(1) (25 points) (a) Calculate the de Broglie wave length of a photon of energy 5 ev.

(b) What is the de Broglie wave length of an electron of kinetic energy 1 Mev and a neutron of same energy.
(c) A proton is traveling with speed that is one third the speed of light. What is its momentum, its energy and its de Broglie wave length.

(2) (25 points) Consider an ionized He-atom, in their second excited state.
(2.1) What is the energy and angular momentum of the atom.
(2.2) What is the energy and the angular momentum for a muonic atom in its first excited state.

(3) (25 points) Consider a particle described by a wave function $\psi(x, t) = Ae^{-0.5x^2}e^{i\omega t/\hbar}$
(a) Determine the expectation values of the position and the momentum of the particle.
(b) What is the energy of the particle??
(c) What is the probability of finding the particle at $x < 0$.
(d) Where is the particle most likely to be found??

(4) (25 points) Suppose a particle is described by a wave function,

$$\psi(x, t) = \begin{cases} Ce^{-(x+2)}e^{i\omega t/\hbar}, & x > -2 \\ Ce^{(x+2)}e^{i\omega t/\hbar}, & x < -2 \end{cases}$$

(a) Determine the energy and the normalization constant $C$.
(b) What is the average value of the position and the momentum of the particle??
(c) What is the probability of finding the particle in the range $0 < x < 2$??