Hackathon 1

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October 12, 2023

Problem Statement

Tunneling is a phenomenon in which a particle (in our case an electron) can go **through** (with some probability) the barrier without having the energy to go over it. This is a purely a quantum mechanical and has no classical analog. For a metal-semiconductor junction (also called as Schottky junction) contact the current may flow through tunneling. The conduction band profile for a metal semiconductor junction is given by

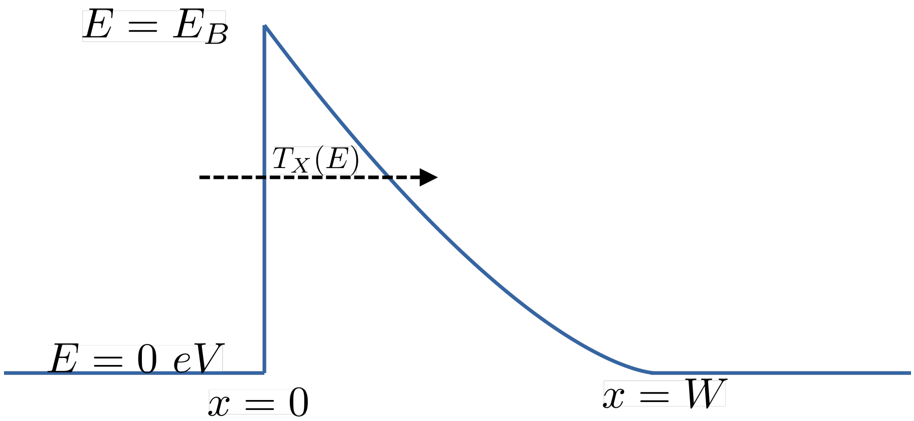
$$E_C = -q(qN_d/\varepsilon)(Wx - x^2/2) + qE_B \qquad 0 \leq x \leq W \tag{1}$$

$$= 0 \qquad x \geq W \tag{2}$$

where W is given by

$$W = \sqrt{2\varepsilon E_B/(qN_d)} \tag{3}$$

This is shown in the figure below



The tunneling probability is given by the following equation (called as WKB approximation):

$$T_x(E) = exp\left(\frac{2}{\hbar}\int_0^{T_B(E)} \sqrt{2m\left(E_c(x) - E\right)}dx\right) \tag{4}$$

where $T_B(E)$ is the tunnelling distance at energy E, m is the tunneling mass (use free electron mass: 9.1E-31 kg), $\hbar$ is the reduce Planck's constant Calculate the following quantity:

$$T_{total} = \int_0^{E_B} T_x(E)dE \tag{5}$$

Use the following material parameters and constants

- q = 1.6E-19 C;
- ε= 11.9×8.854E-12;
- N_d = 1E20 m^{-3};
- E_B = 0.45 eV;
- m = 9.1E-31 kg;
- $\hbar$ = 1.054E-34 J-s;