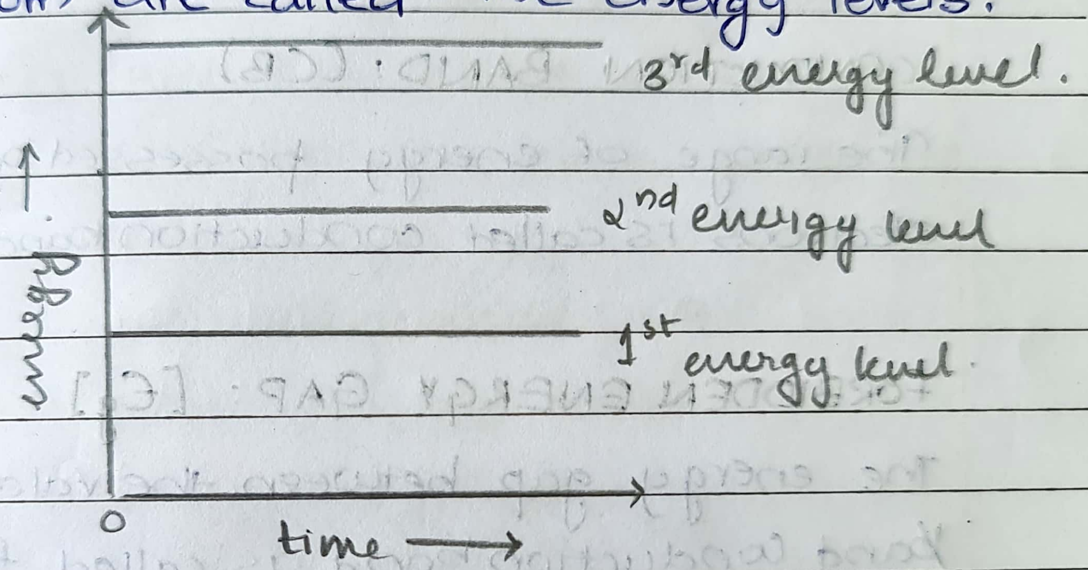
SEMI-CONDUCTORS

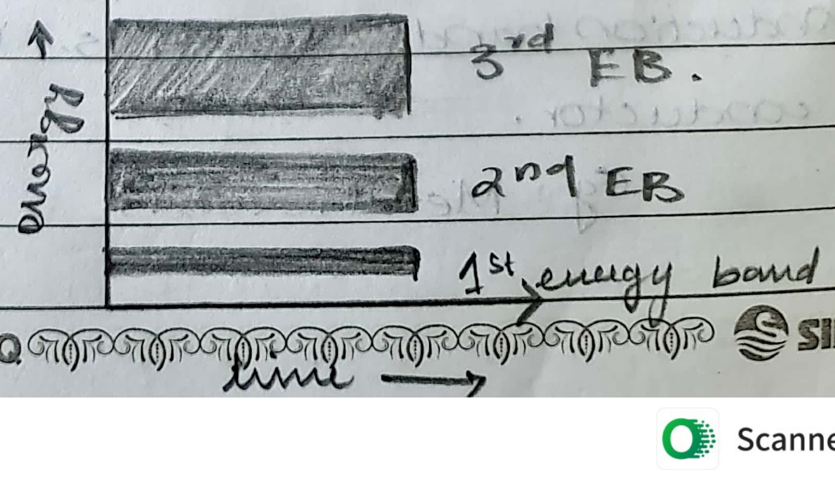
ENERGY LEVEL:

The energy possessed by the electrons in different shells of an isolated atom are called the energy levels.



ENERGY BANDS:

The range of energy possessed by electrons in different shells of an atom in a crystal are called the energy bands.



VALENCE BAND (VB):

The range of energy possessed by the the valence electrons is called the valence band.

CONDUCTION BAND: (CB)

The range of energy possessed by the free electrons is called conduction band.

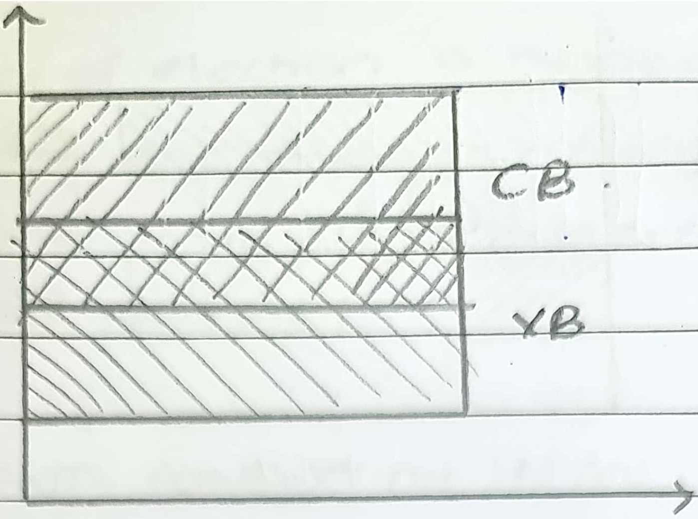
FORBIDDEN ENERGY GAP: [E_g]

The energy gap between the valence band and conduction band is called forbidden energy gap.

CLASSIFICATION OF MATERIALS ON THE BASIS OF BAND THEORY.

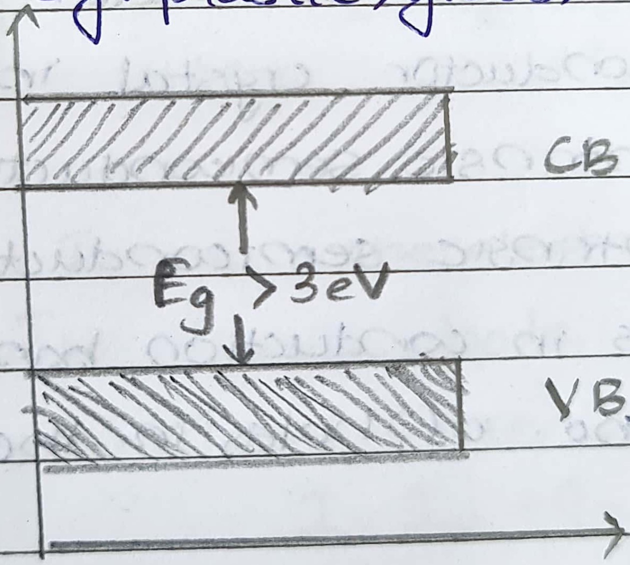
1. Conductors: If the valence band and conduction band overlapps, it is called a conductor.

   Eg: Metal.



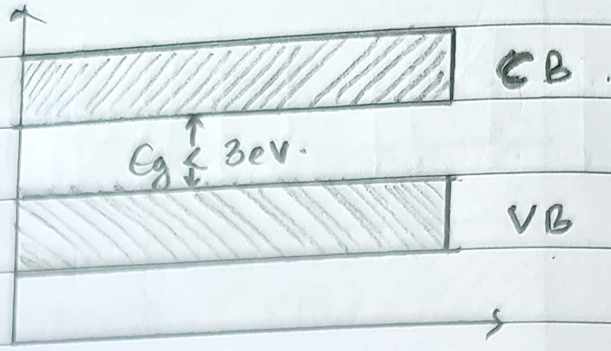
2. Insulator: If the energy gap between valence band and conduction band is greater than 3eV, it is called an insulator.

Eg: plastic, glass, rubber etc..



3. Semiconductors: If the energy gap is less than 3eV between valence band and conduction band, it is called semiconductors.

Eg: Silicon, germanium etc..



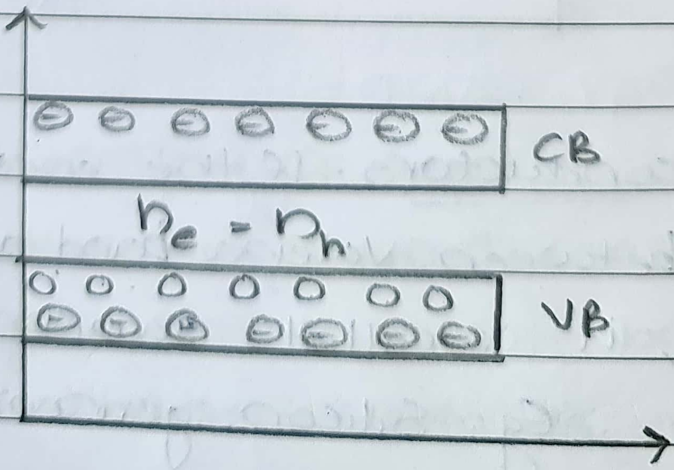
TYPES OF SEMI CONDUCTORS.

1. Intrinsic semiconductor:
2. Extrinsic semiconductors

Intrinsic semiconductor.

A semiconductor crystal in pure form is called intrinsic semiconductor.

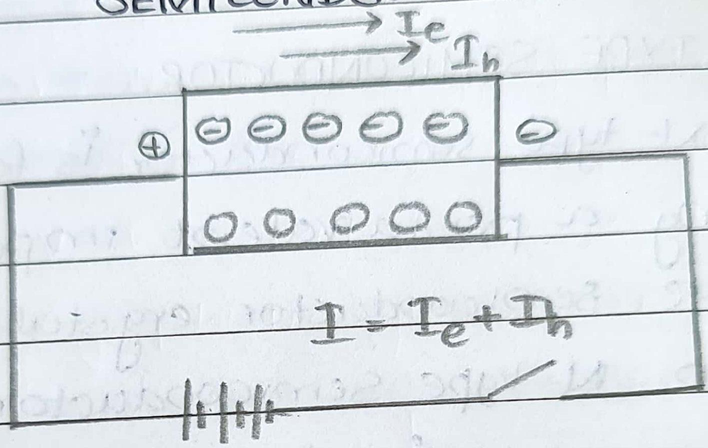
In an intrinsic semiconductor, the no. of electrons in conduction band is equal to the no. of holes in the valence band.



HOLES: When a covalent bond breaks, a vacancy of electron is created. This absence of electron is named as hole.

∵ holes are always ready to accept electrons, they are considered as +vely charged particle.

CURRENT CONDUCTION IN AN INTRINSIC SEMICONDUCTOR.



where I_e is the electron current.

and I_h is hole current.

∴ Total current

$$I = I_e + I_h.$$

Note: ∵ $n_e = n_h$

$$I_e > I_h.$$

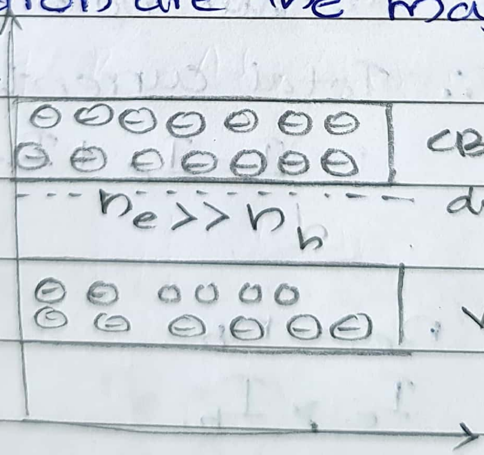
METHODS OF INCREASING THE CONDUCTIVITY OF AN INTRINSIC SEMICONDUCTOR.

1. heating:

2. Doping:-
The process of adding an impurity atom to a pure semiconductor crystal is called doping.
The semiconductor thus obtained are called Extrinsic semiconductor.

N-TYPE SEMICONDUCTOR.

An N-type semiconductor is formed by adding a pentavalent impurity atom to a pure semiconductor crystal.
In an N-type semiconductor, the no. of e^-s in conduction band is greater than the no. of holes in the valence band i.e electron are the majority charge carriers.

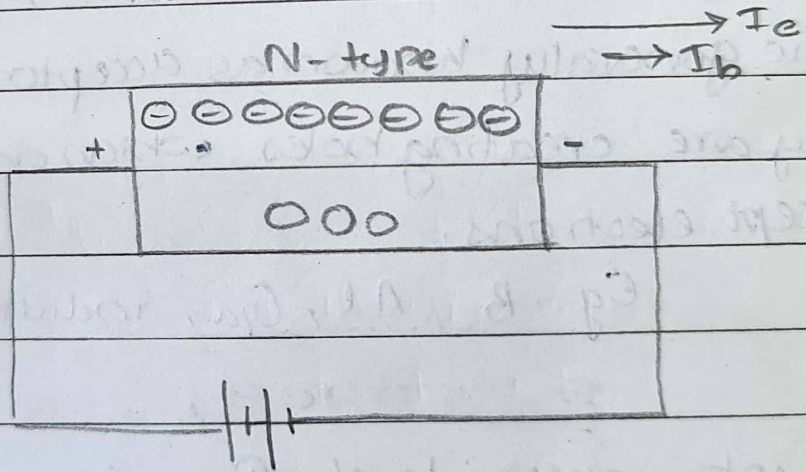


1. Donor atoms: Pentavalent impurity atoms are generally known as donor atoms as it donates free electrons to a pure semiconductor crystal.
Eg: As, Sb, Bi (15^{th} grp).

Donor energy level: The energy level of donor atoms is called donor energy level.

Note: In an N-type semiconductors, e^- are majority charge carriers, but electrically neutral.
The total no. of electrons in the CB is equal to the sum of no. positive ions and no. of holes.

CURRENT CONDUCTION THROUGH N-TYPE SEMICONDUCTOR.



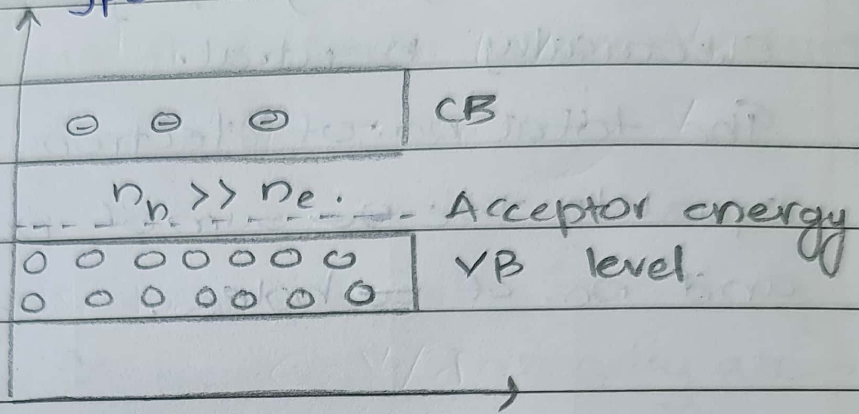
$$I = I_e + I_h$$

where $I_e \gg I_h$.

P TYPE SEMICONDUCTOR:

A P-type semiconductor is formed by adding a trivalent impurity atom to a pure semiconductor crystal.

In a P-type semiconductor, the no of holes in valence band is greater than the no. of e^- in CB.
i,e holes are majority charge carriers in a P-type semiconductor.



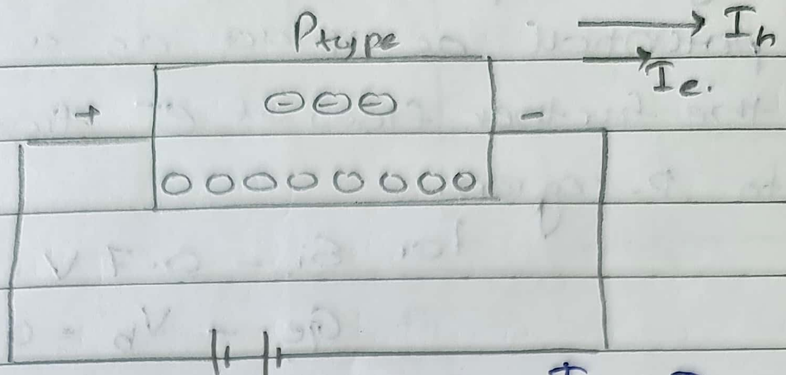
Acceptor atom: Trivalent impurity atoms are generally known as acceptor atom bcz they are creating holes which are ready to accept electrons.

Eg: B, Al, Ga, indium-In

Acceptor energy level: The energy level of acceptor atom.

Note: P-type semiconductor is electrically neutral bcz the total no. of holes in VB is equal to sum of negative ion and e^- in CB.

CURRENT CONDUCTION THROUGH P-TYPE SEMICONDUCTOR.



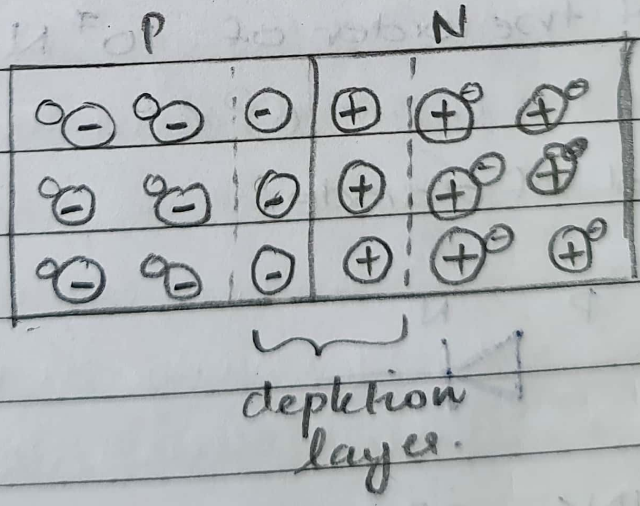
$I = I_h + I_e$

where $I_h >> I_e$.

* Note: $\boxed{n_e n_h = n_i^2}$ → no. of intrisic charges.

P-N-JUNCTION DIODE.

A diode is a combination of p-type and n-type semiconductor.



depletion layer: At the junction of a diode, there is a thin layer, which consist of +ve and -ve ions only. This layer is formed due to the flow of electrons from N to P region. That layer is called depletion la

Barrier potential: The potential offered by the depletion layer is called barrier potential as it act as a barrier for the further flow of e^- from N region to P-region.

For Si − 0.7 V = V_b

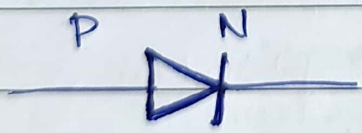
Ge − V_b = 0.3V

Note: We have

$$E = V/d$$

∵ The thickness of depletion layer is very small, there is a very strong ~~small~~ electric field across the jcn. (of the order of 10^7 N/c)

Symbol of a diode.



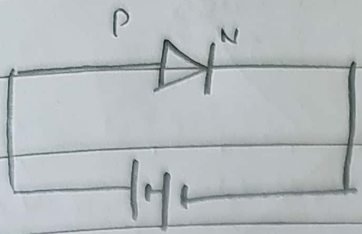
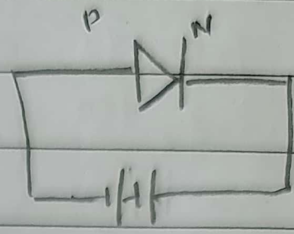
BIASING OF DIODE

Forward biasing

* A diode is said to be in forward biased if its P-site is connected to the +ve terminal and N-side

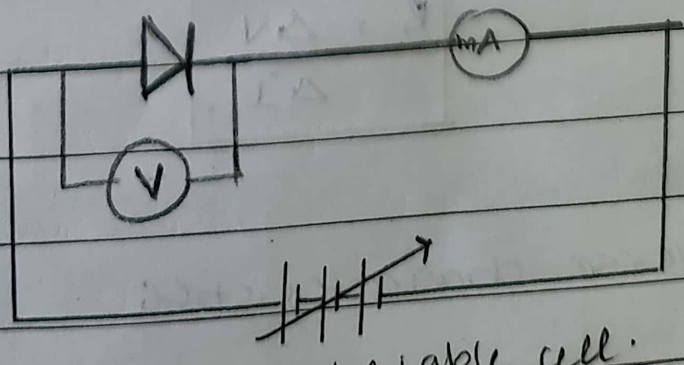
Reverse biasing

A diode is said to be reverse biased if its P site is connected to the −ve terminal and N site

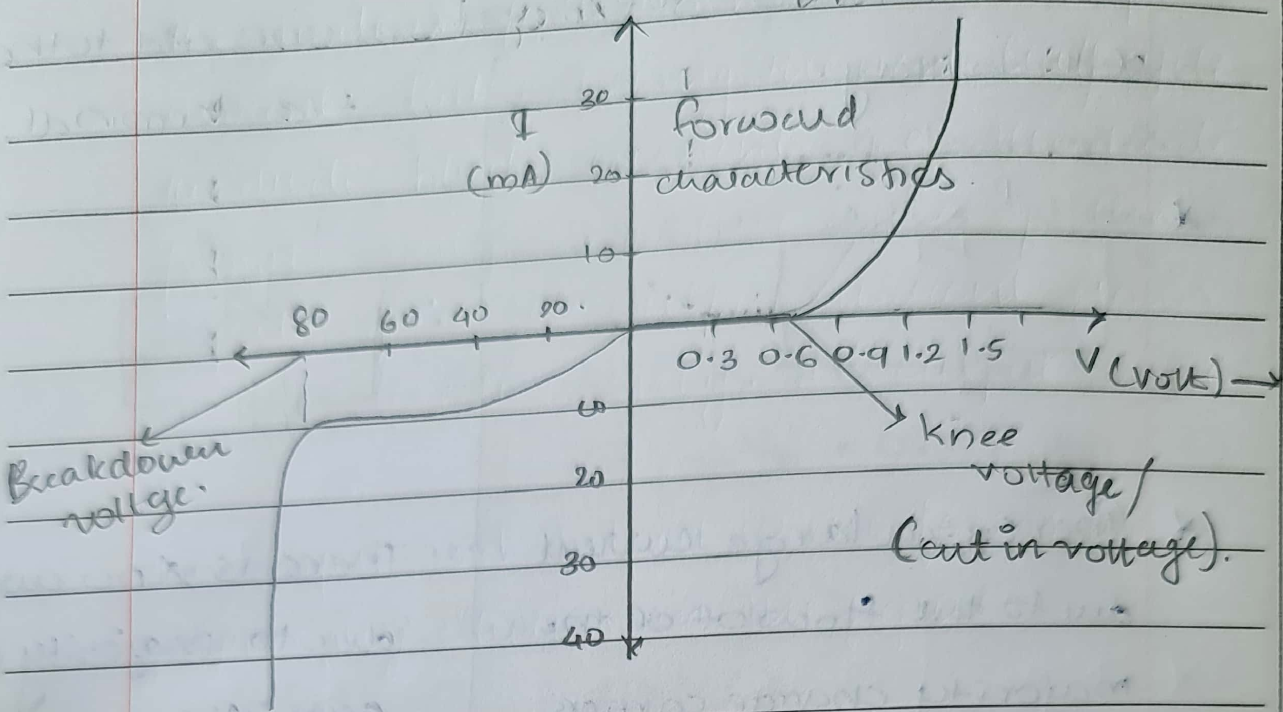
is connected to -ve terminal of the battery.	is connected to the +ve terminal.
* 	
* There is a large current due to the flow of of the majority charge carriers (mA)	There is no current due to majority charge carriers.
* There is no current due to minority charge carrier	There is a small current due to minority charge carrier (µA).
* The resistance is very low.	There is a high resistance
* The width of depletion layer decreases.	The width of depletion layer increases.

* DIODE CHARACTERISTICS.

1. Forward characteristics.



Variable cell.



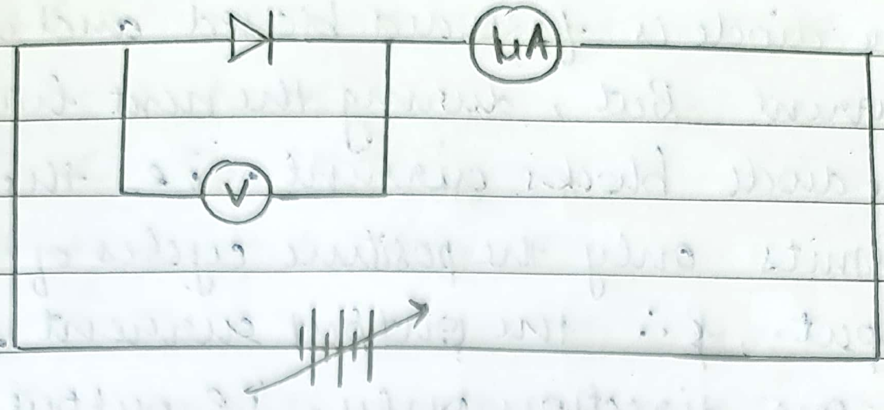
In forward biasing, the current will zero until the applied voltage reaches the barrier potential. The voltage at which the current starts increasing when a diode is forward biased is called the knee voltage.

Dynamic resistance.

It is the ratio of change in voltage to the change in current when a diode is forward biased.

$$\boxed{R = \frac{\Delta V}{\Delta I}}$$

2 Reverse characteristics

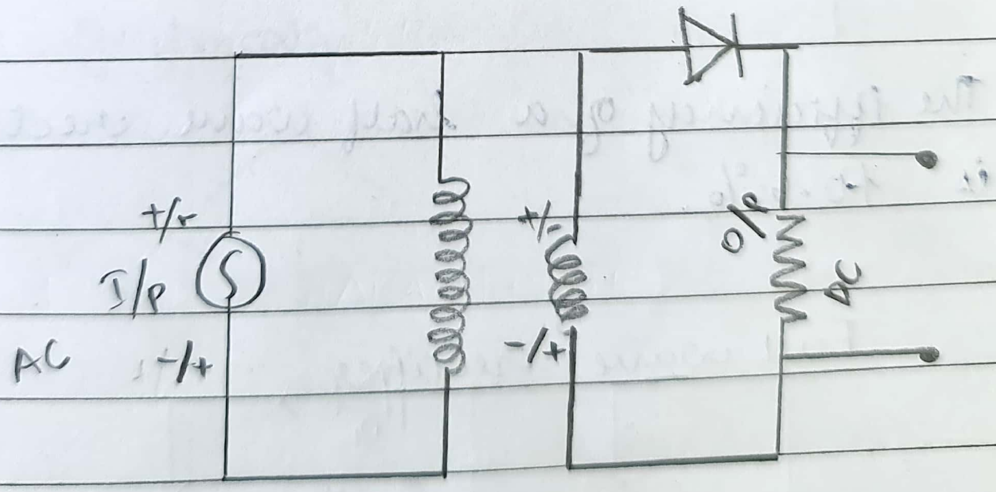


Break down voltage - reverse voltage at which the current increases rapidly and the diode get destroyed is called the break down voltage.

DIODE AS A RECTIFIER.

Rectifier is a device which converts AC to DC.

1. half wave rectifier.

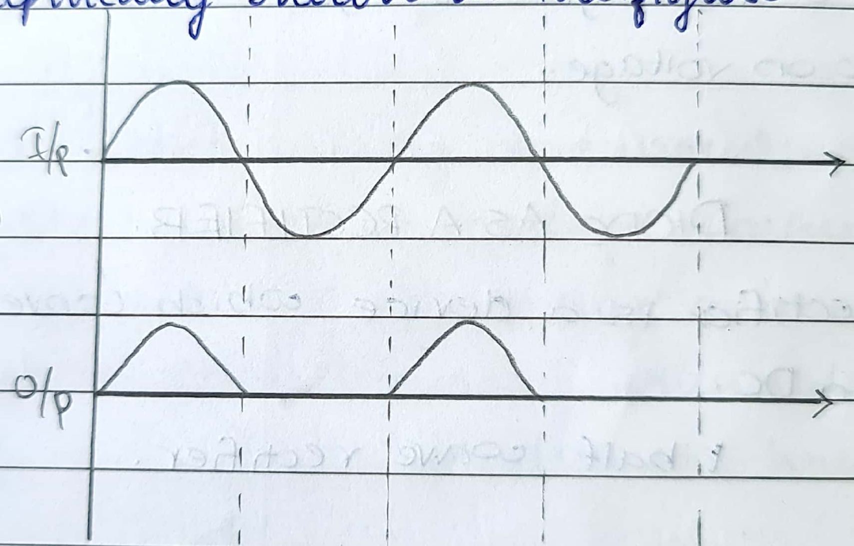


The device consist of a step down transformer and a diode.

During the first half cycle of the input AC the diode is forward biased and it permits current. But, during the next half cycle the diode blocks current. i.e the diode permits only the positive cycles of the input. & ∴ the output current flows in one direction only. i.e output is DC.

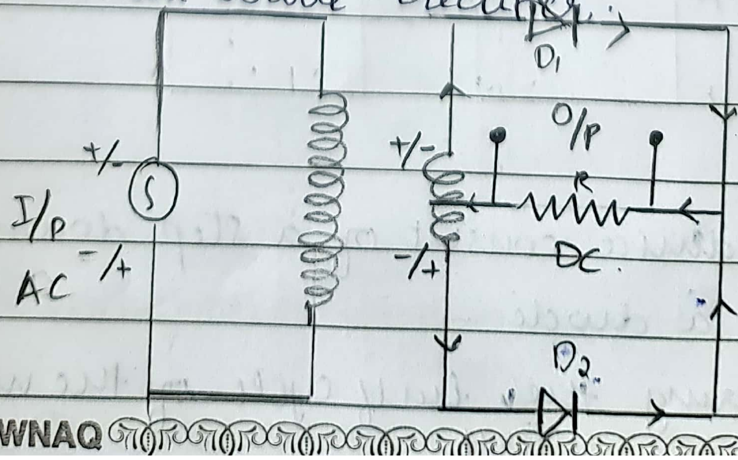
The input and output wave forms are graphically shown in the figure.

40.5 efficiency



The efficiency of a half wave rectifier is 40.5%.

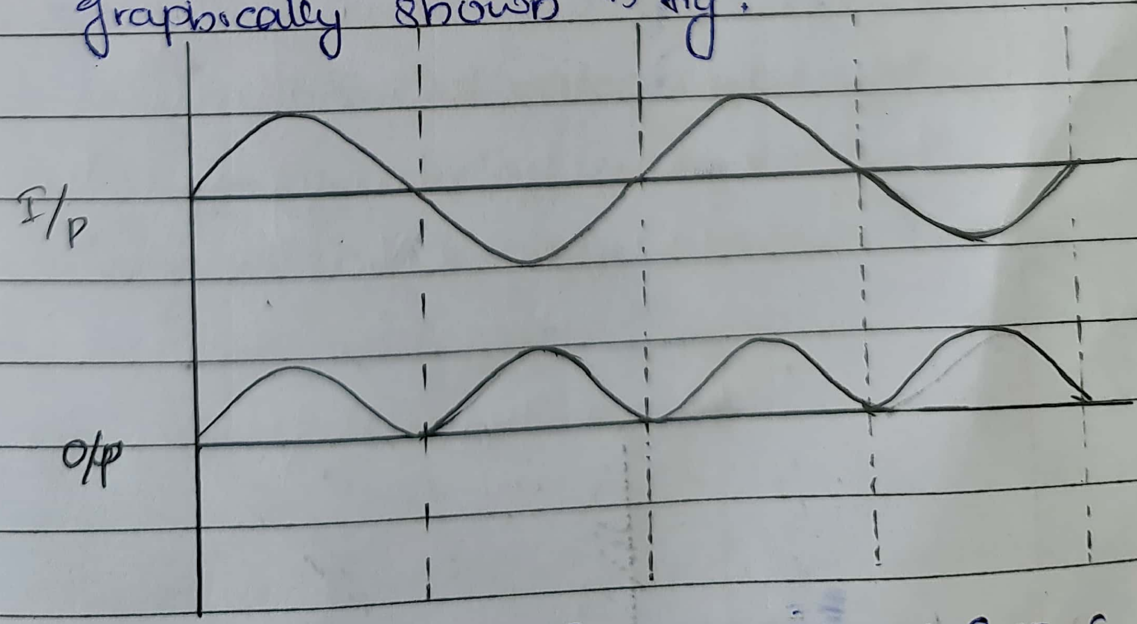
Full wave rectifier.



A full wave rectifier consist of a centre tapped transformer and two diodes D_1 & D_2. During the first half cycle of the input AC, D1 is forward biased and D_2 is reverse biased. i.e D_1 permits current and D_2 blocks current. But during the next half cycle, D_1 is reverse biased and D_2 is forward biased. i.e D_2 permits current and D_1 blocks current.

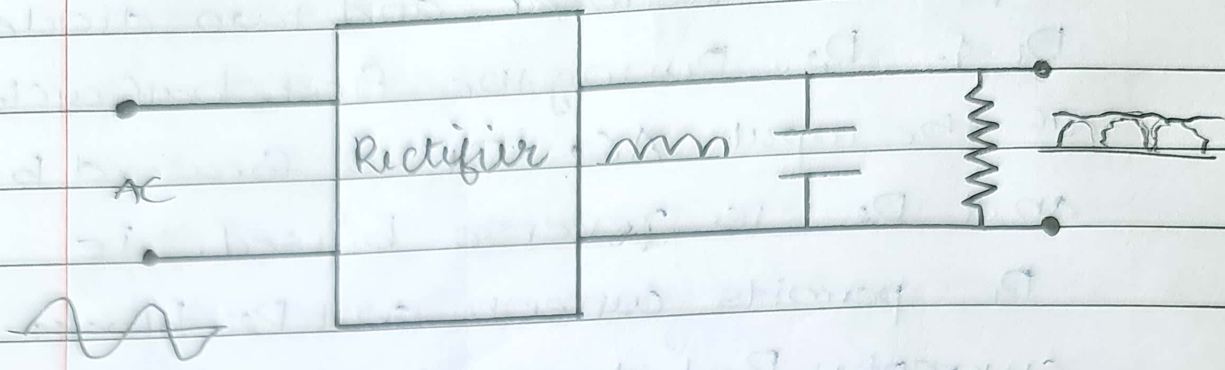
Both the half cycles of input AC, the output current through the resistor R is flowing in the same direction.
i.e Output current is DC.

The input and out put wave forms are graphically shown in fig.



The efficacy of full wave rectifier is 81%.

Capacitor filter circuit



∵ the capacitor act as a filter, the output of a circuit will be a study DC.