

What you need to know – Exam 2

1. Know everything from the “Everything you need to know” list from Exam 1.
2. Be able to derive the Pauli matrices.
3. Be able to find commutation relations among Pauli matrices.
4. Be able to find eigenvalues and eigenvectors of all Pauli matrices and/or linear combinations of Pauli matrices.
5. Be able to express eigenvectors of any Pauli matrix in terms of those of any other Pauli matrix.
6. Be able to show orthonormality and closure relationships for the eigenvectors.
7. Be able to apply spin-1/2 tools and techniques to any two level system.
8. Given an initial state of a spin-1/2 or two-level system, be able to find the time evolution of that state in the presence of a hamiltonain.
9. Given a state of a spin-1/2 or two-level system, be able to answer questions about the possible outcomes of a measurement, the probability of each possible result, and the state in which the system is left after the measurement.
10. Be able to find expectations values (and their time evolution) given an operator and a state of a spin-1/2 or two-level system.
11. Be able to find transition probabilities (possibly time-dependent) given a state and a transition operator for a spin-1/2 or two- level system.
12. Be able to extend the spin-1/2 and/or two-level system solutions to additional dimensions as well as additional particles.
13. Be able to find the eigenvalues and eigenfunctions of the harmonic oscillator using commutation relations and the creation, annihilation, and number operators.
14. Be able to find dimensionless versions of operators.
15. Be able to time-evolve harmonic oscilator solutions.
16. Be able to find expectation values and/or transition probabilities (including time-dependence) using creation and annihilation operators.
17. Be able to describe and sketch harmonic oscilator wavefunctions and understand their symmetry properties.
18. Be able to extend your harmonic oscillator eivenvalue and eigenfunction solutions to more dimensions and to more particles.
19. Understand how the degeneracy of energy eigenvalues depends upon symmetries. From item 18: are the natural frequencies in each direction the same? Are the masses of the different particles the same?
20. Be able to find harmonic oscillator solutions in the presence of an external field.
21. Be able to combine your knowledge of harmonic oscillators and two-level systems so that you can answer questions that involve both.

Recommendation: read the chapters and assigned complements again, make sure you can do the calculations in the reading. Go over the notes and make sure you can reproduce calculations and fill in steps that were left for you to do. Go over the problem sets to make sure you can do all of them correctly without reference to notes. Finally, try making up your own exam problems and solving them.