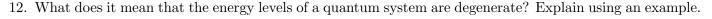
Review Questions

(week of 29 June 2020)

1. The commutator of two operators \hat{A} and \hat{B} is defined as $[\hat{A}, \hat{B}] = \dots$



- 2. Two operators are said to commute, iff $[\hat{A}, \hat{B}] = \dots$
- 3. $[\hat{x}, \hat{p_x}] = \dots$ (give the answer only).
- 5. Give an example of a pair of physical quantities that are compatible/are not compatible.
- 6. What is special about a pair of compatible physical quantities?
- 7. <u>True or false?</u> Two physical quantities that are compatible can be simultaneously measured with arbitrarily small uncertainty.
- 8. True of false? Heisenberg uncertainty principle is a special case of a more general uncertainty principle.
- 9. State the postulates of quantum mechanics.
- 10. What is the wave function collapse?
- 11. The wave function of a particle is of the form $\psi = \sqrt{\frac{2}{3}}\psi_4 + \sqrt{\frac{1}{3}}\psi_5$, where ψ_n is the eigenfunction of the operator \hat{A} representing a physical value A and corresponding to the eigenvalue a_n .
 - (a) We measure the physical quantity A on a particle in the state ψ . What are possible outcomes of this measurement and their probabilities?
 - (b) If, just after the first measurement, we perform another measurement of A, what are its possible outcomes and their probabilities?
 - (c) * If, just after the first measurement is performed, we measure another physical quantity B, is it possible that this second measurement yields a certain value with probability 1? If so, under what conditions?



- 13. Recall that for the 3D isotropic harmonic oscillator $E_N = \hbar\omega \left(N + \frac{3}{2}\right)$, where $N = n_x + n_y + n_z$. List all sets of quantum numbers corresponding to the energy level $7\hbar\omega/2$.
- 14. For the 3D isotropic harmonic oscillator, how can the degeneracy of energy levels be lifted?



- 15. $[\hat{L}_y, \hat{L}_z] = \dots$ (express the answer in terms of the third component of \hat{L}_x)
- 16. $[\hat{L}^2, \hat{L}_z] = \dots$
- 17. $[\hat{L}^2 = \dots (express in terms of the Cartesian components of the orbital angular momentum operator).$
- 18. Discuss consequences of the fact that $[\hat{L}_y, \hat{L}_z] = i\hbar \hat{L}_x$.
- 19. Discuss consequences of the fact that $[\hat{L}^2,\hat{L}_z]=0.$

$$\hat{L}^{2} = \hat{L}_{x}^{2} + \hat{L}_{y}^{2} + \hat{L}_{z}^{2}$$

$$\hat{L}_{x} = \hat{g} \hat{p}_{z} - \hat{z} \hat{p}_{3} = -i4 (y \hat{z}_{z} - z \hat{z}_{y})$$

$$\hat{L}_{y} = \hat{z} \hat{p}_{x} - \hat{x} \hat{p}_{z} = -i4 (z \hat{z}_{x} - x \hat{z}_{z})$$

$$\hat{L}_{z} = \hat{x} \hat{p}_{3} - \hat{y} \hat{p}_{x} = -i4 (x \hat{z}_{y} - y \hat{z}_{x})$$

