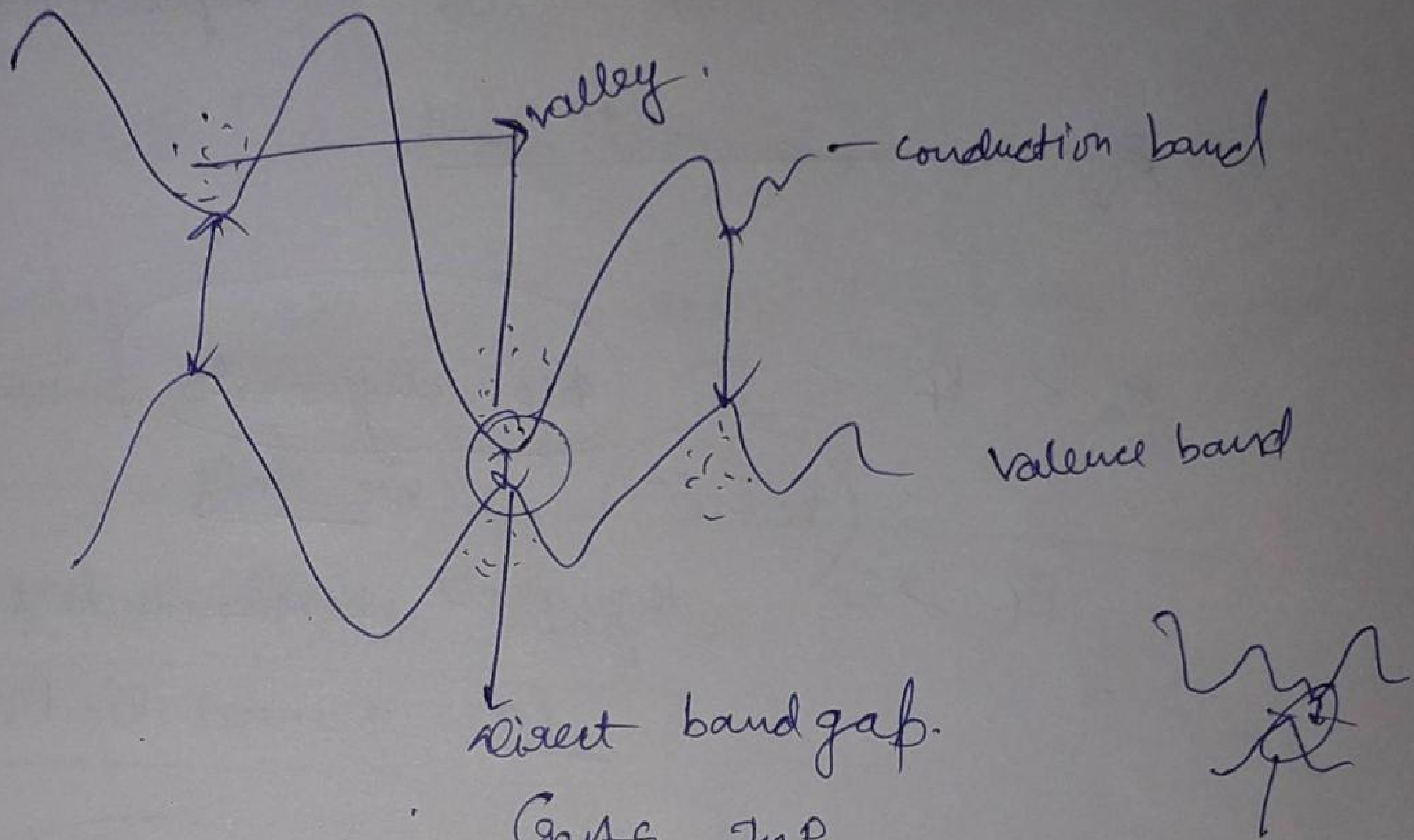
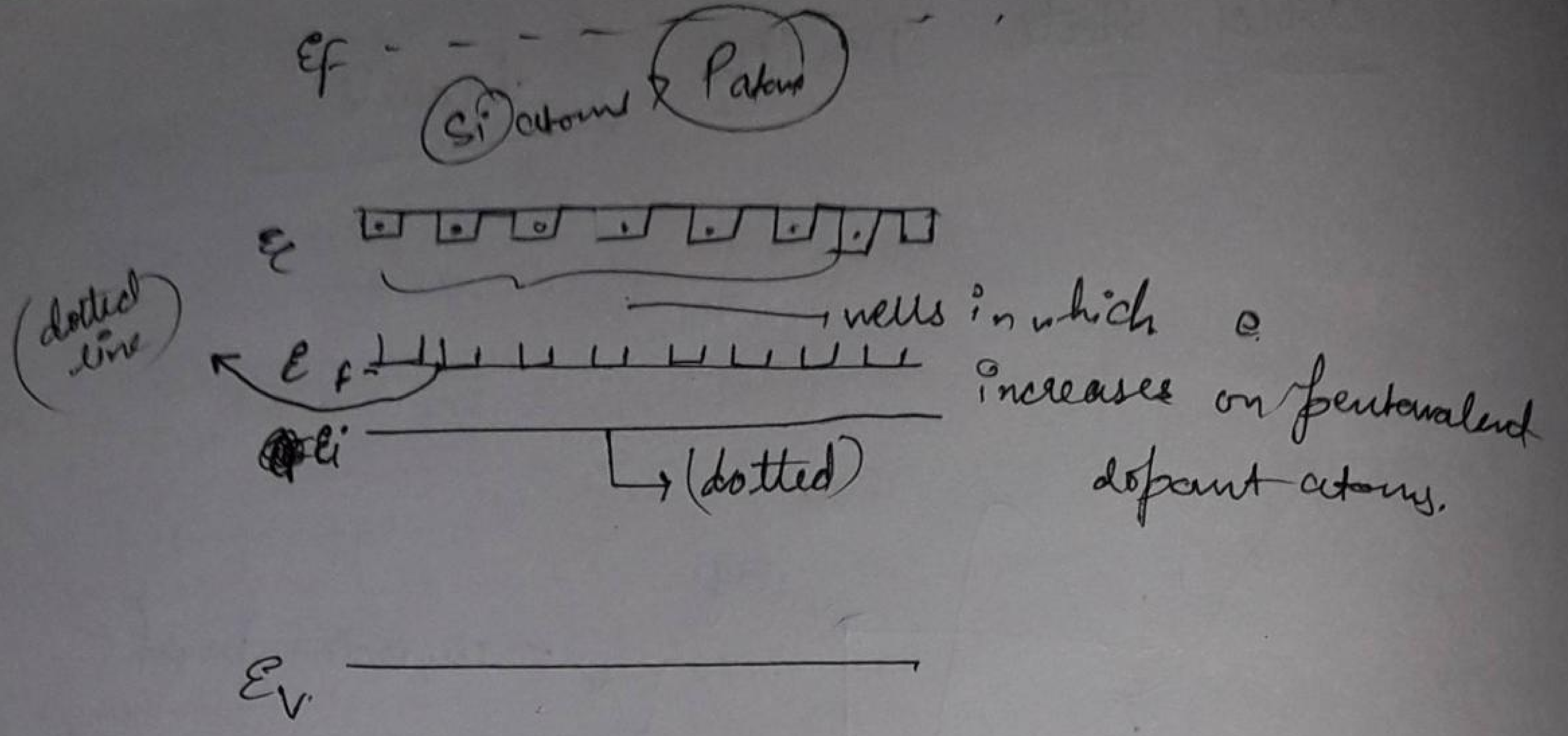
Solid State Devices & circuits



GaAs InP
(Compound Semiconductors) Si, Ge

Minimum gap is called Energy gap.

If we dope Si with Ga/As then
with Ga then it behaves as N type &
with As it makes/behaves as P type
this is called Amphoteric



$E_c < E_f < E_f$ Non degenerate semiconductors we study.

$E_c \approx 10^{22}$

$E_f > E_c$ degenerate semiconductors.

ex: Tunnel diode

Intrinsic concentration of Si 1.5×10^{10} /cm^3 → minimum required.

for impure more than 1.5×10^{10} is required.

if we have 1.8×10^{18} concentration.

$\boxed{\text{Ionisation}}$ → all carriers are participating in conduction.

If we get all carriers or more than expected on inc potential diff. then bonds b/w Si & Si breaks. along with foreinatoms.

when carriers lesser than expected ionize is called [low level injection] → our syllabus.

& when more it is called [high level injection]

Fermi Dirac Delta function

$$\boxed{f(E) = \frac{1}{1 + \exp\left(\frac{E - E_F}{KT}\right)}}$$ 2 variables

Probability of occuring of electron max = 1

Probability of hole

$$\boxed{F(h) = 1 - f(E)}$$

Base is energy & with respect to fermi level.

Case 1 at absolute 0 K.

$$\boxed{f(E) = 0}$$

(ii) at $E = E_f$

$$\boxed{F(E) = \frac{1}{2}}$$

means Fermi level contains half probability of electron.

$K = 1.58 \times 10^{-20}\ eV/K$.

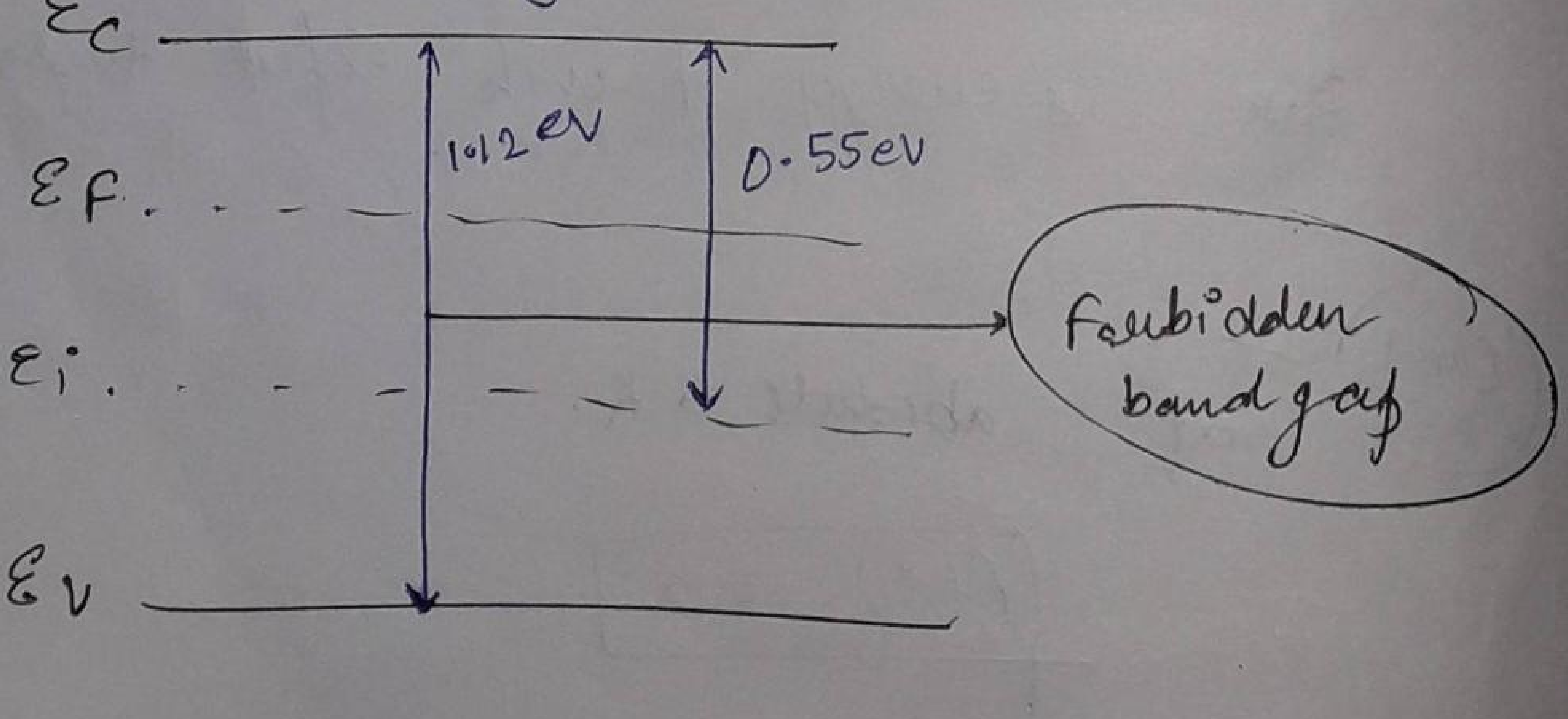
$$\frac{KT}{q} = 26\,mV$$

if Temp changes

$$\frac{KT_1/q}{\frac{KT_2}{q}} = \frac{26}{x}$$

$$\boxed{\frac{T_1}{T_2} = \frac{26}{x}}$$

Energy band diagram



$1s^2$.

$2s^2$ $2p^6$

$3s^2$ $3p^6$ $3d^{10}$

force of attraction

$1s > 2s > 3s$

$F = ma$

e^- move with constant drift velocity

$\therefore$ mass increases as $P\uparrow$ increases.

$\boxed{\text{So effective mass of } e^-}$

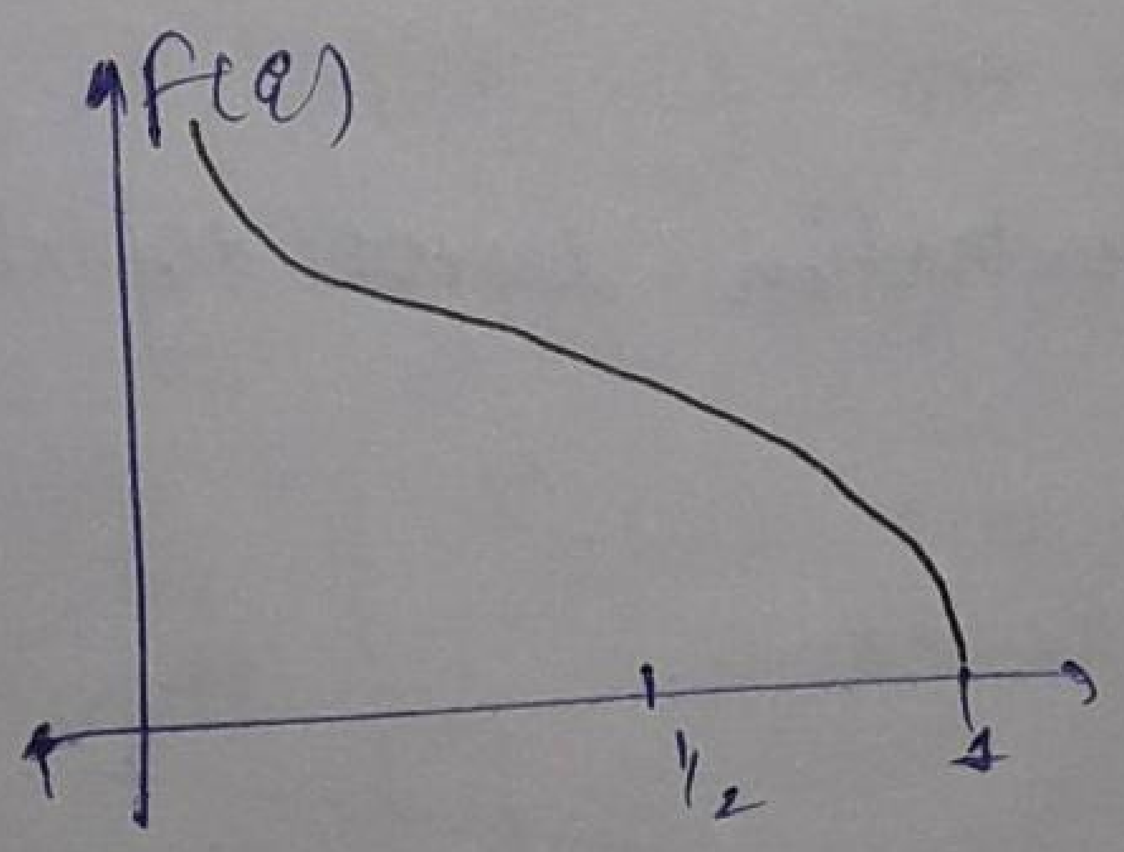
$\boxed{\therefore \text{ mass of whole} > \text{mass of } e^-}$

as e^- in E_c & holes in E_v

bit free

more force

Phonons are emitted in intrinsic semi-conductor Si & Ge (in indirect emission).



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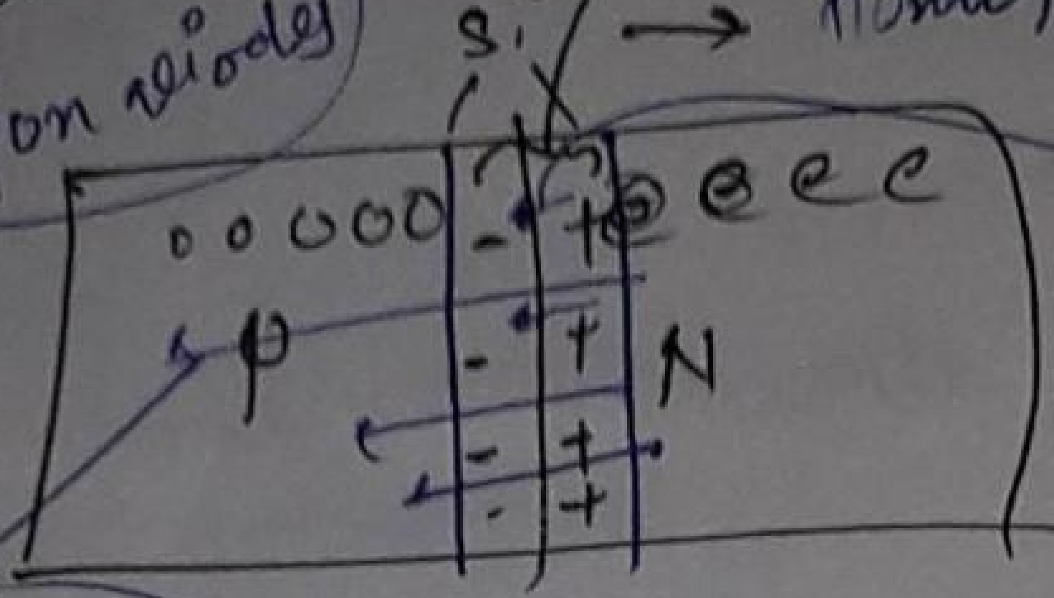
deflection width

Si → Homojunction

Gon diodes

also hetero



combination of e^- with less energy.

e^- with more energy

Metal + Semiconductor

↳ heterojunction → Shottky diodes

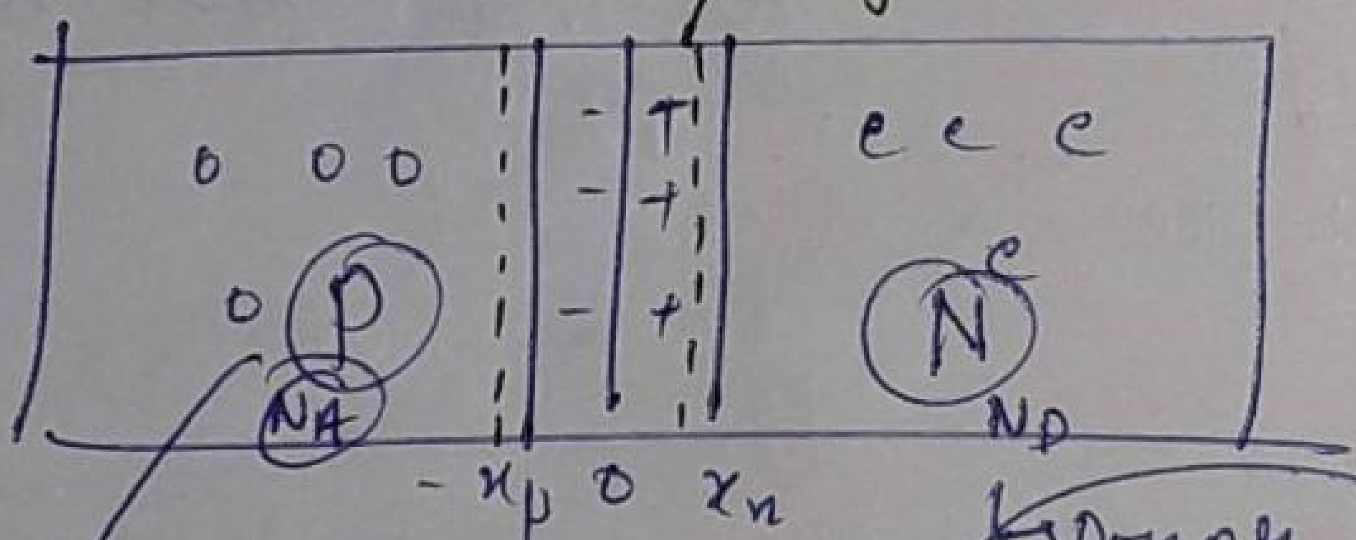
Diffusion

Concentration difference

mean free path → distance travelled by e^- before recombining.

charges are created but e^- ~~are~~ and holes recombine.

deflection width dec as when we dope



↳ Doner

Acceptor

$$\boxed{W = x_n + x_p}$$

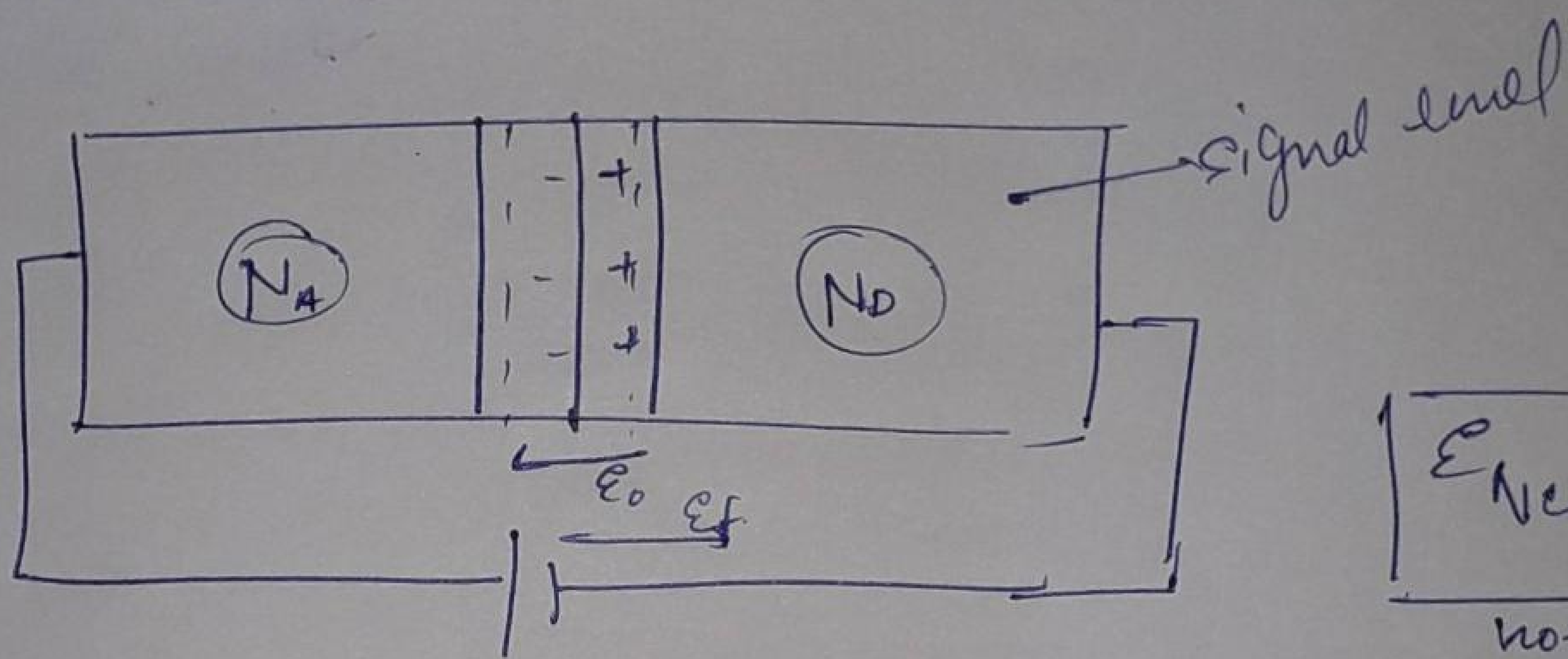
more concentration lesser deflection width

[Delta Debye approximation]

90% recombination at depletion width &

5% — 10% in region except depletion width.

In starting diffusion

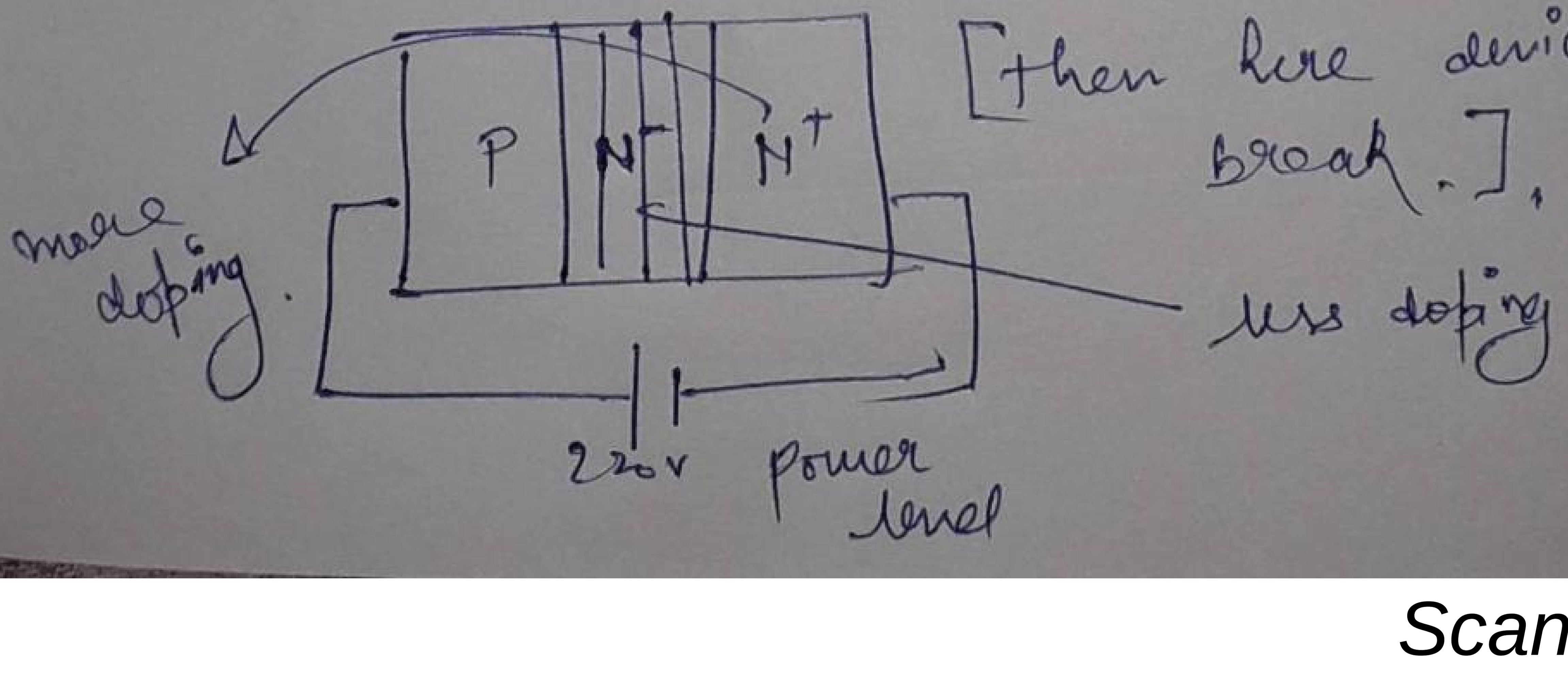


$$\boxed{\mathcal{E}_{Net} = \mathcal{E}_0 - E_f}$$

not $E_f - E_0$

As we apply battery the dep-reg shrinks (& equilibrium disturbs) but again diffusion tries to swell the region & continuous diffusion & drift will occur. i.e. diff, drif, diff, drif.

⇒ If we apply higher volt (≈220) then ~~we~~ the depletion width break & device breaks. So we design device like it can hold power ~~level~~ level device.



[then here device will not break.].