Quantum Mechanics I EX1

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1. [5 pt] Consider a classical oscillator with

$$x(t) = A\cos(\omega t),\ A > 0 \tag{1}$$

   (a) Calculate $P(t) = mv(t)$. then calculate $E = \frac{P^2}{2m} + \frac{1}{2}m\omega^2 x^2$ in terms of A and *vice versa* A in terms of E.

   (b) Determine the space regions which are forbidden in the classical oscillator.

2. [15 pt] Use 1(a) and 1(b) to calculate the quantum mechanical probability of a particle experiencing the harmonic force and having the energy $E = \frac{1}{2}\hbar\omega$ to be in the classically forbidden region.

   Help Wave function (properly normalized):

$$\Psi_n = \left(\frac{1}{\pi\lambda^2}\right)^{1/4} \frac{1}{\sqrt{2^n n!}} H_n\left(\frac{x}{\lambda}\right) e^{-x^2/2\lambda^2} \tag{2}$$

$$\lambda = \sqrt{\frac{\hbar}{m\omega}} \tag{3}$$

   Hamiltonian operator

$$\hat{H}\Psi_n = E_n\Psi_n \tag{4}$$

   This integral might be helpful as well

$$1 - \frac{2}{\sqrt{\pi}}\int_0^1 e^{-\eta^2}\mathrm{d}\eta = 0{,}1578 \tag{5}$$

Question:	1	2	Total
Points:	5	15	20
Score:			