Name: _____

PHYS3701 Intro QM I S24 Quiz #11 25 Apr 2024

You have fifteen minutes to complete this quiz. You may use books, notes, or computers you have with you, but you may not communicate with anyone other than the instructor.

Write your solution on this page, plus the back if necessary, and additional sheets if absolutely necessary. You must show the steps of your solution.

A particle of mass m moves in two spatial dimensions x and y under the influence of a potential energy function $V = m\omega^2 r^2/2 = m\omega^2(x^2 + y^2)/2$. Find the <u>three</u> lowest energy distinct eigenvalues and determine the degeneracy of each of them. You don't need to do a formal derivation, but explain your reasoning.

PHYS3701 Intro QM I Quiz #11 Solution

A particle of mass m moves in two spatial dimensions x and y under the influence of a potential energy function $V = m\omega^2 r^2/2 = m\omega^2(x^2+y^2)/2$. Find the three lowest energy distinct eigenvalues and determine the degeneracy of each of them. You don't need to do a formal derivation, but explain your reasoning.

The Hamiltonian decouples neatly into two independent simple harmonic oscillators, namely

$$H = \left[\frac{p_x^2}{2m} + \frac{1}{2}m\omega^2 x^2\right] + \left[\frac{p_y^2}{2m} + \frac{1}{2}m\omega^2 y^2\right]$$

Whether you solve this using algebra or differential equations, you will find energy eigenvalues

$$E_{n_x,n_y} = \left(n_x + \frac{1}{2}\right)\hbar\omega + \left(n_y + \frac{1}{2}\right)\hbar\omega = (n_x + n_y + 1)\,\hbar\omega$$

where n_x and n_y are separate non-negative integers. Therefore the energy levels are

E	n_x	n_y	Degeneracy
$\hbar\omega$	0	0	1
$2\hbar\omega$	1	0	
	0	1	2
$3\hbar\omega$	1	1	
	2	0	
	0	2	3