

國立中央大學 114 學年度碩士班考試入學試題

系所： 光電類

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科目： 近代物理

* 本科考試可使用計算器，廠牌、功能不拘

Boltzmann constant $k=8.617 \times 10^{-5}$ eV/K

Stefan-Boltzmann constant $= 5.67 \times 10^{-8}$ W/(m² · K⁴)

Electron mass $m_e=0.511$ MeV/c²

Planck's constant $h=6.626 \times 10^{-34}$ J · s

*計算題需計算過程，無計算過程者不予計分

1. (15 pts) Find the momentum of a 100-nm photon. When the photon is incident on a surface of Au (work function of 5.1 eV), what are the group and phase velocities of photoelectron? And what is the stopping potential for photoelectron?
2. (10 pts) Assume the Sun to radiate at a temperature of 6000 K, what is the intensity of the solar radiation emitted in the range of 600 nm to 602 nm? And what fraction of the total solar radiation does this represent?
Given the Planck's blackbody distribution: $I(\lambda) = \frac{2\pi hc^2}{\lambda^5} \frac{1}{e^{hc/\lambda kT} - 1}$
3. Gamma rays of energy 0.7 MeV are Compton scattered,
(a) (5 pts) What is the energy of the scattered photon observed at a scattering angle of 60°?
(b) (10 pts) What is the kinetic energy and scattering angle of the scattered electrons?
4. (10 pts) For a Li²⁺ ion in its first excited state, estimate the electron's kinetic energy using Bohr's model, and also estimate the lowest kinetic energy using the Heisenberg uncertainty principle. Express your results in terms of the Bohr radius a_0 and the electron mass m .
5. (10 pts) For a particle of mass m within an infinite or finite square-well potential of the same width L , compare the ground state energies for both wells and provide your explanation. What is the critical height of a finite square-well potential that supports only one bound state? Express your answer in terms of m and L .
6. (10 pts) Consider an electron with an energy of 5 eV passing a step potential with a height of 3 eV as follows, what is the probability of transmission?

注意:背面有試題

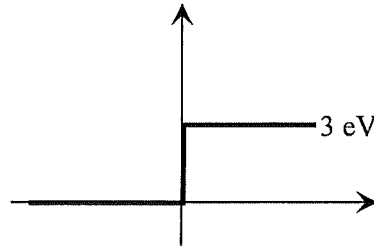
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第 2 頁 / 共 2 頁

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7. (10 pts) Consider a simple harmonic oscillator potential $V(x) = Ax^2 + B$
 - (a) For an electron with mass m in the potential, what is the average potential energy at the first excited state?
 - (b) For ten electrons with mass m in the potential, what is their average energy at $T = 0 \text{ K}$?
8. (10 pts) Derive the Fermi energy for a metal, expressing it in terms of the electron mass m and the electron density per unit volume n . Provide a detailed derivation.
9. (10 pts) If you use a spectrometer to measure the emission of a hydrogen atom in its first excited state and place it in an external magnetic field of 1 T , what wavelengths would you expect to observe?

注意:背面有試題