IInd ASSIGNMENT
Subject: Physics-II (Quantum Mechanics)
Due date: 23/01/2017

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1. Find the de Broglie wavelength of the 40-keV electrons used in a certain electron microscope. $\lambda = \frac{h}{\sqrt{2meV}}$

2. Show that mathematically a wave group or a wave packet associated with a moving particle travels with the velocity of the particles. Find the phase & group velocities of an electron whose de Broglie wavelength is 1.2A^0?

3. Show that $v_g = v_p(1 - \frac{k}{n}\frac{dn}{dk})$ where n is the refractive index of the medium and k is propagation constant.

4. Compare the uncertainties in the velocities of an electron and a proton confined in a 1.00-nm box.

5. Write down the conditions of well behaved wave function.

6. State, giving your reasons, which of the following functions would make satisfactory wave functions for all values of the variable x: (a) $\Psi = A\sec x$ (b) $\Psi = A\tan x$ (c) $\Psi = Ae^{x^2}$ (d) $\Psi = Ae^{-x^2}$ (e) $\Psi = A\sin x$

7. Write down the time dependent Schrodinger equation and time independent Schrödinger equation.

8. Obtain Schrodinger steady state equation from y=A Cos $2\pi\upsilon$ (t - x/v$_p$) with the help of de Broglie relationship λ= h/mv by letting y = Ψ and finding $d^2\Psi/dx^2$.

9. Prove that the wave function in Schrodinger equation is linear by showing that it is satisfied for the wave equation Ψ (x,t)=aΨ_1 (x,t)+bΨ_2 (x,t) where a and b are constants and Ψ_1 (x,t) and Ψ_2 (x,t) describe two waves each satisfying the Schrodinger Equation.

10. The wave function of a particle moving in the x-dimension is

$$\Psi(x) = \begin{cases} Nx(L-x), & 0 < x < L \\ 0, & elsewhere \end{cases}$$

a) Normalize the wave function $|\Psi|^2$
b) Calculate <x>, <x^2> and Δx.
c) Calculate <p$_x$>,<p_x^2> and Δp$_x$.
d) Determine expectation value of total energy of the particle. (Hint: <E>)

11. The normalized wave function of a particle is $\Psi(x) = A\exp(iax - ibt)$, where A, a and b are constants. Calculate the uncertainty in its momentum.

12. For a particle in a one dimensional rigid box/infinite potential well of width 0.1 nm, calculate (a)the separation between the two lowest energy levels; (b) the frequency and wavelength of the photon corresponding to a transition between these two levels.

$E_n = \frac{n^2h^2}{8mL^2}$

$\boxed{n = \frac{c}{v_p}}$