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

Date: **Roll No.** **Name**

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1. Consider a particle whose normalized wave function is

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

   (a) For what value of x does P(x)= $|\Psi(x)|^2$ peak?

   (b) Calculate <x> and <x^2>.

   (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

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

   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 5 draw the wave function for a particle in a rigid box at the n = 4 energy level.
6. For the given function in Q 5 draw the probability density for a particle in a box at the n = 3 energy level.
7. For the given function in Q 5 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 X 10^{14} Hz. Find the width of the box.

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

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.

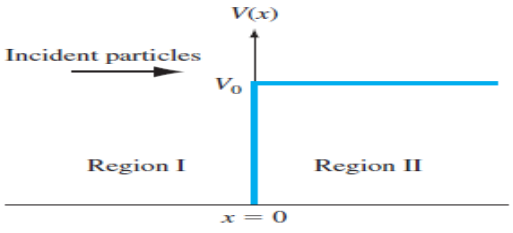

Figure 1 | The step potential function.

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.