Name

5.73

Quiz 6

September 16, 2002

Harmonic Oscillator:

$V(x) = kx^2/2$

$E = T + V$

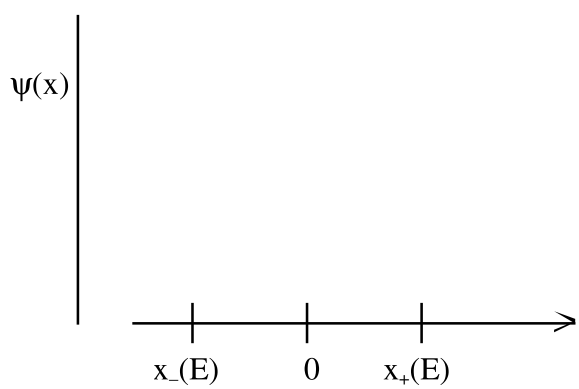
$T = p^2/2m$

$p_E(x) = [2m(E - V(x))]^{1/2}$ classical mechanical momentum

$x_\pm(E) = \pm[2E/k]^{1/2}$ turning points

$\omega = [k/m]^{1/2}$

A. Draw a cartoon of the classical mechanical wavefunction, $\psi(x)$, where $P(x) = |\psi(x)|^2$. Recall that the classical probability $P(x) \propto 1/v(x)$. Pay special attention to $\psi(x)$ at the two turning points, $x_\pm(E)$, and at $x = 0$.



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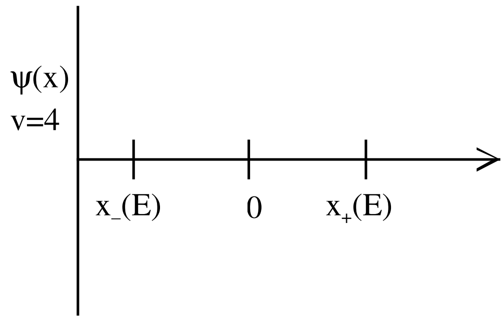
B. Convert your classical mechanical cartoon from part A to a qualitatively correct quantum mechanical cartoon for the v = 4 eigenstate. Use deBroglie's equation, $\lambda(x) = h/p(x)$, generalized to allow λ and p to be functions of x. How many nodes? Are the nodes closer together near x = 0 or near $x = x_{\pm}(E)$?



C. Make *extremely crude approximations* to estimate the fraction of time an oscillator at energy $E_n = (n+1/2)\hbar\omega$ can be found between the two center-most nodes. The period of a harmonic oscillator is $\tau = \frac{2\pi}{\omega}$, the node spacing is $\lambda = \frac{h}{p_E}$, and the velocity is $p_E(0)/m$.