國立彰化師範大學 102 學年度碩士班招生考試試題

系所：電子工程學系　　組別：甲組(選考乙)　　科目：近代物理

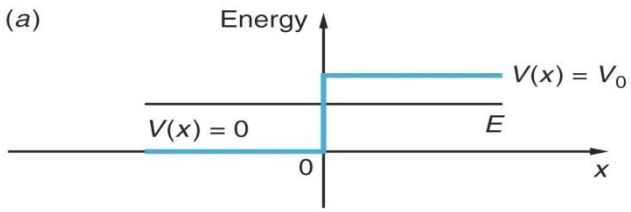
☆☆請在答案紙上作答☆☆　　

Physical constants:

Planck's constant h = 6.626×10^{-34} J-s, c = $3\text{x}10^{8}$ m/sec, $\varepsilon_0 = 8.854\text{ x }10^{-12}$ $C^2/N\cdot m^2$,

$m_e = 9.1\times10^{-31}$ kg, e = $1.602\text{ x }10^{-19}$ C , The Boltzmann's constant $k_B = 1.38\times10^{-23}$ J/K.

1. The energy density spectral distribution function $u(\lambda) = 8\pi k_B T\lambda^{-4}$ is derived by Rayleigh based on classical theory. It does not agree with experimental data and this phenomenon is call "ultraviolet catastrophe". Please explain what does "ultraviolet catastrophe" mean. (10%)
2. In a Compton Effect experiment, It is found that the incident wavelength λ_1 is shifted by 1% when the scattering angle $\theta = 120^o$. Calculate the wavelength of λ_1. What will be the wavelength λ_2 of the shifted photon if the scattering angle is 60^o? (20%)
3. Rydberg-Ritz equation is $\frac{1}{\lambda_{mn}} = R\left(\frac{1}{m^2} - \frac{1}{n^2}\right)$ *for* $n > m$, where m and n are integers. Please calculate the value of R (in MKS unit) based on Bohr's atomic model. Then calculate the shortest wavelength of the Balmer series. (20%)
4. In Moseley plot, the frequencies of the K series can be expressed as $freq. = cR(z-1)^2\left(1 - \frac{1}{n^2}\right)$. Explain why it is $(z-1)^2$ in the formula rather than z^2 that shows up in Bohr's model? (10%)
5. One of the boundary conditions that a wavefunction must satisfy in quantum theory is $\int_{-\infty}^{+\infty}\psi^*(x)\psi(x)dx = 1$. Please explain what does it mean based on Born's interpretation. (10%)
6. A particle with total energy E incident from left hand side. There is a potential energy difference at $x = 0$ as illustrated in the plot. Prove that the reflection coefficient is 1 and plot the wavefunction. (20%)



7. The lifetime of an excited state of an atom is 2×10^{-7} sec. What is the width of the emitted frequency spectrum? (10%)