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國立臺北科技大學 108 學年度碩士班招生考試

系所組別：2403 光電工程系碩士班

第二節近代物理試題（選考）

第一頁 共一頁

注意事項：

1. 本試題共 6 題，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

electron mass $m_e = 9.11 \times 10^{-31}$ kg

electron charge $e = -1.6 \times 10^{-19}$ C

Planck constant $h = 6.63 \times 10^{-34}$ Js

light speed $c = 3.0 \times 10^8$ m/s

1. (1) 1.5 mW of 400-nm light is directed at a photoelectric cell. If only 0.1% of the incident photons produce photoelectrons, find the current in the cell. (7%)
(2) What is the frequency of an x-ray photon whose momentum is 1.1×10^{-23} kg m/s? (8%)
2. When a metal is illuminated with light of frequency f , the maximum kinetic energy of the photoelectrons is 1.3 eV. When the light frequency is increased by 50%, the maximum kinetic energy increases to 3.6 eV. What is the threshold frequency of this metal? (10%)
3. An electron microscope is to be used to measure atoms whose dimensions are 3.5×10^{-10} m. For accuracy, one must use wave with wavelengths ten times smaller than the sizes being measured. What is the minimum energy (in eV) that the electrons need in order to be usable in this application? (10%)
4. Consider a one-dimensional, infinitely deep potential energy well of width L :

$$U(x) = \begin{cases} 0 & \text{for } 0 < x < L \\ \infty & \text{elsewhere} \end{cases}$$

The electron mass is m and the Planck constant is h .

- (1) For an electron trapped in the potential well, find the energy levels E_n of this electron and the corresponding normalized wavefunctions ψ_n by solving the stationary Schrödinger's equation. (15%)

- (2) Following (1), if the electron is in its ground state, calculate the probability that the electron can be detected in the left one-third of the well ($0 < x < L/3$). (10%)
 - (3) If there are 7 electrons trapped in this potential well, what is the energy of the ground state of this system? Assume that the electrons do not electrically interact with one another. (10%)
 - (4) What are the energies of the first two excited states for the situation of question (3)? (10%)
5. A ruby laser operates at a wavelength of 694 nm. A certain ruby crystal has 4.0×10^{19} Cr ions (which are the atoms that lase). The lasing transition is between the first excited state and the ground state and the output is a light pulse lasting 1.5×10^{-6} s. As the pulse begins, 60% of the Cr ions are in the first excited state and the rest are in the ground state. What is the average power emitted during the pulse? (10%)
 6. A beam of electrons enter a uniform 1.2-T magnetic field. Find the wavelength of the radiation that can cause the electrons whose spins are parallel to the field to flip so that their spins are antiparallel. (10%)