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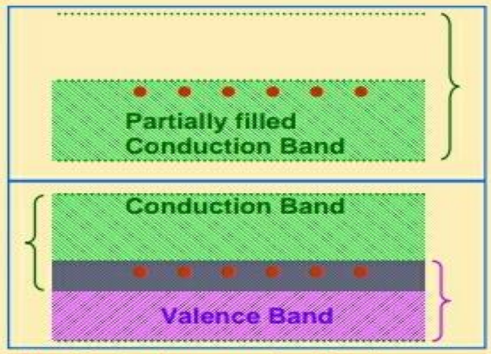
Class 12Sc   Sub Physics (S. C. devices) Dt 10 01 21

Metals:

The first possible energy band diagram shows that the conduction band is only partially filled with electrons.

With a little extra energy the electrons can easily reach the empty energy levels above the filled ones and the conduction is possible.



The second possible energy band diagram shows that the conduction band is overlapping with the valence band.

This is because the lowest levels in the conduction band needs less energy than the highest levels in the valence band.

The electrons in valence band overflow into conduction band and are free to move about in the crystal for conduction.

The highest energy level in the conduction band occupied by electrons in a crystal, at absolute 0 temperature, is called Fermi Level.

The energy corresponding to this energy level is called Fermi energy.

If the electrons get enough energy to go beyond this level, then conduction takes place.

Semiconductors:

At absolute zero temperature, no electron has energy to jump from valence band to conduction band and hence the crystal is an insulator.

At room temperature, some valence electrons gain energy more than the energy gap and move to conduction band to conduct even under the influence of a weak electric field.

$E_{g\text{-}Si} = 1.1$ eV $Eg_{Ge} = 0.74$ eV

The fraction is $p \propto e^{-\frac{E_g}{k_B T}}$

Since E_g is small, therefore, the fraction is sizeable for semiconductors.

As an electron leaves the valence band, it leaves some energy level in band as unfilled.

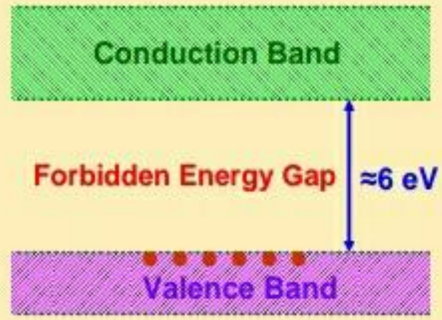
Such unfilled regions are termed as 'holes' in the valence band. They are mathematically taken as positive charge carriers.

Any movement of this region is referred to a positive hole moving from one position to another.

Insulators:

Electrons, however heated, can not practically jump to conduction band from valence band due to a **large energy gap**. Therefore, conduction is not possible in insulators.

$E_{g\text{-}Diamond} = 7\ eV$



Electrons and Holes:

On receiving an additional energy, one of the electrons from a covalent band breaks and is free to move in the crystal lattice.

While coming out of the covalent bond, it leaves behind a vacancy named 'hole'.

An electron from the neighbouring atom can break away and can come to the place of the missing electron (or hole) completing the covalent bond and creating a hole at another place.

The holes move randomly in a crystal lattice.

The completion of a bond may not be necessarily due to an electron from a bond of a neighbouring atom. The bond may be completed by a conduction band electron. i.e., free electron and this is referred to as 'electron – hole recombination'.