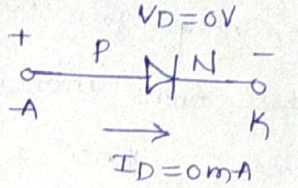
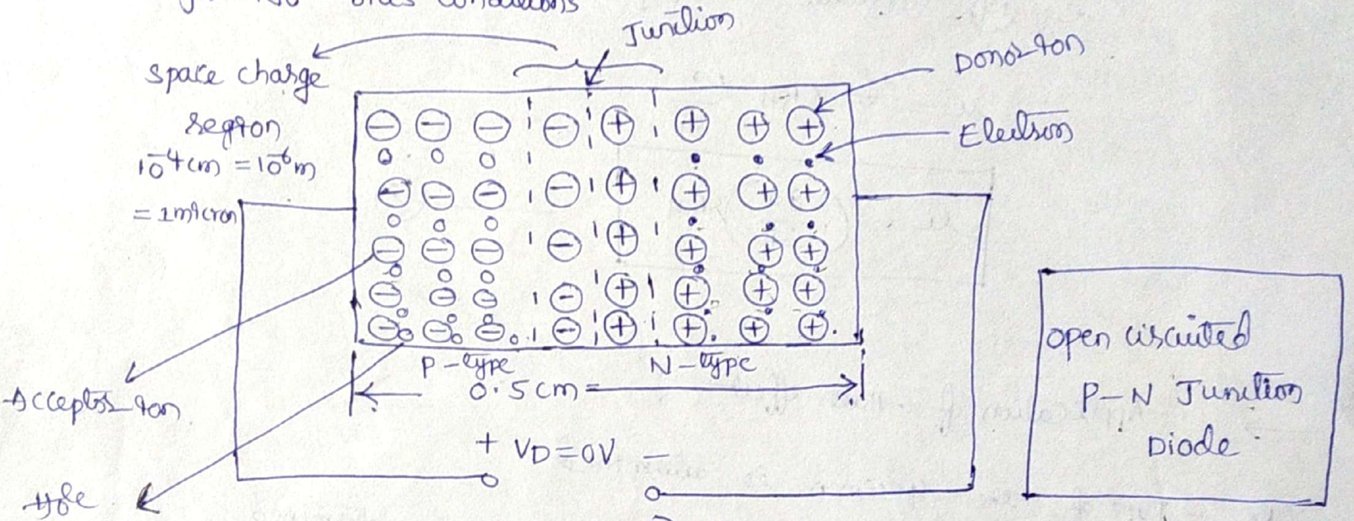
→ **P-N Junction Diode** :- → Diode is a Bipolar device because current flows due to both minority and majority carriers.

→ 

→ The symbol for a diode with associated n-and p-type regions

→ *** Note that the arrow is associated with the p-type component and the bar with the N-type region.

fig: No-bias Conditions



(No-bias)

fig: P-N Junction with no external bias.

→ For $V_D = 0V$, the current in any direction is 0mA.

→ when p-type and N-type materials are Joined electrons to recombine with hole (ions) then a potential gradient exist due to ions.

→ positive and negative ions due to donor and acceptor atoms are created, they are called immobile charges (or) uncovered charges.

→ These immobile charges create a potential called barrier potential (or) Junction potential (or) Contact potential (or) Depletion region (or) space charge region (or) off set region (or) Transition region

→ The thickness of this region is order of

$$\boxed{10^{-4}cm = 10^{-6}m = 1micron}$$

→ Depending upon the quantity of doping the Junction width will vary

→ Doping is inversely proportional to the square root of the potential width (i.e) $\boxed{\text{Doping} \propto \frac{1}{\sqrt{\text{potential width}}}}$

→ $\boxed{\text{The charge density } (\rho) \text{ depends on the amount of doping.}}$

→ In the depletion region there are no mobile charge carriers.

→ The donor ion is indicated schematically by a plus sign because, this impurity atom "donates" an electron, it becomes a +ve ion.

→ The acceptor ion is indicated by a minus sign because, after this atom "accepts" an electron, it becomes a −ve ion.

→ open circuited $V_D = 0V$, the current in any direction is zero.

→ A Diode which permits the easy flow of current in one direction but restrains the flow in the opposite direction.

(a) Forward Biasing :— where anode of the diode is connected to the positive of the supply and cathode of the diode is connected to the negative of the supply.

(b) Reverse Biasing :— where anode of the diode is connected to the negative of the supply and cathode of the diode to positive of the supply.

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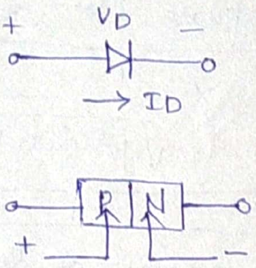
(a) Forward bias (or) Forward characteristics ($V_D > 0V$) :-



(similar)

fig: forward bias conditions for a semiconductor Diode.

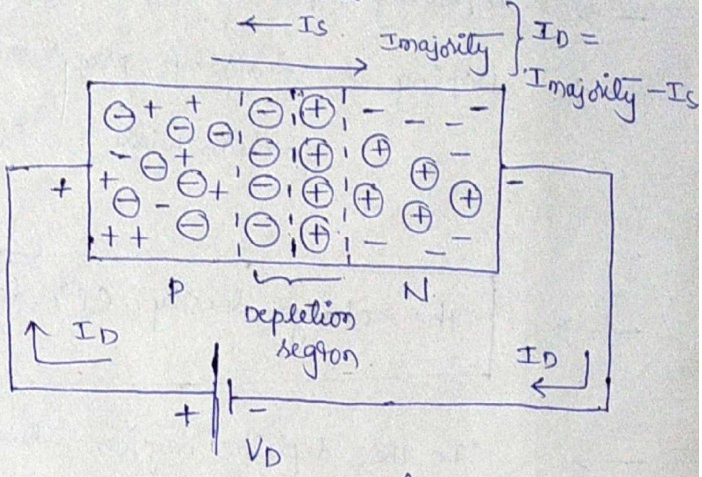


fig: Forward_biased p-n Junction.

→ where anode of the diode is connected to the positive of the supply and cathode of the diode is connected to the negative of the supply is called forward bias

→ The V_D increases the effective barrier potential starts decreasing (barrier height is reduced or depletion region decreases).

→ Therefore majority free electrons (n) and holes (p) starts crossing the Junction. then we can say conduction is taking place.

→ Initially this conduction starts slowly. A stage is reached 'V_B' then barrier voltage nearly vanishes i.e., depletion region disappears.

→ The applied voltage at which V_B disappears is called threshold voltage (or) cutin voltage (or) knee voltage (or) off set voltage

$V_\gamma = 0.7V$ for 'Si', and $V_\gamma = 0.3V$ for 'Ge'.

→ The current starts increasing for a small change of voltage is called cut-in voltage (or) firing potential

→ Forward current scale in milliamperes range.

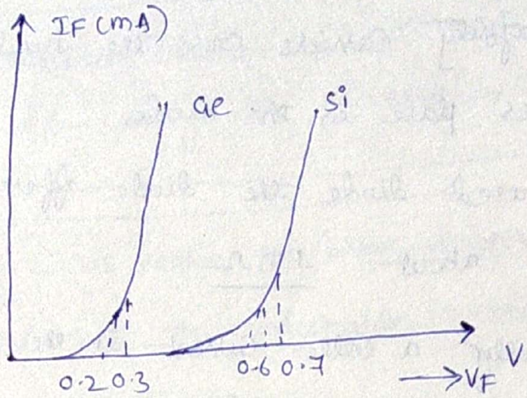


fig :- Forward bias characteristics of diode

(b). Reverse bias (or) Reverse bias characteristics :-

Is minority carriers flow

Imajority = 0.

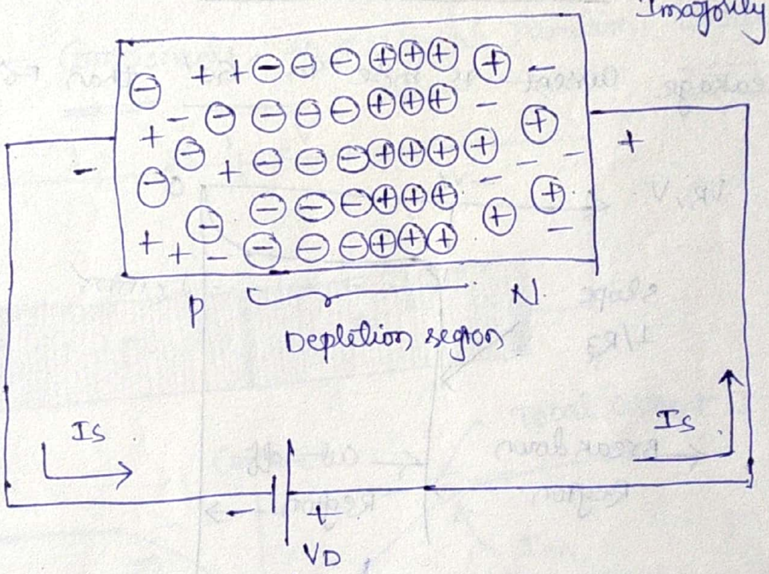


fig: Reverse biased p-n Junction

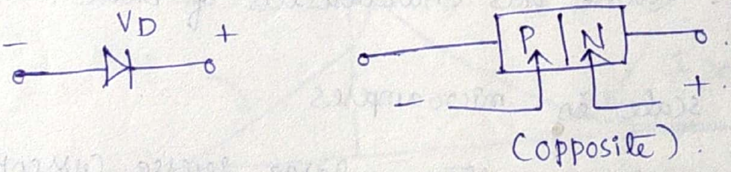


fig: Reverse bias conditions for semiconductor diode

→ If anode is connected to negative and cathode is connected to positive terminal of VD. Then it is called <u>reverse biased</u> <u>condition</u>

→ therefore no majority carriers cross the junction. Hence no conduction takes place in the diode.

→ In reverse biased diode the diode offers high resistance of about 1MΩ.

→ But practically a little current in the order of μA or nA will flow in diode due to minority carriers crossing over the junction. It is denoted as I_0. They are less in numbers. This minority current is also called leakage current (or) reverse saturation current.

→ Leakage current is more in 'Ge' than for 'Si'.

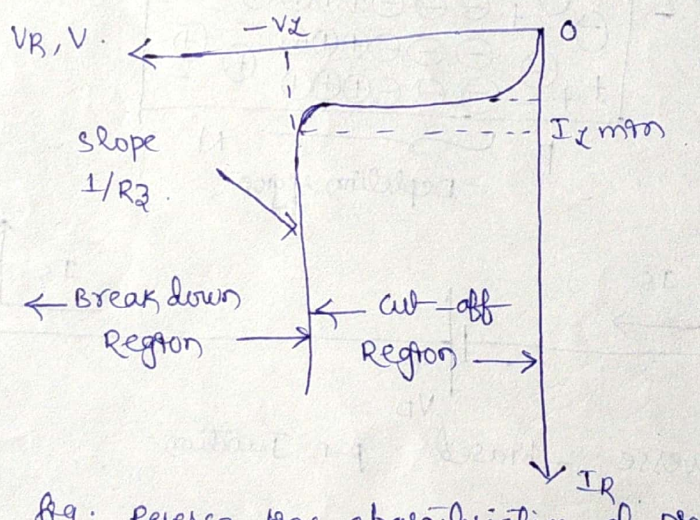


fig: Reverse bias characteristics of Diode.

→ Reverse scale in microamperes.

→ At this critical voltage a large reverse current flows, and the diode is said to be in the breakdown region.

→ If this current exceeds the maximum rating of the diode then the diode burns away or is burnt out.

→ **Diode Applications :—**

1. Rectifiers : The circuits convert AC into DC.

2. Digital Logic Gates : In these circuits, the diode function as a switch. It is ON when the diode conducts and OFF without conduction.

3. clamping network used as d.c. restorer in TV receivers and voltage multipliers.

4. clipping circuits used as wave shaping circuits used in computers, radars, radio and TV receivers.

5. Demodulation (detector) circuits.