Assignment 2 (Quantum Mechanics)

1. Obtain Schrodinger steady state equation from $y=A \cos 2\pi\upsilon (t - x/v_p)$ with the help of de Broglie relationship $\lambda = h/mv$ by letting $y = \Psi$ and finding $d^2\Psi/dx^2$.

2. Prove that the wave function in Schrodinger equation is linear by showing that it is satisfied for the wave equation $\Psi(x,t)=a\Psi_1(x,t)+b\Psi_2(x,t)$ where a and b are constants and $\Psi_1(x,t)$ and $\Psi_2(x,t)$ describe two waves each satisfying the Schrodinger Eq.

3. Find the de Broglie wavelength of a 1.0-mg grain of sand blown by the wind at a speed is 20 m/s.

4. Find the de Broglie wavelength of the 40-keV electrons used in a certain electron microscope.

5. Find the de Broglie wavelength of a 1.00 MeV proton. Is a relativistic calculation needed?

6. The atomic spacing in rock salt, NaCI, is 0.282 nm. Find the kinetic energy (in eV) of a neutron with a de Broglie wavelength of 0.282 nm. Is a relativistic calculation needed? Such neutrons can be used to study crystal structure.

7. Green light has a wavelength of about 550 nm. Through what potential difference must an electron be accelerated to have this wavelength?

8. Find the phase & group velocities of an electron whose de Broglie wavelength is $1.2A^0$?

9. A bacterium moving across a Petri dish at 3.5 μm/s has a de Broglie wavelength of 1.9×10^{-13} m. What is the bacterium's mass?

10. Calculate the de Broglie wavelength of a neutron ($m = 1.67 \times 10^{-27}$ kg) traveling at 5.5×10^4 m/s.

11. A proton ($m = 1.67 \times 10^{-27}$ kg) with a de Broglie wavelength of 4.00×10^{-14} m is moving at an unknown velocity.
    (a) What is the proton's velocity? (b)What is the proton's momentum?

12. What effect on the scattering angle in the Davisson-Gerrner experiment does increasing the electron energy have?

13. Obtain an expression for the energy levels (in MeV) of a neutron confined to a one-dimensional box 1.00 X 10^{-14} m wide. What is the neutron's minimum energy? (The diameter of an atomic nucleus is of this order of magnitude.)

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

15. Marine radar operating at a frequency of 9400 MHz emits groups of electromagnetic waves 0.0800 μs in duration. The time needed for the reflections of these groups to return indicates the distance to *a* target. Find the length of each group and the number of waves it contains.