考 試 科 目	近代物理 81622	所　別	應用物理研究所	考 試 時 間	2 月 28 日（日）第 二 節

1. Explain in equations and reasoning the following terms: (20%)
   A. The uncertainty principle
   B. Fermi–Dirac distribution
   C. Singlet and triplet states of two electronic spins
   D. Nuclear fission

2. (a) Spaceship A moving away from the earth with speed 0.900 c fires a missile in the same direction as its motion, with speed 0.700 c relative to the spaceship. c is the speed of light. What is the missile's velocity relative to the earth? (5%) (b) Spaceship B tries to catch up with spaceship A by traveling at 0.950 c relative to the earth. What is the relative velocity between A and B? (5%) (c) What is the speed of a spaceship such that its total energy is ten times the rest energy? (10%)

3. A particle of mass m is confined in the one-dimensional infinite square well of length L as shown in the figure below. (a) Calculate all its allowed (kinetic) energy eigenvalues in terms of m, L, and other related constants. (b) Calculate the corresponding (normalized) eigenfunctions and the expectation value of the position of the particle. (20%)
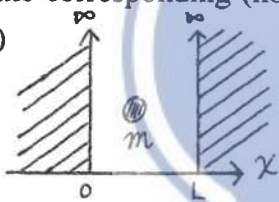
4. A free particle of mass m and with energy E is moving from $-\infty$ to ∞. When the particle reaches $x = 0$, it encounters a constant potential step V, which is smaller than E. (a) What are the wave vectors k_1 and k_2 associated with the particle for the regions $x < 0$ and $x > 0$ respectively? (b) What are the reflection and transmission coefficients of the particle? (20%)
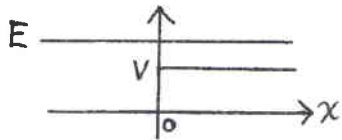
5. There are N free electrons in a metal of volume V and the temperature is at absolute zero. It is also known that the distribution of the free electron energy can be described by the density of the electronic energy levels $g(\varepsilon) = \dfrac{8\pi V m^{3/2}\sqrt{2\varepsilon}}{h^3}$, where ε is the (kinetic) energy of the free electron and $g(\varepsilon)d\varepsilon$ is the number of electronic energy levels (including both spins) between ε and $\varepsilon + d\varepsilon$, m the mass of the electron, and h the Planck constant. (a) Calculate the highest energy level (called Fermi energy) ε_F of the electron in the metal in terms of N, V, and m. (b) What is the total energy of all the N electrons in the metal as expressed in terms of N and ε_F? What is the average electron energy? (20%)

備　　註	一、作答於試題上者，不予計分。 二、試題請隨卷繳交。