III[rd] ASSIGNMENT
Subject: Physics-II (Quantum Mechanics)
Due date: 10/02/2017

Date:

Roll No. **Name**

1. Consider a particle whose normalized wave function is

$$\Psi(x) = \begin{cases} 2\alpha\sqrt{\alpha}\, x e^{-\alpha x}, & x > 0 \\ 0, & elsewhere \end{cases}$$

(a) For what value of x does $P(x) = |\Psi(x)|^2$ peak? (Peak occurs when $\frac{dP(x)}{dx} = 0$)

(b) Calculate $\langle x \rangle$ and $\langle x^2 \rangle$. $\langle p \rangle$, $\langle p^2 \rangle$

(c) What is the probability that the particle is found between x=0 and x=1/α.

2. Consider a particle of mass m moving in a 1-D potential specified by

$$U(x) = \begin{cases} 0, & -a < x < a \\ \infty, & otherwise \end{cases}$$

Find the energy eigen values and eigen functions.

3. Consider the wave function $\Psi(x, t) = A(Sin\pi x)e^{-i\omega t}$ for $-1 \le x \le 1$. Determine the value of A and write the normalized wave function.

4. An electron is described by a wave function given by $\Psi(x) = \sqrt{\frac{2}{L}} Sin\, \frac{n\pi x}{L}$ for $0 \le x \le L$. Determine the expectation value of position and momentum.

5. For the given function in Q 4 draw the wave function for a particle in a rigid box at the n = 4 energy level.

6. For the given function in Q 4 draw the probability density for a particle in a box at the n = 3 energy level.

7. For the given function in Q 4 what is the probability of locating a particle of mass m between x = L/4 and x = L/2 in a 1-D box of length L? Assume the particle is in the n=1 energy state.

8. An electron in a one dimensional infinite potential well, defined by U(x), goes from the n=4 to the n=2 level. The frequency of the emitted photon is 3.43×10^{14} Hz. Find the width of the box.

Where $U(x) = \begin{cases} 0, & -a < x < a \\ \infty, & otherwise \end{cases}$

9. *Consider a step potential function as shown in Figure 1. Let us assume that a flux of particles is incident on the potential barrier. Particles are traveling in the x direction and they originated at $x = -\infty$ and total energy of the particle is less than the barrier height, or $E < V_0$. Write the wave functions and its general solutions only for both regions.*

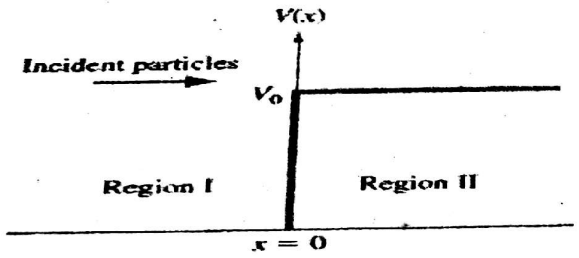

Figure 1 | The step potential function.

$$T = \left[\frac{16E(V_0 - E)}{V_0^2} \right] e^{-}$$

$$k_2 = \frac{\sqrt{2mE}}{\hbar}$$

10. A beam of 12 eV electrons is incident on a potential barrier of the height 30 eV and width 0.05 nm. Calculate the transmission coefficient.

$$\int_0^\infty e^{-x} x^n dx = n!$$

$$2 \sin A \sin B = \cos(A-B) - \cos(A+B)$$