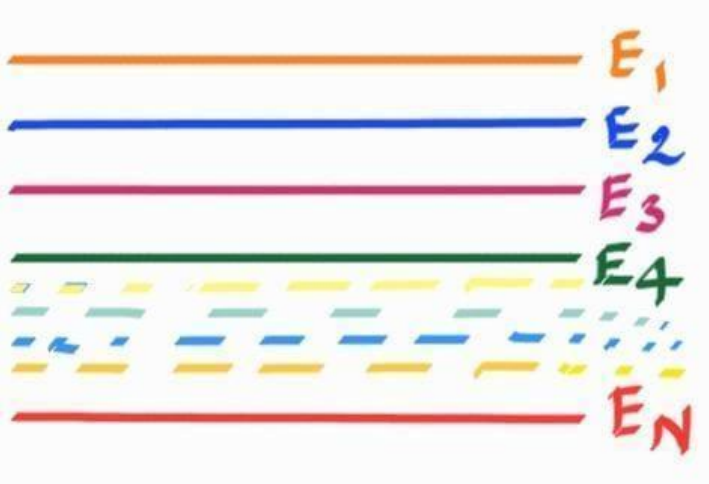
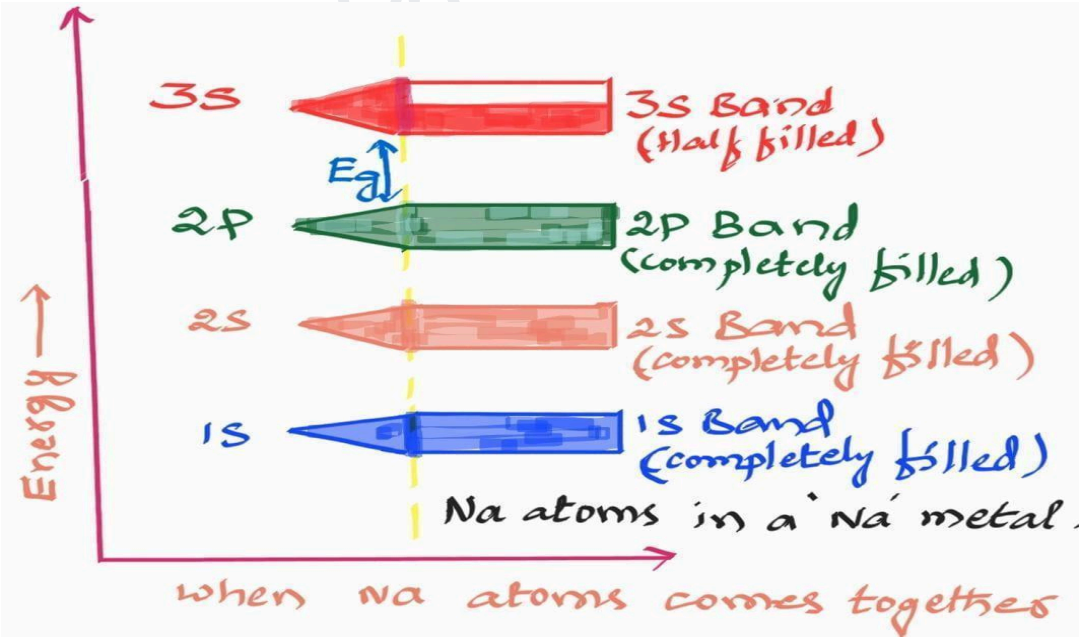
1.17.ORIGIN OF ENERGY BANDS (or) FORMATION OF ENERGY BANDS

- In isolated atoms the electrons are tightly bound and have discrete sharp energy levels. The degree of splitting of energy levels depends on their depth in the atom.
- When two identical atoms are brought to closure the outermost orbit of these atoms overlaps and interacts, then the energy levels corresponding to those atoms are split into two.
- If more atoms are brought together, more Energy levels are formed and for a solid of N-atoms each energy level of an atom splits into N levels.



- The degree of splitting of energy levels depends on their depth in the atom and is largest for outermost atomic electrons.

Example: When Na ($1s^2\ 2s^2\ 2p^6\ 3s^1$) atoms comes together



- The electrons in the inner shells are strongly bound to their nucleus while the electrons in the outermost shells are not strongly bound to the nucleus
- The e's in the outermost shell are called valence electrons.
- The energy levels in the valence band are so close together that they form an almost continuous band.
- The electrons first occupy lower energy bands and are of no importance in determining many of the physical properties of solids.
- The electrons which present in higher energy bands are important in determining many of the physical properties of solids.
- These two lower and higher energy bands are called Valence band and Conduction band.

Valence Band (VB):

- The energy band which comprises the valence electrons of an atom is known as valence band (VB).
- VB is formed by the energy levels of valence electrons and this band having highest occupied electrons.
- VB is located below the Fermi level in the energy band diagram.
- VB may be partially or completely filled depending on the number of valence e's.
- The energy of the VB electrons is less than that of the free electrons & electrons in Fermi energy.
- VB is the lowest energy state.
- The electron density of VB is high because it has a greater number of e's per unit volume.
- At absolute zero temperature, VB is completely filled by electrons.
- Electrons move out of the VB when the atom is excited.

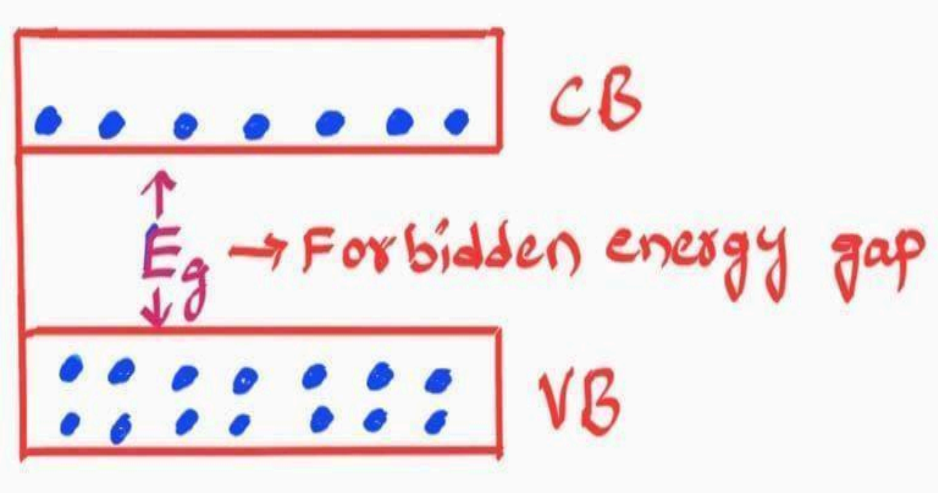
Conduction Band (CB):

- The energy band which comprises the free electrons of an atom is known as conduction band (CB).
- CB is formed by the energy levels of free electrons and this band having lowest occupied electrons.
- CB is located above the Fermi level in the energy band diagram.
- CB is empty or partially filled.
- The energy of the CB electrons is higher than that of the valence electrons & electrons in Fermi energy.
- CB is the highest energy state.
- This band is formed by conduction/free e's.

- This CB has greater energy than Fermi energy and energy of valence electrons.
- The electron density of CB is low, because it has less number of e's per unit volume.
- At absolute zero temperature, the CB is empty
- Electrons move into the CB when the atom is excited.

Energy band diagram of solids:

- The current flowing through the materials due to the electron transfer from VB to CB.



Forbidden energy gap or band gap:

- The CB and VB are separated by a region (or) gap known as forbidden energy gap.
- There are 'No' electrons that exist in the Forbidden Energy Gap.
- This refers to the energy difference (eV) between the top of VB and bottom of CB.
- This is the special characteristic of semiconductor material.
- The minimum amount of energy required to break a covalent band to excite an electron from VB to CB.