quantum mechanics.[2] The major distinction between quantum mechanics and classical mechanics is that quantum mechanics hypothesizes that energy changes of systems occur in discrete rather than continuous amounts. The concept of discrete energy levels can be established by investigating the time-independent Schroedinger equation and the implications of its solution.

Note to the Student. The following paragraphs introduce some concepts of quantum mechanics that are used in statistical thermodynamics. The Schroedinger equation and its solution are presented for a simple yet realistic and important case. The formulation of the Schroedinger equation and the techniques of its solution are not objectives of this unit. The implications of the solution, i.e., that it predicts discrete energy magnitudes for particles and provides a means of calculating these energies, are of paramount importance. Study this material to be convinced that these conclusions are correct. The examples and exercises are intended to reinforce concepts. The post unit exam does not contain problems similar to the numerical exercises included in this section.

The time-independent Schroedinger equation is a second-order partial differential equation which in cartesian coordinates has the form

$$\frac{h^2}{8\pi^2 m^*}\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)\psi(x,y,z)+[\varepsilon - V(x,y,z)]\,\psi(x,y,z)=0$$

where h is Planck's constant ($h = 6.625 \cdot 10^{-27}$ erg-s particle), m^* is the mass of the particle, ε is the energy of the particle, and $V(x,y,z)$ is the potential in the domain of the particle at point (x,y,z). The dependent variable, $\psi(x,y,z)$, is the particle's *wave function*. It is related to the particle's *position probability* by

$$P(x,y,z) = |\psi(x,y,z)|^2 \qquad \text{(IIIA-1)}$$

The position probability for a particle, is the probability that its center of mass will be at the position (x,y,z).[3]

As an example solution of the Schroedinger equation, we solve the case of a *point particle* in a field-free rectangular box of dimension $L_x \cdot L_y \cdot L_z$.[4] A field-free space is one for which the potential function, $V(x,y,z)$, is zero. Particles in such spaces are called *free particles*. The Schroedinger equation for this system is

$$\frac{\partial^2\psi(x,y,z)}{\partial x^2}+\frac{\partial^2\psi(x,y,z)}{\partial y^2}+\frac{\partial^2\psi(x,y,z)}{\partial z^2}+\frac{8\pi^2 m^*\varepsilon}{h^2}\psi(x,y,z)=0 \qquad \text{(IIIA-2a)}$$

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[2] Though the Newtonian limit is not applicable in general, we will find that each particle model has a characteristic temperature above which the Newtonian approximation is adequate (IIIC).

[3] Predicting particle position in time requires the time-dependent form of the Schroedinger equation.

[4] The point particle implies vanishing size.