Chapter - 6

Semi - Conductor Physics

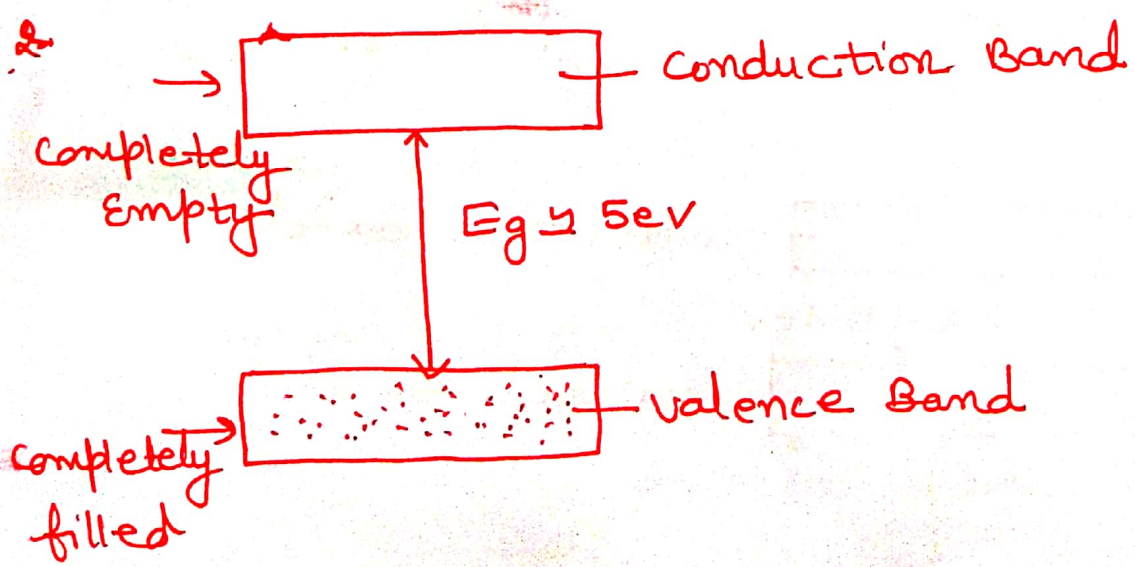
Ques 1 Give classification of materials on the basis of Energy Band structure.

Ans Materials are divided into three categories on the basis of Band theory :-

1. Insulators
2. Conductors
3. Semi - Conductors

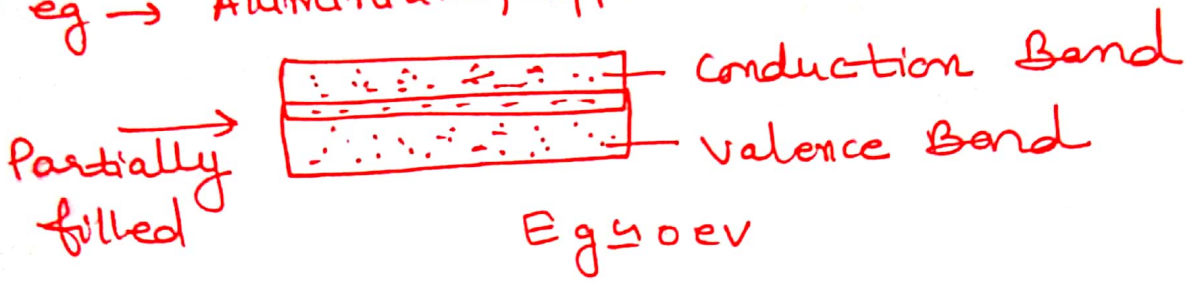
1. **Insulators** :- The material whose valence band is completly filled and conduction band is completly empty are called Insulators. for eg → Diamond, wood etc. The energy band between two band is of the order of 5ev or more.

2.

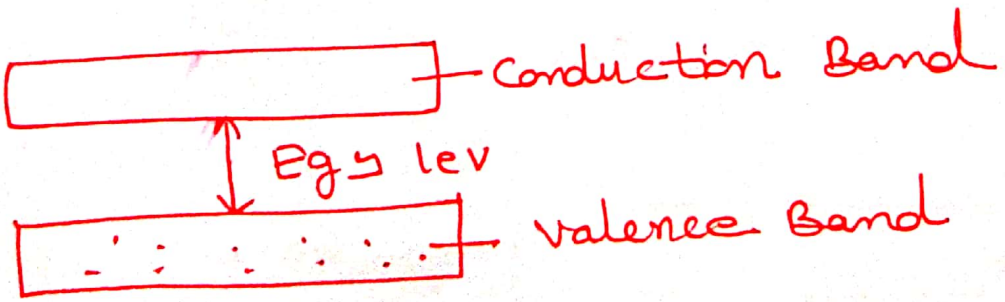


2. Conductors :- Conductors are the materials having large no. of free electrons. A conductors having partially filled valence Band and partially filled conduction Band. The forbidden energy gap for conductors is $E_g \simeq 0$ ev

For eg → Aluminium, copper etc



3. Semiconductors :- Those materials having empty conduction band at 0°c and partially filled valence band. The semi-Conductors behaves like insulator at zero degree centigrade. The Eg for Si is 1.1ev and Ge it is 0.7ev.



Ques Give difference between Intrinsic S.C and Extrinsic S.C

Ans

Intrinsic S.C	Extrinsic S.C
1. The pure form of S.C is called Intrinsic S.C	1. when impurity atoms are added to the pure form of S.C, called Extrinsic S.C.
2. No impurity atoms are added.	2. Impurity atoms are added called doping.
3. No. of electrons and no. of holes are equal.	3. No. of electrons and no. of holes are not equal.
4. Conductivity only depend upon temperature.	4. Conductivity will depend on temperature as well as on impurity atoms.
5. Its electrical conductivity is very low.	5. Its electrical Conductivity is high
Eg → Si, Ge	6. Eg → Si, Ge along with impurity atoms like B, Al, P, Bi, As etc

Ques:- Give difference b/w P type and N type S.C.

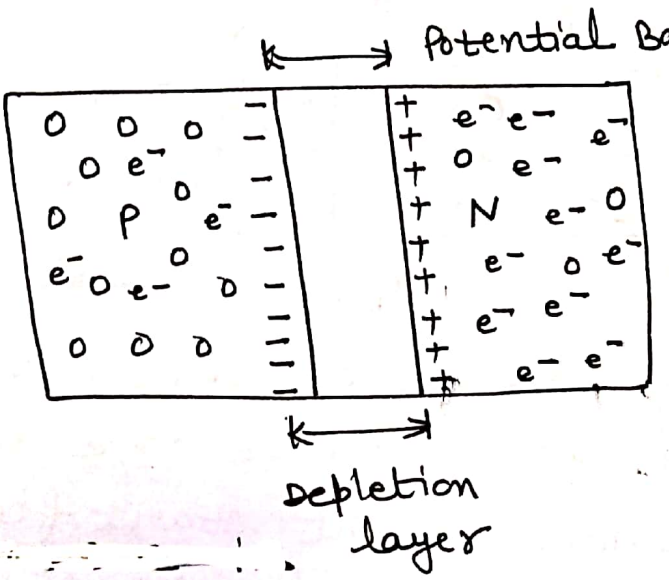
Ans:- Extrinsic S.C is of two type

P-type semi-conductor	N-type semi-conductor
(1) It is an extrinsic S.C obtain by trivalent impurities.	(1) It is an extrinsic S.C obtain by pentavalent impurities.
(2) Eg. of trivalent impurities → Boron, Aluminium	(2) Eg. of pentavalent impurities → Arsenic, Phosphorus, Bismuth etc
(3) No. of holes are more as compare to no. of electrons.	(3) No. of electons are more as compare to no. of holes.
(4) Hole density is more.	(4) Electon density is more.
(5) Holes are majority carriers.	(5) Electons are the majority carriers.
(6) Impurity atoms add extra holes in structure called acceptor atoms.	(6) Impurity atoms add extra electoons in structure called donor atoms.

Ques :- Explain PN Junction Diode.

Ans :- When a p-type semi-conductor is atomically joined with a n-type semi-conductor, it is called P-N Junction diode.

Symbol for PN Junction Diode

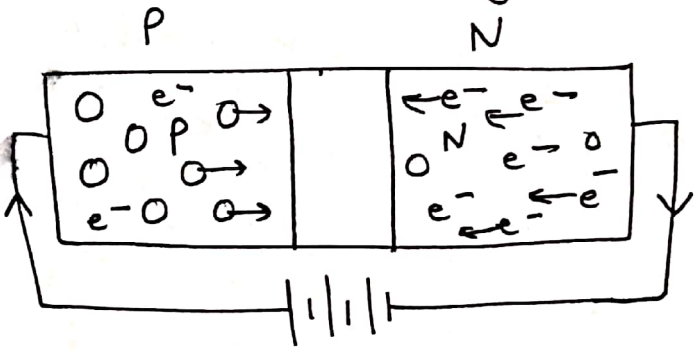


When a p type S.C is atomically joined with a n type S.C, a depletion layer is formed. Depletion layer is that layer having no charge carriers inside the layer. This layer is formed by diffusion of electoons from N-type S.C to P-type S.C and diffusion of holes from P-type to N type S.C. The width of the layer is 10^{-6}m.

Barrier Potential :- The potential barrier in pn junction is the barrier which does not allow charge flow across the junction. Barrier pot^{n} for Si is 0.7v and for Ge is 0.3V.

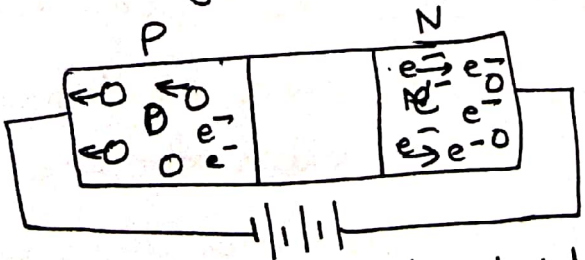
Ques :- Explain Biasing of PN Junction

Ans :- **Forward Biasing** :- A PN junction diode is said to be forward biased if the positive terminal of battery is connected to P-type and negative terminal is connected to the N-type of diode.



The majority charge carriers move towards depletion layer and reduce the thickness of layer and large current start flowing through the layer, called **forward current**.

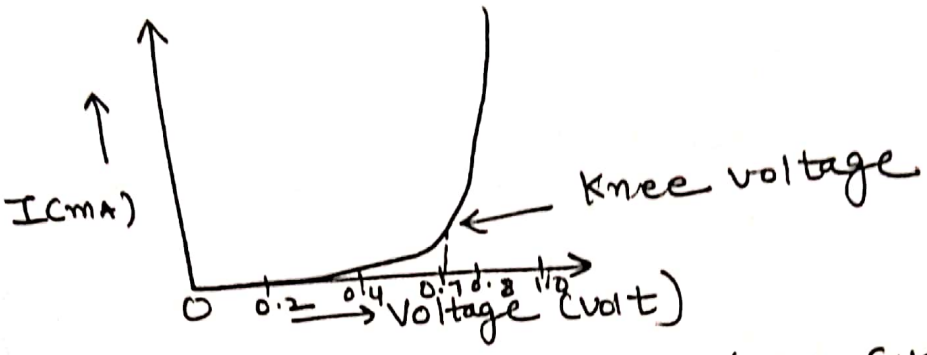
Reverse Biasing :- A PN junction diode is said to be reverse bias if the +ve terminal is connected with N-type and -ve terminal is connected with P-type of diode.



In reverse biasing width of depletion layer increased. In reverse biasing current flow due to minority carriers called **reverse current** or leakage current

Ques:- Explain V-I characteristics of a PN diode.

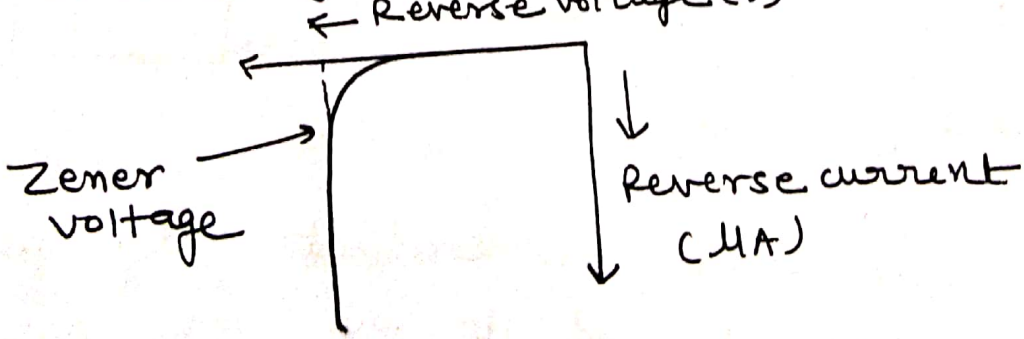
Ans:- (i) Forward characteristics :- Forward characteristics given graphical representation of forward voltage and forward current given to the diode.



The voltage at which current rises suddenly in the circuit, when it is forward biased, called Knee voltage.

Knee voltage for Si = 0.7V
Knee voltage for Ge = 0.3V

(ii) Reverse characteristics :- Reverse characteristics give graphical representation of reverse voltage and reverse current given to the diode.



Zener voltage :- The voltage at which current increase suddenly when it is reverse biased is called zener voltage.

Ques :- What do you mean by rectifier?

Ans :- Rectifier :- The device which converts a.c to d.c called rectifier.

Rectification :- The process of converting a.c to d.c is called rectification.

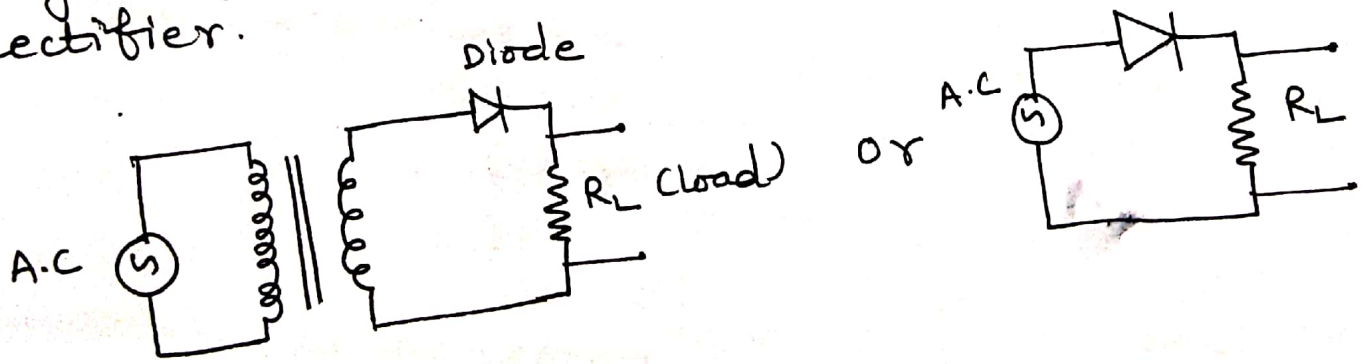
A diode is used for the process of converting a.c to d.c.

Types of Rectifier

1. Half Wave Rectifier
2. Full Wave Rectifier (Central tap rectifier)

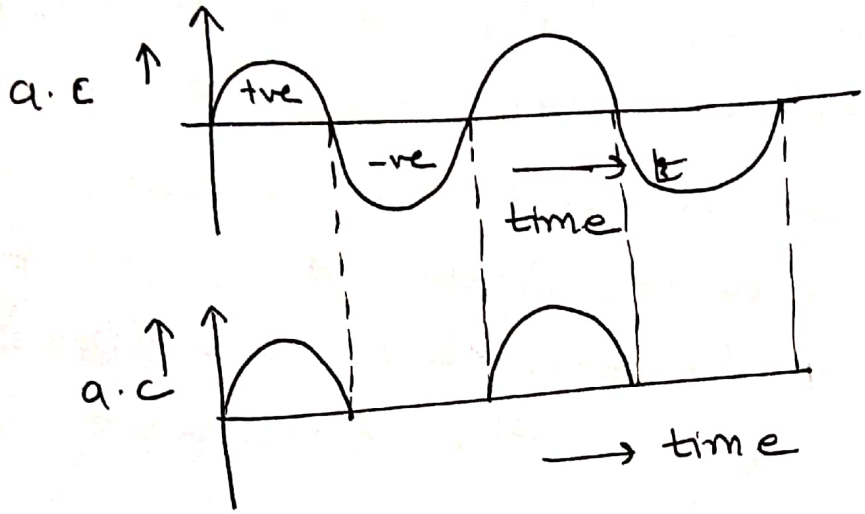
Ques :- Explain the working of Half wave rectifier.

Ans :- Half wave rectifier :- Half wave rectifier is used to convert a.c to d.c. A Half wave rectifier consist only single diode. It rectify only half wave, that's why it is called half wave rectifier.



Principle :- A diode can conduct only when it is forward biased and it will not conduct when it is reversed bias.

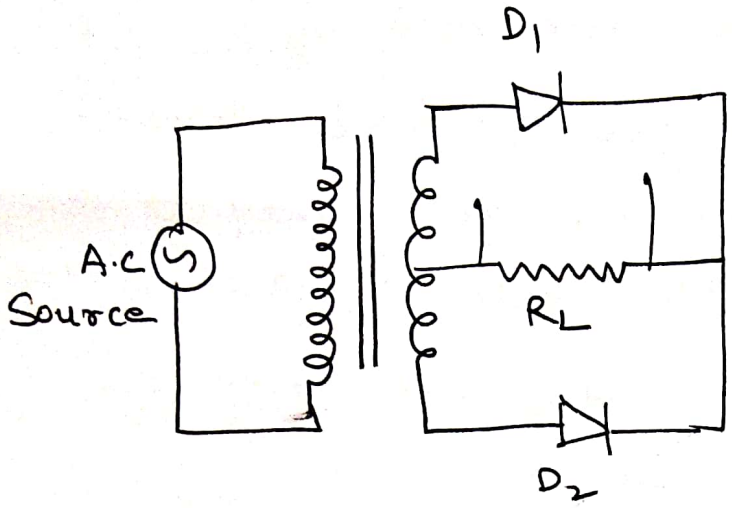
Working :- During the +ve half cycle of a.c voltage, diode get forward biased and it will conduct. We will get output correspond to the +ve half cycle of a.c voltage. During -ve half cycle, diode get reverse bias and it will not conduct.



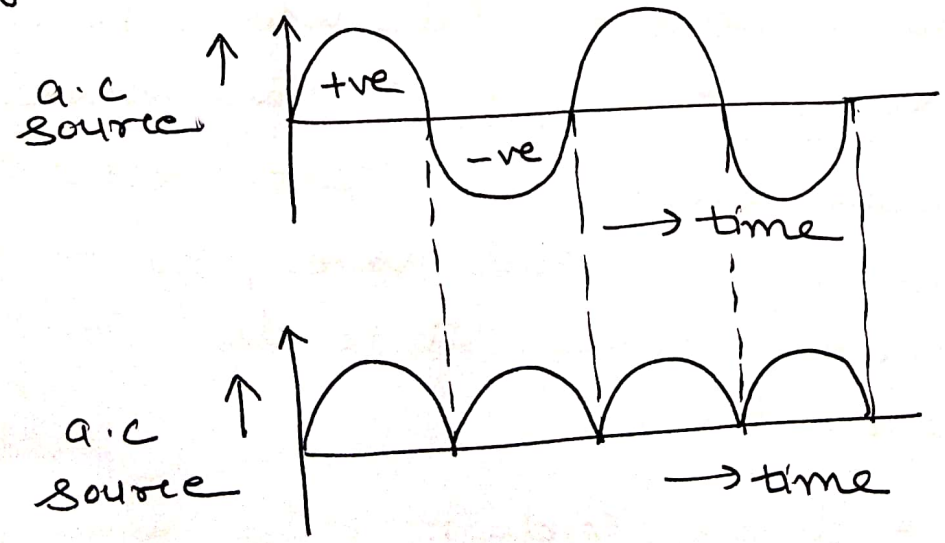
Ques:- Explain working of Full wave Rectifier.

Ans:- **Full wave rectifier :-** Full wave rectifier converts a.c to d.c. It consist two Diodes. It rectify the full wave, so it is called full wave rectifies. It is also called Centeal Tap rectifier.

Principle :- A diode conduct only when it is forward bias and will not conduct when it is reverse biased.



Working :- During +ve half cycle of a.c source diode D_1 get forward bias and diode D_2 get reverse bias. so diode D_1 will conduct. Now During -ve half cycle diode & D_1 get reverse bias and D_2 get forward bias. so diode D_2 will conduct. This is how the full wave get rectified.



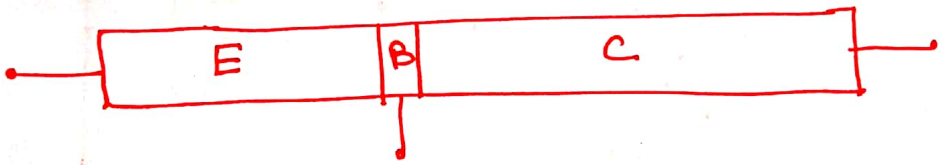
Ques:- What do you mean by Transistor ? What are the types of transistor. Give its symbol also.

Ans:- Transistor is made from Transfer + Resistor which means transfer of resistance.

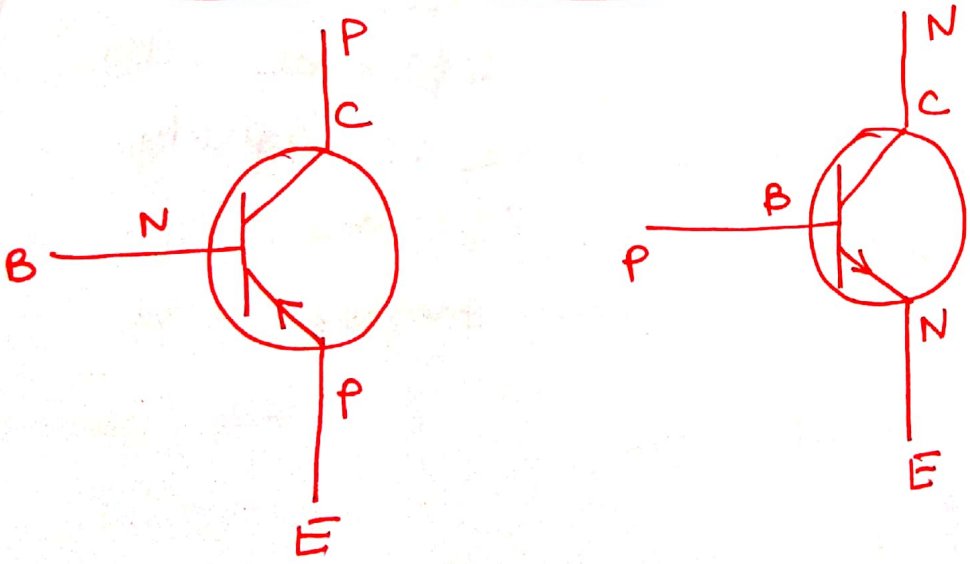
A transistor is made from joining two p-n junction diodes back to back.

A transistor consist of three regions which are Emitter, Base and collector.

The resistance of emitter is less as compare to the resistance of collector. That's why it is called transfer of resistance.



Symbols for a Transistor



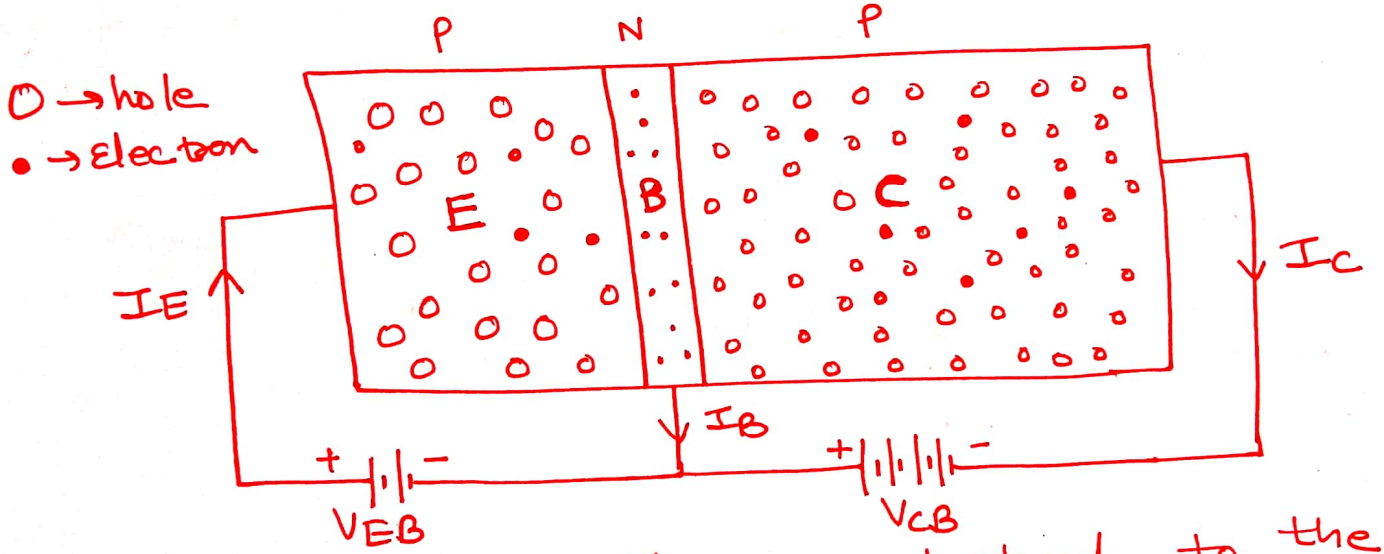
Transistor are used for the process of amplification of voltage, current and power.

* Transistor act as a amplifier.

Ques Explain working of PNP Transistor.

Ans In a PNP transistor, holes are the majority carriers.

Transistor always works in a active region. for this, the emitter base junction should be forward biased and collector-Base junction should be reverse biased.



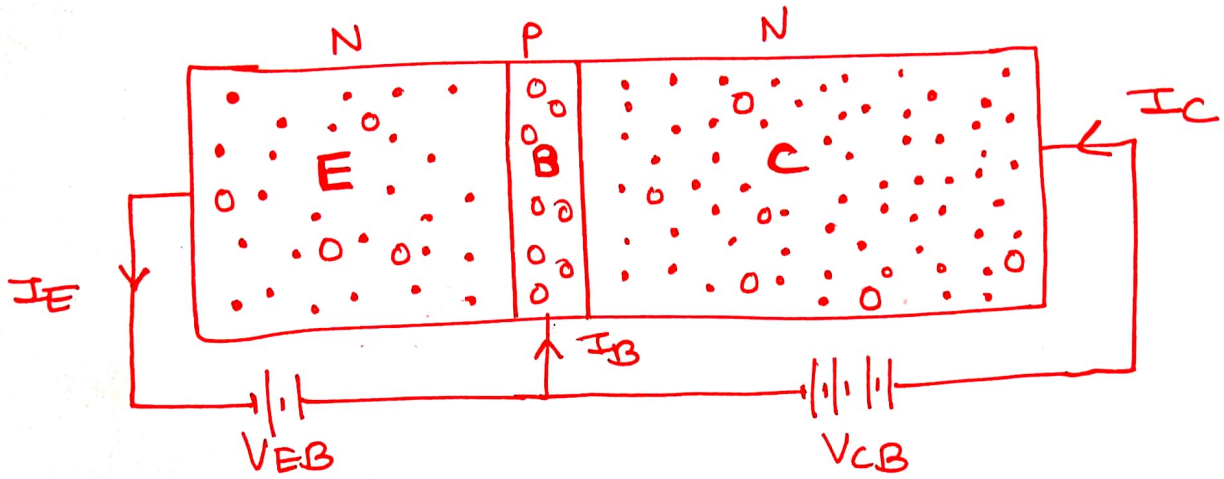
Holes from the emitter are pushed to the base region. where the holes get diffused with electoons in base region. As the base is lightly doped, only 5% diffusion occur. Rest 95% of holes are collected by collector region, and produce collector current (I_C).

$$I_E = I_C + I_B$$

Ques Explain working of NPN transistor.

Ans:- In NPN transistor, electrons are the majority carriers.

As Transistor works in a active region. So the emitter-Base junction should be forward bias and collector-Base junction should be reverse bias.



where V_{EB} → Voltage across emitter-Base junction
V_{CB} → Voltage across collector-Base junction

Now the majority carriers electrons are pushed from emitter to base region. where 5% electrons get diffused with holes. as the base region is lightly doped. Now 95% of electrons are collected by the collector region and produce collector current.

$$I_E = I_C + I_B$$