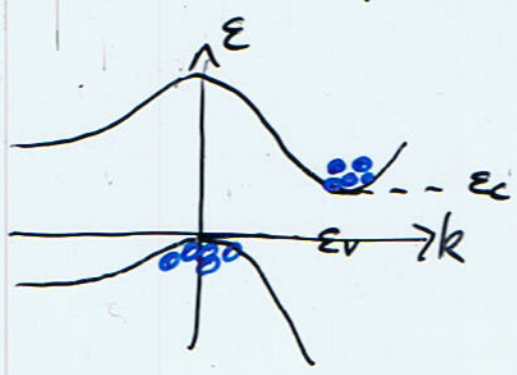
concentration, n

concentration, p

n and p (and $\therefore \sigma$) are strong functions of $E_g/k_B T$.



eg GaAs
Direct bandgap



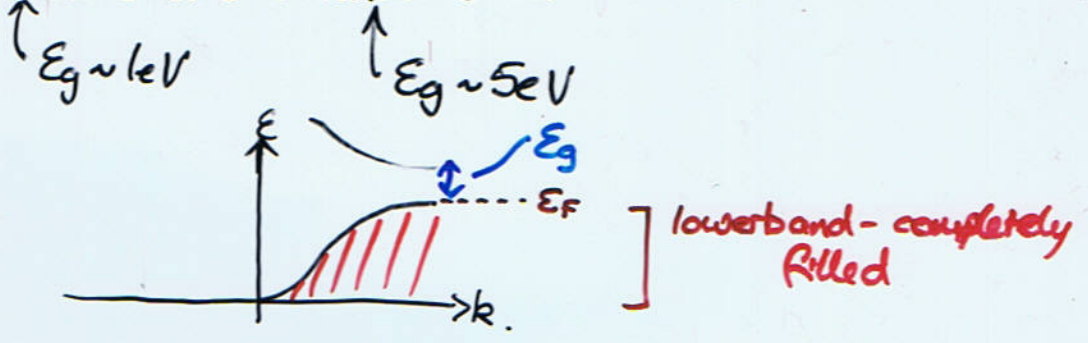
eg Si
Indirect bandgap.
* Electron transition requires interaction from crystal.*

Insulators

The valence electrons completely fill one or more bands, leaving higher bands empty.

Crystals can only be insulators if they have an even no of valence electrons per unit cell.

Semiconductors are insulators at $T=0$.



Metals

Partially filled bands due either to

- (i) odd valency (bands $\frac{1}{2}$ filled)
- (ii) overlapping bands

