

Phys 761

Quantum Mechanics

Problem Set # 6

Dr. Gassem Alzoubi
The Hashemite University Department of Physics, Zarqa, Jordan

1. Use the variational method to estimate the ground state energy of 1D harmonic oscillator using the trial wave function

$$\psi(x) \begin{cases} C(1 - \frac{|x|}{a}), & \text{for } |x| \leq a; \\ 0, & \text{for } |x| > a. \end{cases}$$

your result should lie within less than 10 percent of the exact value ($0.5\hbar\omega$), check it up

2. Consider a particle of mass m moving in the potential $V(x) = g|x|$ (with $g > 0$). Use the variational method to estimate the ground state energy using the trial wave function $\psi(x) = Ae^{-\alpha|x|}$. Compare your result with the exact value $0.809(\frac{g^2\hbar^2}{m})^{1/3}$
3. Consider the same potential of problem 2.
 - (a) Use the variational method to estimate the ground state energy using the trial wave function $\psi(x) = C(a^2 - |x|^2)$; with $|x| \leq a$. Again, Compare your result with the exact value $0.809(\frac{g^2\hbar^2}{m})^{1/3}$
 - (b) Use the variational method to estimate the energy of the first excited state using the trial wave function $\psi(x) = Ax(a - |x|)$; with $|x| \leq a$. Compare your result with the exact value $1.855(\frac{g^2\hbar^2}{m})^{1/3}$

Hint: Exact values of energies for the potential $V(x) = g|x|$ are available in table 7.1 page 124, Merzbacher, third edition.

Good Luck