國立政治大學　106　學年度 碩士班 招生考試試題

考試科目	近代物理 81622	系所別	應用物理研究所	考試時間	2 月 19 日(星期日)第 二 節

1. Explain in equations and/or reasoning the following terms: (20%)
   A. Anomalous Zeeman effect
   B. Compton effect
   C. White dwarf star
   D. Nuclear fusion

2. An electron and a positron are moving along a straight line toward each other with the same individual speed of $c/2$. c is the speed of light. (a) What is the relative speed between the two particles? After the electron-positron annihilation two photons are created. Calculate (b) the frequency and (c) momentum of each photon. Express your answers in terms of c, the electron mass m, and the Planck constant h. (20%)

3. An electron of mass m is confined within a one-dimensional wire segment of length L and subject to the potential of an infinite square well. (a) Calculate the allowed energy values of the electron. If there are now 10 non-interacting electrons with spins trapped inside the same wire segment, calculate (b) the Fermi energy and (c) the total energy of the 10-electron system at T = 0 K. (d) If the 10-electron system is to be optically excited, what is the minimum frequency of the photon? Express your answers in terms of m, L and h. (20%)

4. The radial wave function of a 1s electron in a hydrogen atom is $R(r)=\frac{2}{a_0^{3/2}}e^{-r/a_0}$, where a_0 is Bohr radius. The probability of finding the electron between r and $r+dr$ is $P(r)dr=|R(r)|^2 r^2 dr$. (a) Calculate the expectation value of the radial distance r. (b) Find the most probable value of r. (20%) (Hint: $\int_0^\infty x^3 e^{-bx}dx=\frac{6}{b^4}$)

5. The hydrogen molecule H_2 can be considered as a simple harmonic oscillator with a force constant of 573 N/m. (a) Find the reduced mass of the oscillator and the oscillating angular frequency. (b) Find the energy (in eV) of its ground and first excited vibrational states. (c) Find the vibrational quantum number that approximately corresponds to its 4.5 eV dissociation energy. (20%) (1 atomic mass unit = 1.66×10^{-27} kg, $\hbar = h/2\pi = 1.055\times10^{-34}$ J·s = 6.582×10^{-16} eV·s)

備註	一、作答於試題上者，不予計分。 二、試題請隨卷繳交。