

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

科目名稱：近代物理【光電所碩士班選考】

題號：435003

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）

共 1 頁第 1 頁

一、簡答題：

1. The pion has an average lifetime of 26.0 ns when at rest. For it to travel 10.0 m, how fast must it move? _____ (5 分)
2. A proton has a kinetic energy of 1MeV. If its momentum is measured with an uncertainty of 5.0%, what is the minimum uncertainty in its position? _____ (5 分)
3. The density of gold is 19 g/cm³, and its molar weight is 197 g/mol. What is the Fermi energy of gold at 0 K? _____ (5 分)
4. (a) What is the associated operator of energy [E]? _____ (3 分)
(b) What is the associated operator of momentum [P]? _____ (3 分)

二、討論題：

5. For the simple harmonic oscillator, the potential energy function is $U(x)=1/2 m\omega^2x^2$,
 - (a) Write down the time-dependent Schrodinger equation. (5 分)
 - (b) Derive state energy and wavefunction from Schrodinger equation. (15 分)
 - (c) Use uncertainty principle to calculate the ground-state energy of a harmonic oscillator. (10 分)
 - (d) How do the quantum probabilities agree well with classical probabilities? (5 分)
6. The central force on an atomic electron is one directed toward a fixed point, the nucleus.
 - (a) Derive the radial wave equation with orbital quantum number ℓ and magnetic quantum number m . (10 分)
 - (b) For hydrogen-like atom, the force is the coulomb force, with its associated potential energy $U=kZe^2/r$. Calculate the radial wave functions $R_{n\ell}(r)$ for $n=1, 2$. (15 分)
 - (c) What are the physical meanings of these quantum numbers (n, ℓ, m) and how do they relate to each other? (9 分)
 - (d) Explain the Zeeman effect and how do Stern-Gerlach experiment detect space quantization. (10 分)

Electron mass: 9.11×10^{-31} Kg

Proton mass: 1.67×10^{-27} Kg.

Planck constant: 6.625×10^{-34} Js

Boltzmann constant: 1.38×10^{-23} J/K

