國立中央大學107學年度碩士班考試入學試題

所別： 光電科學與工程學系 碩士班 不分組(一般生)　　共1頁 第1頁

科目： 近代物理

本科考試可使用計算器，廠牌、功能不拘　　＊請在答案卷(卡)內作答

1. (a)The surface temperature of the sun is about 5500°C. Assuming that the sun radiates like an ideal blackbody, at what wavelength does the peak of the solar spectrum occurs? (b) The human body temperature is about 39°C. Assuming that the human body radiates like an ideal blackbody, at what wavelength does the peak of the solar spectrum occurs? The wavelength is in the ultraviolet, visible or infrared region? (20 %) (Wien's displacement law: $\lambda_m T = 2.898 \times 10^{-3} m \cdot k$)
2. The wavelengths of visible light range from 400nm to about 700nm. (a) What is the range of Photon energies (in eV) in visible light? (b) A typical FM radio station's broadcast frequency is 104.9MHz. What is the energy of an FM photon of that frequency? (20 %) (Planck's constant $h = 6.626 \times 10^{-34} J \cdot s$)
3. Calculate the wavelength of the H_r spectral line is emitted in the transition from n_i=5 to n_f=2. (10%) (Rydberg constant, $R = 1.097 \times 10^{7} m^{-1}$)
4. For an atom having two valence electrons, one in the *4p* and the other in the *4d* state. Using the LS coupling scheme, list all the possible atomic states and plot their relative energies. (10%)
5. Consider that a particle with mass *m* is constrained inside a cubic box with the length *L* along the x, y, and z axes. Calculate the energy and de Broglie wavelength of the second excited state. (10%)
6. For a particle with mass *m* in simple harmonic motion, where the potential energy is $V(x) = \kappa(x - x_0)^2/2$, calculate the uncertainty value $\Delta x \Delta p$ at the first excited state. (10%)
7. In the Rutherford scattering, a charge particle of mass *m*, charge $Z_1 e$, and speed v_0 is incident on the target nucleus of charge $Z_2 e$, the impact factor *b* is the closest distance of approach between the beam particle and the nucleus if the projectile continues in a straight line

$$b = \frac{Z_1 Z_2 e^2}{4\pi\varepsilon_0 m v_0^2} \cot\left(\frac{\theta}{2}\right),$$

where θ is the scattering angle. If θ=90 degree, what is the distance of the closest approach of the projectile to the target nucleus? Express in unit of *b*. (10%)

8. If confining an electron gas in a square region of length *L* on each side, what is the density of states (per unit area) for the gas of electrons with mass *m*? And if there are *N* electrons in the gas, what is the Fermi energy at T=0 K? (10%)

參考用