Assignment 2 (Quantum Mechanics)

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

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

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

4. 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.

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

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

7. 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?

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

9. 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?

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

11. 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.)

12. The lowest energy possible for a certain particle trapped in a certain box is 1.00 eV *(a)* what are the next two higher energies the particle can have. (b) If the particle is an electron, how wide is the box.

13. A proton in a one-dimensional box has energy of 400 keV in its first excited state. How wide is the box?

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 in duration. The time needed for the reflections of these groups to return indicates the distance to *a* target. (a) Find the length of each group and the number of waves it contains.