~~Junct~~

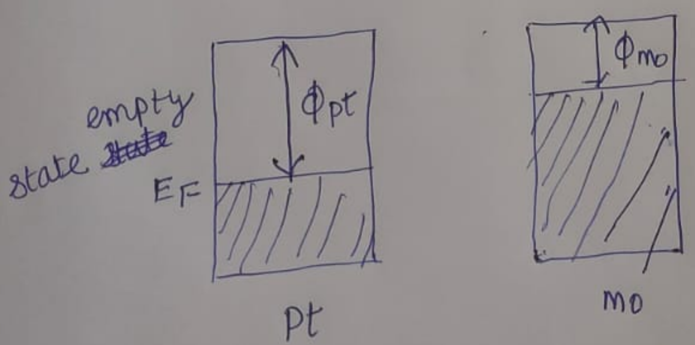
Junction's

1) Metal - Metal
2) Metal-Semiconductor (ohmic contact (or) Schotty)
3) Semi conductor-Semiconductor (PN-Junction)

1) Metal - Metal Junction's

Rule :- whenever you have Junctions formation the Fermi level will line up at thermal equilibrum (No external potential applied).

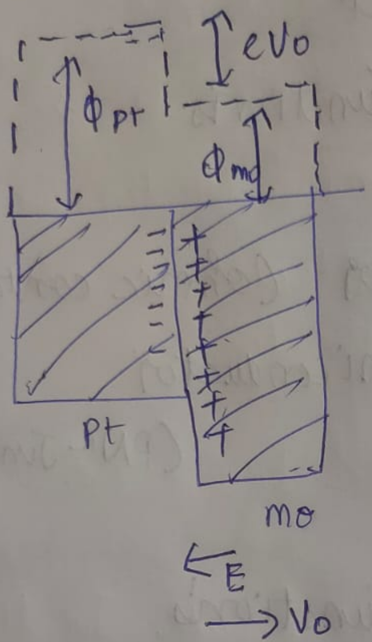
<u>Before Junction formation</u>



$\phi = 5.36\,eV$ $\qquad$ $\phi_{Mo} = 4.2\,eV$

$$\phi_{pt} > \phi_{mo}$$

net positive on mo
net negative charge on pt.
because it's gain electron's which mean's, an electric field will be setup when a Junction formed.



$eV_0 = \phi_{pt} - \phi_{mo}$

$= 5.35 - 4.2$

$= 1.16\ eV$

$V_0 = 1.16\ V.$

V_0 opposes Further motion of electron e^-

$\equiv$ Junctions equilibrum.

Application :- seeback effect.

(a) Thermo electric

ϕ_{mo}
-4.2
eV
$1.16V$.
one e^-

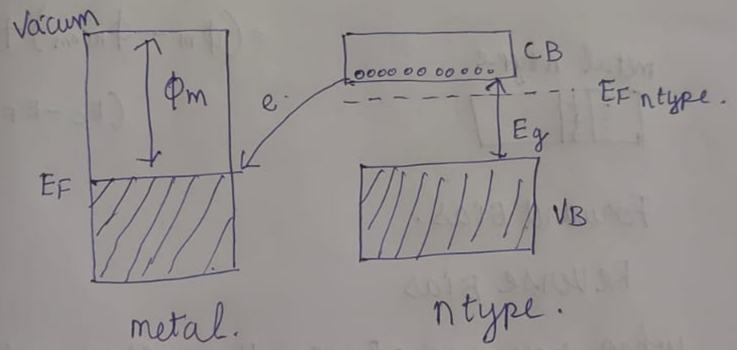
2) Metal -semi conductor :-

$\phi_m - \phi_{semi}$

condition.

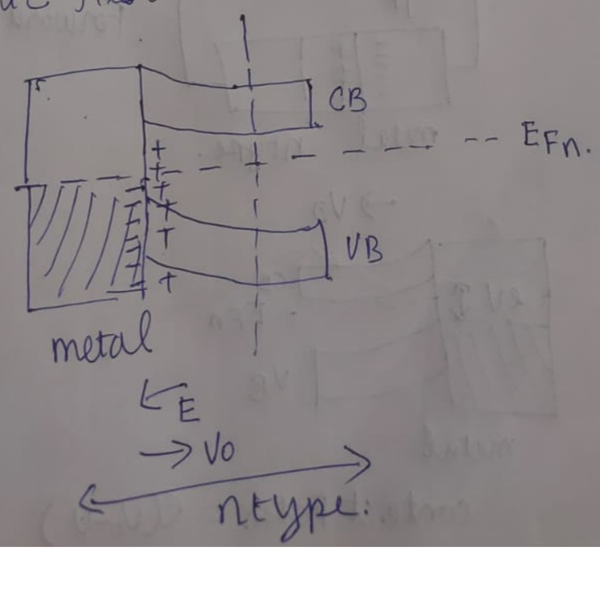
1) $\phi_m > \phi_{semi} \rightarrow$ schottky
2) $\phi_m < \phi_{semi} \rightarrow$ ohmic.

1) Schottky Junction ($\phi_m > \phi_{semi}$)

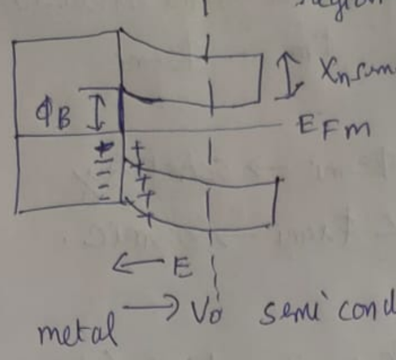


condition :-

Band Bending goes up in the direction of electric field.



$\leftrightarrow$ ~~dele~~ depletion region (space charge layer)



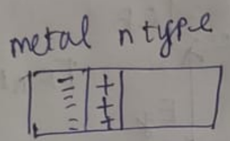
$eV_0 = \phi_m - \phi_{nsem}$

ϕ = schottky barrier

$= \phi_m - X_{nsem}$

$= \phi_m - X_{nsem}$

$= (\phi_m - \phi_{nsem}) + (E_C - E_{Fn})$

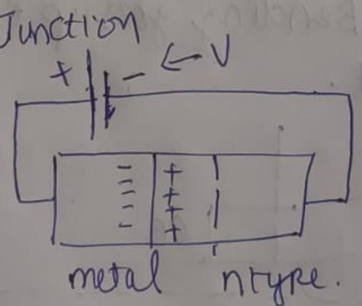


Forward Bias.

Reverse Bias

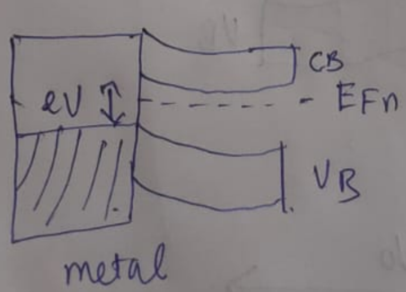
when you are Biasing the system will ~~not~~ not be in equilibrium

Schottky Junction



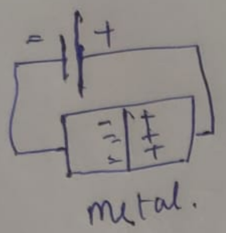
Forward Bias

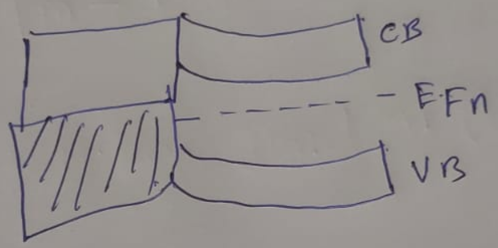
$\rightarrow V_0$

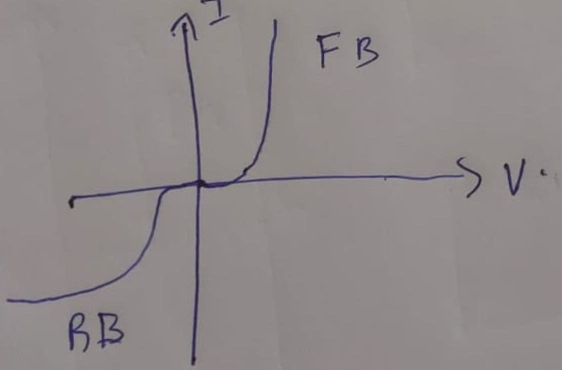


contact Poten $= e(V_0 - V)$

Reverse Bias.



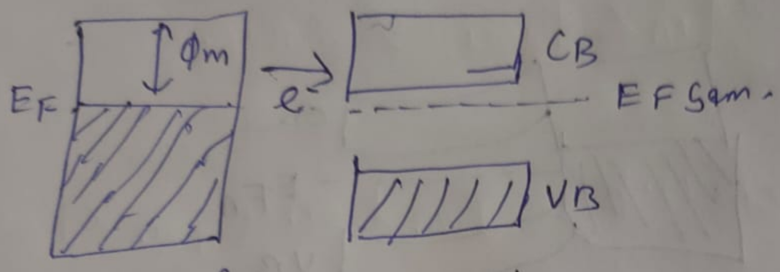




~~Ohmic~~

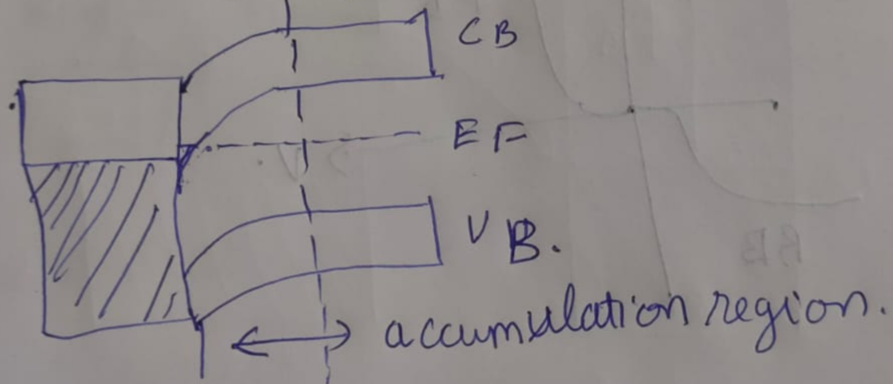
Ohmic contact.

($\Phi_m < \Phi_{semi}$)



metal semi

(Before) ~~For~~



metal semi

Ohmic Junction - Resistor

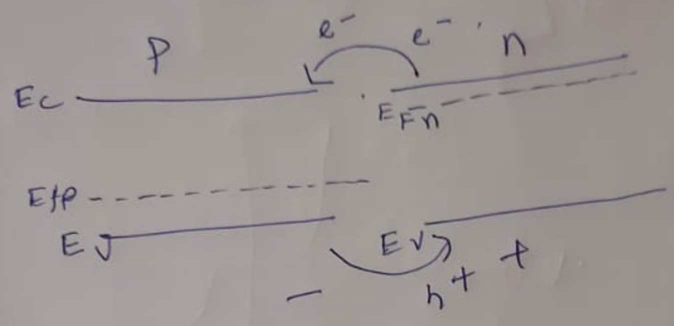
Schottky Junction - Rectifier - condu
in forward b

Pn Junction

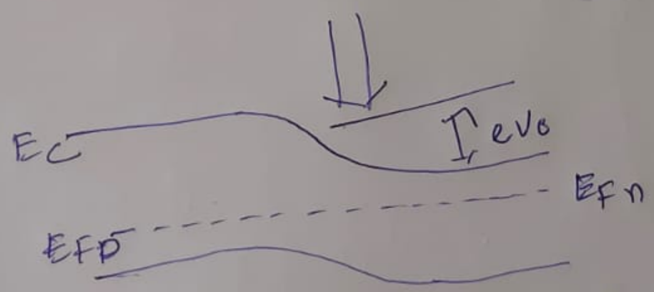
Homo Junction P & n type are from same material

Hetero Junction :- P & n type are different materials

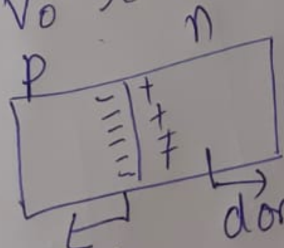
Si standard materials



Electric field.



$V_0 \rightarrow$ contact potential.



donar ions

acceptor ions.

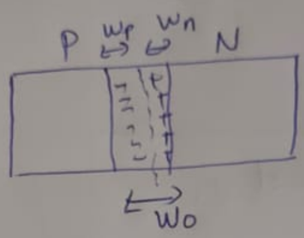
e^- from $n \rightarrow P$
h^+ from $P \rightarrow n$] depletion region.

Pn Junction

e^- from $n \to P$
h^+ from $P \to n$

$N_A \to$ acceptor conc N_A
$N_D \to$ donor conc N_D

$N_A > N_D$
P side n side



W_0 = total width of depletion region

$$W_0 = W_P + W_n$$

A = cross sectional area of Junction

Total charge on depletion region
in p-side $= N_A (AW_P)$
$\downarrow$ conc $\downarrow$ volume)

Total charge on n-side
$= N_D (AW_n)$

$$\cancel{A}W_p N_A = \cancel{A} W_n N_D$$

$$\Downarrow$$

$$W_P N_A = W_n N_D$$

$$\frac{W_P}{W_n} = \frac{N_D}{N_A}$$ The ratio of depletion region widths is inversely proportional to the conc of dopants.

if $N_A > N_D$

$W_p < W_n$

$p^+ n \rightarrow N_A >> N_D \Rightarrow W_p << W_n$

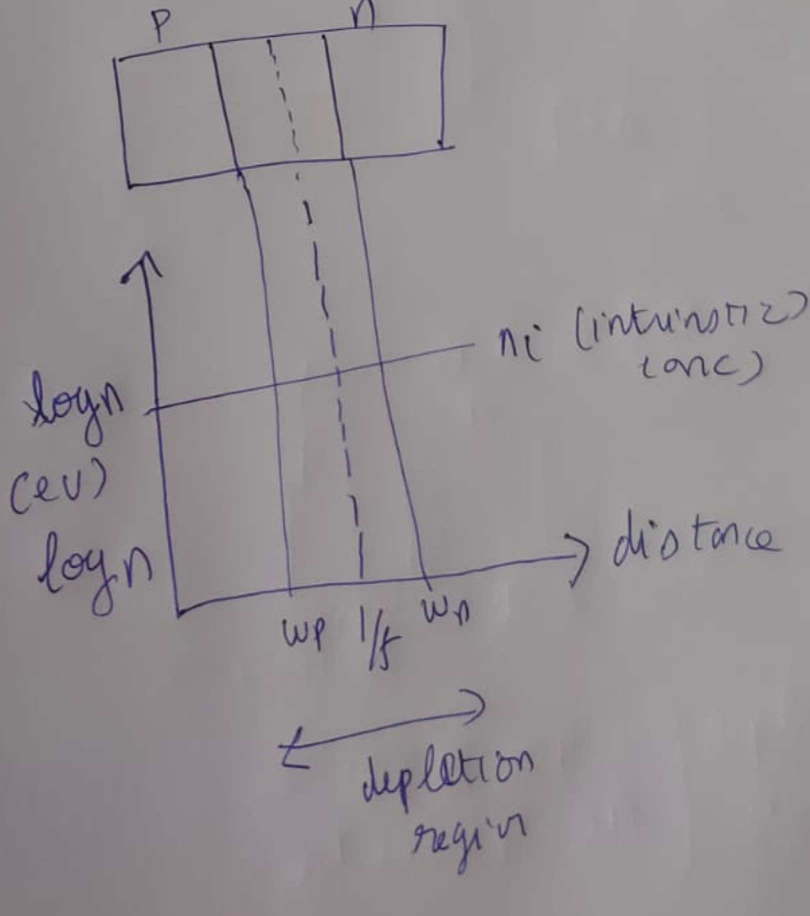
↓

heavily doped.

So depletion region almost on the n type.

Calculate the built in potential

$N_A > N_D$



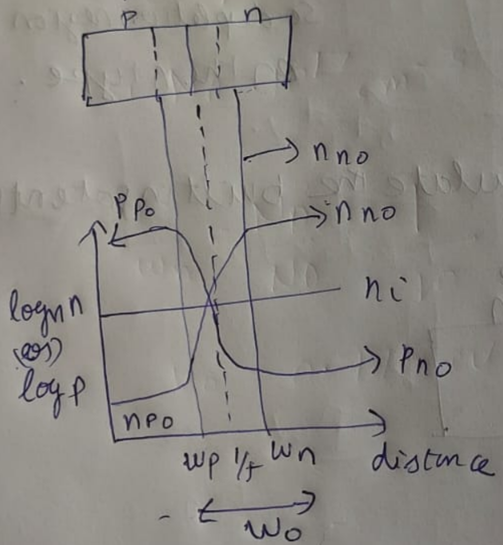
$n_{no} = N_D$

$p_{no} = \frac{n_i^2}{N_D} \ll n_{no}$

$p_{po} = N_A$

$n_{po} = \frac{n_i^2}{N_A}$

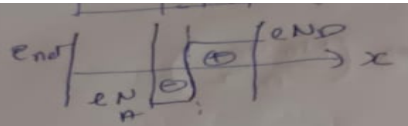
$N_A > N_D$



V_0 = built in pot t

$$\frac{n_{po}}{n_{no}} = \exp\left(-\frac{eV_0}{kT}\right)$$

$$V_0 = \frac{kT}{e} \ln\left(\frac{N_A N_D}{n_i^2}\right)$$



$$E(x) = \frac{1}{\varepsilon} \int e_{net}(x)\, dx$$

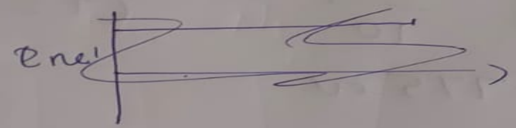
substitution

$P_{net} = -eN_A$ (P side)

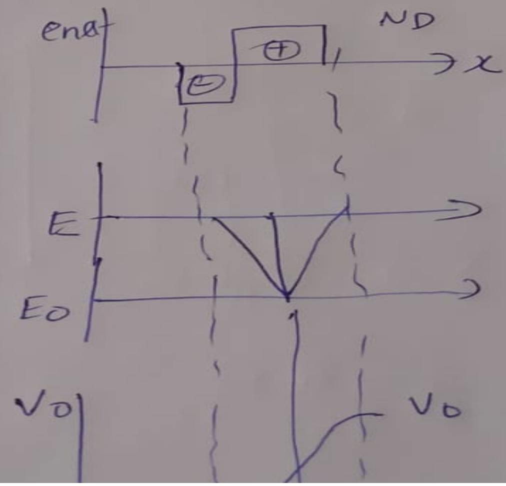
$= eN_D$ (N side)

$$E(x) = \frac{eN_d}{\varepsilon} x \quad (\text{or}) \quad -\frac{eN_A}{\varepsilon} x$$

$$E_0 = -\frac{eN_d w_n}{\varepsilon} = -\frac{eN_A w_p}{\varepsilon}$$



$$E_x = \frac{dV}{dx} = V \int E\, dx$$



~~$V_0 = W_0$~~

$$V_0 = -\frac{1}{2} E_0 W_0$$

$$= \frac{e N_A N_D W_0^2}{2 \varepsilon (N_A + \ldots}$$

$$\frac{W_P}{W_n} = \frac{N_D}{N_A}$$

$\varepsilon = \varepsilon_0 \varepsilon_r$ Si $\varepsilon_r = 11.9$

Si $N_A = 10^{17}\,cm^{-3}$ $N_D = 10$

$n_i = 10$

$$\frac{W_P}{W_n} = \frac{N_D}{N_A} = \frac{1}{10}$$ $(T =$

$V_0 = 0.775\,eV$