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Unit  
**1**  
**The Solid State**

**Electrical properties of solids:**

Based on their conductivities solids can be classified as,

- (i) Conductors
- (ii) Insulators
- (iii) Semiconductors

**Conductors:**

The solids whose conductivity is ranging between  $10^4$  to  $10^7 \Omega^{-1}\text{m}^{-1}$  are called Conductors.

- Conduction of electricity in conductors may be due to movement of electrons (metals) or ions (electrolytes).
- Atomic orbitals of metal atom form molecular orbitals which are so close to each other to form band.
- In conductors, the gap between valence band and conduction band is so small.

**Insulators:**

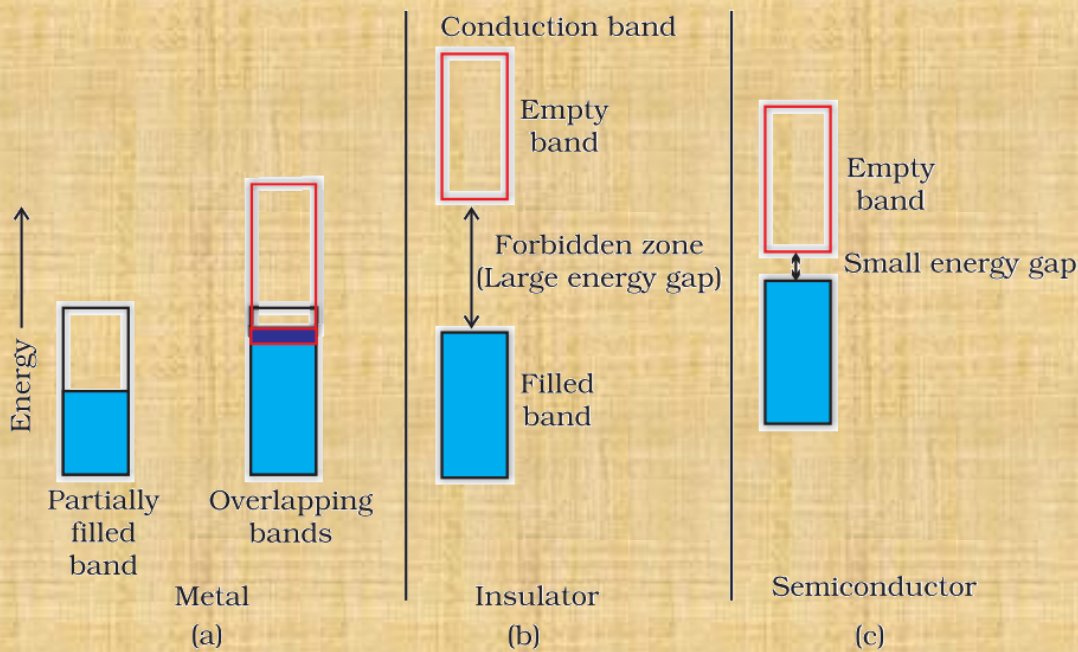
The solids whose conductivity is ranging between  $10^{-20}$  to  $10^{-10} \Omega^{-1}\text{m}^{-1}$  are called insulators.

- In insulators, the gap between valence band and conduction band is so large.

**Semiconductors:**

The solids whose conductivity is ranging between  $10^{-6}$  to  $10^4$  are called Semiconductors.

- In semiconductors, the gap between valence band and conduction band is moderate.



**Fig.** Distinction among (a) metals (b) insulators and (c) semiconductors. In each case, an unshaded area represents a conduction band.

- Conductivity in semiconductors rises with increasing temperature or with addition of impurities.
- Semiconductors are classified as Intrinsic & extrinsic semiconductors.

#### a) Intrinsic semiconductors:

The semiconductors whose conductivity rises by increasing temperature.

Ex. Si, Ge.

#### Extrinsic semiconductors:

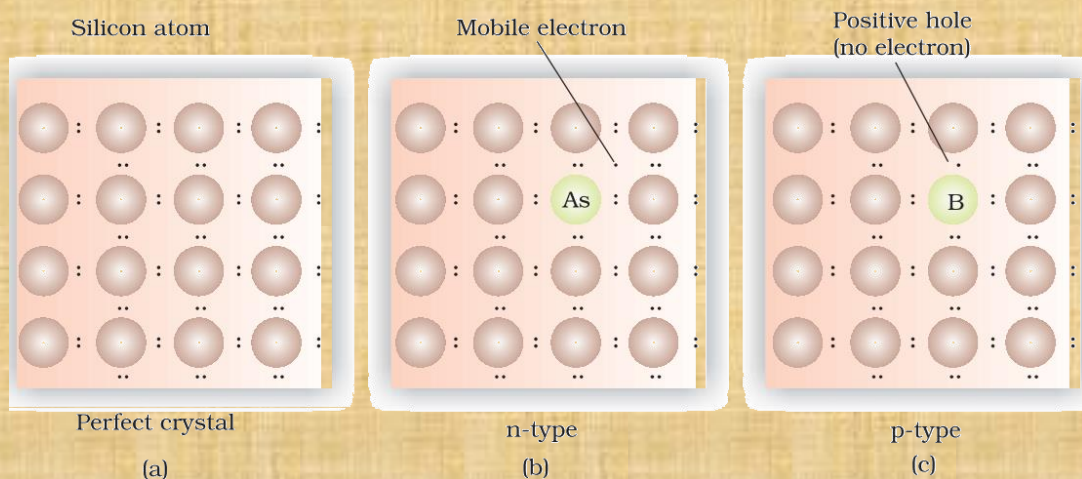
The semiconductors whose conductivity increases by addition of impurity based on the impurity added, extrinsic semiconductors are classified as, n type & p – type semiconductors.

#### b) n – type semiconductors:

Elements of group 14 are doped with electron rich impurities like group 15 elements. Charge carriers are negatively charged electrons.

#### c) p – type semiconductors:

Elements of group 14 are doped with electron deficient impurities like group 13 elements. Charge carriers are positively charged holes.



**Fig.** Creation of n-type and p-type semiconductors by doping groups 13 and 15 elements.