國立嘉義大學九十五學年度
光電暨固態電子研究所碩士班招生考試試題

科目：近代物理

Coulomb constant $\frac{1}{4\pi\varepsilon_0} = 9\times10^9$ N·m^2/C^2 ；Planck's constant $h = 6.626\times10^{-34}$ J·s

Rest mass of electron $m_e = 9.1\times10^{-31}$ kg；Rest mass of proton $m_p = 1.67\times10^{-27}$ kg

第一部分：計算題

1. The atom of positronium consists of an electron and a positron orbiting about each other.
   (a) Find the Bohr radius of this system. (8%)
   (b) Find the longest wavelength of the photon released in the transition to n = 1. (7%)

2. Consider a system of three noninteracting, identical spin 1/2 particles that are in the same spin state $\left|\frac{1}{2},\frac{1}{2}\right\rangle$ and confine to move in a one-dimensional infinite potential well of length a: $V(x)$ = 0 for 0 < x < a and $V(x) = \infty$ for other values of x. Determine the energy and wave function of the ground state. (15%)

3. (a) Write down the quantum number for the states described in spectroscopic notation as：
   $^2S_{3/2}$, $^5P_3$, $^3D_2$. (8%)
   (b) Determine these states are possible or impossible, and explain why. (7%)

4. (a) Considering a collision between a photon with energy and momentum (E_0, p_0) and a free stationary electron, derive the Compton equation by means of the quantum explanation and relativistic theory. (8%)
   (b) In what region of the electromagnetic spectrum will be dominated by the Compton scattering, please specify why? (Compton wavelength = 0.0243 Å) (7%)

5. The optical electron configuration of an atom with two optically active electrons is 3d^2. The energy levels of the atom are in spin-orbit (LS) interactions.
   (a) Find the possible values of quantum numbers s', ℓ' and j', where s', ℓ' and j' are total spin, total orbital and total atomic angular momentum quantum numbers, respectively. (8%)
   (b) Indicate the splitting of the energy levels by a typical LS coupling configuration. You have to label quantum numbers and spectroscopic notations of the energy levels. (7%)

第二部分：解釋名詞

1. Wien displacement law (5%)
2. De Broglie wavelength (5%)
3. Paschen-Bach effect (5%)
4. Zeeman effect (5%)
5. Rayleigh scattering (5%)