國立彰化師範大學 101 學年度碩士班招生考試試題

系所： 電子工程學系　　　　組別： 甲組　　　　科目： 近代物理

☆☆請在答案卷上作答☆☆　　　　　　　　　　　　　　共 2 頁，第 1 頁

Physical constants:

Planck's constant h = 6.626×10^{-34} J-s., c = 3×10^8 m/sec, $m_e = 9.1 \times 10^{-31}$ kg.

e = 1.602×10^{-19} C , $\varepsilon_0 = 8.854 \times 10^{-12}$ C^2/N·m^2 ,

The Boltzmann's constant $k_B = 1.38 \times 10^{-23}$ J/K.

1. (a) The energy density distribution of the radiation in the cavity can be expressed by Planck's law as

    $u_\nu(\nu) = \dfrac{8\pi h \nu^3}{c^3(e^{h\nu/kT}-1)}$. Prove that it can also be expressed as a function of wavelength

    $u_\lambda(\lambda) = \dfrac{8\pi h c \lambda^{-5}}{e^{hc/\lambda kT}-1}$.　(10%)

    (b) A narrow band pass optical filter centering at 950 nm is inserted in front of a AlGaAs semiconductor photodetector. The detector is used to measure the blackbody radiation intensity of a metal surface at 27℃ and 700℃. What will be the photocurrent signal ratio? (Assume both the emissivity of the metal and the responsivity remain constant.)　(10%)

2. In photoelectric effect experiment, a metal is illuminated by a blue laser with 405 nm wavelength and the stopping potential is 1.09 eV. If a green laser with a wavelength of 532 nm is used, then the stopping potential is 0.41 eV. Calculate the Planck's constant and the work function of the metal. (20%)

3. (a) Use the Bohr model of the hydrogen atom to prove that the quantized energy levels of the H atom

    is $E_n = -\dfrac{me^4}{2(4\pi\varepsilon_0)^2 n^2 \hbar^2}$.　(10%)

    (b) Calculate the wavelength of the L_α x-ray emitted by the H atom.　(5%)

4. Electrons in an metal was pumped to an excited state. They stays at the excited state for a lifetime of 1×10^{-9} second and then returned to the ground state by emitting photons. Calculate the minimum frequency line-width of the emitted spectrum.　(10%)

5. (a) Write down the operator corresponding to the x-component of momentum.　(5%)

    (b) Then explain the relationship between the operator and experimentally measured momentum. (5%)

    (c) Both Bohr's model and the Schrodinger equation can be used to calculate the quantized energy levels of H atoms. What is the advantage of the Schrodinger equation compared with Bohr's model?　(5%)

    More on next page…

6. Draw the wave function (n=4) for a particle confined in an infinite potential well as illustrated in the figure. Please label x-coordinate clearly in your plot. (10%)
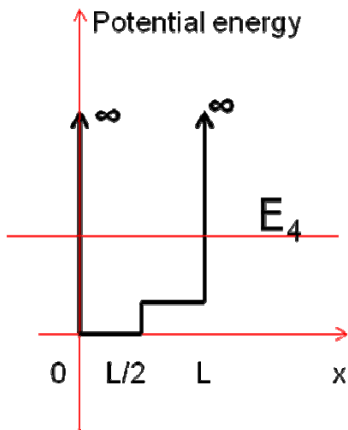
7. Explain how a KLL Auger electron can be generated. (10%)