Lesson: HARMONIC OSCILLATOR

PROBLEM SHEET: QUESTIONS

1. (♦♦◇) Prove that the mean values of the kinetic and potential energies are identical for the ground state of the harmonic oscillator.

2. (♦♦◇) Prove that the Heisenberg's uncertainty principle is satisfied for ground state of the harmonic oscillator.

3. (♦♦♦) Calculate the probability of finding a harmonic oscillator in the ground state in the classical forbidden region.

4. (♦♦♦) The following variational function

$$\begin{cases} l^2 - x^2 & |x| \le l \\ 0 & |x| > l \end{cases}$$

is propossed to describe the ground state of a harmonic oscillator. Calculate the value of l which minimizes the variational integral. Plot the resulting normalized variational function and the accurate one using as unit system $m = k = \hbar = 1$.

Dificulty level: (♦◇◇) Easy, (♦♦◇) Normal, (♦♦♦) To think a bit.

Question 2 $\Rightarrow$ $\Delta x = \frac{1}{\sqrt{2}\alpha}$, $\Delta p = \sqrt{\frac{h\nu\mu}{2}}$, $\Delta x \cdot \Delta p = \frac{\hbar}{2}$

Question 3 $\Rightarrow$ 15.7%

Question 4 $\Rightarrow$ $l = \sqrt[4]{\frac{35\hbar^2}{2mk}}$