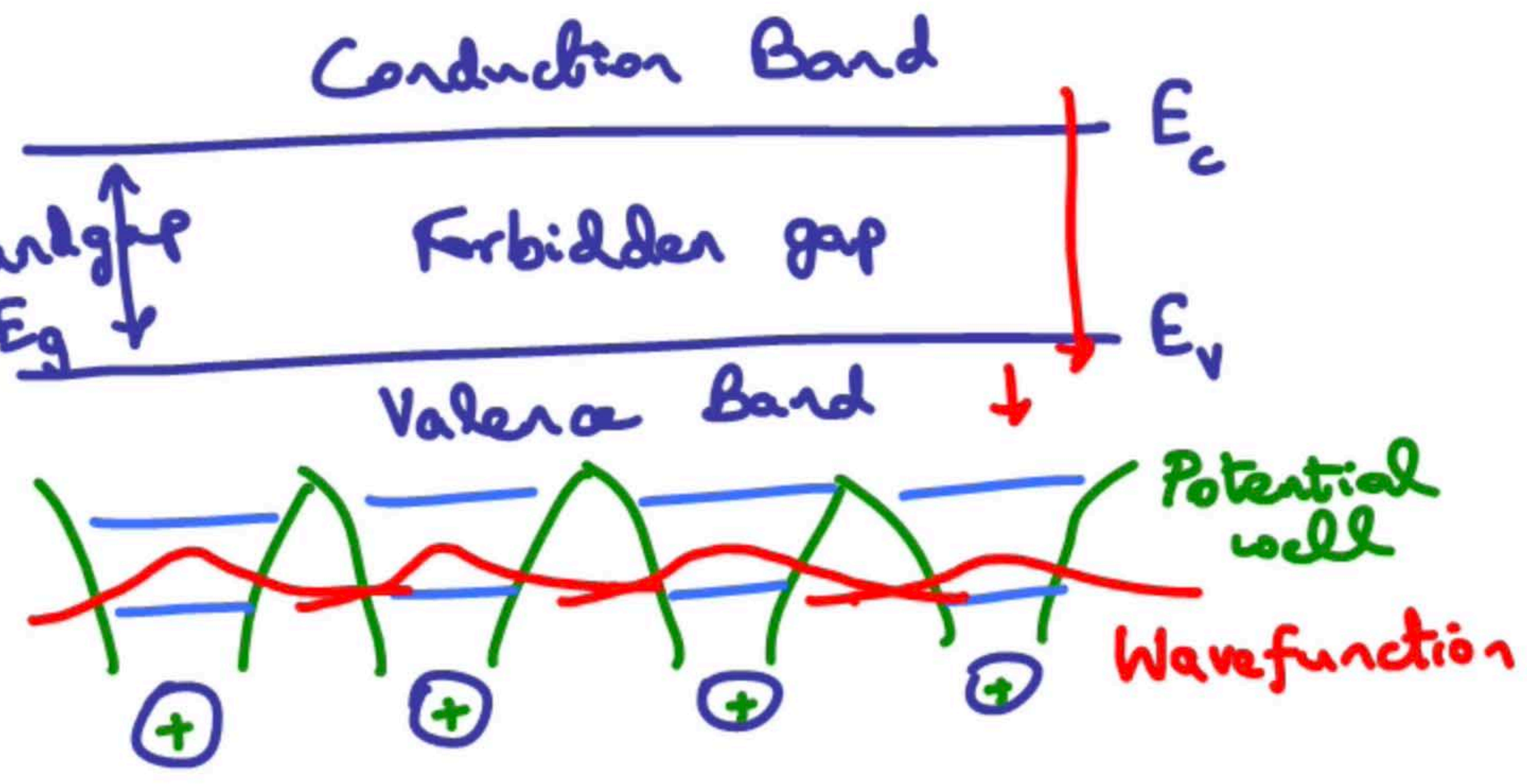
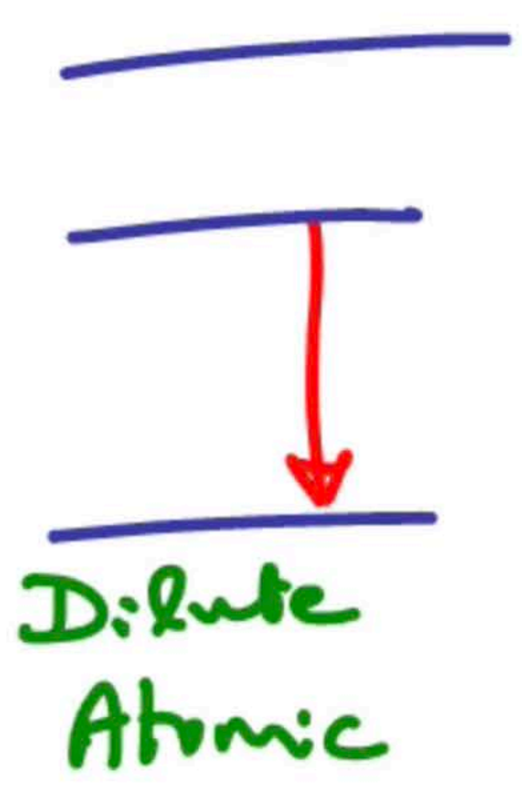
Note Title

Learning Objective: Identify fundamental principles of semiconductor light sources & detectors

Schroedinger wave equation

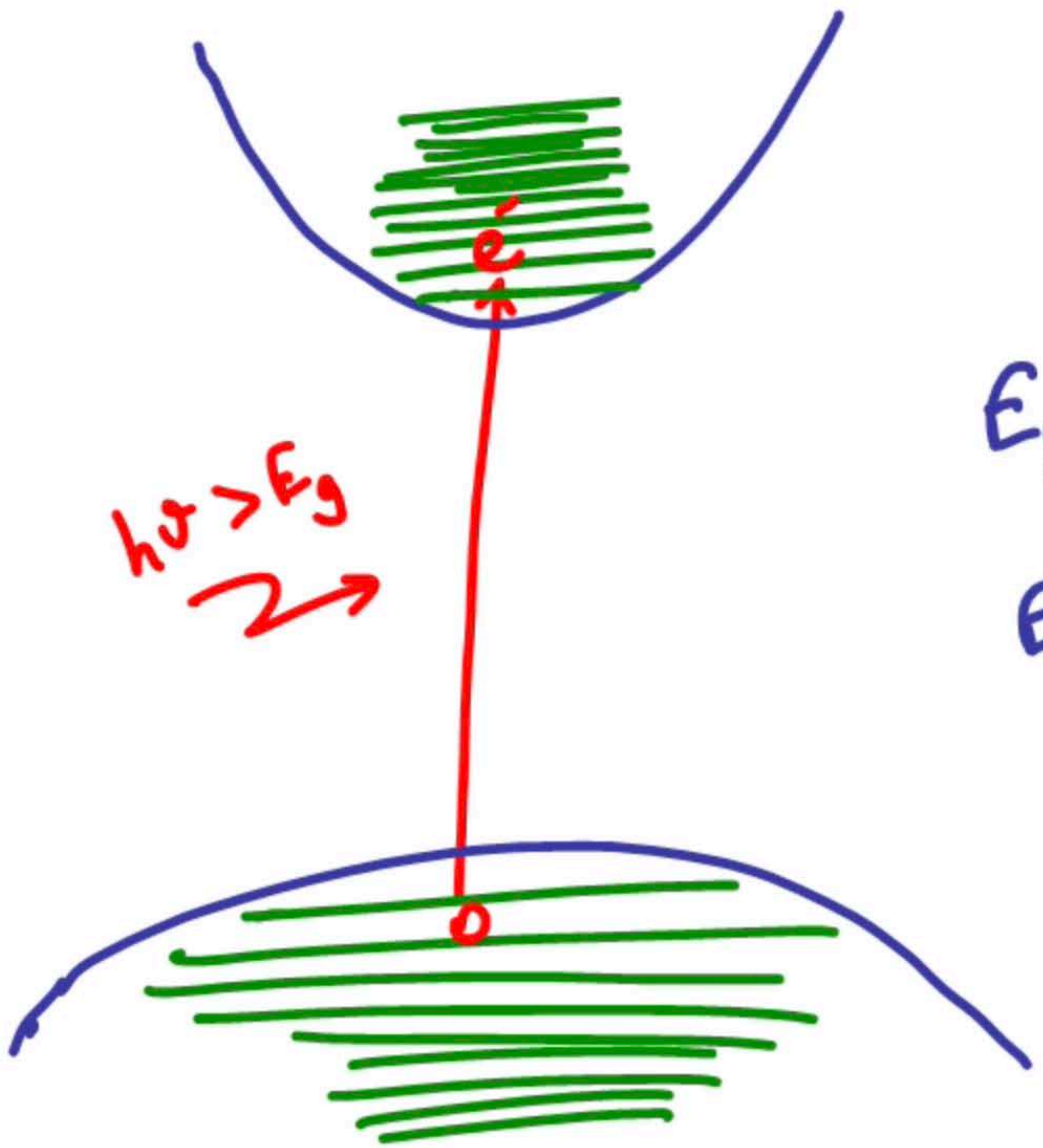




$E_g \gg K_B T$

25 meV

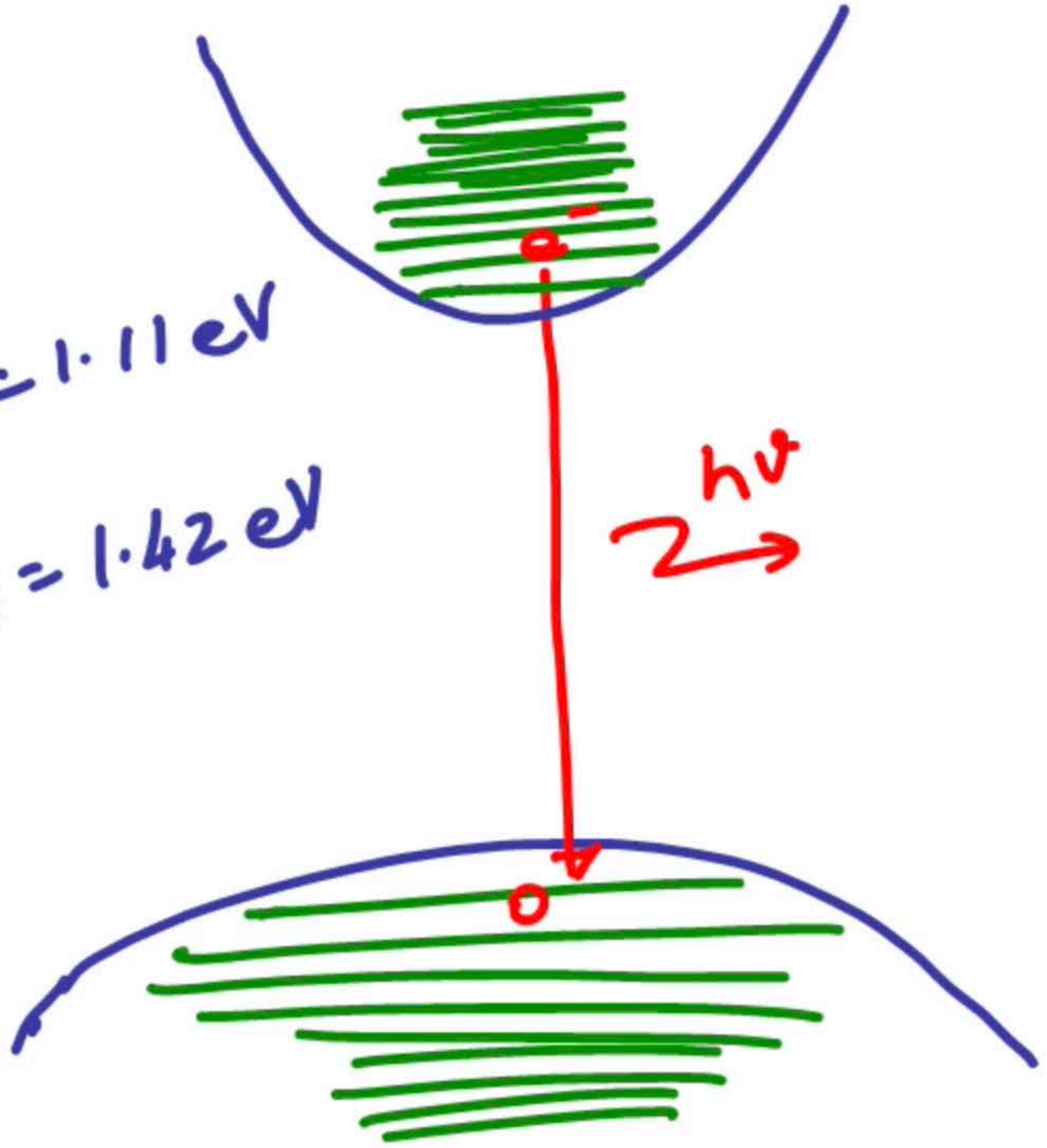
Kronig-Penney Model



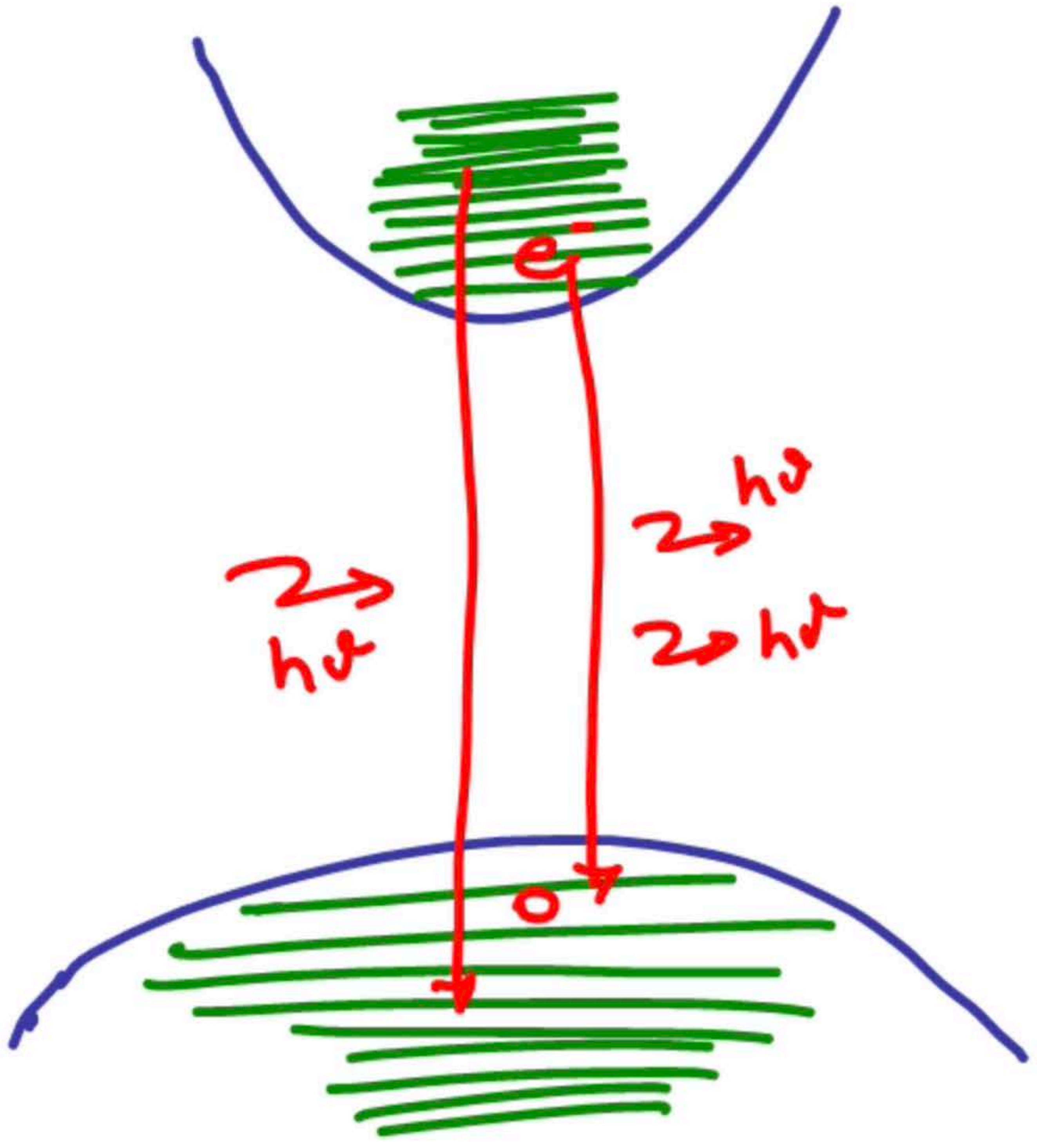
Absorption

$E_g(Si) = 1.11\ eV$

$E_g(GaAs) = 1.42\ eV$

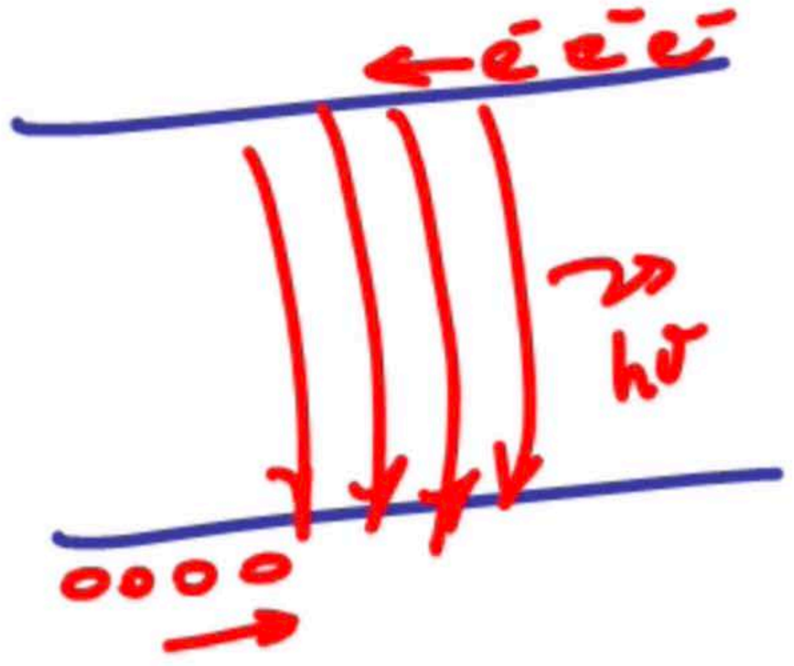


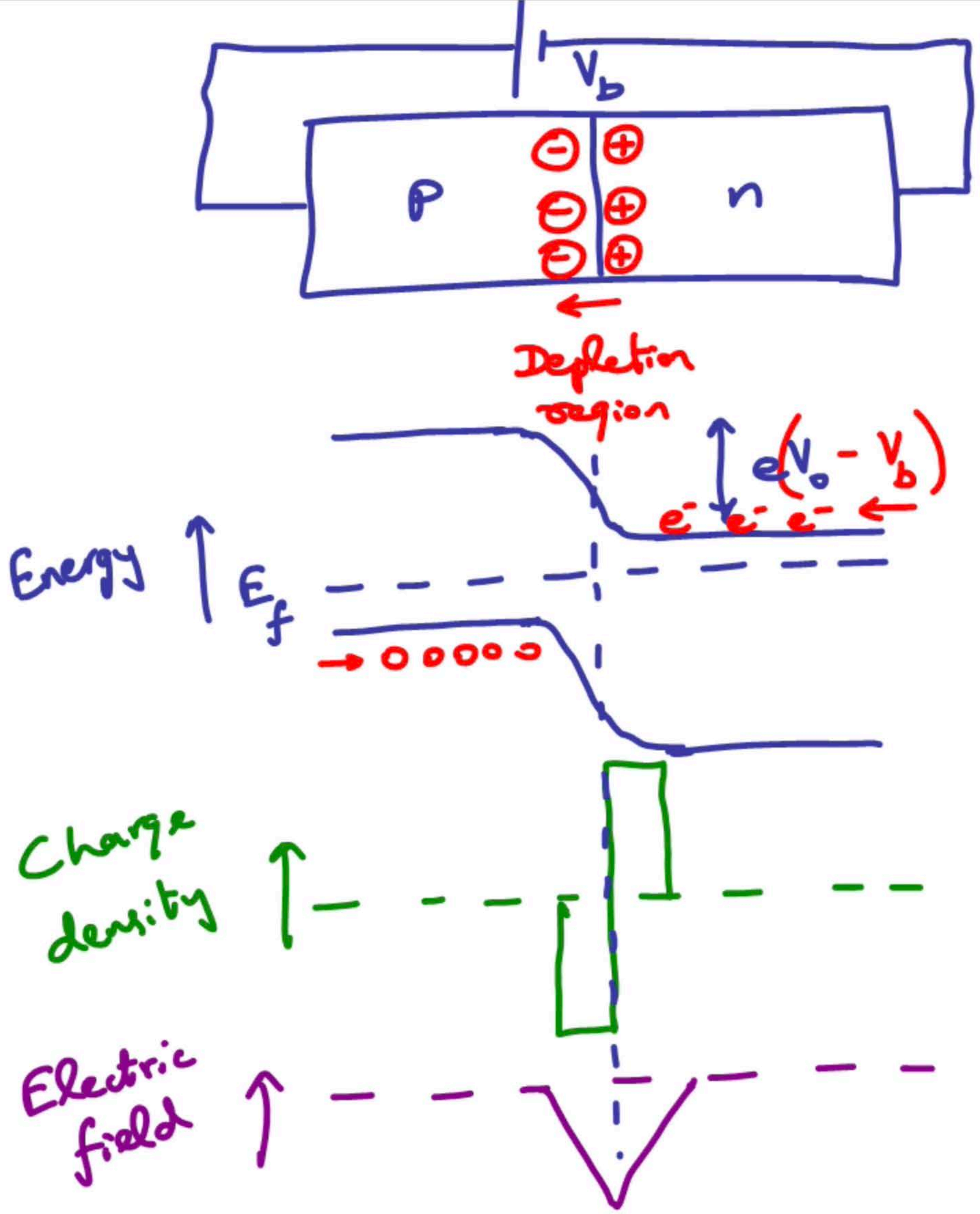
Spontaneous emission



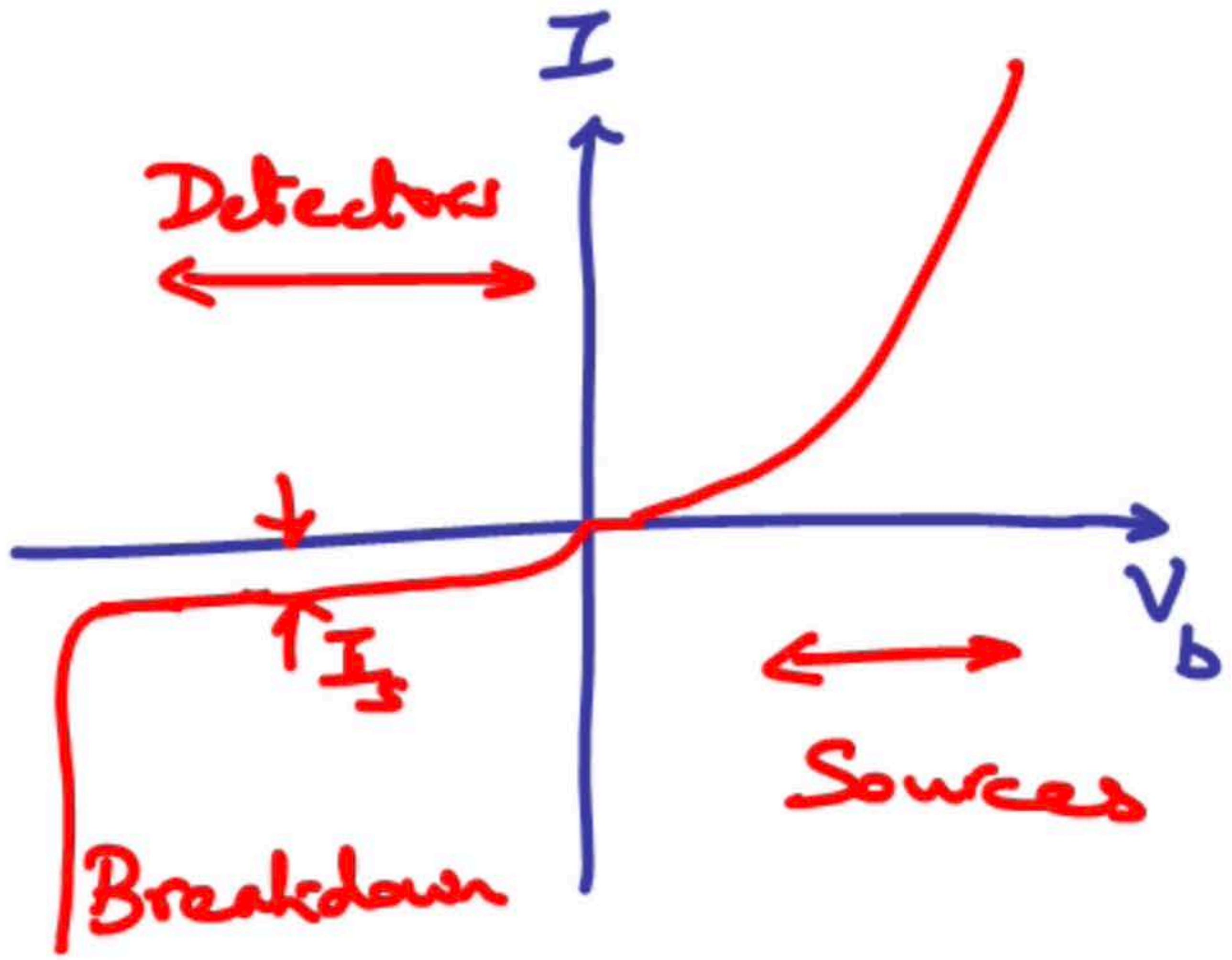
Stimulated emission

PN Junctions





$$I = I_s \exp\left(\frac{eV_b}{k_B T}\right) - I_s$$

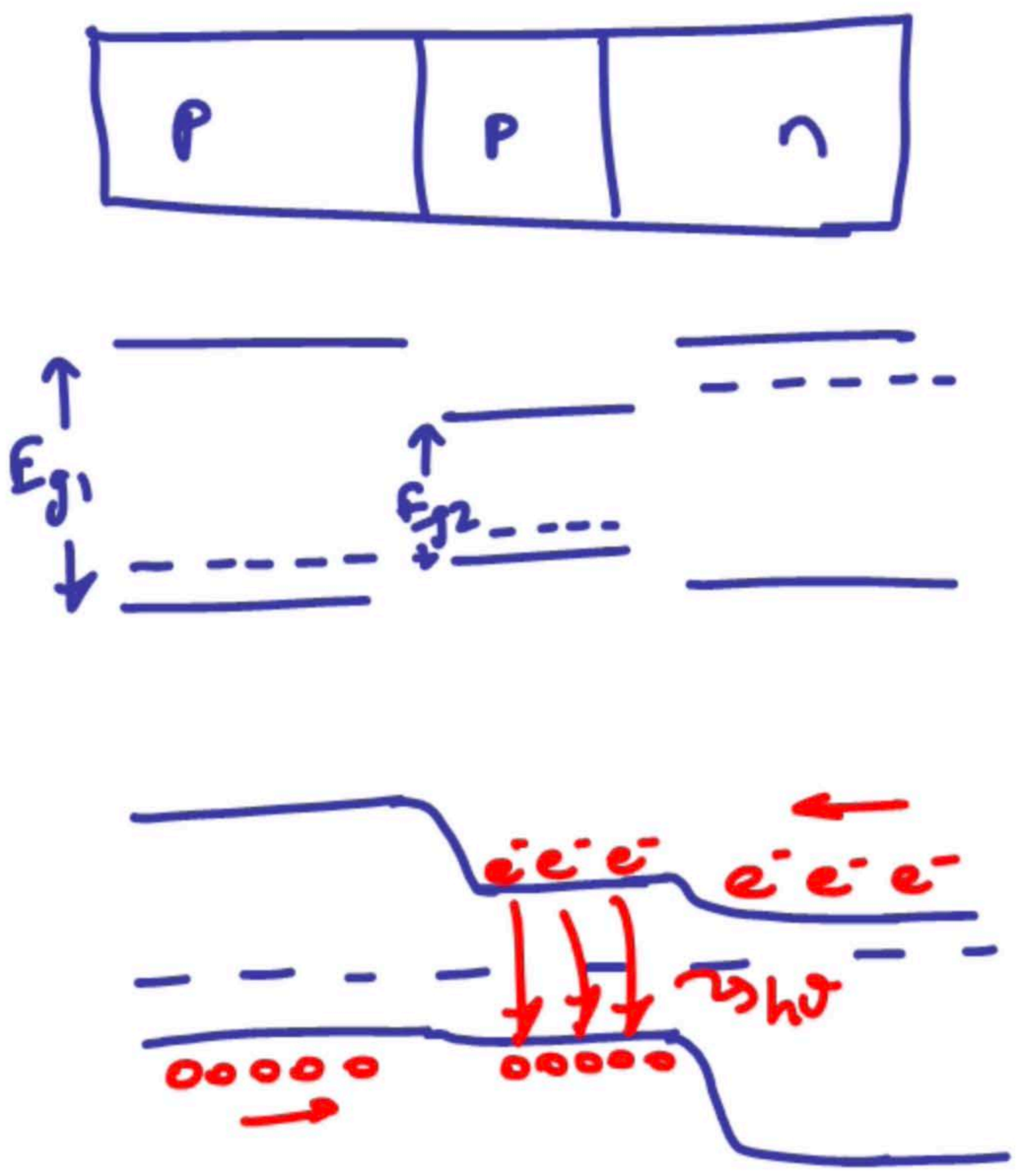


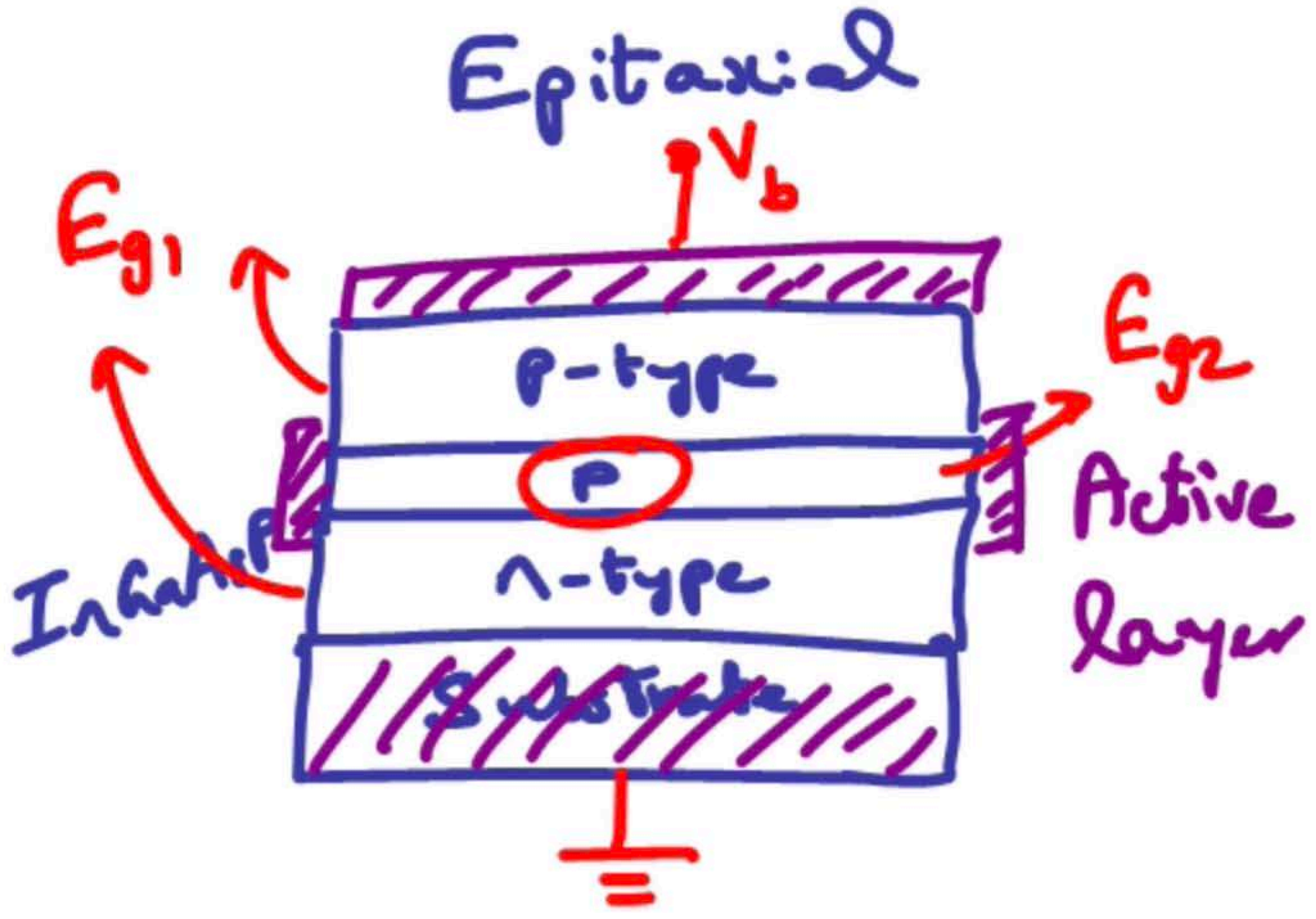
Gauss law

$$\nabla \cdot \vec{D} = \rho_v$$

Heterostructure

Carrier & Light Confinement

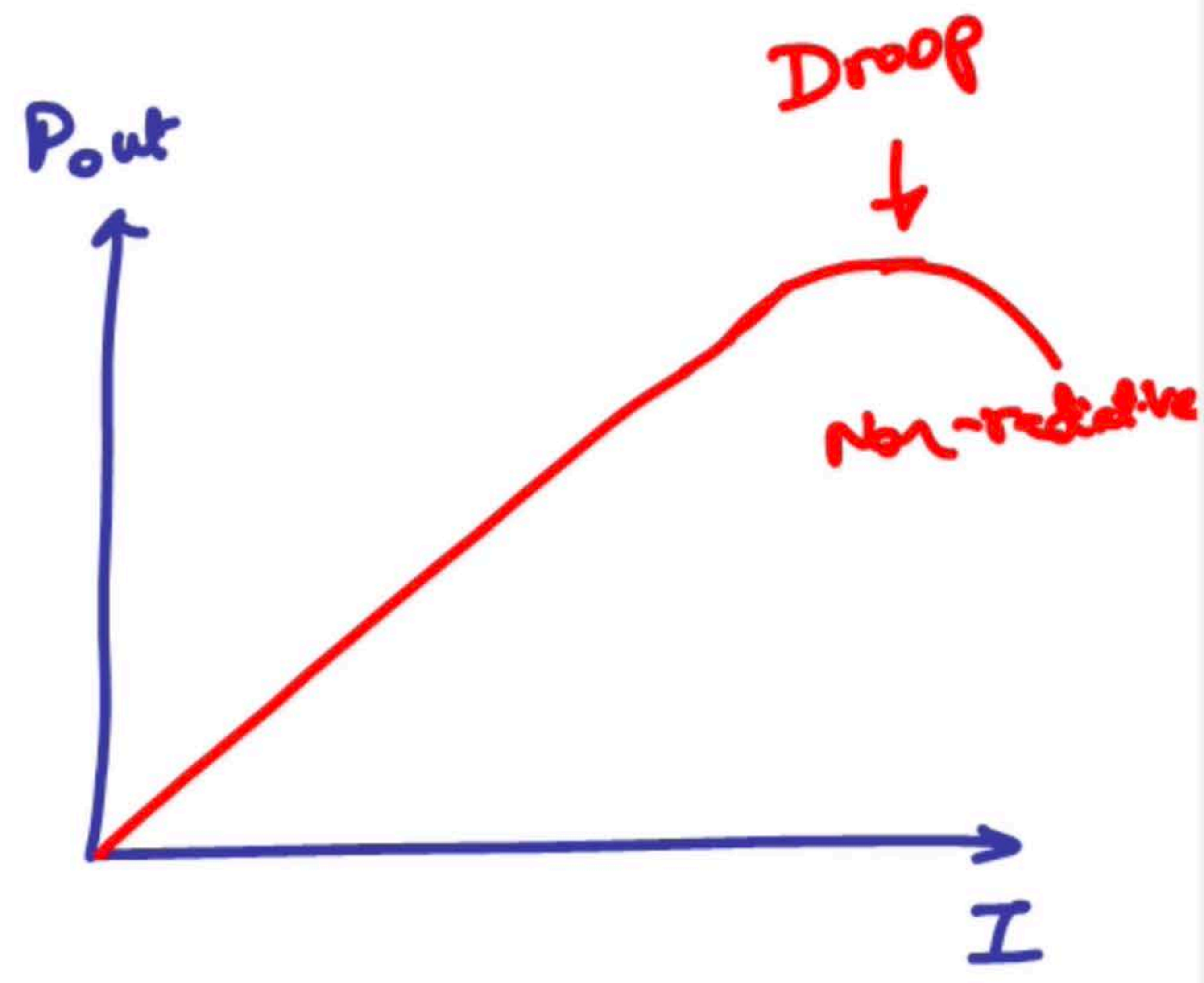


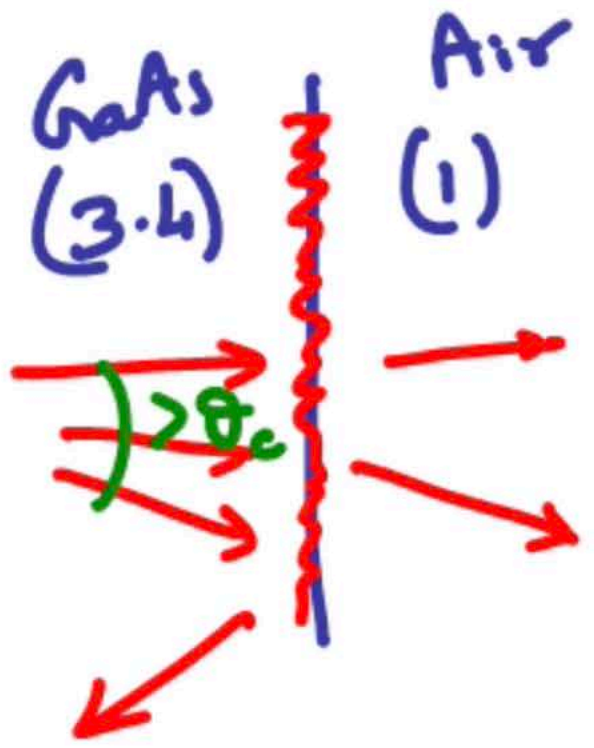


Light Emitting Diodes

Output Power. $P_{out} = \frac{I}{e} h\nu \, \eta_{int} \, \eta_{out}$

$$\frac{R_{rad}}{R_{rad} + R_{non\text{-}rad}} = \frac{\tau_{nr}}{\tau_r + \tau_{nr}} \sim 80\text{-}90\%$$





$$R = \left(\frac{n-1}{n+1}\right)^2 \Rightarrow T = 1 - \left(\frac{n-1}{n+1}\right)^2 = \frac{4n}{(n+1)^2}$$

$$\left.\begin{array}{c}\text{Fraction of light}\\ \text{escaping}\end{array}\right\} = 1 - \cos\theta_c = 1 - \sqrt{1 - \left(\frac{1}{n}\right)^2} \simeq \frac{1}{2n^2}$$

$$\eta_{out} = \frac{4n}{(n+1)^2} \cdot \frac{1}{2n^2} = \frac{2}{n(n+1)^2}$$