

編號：E 50 系所：光電科學與工程研究所

科目：近代物理

本試題是否可以使用計算機： 可使用， 不可使用（請命題老師勾選）**Physical constants:**Avogadro's number: $N_A = 6.02 \times 10^{23}$ particles/molBoltzmann's constant: $k = 1.38 \times 10^{-23}$ J/KCoulomb constant: $k = 8.987 \times 10^9$ N·m²/C²Fundamental charge: $e = 1.6 \times 10^{-19}$ CMass of electron: $m_e = 9.1 \times 10^{-31}$ KgMass of proton: $M_p = 1.67 \times 10^{-27}$ KgMass of unit: $u = 1.66 \times 10^{-27}$ KgPlanck's constant: $h = 6.6 \times 10^{-34}$ J·sSpeed of light: $c = 299792458$ m/sConstant of gravitation: $G = 6.67 \times 10^{-11}$ N·m²/Kg²Fine structure constant: $\alpha = 7.297 \times 10^{-3}$ Gas constant: $R = 8.3$ J/mol·KPermeability of free space: $\mu_0 = 4\pi \times 10^{-7}$ N/A²**1. Explain briefly**

(a) Photoelectric effect, (b) Compton effect, (c) Heisenberg's uncertainty principle. (15%)

2. Photoelectric effect

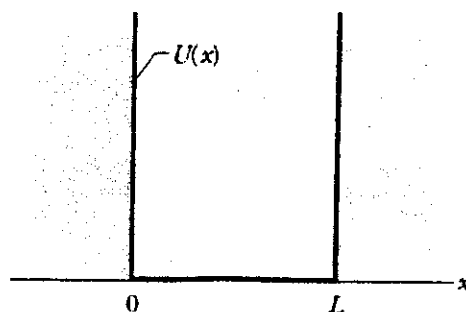
In a photoelectric experiment using a sodium surface, you find a stopping potential of 1.85 V for a wavelength of 300 nm and a stopping potential of 0.820 V for a wavelength of 400 nm. From these data find (a) a value for the Planck constant, (b) the work function Φ for sodium, and (c) the cutoff wavelength λ_0 for sodium. (15%)

3. Quantum number

(a) For a given value of the principal quantum number n , how many values of the orbital quantum number l are possible? For a given value of l how many values of the orbital magnetic quantum number m_l are possible? (b) For a given value of n , how many values of m_l are possible? (10%)

4. An electron in an infinite well (見下圖)

An electron is confined to a one-dimensional, infinitely deep potential energy well of width $L = 100$ pm. (a) What is the smallest amount of energy the electron can have? (b) How much energy must be transferred to the electron if it is to make a quantum jump from its ground state to its second excited state? (10%)



(背面仍有題目,請繼續作答)

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5. 名詞解釋 (15%)

- (a) Pauli exclusion principle (5%)
- (b) Hall effect (5%)
- (c) Cooper pairs (5%)

6. According to the free-electron model, show that the resistance R of a length L of wire is given by $R = mL/nAe^2T$, where A is the cross-sectional area of the wire, T is the mean time between collisions, m is the electron mass, e is the electron charge, and n is the numbers of electron per unit volume. (10%)

7. (a) Write down the Schrödinger equation for a particle in three dimensions moving under the action of a spherically symmetrical elastic force with an elastic coefficient, K . (b) Do the same for a charged particle moving in a Coulomb field. (10%)

8. A particle is in the ground state in a potential well of length a . At time $t=0$ the wall at $x=a$ is suddenly moved to $x=2a$. Calculate the probability that, at time $t>0$, (a) the energy of the particle is the same as before $t=0$; and (b) the energy of the particle is less than before $t=0$. (15%)