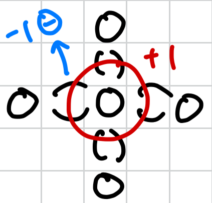
Review

$J = \sigma E$

$\sigma = q n \mu$



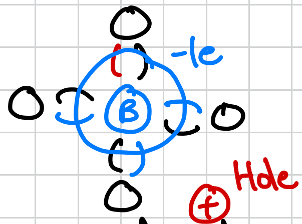
Thermal $n_i \approx \frac{10^{10}}{cm^3}$

Electron
Hole
Pair

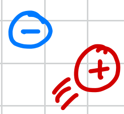
$n_0 = P_0 = n_i$

Concentration of electrons

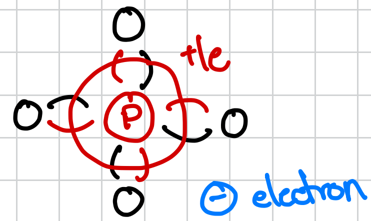
Concentration of holes



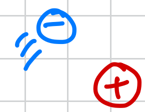
Doping w/ Acceptors



(P-type)



Doping w/ Donors



(N-type)

Acceptors
if $N_a >> P_0$
then $P \approx N_a$

Donors
if $N_d >> n_0$
then $n \approx N_d$

Doping is much stronger than thermal generation

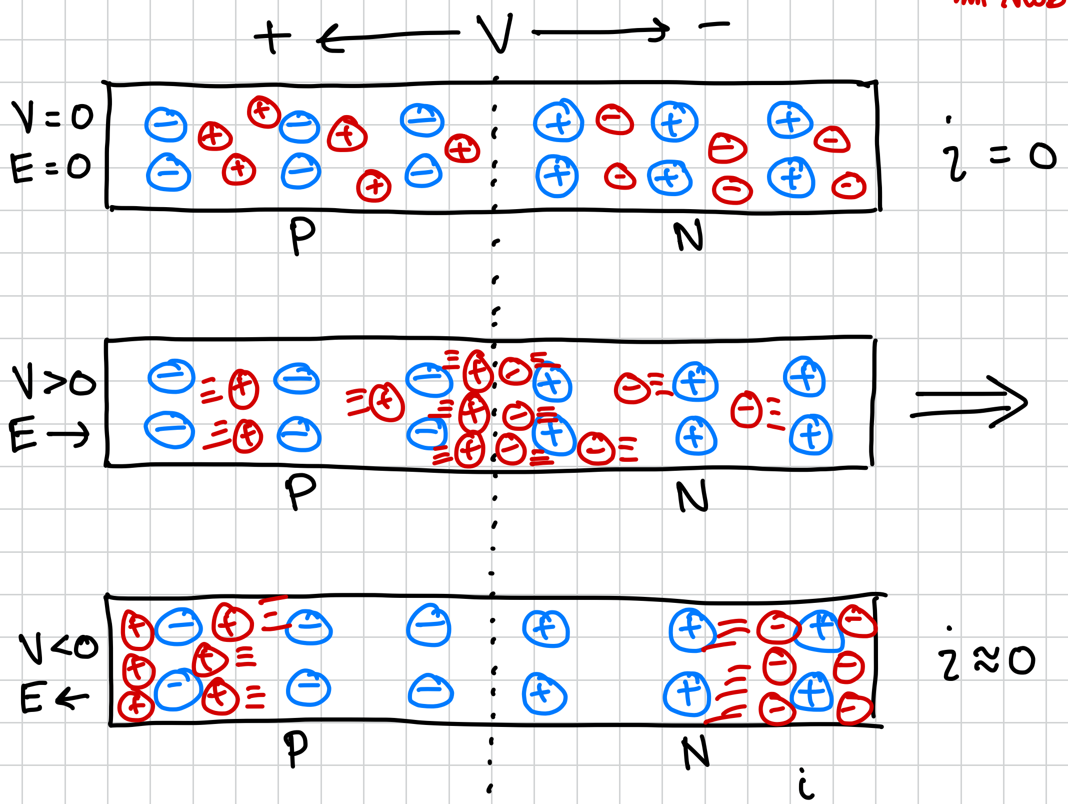
Doped w/ Acceptors
$P \approx N_a$
Mass Action Law $\Rightarrow n \times p = n_i^2$
$\Rightarrow n = \frac{n_i^2}{N_a}$

$J = J_e + J_n$

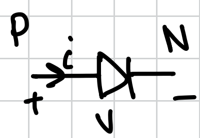
$= |q_e| \times n \times \mu_e + |q_h| \times P \times \mu_h$

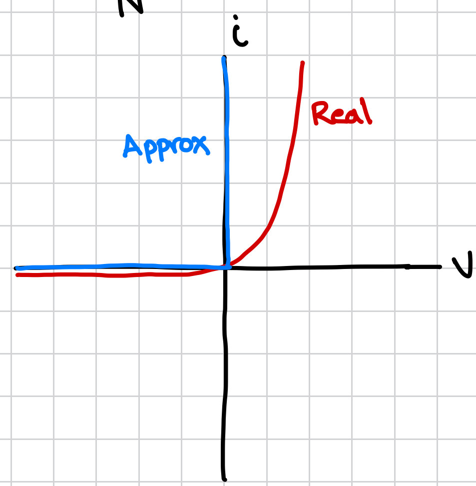
p-n junction

Stationary
Mobile

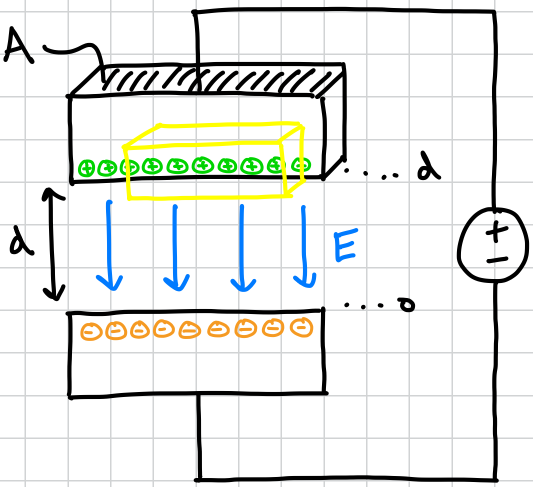


★ Diode





Capacitor



Integrating from top to bottom

$$V = -\int_d^0 E\, dl$$

$$V = \int_0^d E\, dl$$

$$V = E \times d$$

$$\Longrightarrow$$

Gauss' Law

$$\oint E\epsilon \cdot dA = Q_{enc}$$

pointing outside $\Rightarrow +$

into $\Rightarrow -$

$$\underbrace{E\epsilon A}_{\text{bottom}} + \underset{\text{top}}{0} + \underset{\text{sides}}{0} = E\epsilon A = Q_{enclosed}$$

permittivity

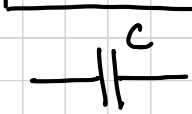
$$E = -\frac{dv}{dl} \qquad V = -\int E\, dl$$

$$Q = \frac{\epsilon A}{d} V$$

E

Capacitance $\frac{C}{V} = \frac{A \cdot s}{V} = F$ farad

$$\frac{dQ}{dt} = \boxed{i = C\frac{dV}{dt}}$$

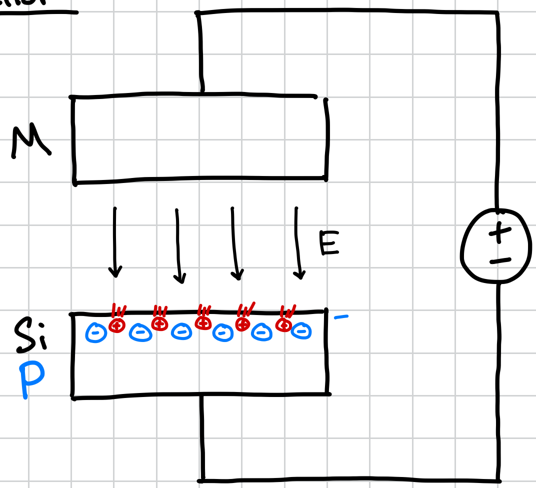


Steady State $\Rightarrow$ Nothing changing
$\Rightarrow$ derivatives $= 0 \Rightarrow$ Capacitor is OC.

$$Q = CV$$

$$V = \frac{Q}{C}$$

MIS Capacitor



$V < V_{threshold} \Rightarrow$ Holes pushed away

$V = V_{threshold} \Rightarrow$ No holes / No electrons near surface

$V > V_{threshold} \Rightarrow$ Attract mobile e^- to surface
- Electrically inverted n-p