Classical

$$F = ma$$

$$E = \frac{mv^2}{2}$$

$$E_{field} = \frac{\delta V}{\delta x}$$

Drift: $j = \sigma \times E_{field}$

Diffusion:

$$j_n = qD_n \frac{\delta n}{\delta x}$$

$$j_p = -qD_p \frac{\delta p}{\delta x}$$

Waves

$$v_{phase} = \frac{\omega}{k} = \lambda f$$

$$\omega = 2\pi f$$

$$k = \frac{\omega}{v_{phase}}$$

$$\lambda = \frac{2\pi}{k}$$

Plane wave: $= Ae^{i(kx-\omega t)}$

Plane wave absorbtion factor: $= e^{\frac{-\alpha x}{2}}$

Transverse: $E \cdot k = 0$

Quantum

$$E = \hbar\omega$$

$$p = \hbar k$$

Free electron: $E = \frac{\hbar^2 k^2}{2m}$

$$\frac{-\hbar^2}{2m}\nabla^2\Psi + V\Psi = E\Psi$$

Devices

Excitation over a barrier: $\approx e^{\frac{qV_b}{kT}}$

Diode: $I = I_0 e^{\frac{qV}{kT}-1}$

Transistor: $I_c = \beta I_b$

Optical Amp/Laser:

$$I = I_0 e^{-\alpha x}$$

$$\alpha \approx n_1 - n_2$$