科目：近代物理(2003)

校系所組：中央大學光電科學與工程學系照明與顯示科技碩士班
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I. Multiple choice (5% each)〈單選題，答錯扣該題 1. 25 分，不作答不扣分也不計分〉

1. The wavelength of Cu K_α fluorescence photons is 1.5406Å. What is the photon energy? (A) 4510.8 eV (B) 8048.2eV (C) 14958.4eV (D) 17479.3eV (E)26359.1 eV.
[Hint: Planck's constant h=4.1357x10^{-15} eVs. Speed of light c=2.9979x10^8 m/s]
2. The energy of electron orbitals in an unperturbed hydrogen-like atom is determined by what quantum number? (A) n (B) l (C) m (D) s (E) m_s
3. What combination of perturbation terms lifts the energy of $2P_{3/2}$ while leaving $2S$ and $2P_{1/2}$ degenerate in the hygroden-like atom model?
(A) Lamb shift and hyperfine splitting (B) Zeemann splitting and Stark effect (C) Lamb shift and L-S coupling (D) relativistic correction and L-S coupling (E) Zeemann splitting and relativistic correction.
4. When light is shined on an atom, what perturbation method is used for calculating the transition of electrons in the atom? (A) time-independent non-degenerate perturbation (B) time-independent degenerate perturbation (C) time-dependent perturbation (D) all of the above (E) non of the above
5. What in the following is used to calculate the transition probability for electrons in an atom in the presence of electromagnetic wave? (A) Pauli's exclusion principle (B) Heisenberg's uncertainty principle (C) the selection rule (D) Fermi's golden rule (E) equivalence principle
6. Consider a 1-D rectangular potential well of depth V and width w. Which statement is true? (A) There exists a bound state of odd parity no matter how shallow the well is. (B) There exists a bound state of even parity no matter how shallow the well is. (C) There can be bound states only when $V>w$. (D) There can be bound states only when $V<w$. (E) None of the above.
7. In quantum mechanics, which two physical quantities can be simultaneously determined? (A) $\mathbf{r}$ and $\mathbf{p}$ (B) L_x and L_y (C) L^2 and L_z (D) p_x and L_y (E) x and L_z [Note: position $\mathbf{r}=(x,y,z)$, momentum $\mathbf{p}=(p_x,p_y,p_z)$, angular momentum $\mathbf{L}=(L_x,L_y,L_z)$]
8. A particle can have zero kinetic energy when (A) it is a free particle (B) it is confined in a finite box of impenetrable walls (C) it is confined in a finite potential well (D) it is restrained by a spring (E) it is bonded to another particle.
9. A particle is subject to a net force represented by a potential U. If the z-component of its angular momentum is a constant of motion, then (A) U is zero (B) U has mirror symmetry (C) U is independent of time (D) U has translational symmetry (E) U has rotational symmetry.
10. What was revealed by the Stern-Gerlach experiment? (A)e/h (B)e/m_e (C) energy gap in crystals (D) energy levels of a hydrogen atom (E) spin angular momentum of electrons.

注意：背面有試題

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II. A particle in the infinite square well with width a has the initial wave function $\Psi(x,0)=A[\psi_1(x)+\psi_2(x)]$, where $\psi_1(x)$ and $\psi_2(x)$ are the eigenfunctions of the ground state and the first excited state, respectively. (a) Find $\psi_1(x)$ and $\psi_2(x)$, and the associated eigenenergies. (4%) (b) Find $\Psi(x,t)$ and $|\Psi(x,t)|^2$. To simplify the results, let $\omega\equiv\pi^2\hbar/2ma^2$. (5%) (c) Compute the expectation values of x and p at t. (6%) (d) If you measured the energy of this particle, what energy you might get, and what is the probability of getting each of them? Find the expectation value of energy. (5%)

III. (a) What are spins of fermions and bosons, respectively? (b) Write down the statistical distributions fermions and bosons follow, respectively. (You do not have to prove them.) (c) Give *two* examples for each case. (4% each)

IV. Using the example of a free particle wave packet passing a particular point in space and to estimate $\Delta E\Delta t$, given the uncertainty principle $\Delta x\Delta p \geq \frac{\hbar}{2}$. (6%)

V. Explain the following sujects: (a) cosmic microwave background; (b) superconductors; (c) graphene; (d) dark energy. (3% each)