

## PHYS 452 Quantum Mechanics II (Fall 2019)

## Quiz #1

1. Consider a particle moving in 1D ( $-\infty < x < \infty$ ). Suppose we can restrict a trial wave function  $\phi(x)$  to be orthogonal to the exact ground state wave function, regardless of how much  $\phi(x)$  is tuned. Show that in this case the trial energy will be a strict upper bound to the exact energy of the first excited state.
2. If a particle moves in the potential  $V(x) = -Be^{-bx^4}$ , where  $B > 0$  and  $b > 0$ , what would be the most meaningful choice of a trial wave function (out of those given below) to estimate the energy of the first excited state? Explain.  $A$  and  $\alpha$  are assumed to be real positive numbers.

(a)  $A$

(b)  $Ae^{-\alpha x}$

(c)  $Ae^{-\alpha x^2}$

(d)  $Ae^{-\alpha x^4}$

(e)  $Ax$

(f)  $Axe^{-\alpha x}$

(g)  $Axe^{-\alpha x^2}$

(h)  $Axe^{-\alpha x^4}$

(i)  $Ax^2$

(j)  $Ax^2e^{-\alpha x}$

(k)  $Ax^2e^{-\alpha x^2}$

(l)  $Ax^2e^{-\alpha x^4}$

(m)  $Ax^4$

(n)  $Ax^4e^{-\alpha x}$

(o)  $Ax^4e^{-\alpha x^2}$

(p)  $Ax^4e^{-\alpha x^4}$