1070E04

國立臺北科技大學 107 學年度碩士班招生考試

系所組別：2403 光電工程系碩士班

第二節　近代物理　試題　（選考）

注意事項：

1. 本試題共 6 題，共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

electron mass $m_e = 9.11\times10^{-31} kg$　　electron charge $e = -1.6\times10^{-19} C$

Boltzmann constant $k_B = 1.38\times10^{-23}$ J/K　　Planck constant $h = 6.63\times10^{-34} J\cdot s$, $\hbar = \frac{h}{2\pi}$

light speed $c = 3.0\times10^{8} m/s$

1. (a) Find the matter wave wavelength for electrons of kinectic energy 56 eV (5%)

   (b) Calculate the atomic spacing in crystal that has a first diffraction maxima at $\phi = 65^{\circ}$ in the scattering of electrons of kinectic energy 56 eV. (5%)

2. Electrons with the energy of 8.0 eV are incident on a barrier 10.0 eV high and 0.5 nm wide. Find the transmission probabilities. (10%)

3. Maxwell Speed Distribution for gas Molecules at temperature T is

$$n(v) = \left(\frac{4\pi N}{V}\right)\left(\frac{m}{2\pi k_B T}\right)^{3/2} v^2 e^{-mv^2/2k_B T}$$

   (a)Please evaluate the most probable speed of a gas molecule (10%)

   Molecular energy distribution for gas Molecules at temperature T is

$$n(\varepsilon)d\varepsilon = \frac{2\pi N}{(\pi k_B T)^{3/2}}\sqrt{\varepsilon}e^{-\varepsilon/k_B T}d\varepsilon$$

   (b) Please evaluate the average molecular energy of an ideal-gas molecule(10%)

$$\left(\int_0^{\infty} x^{3/2}e^{-ax}dx = \frac{3}{4a^2}\sqrt{\frac{\pi}{a}}\right)$$

4. Plank radiation formula for spectral density $u(\lambda, T)$ is written in terms of wavelength λ as

$$u(\lambda, T) = \frac{2\pi c^2 h}{\lambda^5}\frac{1}{e^{hc/(\lambda k_B T)} - 1}$$

   (a) Please derived Wein's displacement law. (10%)

   (b) The brightest part of the spectrum of the Star Sirius is located at a wavelength about 300nm. What is the surface temperature of Sirius? (10%)

5. (a) Find the wavelength of the spectral line that corresponds to a transition in hydrogen from the n=6 state to the n=3 state. In what part of the spectrum is this? (10%)

   (b) Find the longest wavelength present in the Balmer series of hydrogen, corresponding to the Hα line.(10%)

6. A sample Hydrogen atom is suitably excited to 2p state.

   (a) Calculate the energy separation in the 2p state of atomic hydrogen placed in an external magnetic field of 2T. (5%)

   (b) **Illustrate** the all the possible states in 2p level. (5%)

   (c) Calculate the wavelength of the spectral line from n=2 to n=1 without magnetic field(5%)

   (d)How far apart are the Zeeman components of the λ_0 spectral line? (5%)