國立彰化師範大學103學年度碩士班招生考試試題

系所：光電科技研究所　　選考乙　　科目：近代物理

☆☆請在答案紙上作答☆☆　　

- ✓ Planck's constant = 6.626×10^{-34} J-s, Boltzmann's constant = 1.38×10^{-23} J/K or 8.62×10^{-5} eV/K.
- ✓ electron charge = 1.602×10^{-19} C , electron mass = 9.11×10^{-31} kg

1. The total energy of a proton is ten times its rest energy. What is the proton speed in c ? **(10%)**

2. A light source of wavelength λ illuminates on a metal and ejects photoelectrons with a maximum kinetic energy of T. A second light source with half of the wavelength of the first light ejects photoelectrons with a maximum kinetic energy of $1.5T$. What is the kinetic energy T in hc/λ? **(20%)**

3. A beam of x-ray with wavelength $\lambda_c = h/mc$ (m is the mass of electron, c is the speed of light and h is the Plank constant) is directed toward a sample. The x-rays scatter from the electrons within the sample, imparting momentum to the electrons, which are initially at rest in the lab frame. After scattering, the x-rays are detected at various angles relative to the direction of the incoming beam using a detector that can resolve their wavelengths. **(20%)**

(a) What is the longest wavelength measured by the detector?

(b) If the wavelength of the scattered x-rays was detected to be $1.5\ \lambda_c$, what is the x-ray scattering angle?

4. Please answer the following questions: **(30%)**

(a) From Heisenberg uncertainty principle, please derive the uncertainty principle relation between energy and time for photons.

(b) The lifetime of a typical excited state in an atom is about 10 ns. Suppose an atom falls from one such excited state and emits a photon of wavelength about 600 nm. Find the fractional energy uncertainty ΔE/E.

(c) Please derive the wavelength uncertainty Δλ/λ from the fractional energy uncertainty ΔE/E and then calculate the wavelength uncertainty Δλ/λ of this photon.

5. An electron with 180 eV of kinetic energy in free space passes over a finite potential well of 60 eV deep that sketches from x = 0 to x = 1 nm. **(20%)**

(a) Please calculate the electron's wavelength in free space and when over the well.

(b) Please write down the possible form of wave function for this electron and sketch a possible wave function shown on a potential energy diagram as function of x.