國立臺灣師範大學100學年度碩士班招生考試試題

科目：近代物理　　適用系所：物理學系

注意：1.本試題共 2 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

Boltzmann constant: $k_B = 1.38 \times 10^{-23}$ J/K;
electron mass: $m_e = 9.11 \times 10^{-31}$ kg;
elementary charge: $e = 1.60 \times 10^{-19}$ C;
Planck's constant: $h = 6.63 \times 10^{-34}$ J·s;
speed of light in vacuum $c = 3.00 \times 10^{8}$ m/s

1. Explain the following terms [12 points]
   (a) giant magnetoresistance
   (b) charge coupled device
   (c) exchange force
   (d) nuclear fusion

2. The Michelson-Morley experiment [15 points]
   (a) Show the schematic drawing of experimental setups, and explain the experimental principle and the important findings of the Michelson-Morley experiment.
   (b) If ether does exist, calculate the fringe shift by using the speed of the earth about the Sun (3×10^4 m/s), path length at 8 m, and red light of 650 nm.

3. Typically, the kinetic energy of accelerated electrons for TEM (transmission electron microscopy) is 300 keV. What is the velocity of the electrons? [10 points]

4. Calculate the atomic spacing on a crystal surface from the experimental results of electron diffraction with the second consecutive diffraction maxima at $\varphi = 54.9^{\circ}$ for 100 eV-electrons. φ is the angle between the incident and diffracted beams.
   ($\sin 54.9^{\circ} = 0.82$) [15 points]

5. For a particle moving in an infinite square well, $V(x) = 0$ for $|x| < L/2$ and $V(x) = \infty$ for $|x| \geq L/2$.
   (a) Write down the time-dependent Schrödinger equation (TDSE). Use the method of separation of variables to obtain the time-independent Schrödinger equation (TISE) and to solve the part depending on time *t*. [8 points]
   (b) Starting from solving the TISE, derive the eigenfunctions and energy eigenvalues. [10 points]

6. A particle is confined to a three-dimensional (3D) box that has sides L_x, L_y, and L_z with $L_x=L_y=L_z=L$. For a particle in the ground state in a one-dimensional box, the energy is $E_1=\frac{\hbar^2\pi^2}{2mL^2}$. In such a 3D box, what are the energies (in terms of E_1) and degeneracy of a particle in the first excited state, second excited state and third excited state? [15 points]

7. (a) Write down the spectroscopic notations of an electron in the state of $n=2$, $\ell=1$ and $s=½$. [5 points]

   (b) Auger electrons are classified by referring the energies involved in their production. After excitation with high energy electrons, a hole in the K shell may be filled by transition from a higher shell, say L_1. If the emitted electron, excited by energy transfer, originates from the L_2 shell, then this Auger electron is called KL_1L_2 electron in the standard notation. Two final states $2s^1p^5$ are possible for the doubly ionized atom after a KL_1L_2 transition. Show the final states in the spectroscopic notation. [10 points]