

Homework 7 (10)

1. For the case of one dimensional Harmonic Oscillator show *that* :

$$[a, a^\dagger] = 1$$

$$[a, a^\dagger a] = a$$

$$[a, H] = \hbar\omega a$$

$$[a^\dagger, H] = -\hbar\omega a^\dagger$$

2. For the case of one dimensional Harmonic Oscillator show that

$$|\psi_n\rangle = \frac{1}{\sqrt{n!}} (a^\dagger)^n |\psi_0\rangle \text{ is normalized to unity.}$$

3. (bonus 5 points) What will be the classical analogue of the

$N = a^\dagger a$ operator?

4. Derive the Momentum Distribution function of the ground state wave function of HO.

5. Test the uncertainty principle for the ground state of HO

6. Calculate $\langle \psi_n | V | \psi_n \rangle$ and $\langle \psi_n | \frac{p^2}{2m} | \psi_n \rangle$

7. Solve problem 3.7 for the case when masses are equal