國立中山大學 104 學年度碩士暨碩士專班招生考試試題

科目名稱：近代物理【物理系碩士班】　　題號：423002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答計算題）共 1 頁第 1 頁

1. (20%) Explain the following terms
   (a) (5%) Normal Zeeman effect
   (b) (5%) Spin-orbital interaction
   (c) (5%) Franck-Hertz experiment
   (d) (5%) How to obtain the Planck constant experimentally?

2. (20%) Eight identical and non-interacting particles are placed in a cubical box of sides L=0.4 nm. Find the lowest energy of the system (in eV) and list the quantum numbers of all occupied states if (a) (10%) the particles are electrons and (b) (10%) the particles have the same mass as the electron but do not obey the exclusion principle.

3. (20%) (a) (5%) The wavelength of Compton-scattered photons is measured at $\theta = 90^{\circ}$, if $\Delta\lambda/\lambda \sim 1\%$, what is the wavelength of the incident photon? (b) (15%) Can a photon transfer all of its energy to a free electron? *Must be answered mathematically. No point for just "yes" or "no".*

4. (20%) For an electron in a one-dimensional infinite square well of width L, find (a) (5%) $< x >$, (b) (5%) $< x^2 >$, and (c) (5%) Δx. (d) (5%) What is the probability of finding the electron between x = 0. 2 L and x = 0.4 L if the electron is in n=5 state.

5. (20%) The electron is bound to the proton in a hydrogen atom due to the Coulomb force. Now assume that electric charge did not exist and the electron was bound to the proton by the gravitational force to form a hydrogen atom, please derive the corresponding expressions for (a) (8%) the Bohr radius a_o and (b) (7%) energy E_n. (c) (5%) Compute the smallest frequency of the Balmer series. ($G \sim 6.67 \times 10^{-11}\, N\, m^2/Kg^2$)