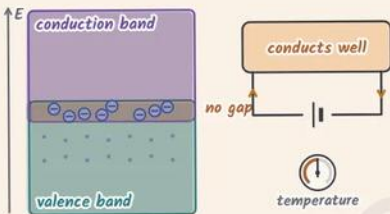


a material poised between conductor and insulator, and a junction that only lets current through one way

Conductor vs insulator vs semiconductor

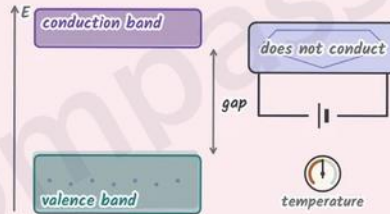
Conductor



the bands overlap: free electrons everywhere, it conducts well

- conduction and valence bands overlap
- plenty of free electrons, always
- conductivity falls as temperature rises

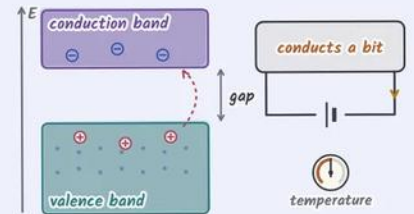
Insulator



a wide gap: nothing crosses, it does not conduct

- a wide gap, several eV, between the bands
- electrons almost never cross it
- conductivity negligible at ordinary temperatures

Semiconductor



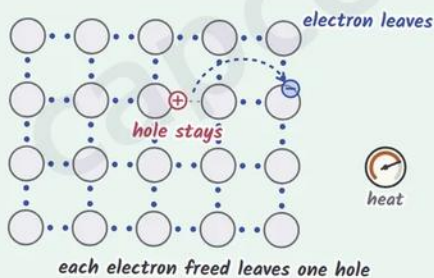
a narrow gap: heat lifts a few electrons across, each leaving a hole

- a narrow gap, about 1 eV, between the bands
- heat alone lifts a few electrons across
- conductivity rises as temperature rises

silicon's gap is about 1.1 eV, germanium's about 0.7 eV, diamond's about 5.5 eV: the gap alone sorts the three

Two carriers, not one *

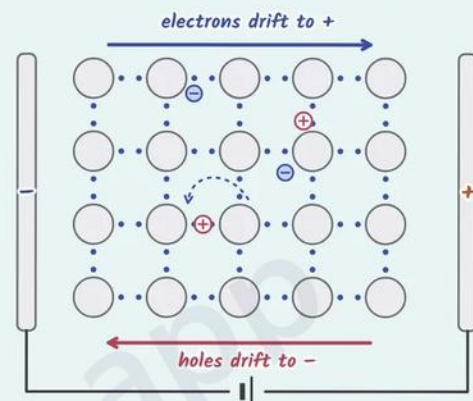
Heat makes pairs



heat breaks a bond: an electron leaves, a hole stays, always one of each

- heat breaks a bond: one electron freed, one hole made
- a hole acts as a positive charge carrier
- in a pure (intrinsic) crystal $n_e = n_h = n_i$

A field moves them



in a field electrons drift to +, holes to -, each hole step is a neighbour's electron hopping in

- electrons drift toward +, holes toward -
- a hole moves when a neighbour's electron hops in
- both carriers add to the current