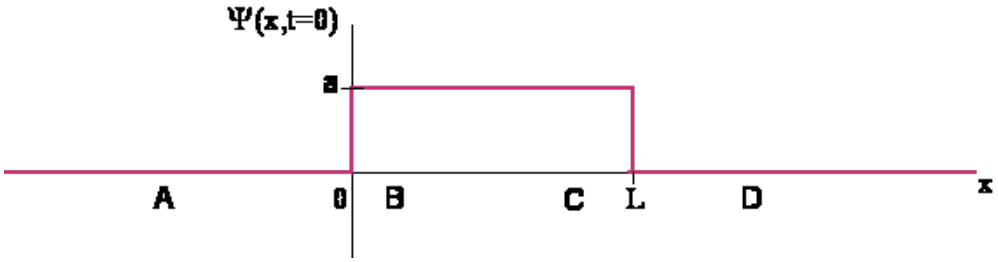
PHYS 225: Applications of Modern Physics **Marie Lopez del Puerto**

HW #13

1. Explain, in a few sentences, why we don't see the wave-like properties of matter in our everyday lives.

2. The electron wave function at time t = 0 is a square wave between 0 and L, as shown below (note $\Psi(x,t)=0$ all the way out to $-\infty$ and $+\infty$):



i. How do the probabilities of finding the electron very close (within a very small distance dx) to x=A, B, C, and D compare? (P(A)=Probability of finding the electron near point A)

a. P(A) = P(B) = P(C) = P(D)
b. P(A) < P(B) < P(C) < P(D)
c. P(A) > P(B) > P(C) > P(D)
d. 0 < {P(A) = P(D)} < {P(B) = P(C)}
e. {0 = P(A) = P(D)} < {P(B) = P(C)}
f. {0 = P(A) =P(D)} < P(B) < P(C)

ii. In the graph, what does the value for "a" have to be?

iii. What is the total probability of finding the electron between x=0 and x=L/5?

iv. Which of the following interpretations of this wave function are valid:

True False The electron's position is higher at x=C than at x=D
True False The electron is initially moving to the right, moves up then moves down, and keeps going.
True False At time=0, the electron has no chance of being found where $\psi(x,t)=0$
True False The electron is equally likely to be found anywhere between x=0 and x=L.

Note: we did the following problem in class, and it is also in your book. You should try to work through the problem without looking at your notes or the book. If you do need to look at your notes, try to understand what it is we did and why, and ask questions in the next class (or come by my office).

3. a) Solve the time-independent Schrödinger equation for a free electron whose energy is E. (You don't need to normalize the wavefunction).

   b) Show that the energy of the electron (which is simply kinetic energy, KE) is given by

$$KE = E = \frac{(\hbar k)^2}{2m}$$

   c) By comparing the expression for the kinetic energy from part (b) to the classical physics expression $KE = p^2/2m$, show that the momentum is given by

$$p = \hbar k = h/\lambda$$

   which is the de Broglie relationship.

   d) What is the probability distribution for the electron? (It will be in terms of the constant in your solution if you didn't normalize the wave function). Make a sketch of the probability as a function of x.

   e) How does the probability of finding the electron on the positive x-axis compare to the probability of finding the electron on the negative x-axis?