Second course of 4th class physics
Semiconductor

Semiconductor are a group of materials in which the energy gap between the filled (valance band) and unfilled zones(conduction band) is very small (Fig. 1). Due to small energy gap between the two zones, no electron can jump from the first zone to the second zone (which is empty) at absolute zero temperature (i.e., at 0°K). When temperature is raised , electrons get sufficient thermal energy $K_\beta T$) which makes electron to jump across the small gap into the empty zone 2 and semiconductor become good conductivity . Obviously, in semiconductors, the electrical conductivity (or flow of electron, i.e., current) increases with the increase in temperature. At 0°K, a semiconductor behaves as an insulator . The electrical conductivity of semiconductors lies in between those of conductors and insulators.

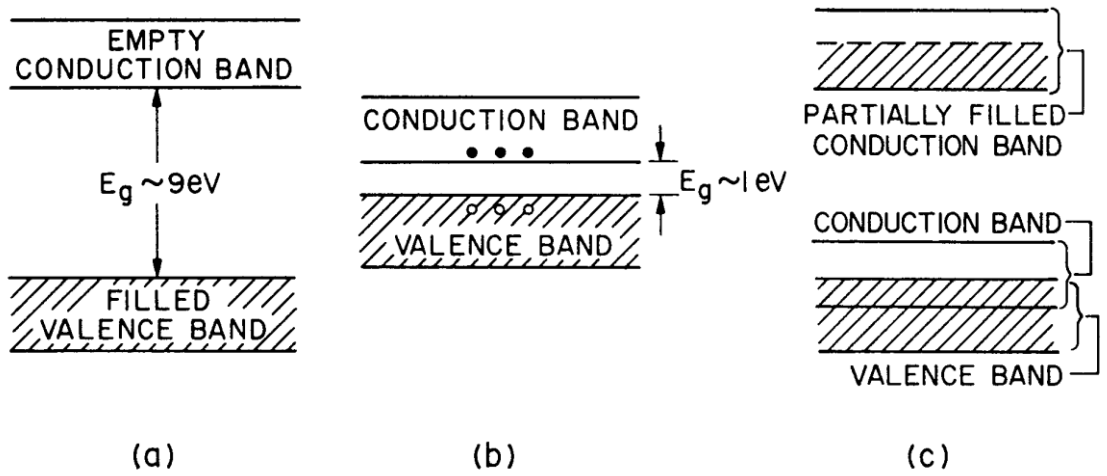

Figure 1. : Schematic energy band representations of (a) an insulator, (b) a semiconductor, and (c) conductors

Intrinsic semiconductor become good conductivity at high temperature because semiconductor at high temperature have resistance with negative thermal coefficient so resistance decreases with increases temperature.(Energy gap (0.1 – 10 e v)

Extrinsic semiconductor (doping semiconductor) resistance increases with increase temperature until reach glass temperature T_g decreases strongly .

As the temperature increases above 0 K, a few valence band electrons may gain enough thermal energy to break the covalent bond and jump into the conduction band. Figure 1.

The semiconductor is neutrally charged. This means that, as the negatively charged electron breaks away from its covalent bonding position, a positively charged "empty state" is created in the original covalent bonding position in the valence band. As the temperature further increases, more covalent bonds are broken, more electrons jump to the conduction hand, and more positive "empty states" are created in the valence band. We can also relate this bond breaking to the E versus k energy bands Fig 2. Energy gap of Ge (0.75 ev) and for Si (1.22 ev) .

The important properties of semiconductor material:

1- Semiconductor have resistance with negative thermal coefficient .
2- The resistivity of semiconductor lies between ($10^{-5} – 10^{4}$ ohm.meter).

3- Semiconductor can product very high thermal electrical power .
4- Semiconductor have tow type of carriers (electrons , holes).
5- Semiconductor
6- We can control to the resistance of semiconductor material by adding impurities .

Intrinsic Semiconductor

Semiconductor without impurity (pure material or crystal)called intrinsic semiconductor which have valance band completely full with electrons and conduction band completely empty at low temperature (0 K) .

When increases temperature more electrons in valance band leaves position and reach conduction band , so conduction band become partially full with electrons and be ready to move under electrical field . The hole form in valance band as the result of this process . the positive charge (hole) be easy attractive electrons to be occupied its and this motion create current or field.

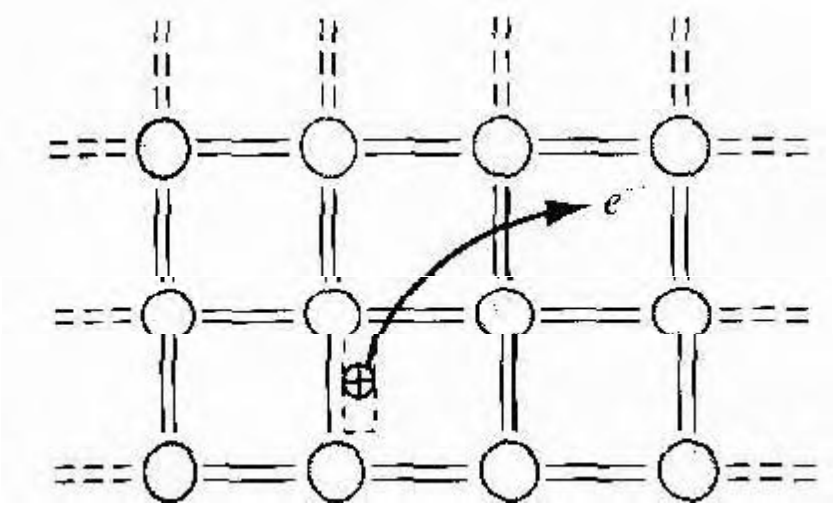

Figure 1 (a) Two-dimensional representation of the breaking of a covalent bond.
(b) Corresponding line representation **of** the energy band and the generation **of** a negative **and** positive charge with the breaking of a covalent bond.

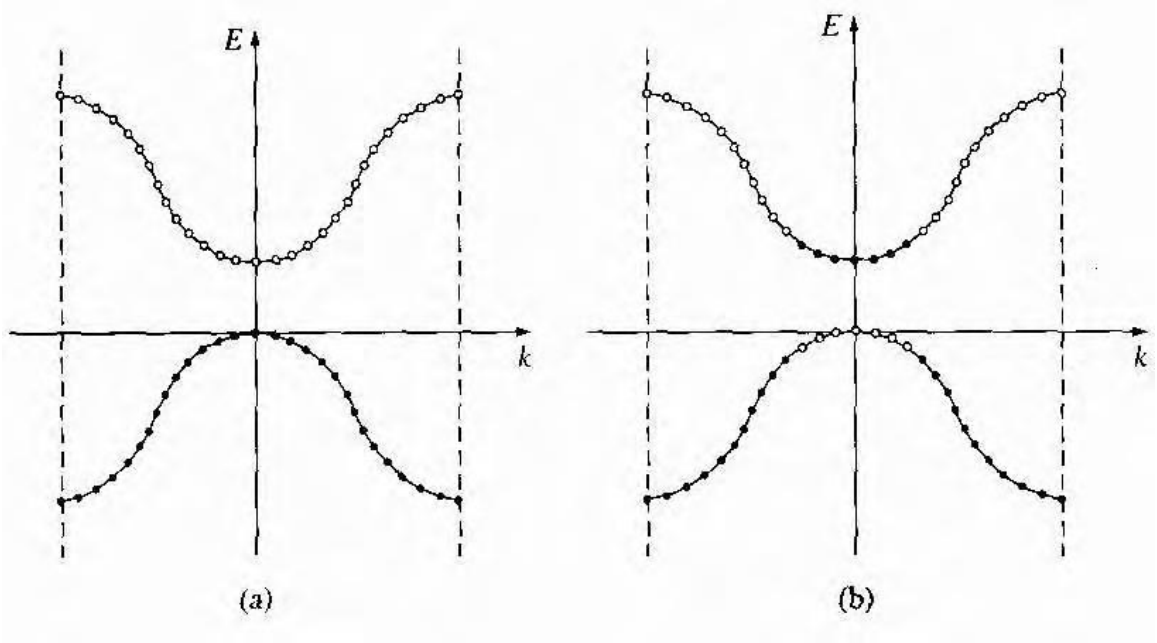

Figure 2. The ***E*** versus ***k*** diagram of the conduction and valence bands of a semiconductor at (a) $T = 0$ K and (b) $T > 0$ **K**