Study Guide 2

For the following, when a question asks how something is determined, it means how would it be established in an experiment, how would it be calculated using its defining equation, or how would it be used in its defining equation or other related equations.

General

Know how to work the homework problems backward and forward. Review similar exercises and problems in the textbook to those given as homework assignments. Review all example problems in the textbook. Be prepared to answer short essay questions (with a few sentences) and to do problems involving numerical calculations with the equations given. Be prepared to perform general derivations using algebraic manipulations of formulations and principles in calculus (differentiation, partial differentiation, and integration).

Chapter 11: Quantum Mechanics?

What is the relationship between wavelength, frequency, and wavenumber for light? Calculate any one of the other two given any one of the three.

What is quantum mechanics about?

What are four experimental observations that cannot be explained without the help of quantum mechanics?

How is the energy of light determined?

What is a black body radiator? How is the emission energy density of a black body radiator determined? What is shape of the classical prediction for energy density as a function of wavelength from a black body radiator? What is the experimentally observed energy density as a function of wavelength? How does this change with increasing temperature? Calculate energy density, maximum wavelength, and power from a black body radiator as a function of temperature.

What is the classical predication of the variation of heat capacity with temperature? What is the experimental observation? What formulations explained the experimental observations? Calculate heat capacity as a function of temperature for any formulation (classical or otherwise).

What is the typical light spectra observed from an excited atomic or molecule. How are the wavelengths of the spectral lines determined? Calculate the wavelength of a spectra line from an atom given its orbital binding energy levels.

What is the work function of a material? Calculate or use the work function of a material appropriately.

What is the Schrödinger equation? How does it relate to the classical system of a moving particle? How is energy represented in the expression? How is position represented? Why is the wavefunction normalized? Given the form of the potential energy, a general form of the wavefunction, and the boundary conditions for a quantum mechanical system, utilize the Schrödinger equation to specify the exact form of the wavefunction and the energy of the system.

Chapter 12: Quantum Mechanics!

Given the appropriate values, determine the energies of levels for the systems of

- a particle in an infinite 1-D square well
- a particle in an infinite 3-D box
- a 1-D harmonic oscillator
- a 3-D rigid rotor

What is degeneracy? Determine the degeneracy of levels in quantum mechanical systems.

Determine the energies given off by an excited quantum mechanical system as it changes from one level to another. Determine the energies needed to excite a quantum mechanical system from one level to another. Determine the wavelength of light equivalent to either of the above energies.

What is reduced mass? Why is it important for quantum mechanical systems? Determine the reduced mass of a vibrating or rotating molecule.

Apply the above formulations for energy levels to equivalent atomic and molecular systems - electrons in atoms, vibrating molecules, rotating molecules. For a given set of atoms or molecules, determine which will given off the most energy when relaxing from an excited quantum mechanical state. For a given set of atoms or molecules, determine which will require the most energy to be promoted to an excited quantum mechanical state.

What are the ground states of electrons in atoms or molecules, vibrating molecules, and rotating molecules? Which of these has zero energy?