Physics 2403, Fall 2000

Notes 4: Chapter 36 Summary

$100. Quantum mechanics is a complementary theory to classical (Newtonian) mechanics. The differences between quantum and classical mechanics are most significant when

(a) Energies, momenta and distances are large
(b) Energies, momenta and distances are small

$200. Although their predictions differ in many contexts by at most imperceptible amounts, quantum mechanics and classical mechanics differ in their fundamental assumptions. Which of the following is **not** true of quantum mechanics?

(a) Quantum mechanics is not deterministic. QM can only determine probabilities that something will occur.
(b) All possibly knowable information about a system is contained in a *wave function* that is a solution to a partial differential equation known as the Schroedinger equation.
(c) The Schroedinger equation depends on both spatial coordinates and time.
(d) The Schroedinger equation is always much easier to solve than the Newton equation **F**=m**a**.

$400. Since the Schroedinger equation is a partial differential equation, one common technique to find a solution is called *separation of variables*. Which of the following statements about separation of variables is true?

(a) Separation of variables means that all equations involving x should be written on the left-hand-side of the page and all equations involving t on the right-hand-side.
(b) Separation of variables is an assumption that the solution to a partial differential equation can be written as a product of functions, each of which depends only on one variable.
(c) Separation of variables means that the time dependence of the solution to the SE can always be written as $e^{-I\omega t}$.
(d) Separation of variables means that the time-independent SE has eigenvalues.

$800. Using separation of variables with the full SE produces a time-independent SE. For one-dimensional problems, the time-independent SE is a differential equation. For 2- and 3-dimensional problems, the time-independent SE is a partial differential equation with 2 or 3 variables. Which of the following statements about the time-independent SE is **false?**

(a) The time-independent SE can be written as $H\psi=E\psi$.
(b) The variable E in the time-independent SE indicates energy and is a scalar.
(c) The variable H in the time-independent SE is an operator whose definition includes the differentiation operator.
(d) The time-independent SE is obtained from the full SE by use of a technique called revolution.

$1600. Solutions to the time-independent SE are quantized, that is, only certain values of the energy yield acceptable solutions. Mathematically, this quantization results from

(a) The fact that currency is quantized and therefore only certain prices are allowable.
(b) The fact that atomic spectra are quantized.
(c) The fact that multiple choice tests are quantized.
(d) The requirement that the wave function and its derivative should be continuous everywhere, including points at which the potential energy changes.

$3200. Which of the following is not true about infinite square wells?

(a) Most infinite square wells contain water.
(b) An infinite square well means that the potential energy is zero inside the well and infinity outside the well.
(c) The requirement that the wave function should go to zero (i.e. vanish) on the boundary of an infinite square well leads to a quantization condition that the wave vector k must be an odd multiple of $\pi/2a$.
(d) The energy levels for a particle in an infinite square well are distributed parabollically, that is, proportional to an odd integer squared.

$6400. Quantized solutions to differential equations such as the time-independent SE can often be written as a superposition or sum of an infinite series of polynomials. Each of these polynomial terms has an order parameter n

that refers to the highest power in the polynomial. For example, solutions to the time-independent SE for a harmonic oscillator potential are Hermite polynomials H_n.In their standard form, these polynomials are orthonormal. Which of the following statements are orthonormality is true?

(a) Orthonormal polynomials are those that obey a Gaussian distribution function.
(b) A polynomial is orthonormal if the scalar or dot product of H_m and H_n is zero for $m \neq n$ and one for $m=n$.
(c) An orthonormal polynomial has a maximum value of n.
(d) Orthonormal polynomials are usually found in organic molecules.

$12800. Information is extracted from wave functions by calculating expectation values. These expectation values rely on the fact that the norm squared of a wave function is proportional to the probability of finding a particle in a specific location. Which of the following statements about expectation values is false?

(a) The expectation value of a parameter x is written as $\langle x \rangle$.
(b) Calculating the expectation value of a function f(x) involves an integration over all space in which the integrand is f(x) times the norm squared of the wave function.
(c) The expectation value of a quantity such as $\langle x^2 \rangle$ can be used to calculated the variance (standard deviation squared) which is a measure of the distribution width of the variable x.
(d) The uncertainty principle requires that expectation values of all parameters must be zero.

$25600. Consider an electron in a 3-dimensional infinite square well with dimensions $x=\pm 1$ Angstrom, $y=\pm 1$ Angstrom, $z=\pm 2$ Angstroms. The mass of an electron is 9.1×10^{-31} kg. Calculate the first eight energy levels. Indicate which levels are degenerate.