國立中央大學八十八學年度碩士班研究生入學試題卷

所別: 物理研究所 不分組 科目: 近代物理 共 1 頁 第 1 頁

Modern Physics
(1999.5.2)

(20分) 1. A quantum-mechanical system in the absence of perturbations can exist in either of two states 1 or 2 with energies E_1 and E_2. Suppose that it is acted upon by a time independent perturbation $V = \begin{pmatrix} 0 & V_{12} \\ V_{21} & 0 \end{pmatrix}$. If at time t = 0, the system is in state 1, determine the amplitudes for finding the system in either state at any later time. (Hint: The Hamiltonian is Hermitian.)

(20分) 2. Consider the one-dimensional Schrodinger equation with $V(x) = \begin{cases} \frac{m}{2}\omega^2 x^2, & \text{for } x > 0 \\ +\infty, & \text{for } x < 0. \end{cases}$ Find the energy eigen-values.

(20分) 3. An electron is contained inside a sphere of radius R. What is the pressure P exerted on the surface of the sphere, if the electron is in the lowest energy state. (Hint: the lowest state is one of the S-polarized states and consider the spherical symmetry.)

(20分) 4. Consider a particle in one-dimension. The wave function is given by $\varphi(x) = \begin{cases} A\cos\frac{\pi x}{a} e^{-iEt/\hbar}, & \text{for } |x| \le a/2 \\ 0, & \text{for } |x| \ge a/2 \end{cases}$. Please evaluate the expectation values of x, p, x^2, and p^2 for the particle associated with this wave function.

(20分) 5. The probability of finding a particle at energy E is $|A_E|^2 = \frac{1}{(E-E_0)^2 + (\hbar\gamma/2)^2}$, which has a peak at E_0. Find (a) the characteristic width of ΔE and the mean lifetime of the state. (b) Can you obtain the result of the Heisenberg uncertainty relation from the above values?

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