

Cairo University
Physics Department
Midterm Exam
Date: Thursday, 17 Nov. 2016
Name:

Faculty of Science
Quantum Mechanics I
Phys. 362
Time: 3:00-3:45
Code number:

Answer the following Questions:

Question one:

- a) Replace the following classical mechanical expressions with their corresponding Quantum mechanical operators. p_x and $\frac{1}{2}mV_x^2$.
- b) For a particle in an infinite one-dimensional box, write and plot the wave functions and the energy levels for $n=1, 2,$ and 3 . Calculate, $\frac{E_{n+1} - E_n}{E_n}$, what happens for this quantity as $n \rightarrow \infty$.
- c) For a particle in a harmonic oscillator potential has the following normalized wave function:

$$|\psi\rangle = \frac{1}{\sqrt{4}}|\psi_1\rangle + A|\psi_2\rangle, \text{ find the value of the constant } A.$$

Question two:

Calculate

- a) $[x, H]$
- b) $\frac{d}{dt}\langle x \rangle$
- c) $[a, a^+]$, where $a = \sqrt{\frac{m\omega}{2\hbar}}\left(\hat{x} + \frac{i}{m\omega}\hat{p}_x\right)$, $a^+ = \sqrt{\frac{m\omega}{2\hbar}}\left(\hat{x} - \frac{i}{m\omega}\hat{p}_x\right)$

Question three:

Prove the following:

- a) The operator $I = \sum_i |i\rangle\langle i|$ is the identity operator.

- b) The hermitian operators have real eigenvalues and orthogonal eigenfunctions.
- c) The operator P_x is hermitian.

Question four

A particle of mass m moves in a one-dimensional box of length L , with boundaries at $x= 0$ and $x = L$.

- a) Calculate the probability that the particle is found somewhere in the region $0 \leq x \leq L/4$.
 - b) For what value of n is there the largest probability of finding the particle in $0 \leq x \leq L/4$.
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Table of the distribution of Marks.

Question	a	b	c
One	1	2	2
Two	2	2	2
Three	1	2	2
Four	2	2	