國 立 清 華 大 學 命 題 紙

八十八學年度 物理 系（所） 物理 組碩士班研究生招生考試

科目 近代物理 科號 040 共 二 頁第 一 頁 *請在試卷【答案卷】內作答

1. (10%) Consider a body rotating freely about a fixed axis, and the moment of inertia is I. Apply the Wilson-Sommerfeld (also known as Bohr-Sommerfeld) quantization rule to calculate the possible values of the total energy.

2. (10%) A three-dimensional isotropic harmonic oscillator has the energy eigenvalues $\hbar w(n + 3/2)$ where $n = 0, 1, 2, ...$ What is the degree of degeneracy of the quantum state n?

3. (10%) Certain surface waves in a fluid travel with phase velocity $\sqrt{b/\lambda}$, where b is a constant and λ is wavelength. Find the group velocity of a packet of surface waves, in terms of the phase velocity.

4. (10%) A particle of mass m moves freely in a two-dimensional box. The potential energy $U(x, y)$ is zero in the region $0 \leq x \leq L; 0 \leq y \leq L$, otherwise the potential energy is infinity. Find all possible normalized wave functions and their corresponding energy values.

5. (45%) Explain
   (a) Davisson-Germer experiment
   (b) Stern-Gerlach experiment
   (c) Michelson-Morley experiment
   (d) Meissner effect
   (e) Josephson effect
   (f) Lamb shift
   (g) Baryon number
   (h) Isospin
   (i) Franck-Hertz experiment
   (j) CPT theorem
   (k) Hubble's law in astrophysics
   (l) Magic number in nuclear physics
   (m) Ultraviolet catastrophe in blackbody radiation
   (n) Wu experiment which shows that parity is not conserved
   (o) Space quantization.

6. (15%) Answer the following questions:

(a) Why a free proton can not decay into a neutron, a positron, and a neutrino?

(b) Why the Bohr model of atom is unstable in classical physics?

(c) Why nuclear fusion reactions (in which two light nuclei combine to form a heavier nucleus) require extremely high temperature?

(d) How does the quantum-mechanical interpretation of the hydrogen atom differ from the Bohr model?

(e) Suppose there is a pair of twins on Earth. The brother remains on Earth, while his twin sister sets off in a space ship on a trip to another planet. When his sister returns to the Earth, she is younger that her brother. The brother has a question, based on his understanding of special relativity, for two observers in relative motion, each thinks the other's clocks are runing slow. Therefore each twin expects the other to be younger. Can you solve this so-called twin paradox?