PHYS 402 Homework---Due Friday April 22

1. Consider a particle of mass *m* moving in the one dimension delta function potential $V = -g\delta(x)$. Last term we showed the exact energy of the ground state is $-\frac{2mg^2}{\hbar^2}$. In this problem I would like you to try to estimate the energy of the ground state using trial wavefunctions of various forms. In all of the forms *N* is a normalization constant and α is a parameters. Which of these forms gives the best result? Do you have any intuition as to why?
   a. $Ne^{-\alpha x^2}$
   b. $\frac{N}{1+\alpha x^2}$
   c. $\frac{N}{1+\alpha |x|}$
   d. $Ne^{-\alpha |x|}$
2. Derive the viral theorem for three dimensions. In particular show that if the potential is written in polar coordinates that $\langle T \rangle = \frac{1}{2}\left\langle r\frac{\partial V(r,\theta,\phi)}{\partial r}\right\rangle$.
3. The potential due to the exchange of a massive scalar particle can be derived from quantum field theory and is known to be central and of the form $-\frac{g^2 e^{-kr}}{r}$ where *g* and *k* and constants. Use the result of part one to find an expression for the expectation of the kinetic energy for this potential.