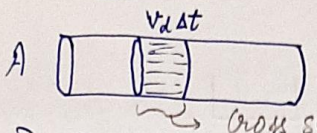
Notes

(1)



Drift velocity $v_d \propto E$

Collision time = τ

$$a = \frac{eE}{m}, \quad v = \frac{eE}{m}\tau$$

$$v_d = \boxed{\frac{e\tau}{m}} E$$

$\frac{e\tau}{m}$ → Mobility (μ)

density of conduction electrons = n

drift velocity is v_d

Charge crossing the cross section = $nA(v_d \Delta t)e$

$$I = Ane\,v_d$$

$$J = I/A = ne\,v_d$$

$$= ne\mu E$$

$ne\mu$ → Conductivity (σ)

$$J = \sigma E \quad \text{'Ohm's law'}$$

$$\mu = \frac{e\tau}{m^*}$$ → effective mass

Si ⇒ $m_e^* = 0.26\, m_e$

Holes

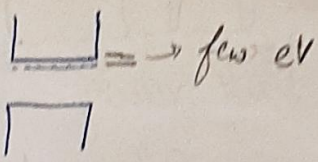
$$J = (n_e \mu_e + n_h \mu_h) \times eE$$

$$I = I_e + I_h$$

2. Impurity Levels

★ n- type semiconductors

Impurity levels are created slightly below the conduction band.



Hydrogen Atom

Ionization energy = 13.6 eV

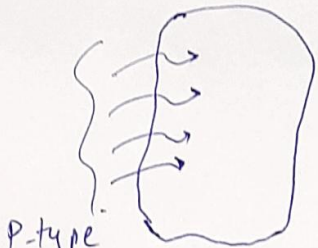
$$m^* \rightarrow \frac{me^4}{2(4\pi\epsilon_0)^2 n^2 h^2}$$

$\epsilon = k\epsilon_0$

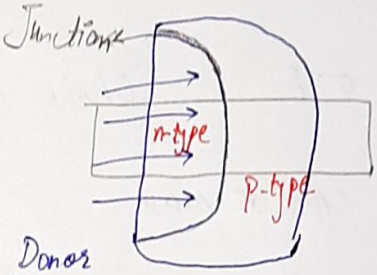
Dielectric constant

$K = 12$ (Si)

3. p-n Junction

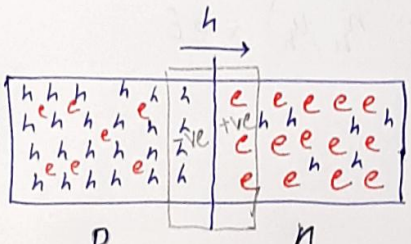


Acceptor impurities



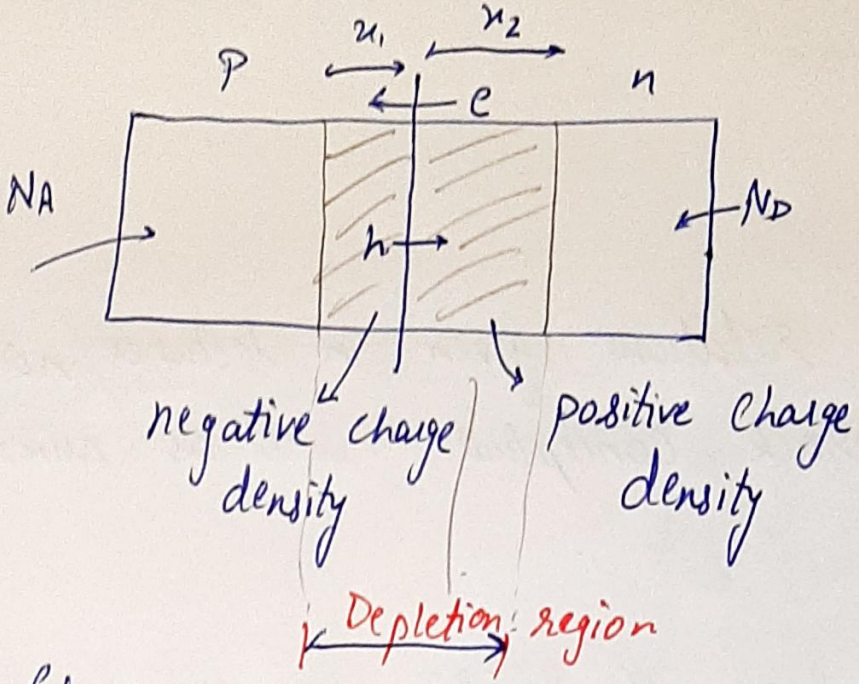
Donor impurities

p-type



e = minority carrier
h = majority carrier

e = majority carrier
h = minority carrier



★ Charge density $\neq 0$ ★

★ Charge carrier density $= 0$ ★

Width of depletion region depends on N_A, N_D & potential barrier (V)