MADE EASY

ELECTRONICS ENGINEERING

E.D.C

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- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

ELECTRONICS DEVICE CIRCUIT

1. Electronics is a study of motion of e^{-n} in a semiconductor.
2. Electronic device is a device made up of semiconductor materials.
3. Electronic circuit are of 3 types
   (i) Analog circuit
   (ii) Digital circuit
   (iii) Mixed circuit

Active device

Device which can act as energy source is called active device e.g:- all voltage and current sources

- In passive devices, the time average power delivered to the device over an infinite time period is always greater than or equal to zero while active devices are capable of supplying power.

Ionisation Potential

It is the energy required to remove the electron from the outer orbit of an atom.

Electronegativity

- The tendency of an atom to attract e^{-n} to itself during the formation of bonds with other atoms.
- The amount of energy required to remove the e^{-n} from the given energy level increases when the radius is decreasing to show this the energy of the e^{-n} in the energy level is indicated with negative sign.
- The potential energy of the e^{n} is given by

  $$P.E = \frac{-e^2}{4\pi\varepsilon_0 R}$$

- The kinetic energy $K.E = \frac{1}{2}mv^2$
- The total energy is given by $W = \frac{-e^2}{8\pi\varepsilon_0 R}$

WORK FUNCTION

The minimum amount of energy required for the e^{-n} to escape from the metal at absolute zero temperature is called work function.

Expression for atomic concentration.

$$\text{Atomic concentration} = \frac{A_0 d}{A} \text{atoms/cm}^3$$

A_0 = Avagadro's number
d = density
A = atomic weight

Atomic Concentration

No. of atoms per unit Volume

Q. Find the atomic concentration for the germanium and silicon and give a comment based on those value

Solution:- Atomic concentration for germanium = $\frac{A_0 d}{A}$

$A = 72.6$, density = $5.32\ gm/cm^3$, $A_0 = 6.023 \times 10^{23}$ mole

$n_{Ge} = 4.4 \times 10^{22}$ atom/cm^3(Ans.)

Atomic concentrator for silicon.

$A = 28$, $D = 2.33$, $A_0 = 6.023 \times 10^{23}$

$n_{Si} = 5 \times 10^{22}$ atom/cm^3

Atomic concentrator of silicon is greater than that of germanium because atomic number of Si is less than atomic number of germanium

LCAO·

Q. Explain the classification of materials based on linear combination of atomic orbitals Or Explain energy band theory for the material classification

Ans. **Potential Well**

Atom is represented in the form of potential well as shown where the nucleus is reference and deft possible energies are represented as potential energy levels or simply energy level.

Allowed potential energy levels must satisfy the condition of :-

Angular momentum of e^{-n}

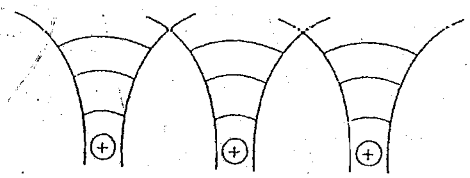
$$Mvr = \frac{nh}{2\pi}$$

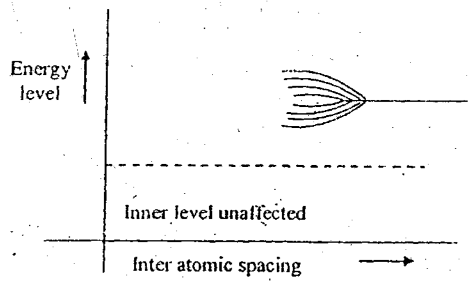
h = Plank's constant

n = 1 2 3 ......

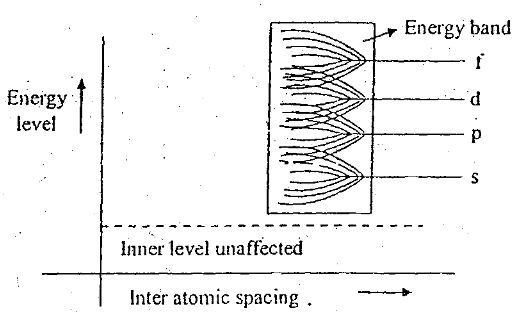
An isolated atom will have the single possible potential energy value for its electron, but during the material formation time by of neighbouring atoms will come close to each other & there will be so many potential energy values causing n number of potential energy levels as shown

• an electron can reside at a energy level at which the centripetal force is balanced by centrifugal force.





In the same manner, s, p, d, f, potential energies of an e^{-n} of an atom can have so many possible potential energy levels by n number of atoms influence i.e as shown



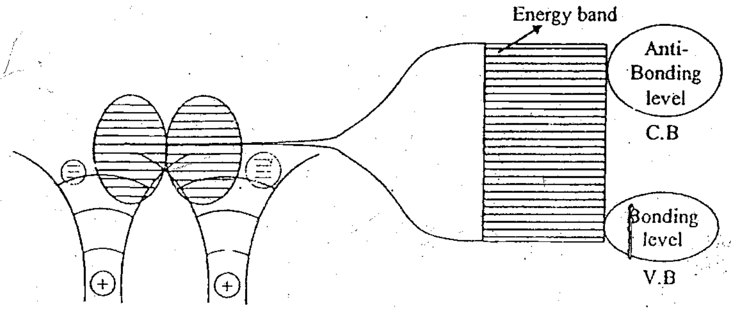
During the material formation time when n number of atoms are coming close to each other there is a possibility of 2 e^{-n} with the same potential energy values with s, p, d, f because of which there will be formation of bonding and anti bonding energy levels with the hybridization of orbital's.

e.g;- s–s hybridization, s–p hybridization etc

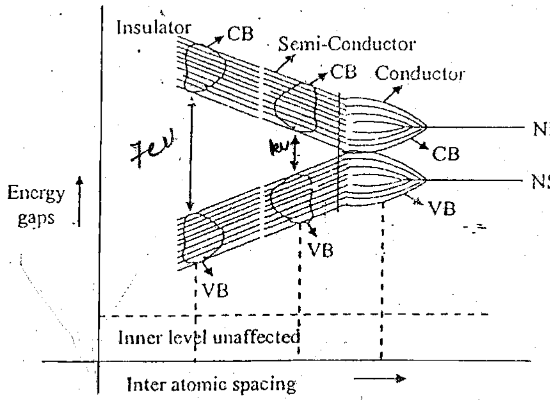
Note : - Here Pauli's exclusion principle plays important role to get bonding and anti bonding levels.

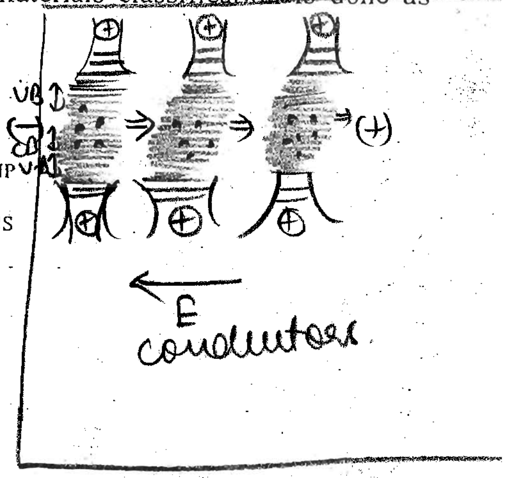
Bonding levels group is known as valence band (valence e^{-n} are available)

Anti bonding level group is also known as conduction band (free e^{-n} availability will be there during conduction).

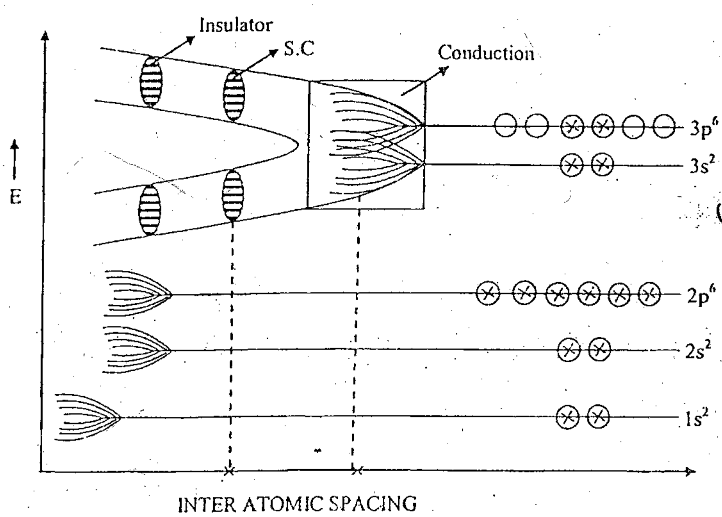


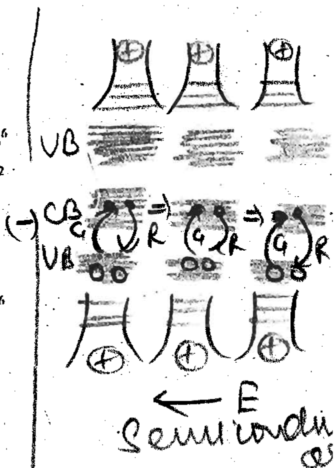
The distance b/w the atoms is responsible for considerable un-allowed potential energy region (forbidden energy gap) depending on which materials classification is done as shown





HYPOTHESIS OF VARIATION OF ENERGY LEVELS WITH INTER ATOMIC SPACING



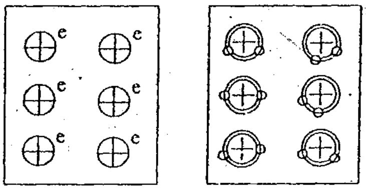


Note:-

The classification based on orbital hybridization is treated as linear combination of atomic orbital's (LCAO)

Semi classical physics Funda

- Insulator is not having the free electrons availability because there is no unpaired electrons (all electrons are paired).
- Conductor consists of their atoms in the form of +ve ions and free e^{-n} because outer level electrons are unpaired.
- In the absence of external electric field, these electrons will move randomly and the net current will be zero.
- Potential is the magnitude of charge.
- Positive charge is taken as the reference charge to define the potential and the current direction.
- When two points are maintained, difference in the potential can be treated as potential difference or voltage present between those two points.
- At constant temperature current is directly proportional to the potential difference and we get V = IR, a relation known as Ohm's law.



Conductor   Insulator

- Potential is the magnitude of charge (+ve is Reference)
- If two points are maintaining difference in their charge levels i.e known as potential difference or voltage
- P.d is a reason and the result of this is current
- I is proportional to v or

$$I \alpha V$$

$$V = IR$$

R is known as resistance of the material

RESISTANCE

While e^{-n} are moving inside the conductor these will make collision with +ve ions so that the free flow of charge is opposed known as resistance.

LAWS OF RESISTANCE

1. $R \propto L$
2. $R \propto \frac{1}{A}$
3. $R \propto \frac{l}{A} \Rightarrow R=\rho\frac{l}{A}$

ρ is known as specific resistance or resistivity $\rho=\frac{RA}{l}$

When length and area of cross section is taken as unity then $\rho=R$. i.e specific resistance or resistivity is the resistance per unit length and unit area of cross section.

4. Conductance $G=\frac{1}{R}$

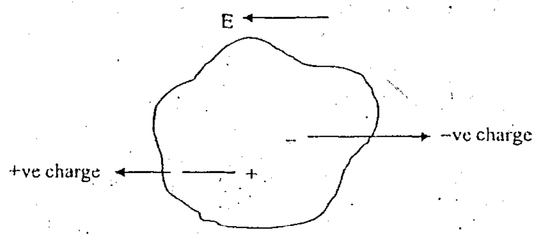
Conductivity $\sigma=\frac{1}{\rho}$

SPECIFIC RESISTANCE OR RESISTIVITY :-

- It is the resistance for unit length and unit area of cross section.
- Potential differential is not constant in series connection.
- Voltage is same in parallel connection.
- Direction of electric field will be from +ve plate to −ve plate in the external circuit.
- −ve charged particle experiences the force opposite to the direction of electric field.
- +ve charged particle experiences the force in the same direction of the electric field.
- The force experienced in the electric field $F = E \times q$, where E is strength of electric field and q is charge of particle.
- The rate of flow of charge is current $I = \frac{q}{t}$

ELECTRO MOTIVE FORCE (EMF)

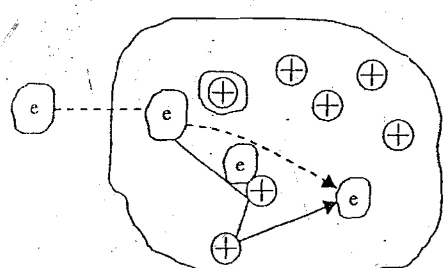
1. It is the amt of work done to move the e^{-n} in the electric circuits
2. Under the influence of electric field charged particle will experience the force i.e $F = Eq$
3. −ve charged particle experiences the force in the opp direction of electric field
4. +ve charged particle experiences the force in the same direction of electric field



5. Through any cross sectional area if Q amt of charge is passing in t seconds of time then the amt of charge passing per 1 sec i.e the rate of flow of charge is known as current i.e. $I = \frac{Q}{t}$

Q. What is meant by drifting and also define the terms
(i) Drift velocity
(ii) Mobility
(iii) Relaxation time (collision time)
(iv) Mean free path

Q.



1. While e^{-n} is moving inside the conductor because of the collusions it maintains different velocities. Just before collision the velocity is V_{max} and just after the collision it is V_{min} and the drift velocity is defined as average of these two velocity i.e. $V_{drft} = \frac{V_{max} + V_{min}}{2}$
2. $V_d \propto E$