CL14_Q1. Define the terms reflection coefficient and transmission coefficient with respect to step potential.

Ans:

The classical reflection coefficient ‘R’ is defined as the ratio of intensity reflected to intensity incident. The classical transmission coefficient ‘T’ is the ratio of intensity transmitted to intensity incident.

Quantum mechanically, intensity is analogous to probability density. Quantum mechanical transmission and reflection coefficients are based on probability density flux.

$$\boldsymbol{R = \frac{reflected\ flux}{incident\ flux}} \quad ; \quad \boldsymbol{T = \frac{transmitted\ flux}{incident\ flux}}$$

The reflection and transmission coefficients must sum to 1 in either classical or quantum mechanical regimes. I.e. R+T = 1, the flux incident has to be partially reflected and partially transmitted.

CL14_Q2 A stream of particles of mass **m** and total energy **E** moves towards a potential step of height $\boldsymbol{V_0}$, if the energy of the electrons is lesser than the step potential ($\boldsymbol{E > V_0}$) then by applying continuity conditions obtain the expression for reflection coefficient.

Ans:

By solvng SWE in region 1 and 2 we get

$\psi_1 = Ae^{ik_1x} + Be^{-ik_1x}$ and $\psi_2 = De^{ik_2x}$

Continuity condition

at x=0, $\psi_1 = \psi_2$ $\qquad$ $A + B = D$

$at\ x$=0, $\frac{d\psi 1}{dx} = \frac{d\psi 2}{dx}$ $\qquad$ $(A - B)k_1 = Dk_2$

$Reflection\ coefficient = \frac{B*B\ v1}{A*A\ v1}$

$$R = \frac{(k_1 - k_2)}{(k_1 + k_2)}$$

CL14_Q3. The probability of reflection from a potential step is given by $\frac{(\boldsymbol{k_2 - k_1})^2}{(\boldsymbol{k_2 + k_1})^2}$, where the k's are the wavenumbers in the two regions. If a **5 eV** electron encounters a **2 eV** potential step, what is the probability that it will be reflected?

Ans:

$R = \frac{(\boldsymbol{k}_1 - \boldsymbol{k}_2)^2}{(\boldsymbol{k}_1 + \boldsymbol{k}_2)^2}$ where $\boldsymbol{k}_1 = \frac{\sqrt{\boldsymbol{2mE}}}{\hbar}$ and $\boldsymbol{k}_2 = \frac{\sqrt{\boldsymbol{2m(E - V_0)}}}{\hbar}$

$$R = \frac{\left(\sqrt{3} - \sqrt{1}\right)^2}{\left(\sqrt{3} + \sqrt{1}\right)^2} = 0.0716$$

We know that $R + T = 1$ therefore $T = 0.928$