

※請在答案卷內作答

(所有試題皆為計算題，請詳列計算過程，無計算過程者不給分)

Rydberg constant,  $R = 1.097 \times 10^7 m^{-1}$ Planck's constant  $h = 6.626 \times 10^{-34} J \cdot s$ 

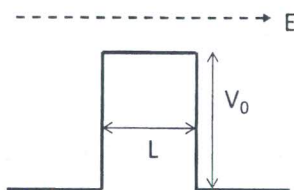
- (a) The surface temperature of the sun is about  $5500^\circ C$ . Assuming that the sun radiates like an ideal blackbody, at what wavelength does the peak of the solar spectrum occur? (b) The human body temperature is about  $36.5^\circ C$ . Assuming that the human body radiates like an ideal blackbody, at what wavelength does the peak of the spectrum occur? The wavelength is in the ultraviolet, visible or infrared region? (15 points) (Wien's displacement law:  $\lambda_m T = 2.898 \times 10^{-3} m \cdot k$ )
- Planck's law:  $u(\lambda) = \frac{8\pi hc\lambda^{-5}}{e^{hc/\lambda kT} - 1}$ , derive the expression in term of frequency  $f$ ,  $u(f) = \frac{8\pi f^2}{c^3} \frac{hf}{e^{hf/kT} - 1}$  (10 points)
- The wavelengths of visible light range from 380 nm to about 750 nm. (a) What is the range of photon energies (in eV) in visible light? (b) A typical FM radio station's broadcast frequency is 100 MHz. What is the energy of an FM photon of that frequency? (10 points)
- Calculate the wavelength of the  $H_\beta$  spectral line emitted in the transition from  $n_i=4$  to  $n_f=2$ . (5 points)
- What is the Bragg scattering angle  $\phi$  for electrons scattered from a nickel crystal if their energy is (a) 75 eV, (b) 100 eV? (10 points) ( $n\lambda = D \sin \phi$ ,  $D=0.215$  nm)

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參考用

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6. In the Compton scattering experiment, if the incident photon of wavelength  $\lambda$  is scattered at an angle of  $90^\circ$  relative to the incident direction, calculate (a) the momentum and (b) the kinetic energy of the scattered electron with a mass of  $m$  (10 points)
7. Put  $N$  helium atoms (each has a mass of  $m$ ) in the container with a volume of  $V$ , at what critical temperature does the Bose-Einstein condensation occur? (10 points) ( $\int_0^\infty \frac{u^{1/2}}{e^u - 1} du = 2.315$ )
8. Compute the emitted wavelengths of the  $2p \rightarrow 1s$  photon when a hydrogen atom is placed in a magnetic field of 5T. (10 points)
9. An electron with a mass of  $m$  is located in a potential well  $V(x) = A(x-B)^2 + C$ , what is the average value of kinetic and potential energy at the second excited state? (10 points)
10. Consider a potential barrier of height  $V_0$  and width  $L$  as follows:



If the total energy  $E$  of the particle (with a mass of  $m$ ) is greater than  $V_0$ , what is the condition of  $L$  for the highest probability of transmission? (10 points)

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