國立成功大學 106 學年度碩士班招生考試試題

系　所：光電科學與工程學系

考試科目：近代物理

考試日期：0214，節次：1

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (12%) Describe below in brief
   a) Photoelectric effect
   b) Auger electron generation
   c) Boltzmann distribution
   d) Blackbody radiation
2. (12%) An electron in the $n = 5$ state of hydrogen makes a transition to the $n = 2$ state. What are the energy and wavelength of the emitted photon? (Hint: The ionization energy of the hydrogen atom in its ground state is 13.6 eV. 1 eV = 1.602×10^{-19} Joules)
3. (20%) According to quantum mechanism, electromagnetic radiation of frequency ν can be regarded as consisting of photons of energy hν.
   a) What is the energy range of near infrared wavelengths (660-1300 nm)?
   b) At a given power of an electromagnetic wave, do you expect a classical wave description to work better for microwave, or vacuum ultraviolet (why?).
4. (6%) Assume that a certain 600-Hz tuning fork can be considered as a harmonic oscillator whose vibrational energy is 0.04 J. Compare the energy quanta of this tuning fork with those of an atomic oscillator that emits and absorbs orange light whose frequency is 5.00×10^{14} Hz.
5. (10%) Compared to the electron Compton wavelength, the Bohr radius of the hydrogen atom is approximately (explain your answer in detail)
   a) 100 times larger.
   b) 1000 times larger.
   c) about the same.
6. (15%) An electron is in a potential well of thickness 1 nm, with infinitely high potential barriers on either side. It is in the lowest possible energy state in this well. What would be the probability of finding the electron between 0.1 and 0.2 nm from one side of the well?
7. (10%) For the hydrogen atom,
   a) How many states are there with principal quantum number $n = 3$?
   b) How many of these states have the same energy?
8. (15%) Conventionally, we express Bloch functions within the first Brillouin zone, which for a simple one-dimensional crystal of repeat length a is the range $-\pi/a \leq k \leq \pi/a$. We could instead consider k values lying outside this range. Show, however, that any such Bloch function (i.e., a function of the form $\psi(x)=u(x)exp(ikx)$, where $u(x)$ is a function periodic with repeat length a) for any k_{new} outside this first Brillouin zone can also be expressed as a Bloch function with a k value inside the first Brillouin zone. (Hint: Any k_{new} lying outside the first Brillouin zone can be written as $k_{new}=k+2n\pi/a$) for some positive or negative integer n.)