CL17_Q1. A proton and an alpha particle with the same energy $\boldsymbol{E}$ approach a potential barrier whose height is $\boldsymbol{V_o} > E$. Do they have the same probabilities of getting through? If not which has greater probability and why?

Ans:

Transmission probability is given by $\boldsymbol{T = e^{-2k_2L}}$

As the particle of same energy but different masses approaches the same barrier, $\boldsymbol{k_2}$ will be more for heavier particles (alpha particle) than the lightest particle (proton). This means the transmission probability will be lower for heavier particle.

CL17_Q2. The quantum mechanical transmission coefficient of an alpha particle through a nuclear potential barrier is 2.54×10^{-24}. Taking the velocity of the alpha particle and the nuclear radius as 1.7×10^{7} m/s and 10^{-14} m, respectivetly, calculate the mean lifetime of alpha decay.

Ans:

Transmission coefficient $T = 2.54 \times 10^{-24}$

The number of collision of alpha particle with the barrier in one second is

$$n = \frac{velocity\ of\ the\ particle}{nuclear\ diameter} = \frac{1.7 \times 10^{7}}{2 \times 10^{-14}} = 8.5 \times 10^{20}$$

So the probability of the alpha particle to to escape in one second is

$$P = nT = 8.5 \times 10^{20} \times 2.54 \times 10^{-24} = 2.12 \times 10^{-3}$$

The mean lifetime of alpha decay is $\tau = \frac{1}{P} = 7\ \text{min}\ 52\ s$