Tutorial Sheet 2: Modern Physics – Unit 2
2021-2022

Answer All the Questions

Q1) Calculate the potential energy V(x) and total energy (E) of a quantum mechanical particle represented by a wave function $\varphi = x/a\ e^{-x/a}$ where a is a constant. Don't forget to make an assumption that V(x) = 0 at x = ∞.

Q2) Calculate the total energy (E) of a quantum mechanical particle moving in a potential $V(x) = 0.5kx^2$. The wave function of the particle is $\varphi = Ae^{-\sqrt{km}\frac{x^2}{2\hbar}}$ where A is a constant.

Q3) A free electron with energy E = 1 eV is incident upon a rectangular potential barrier of width 5 nm and height U_o = 6 eV. Calculate the transmission probability for the electron.

Q4) A free electron with energy E = 1 eV is incident upon a rectangular barrier of potential energy U_o = 2 eV. About how wide must the barrier be so that the transmission probability is 10^{-3}.

Q5) A free electron with energy E = 1 eV is confined in a region B, between an infinitely large potential barrier and a finite potential barrier of width 5 nm and height U_o = 6 eV as shown below. If the infinitely large potential barrier V(x) = ∞ is at x = -20 nm, calculate the maximum time required to find the electron on the other side of the barrier. Assume that the electron is at x = 0 moving in -x direction when time t = 0 s.