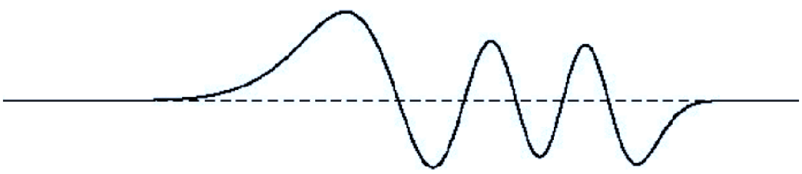
PHYS460, Test 1, Fall 2014

You must show work to get credit.

(1) (5 pts) Write as much information as you can about the eigenstate below and the potential that goes with it.



(2) (5 pts) I've acquired sock data for the class: 2 students have 0 socks, 5 students have 6 socks, 3 students have 7 socks, 4 students have 8 socks and 1 student has 9 socks. (a) Compute the average number of socks owned. (b) Compute the variance in the number of socks owned. (c) Is it OK to not own socks? Justify your answer.

(3) (5 pts) A plastic sphere with a density of 200 kg/m^3 and radius of 0.5 nm is held between two hard walls with separation L. You measure the $< v^2 >= 0.01$ m^2/s^2. (a) Is there a maximum or is there a minimum L? Explain. (b) If there is a minimum L, give that value. (c) If there is a maximum L, give that value.

(4) (5 pts) You have an infinite square well where $V(x) = 0$ for $0 < x < a$ and ∞ everywhere else. At $t = 0$, $\Psi(x, 0) = Ax(a - x)e^{ikx}$. Compute $< \hat{x} > (0)$ and $< \hat{p} > (0)$.

(5) (10 pts) You have an infinite square well where $V(x) = 0$ for $0 < x < a$ and ∞ everywhere else. (a) For $E = 0$, find the two linearly independent solutions of Schrodinger's equation in the region $0 < x < a$. (Note: $\psi(x) = 0$ is *not* one of the two solutions.) (b) Show that they can or show that they can't satisfy the boundary conditions when they are superposed. (c) Is there a solution if the boundary conditions are changed to $d\psi/dx = 0$ at $x = 0$ and at $x = a$? If yes, give the normalized eigenstate.

(6) (10 pts) The internal vibration of a CO molecule can be treated as a harmonic oscillator. At $t = 0$, the wave function is $\Psi(x, 0) = A[3\psi_n(x) + e^{i\phi}4\psi_{n+1}(x)]$. (a) Compute $< a_+ > (t)$, $< a_- > (t)$, $< a_+^2 > (t)$ and $< a_-^2 > (t)$. (b) Use this information to compute $< x > (t)$. (c) Without doing more calculations argue why $< x > (t) = 0$ for $\Psi(x, 0) = A[3\psi_n(x) + e^{i\phi}4\psi_{n+2}(x)]$.

(7) (10 pts) An electron starts at large **positive** x with **negative** momentum $-p$. It interacts with a potential $V(x) = -V_0$ for $x < 0$ and $V(x) = 0$ for $x > 0$. (a) From the wave function compute the reflection and transmission probabilities as a function of p. (b) Do they add up to 1? Explain why you should get the answer you found for the sum.