

系所組別: 工程科學系丙組

考試科目: 近代物理

考試日期: 0223, 節次: 2

※ 考生請注意: 本試題不可使用計算機。請於答案卷(卡)作答, 於本試題紙上作答者, 不予計分。

1. A moving particle behaves in certain ways as though it has a wave nature. (30%)

(1) Define the group velocity and the phase velocity of the de Broglie waves. (10%)

(2) Show that the product of the group velocity and the phase velocity is equal to  $c^2$ , where  $c$  is the velocity of light. (10%)

(3) An electron has a de Broglie wavelength of  $2.00 \times 10^{-12}$  m. Find its kinetic energy and the phase and group velocities of its de Broglie waves. (10%)

2. Evidence for the electron spin was provided by the Stern-Gerlach experiment. (30%)

(1) Sketch and briefly describe the key features of the experiment. (10%)

(2) What is the prediction of classical mechanics for this experiment? (10%)

(3) Explain what was observed in the experiment and how this observation may be interpreted in terms of electron spin. (10%)

3. The energy of a trapped particle can be quantized. (20%)

(1) Given a particle that is in a box with a width  $L$ , show that the general formula for the permitted De Broglie wavelengths of the trapped particle is  $\lambda_n = 2L/n$ ,  $n = 1, 2, 3, \dots$ . (10%)

(2) If an electron is trapped in a box with  $L = 0.15$  nm, find the permitted energies of the electron. (10%)

4. The uncertainty principle, which was discovered by Werner Heisenberg in 1927, is one of the most important of physical laws. (20%)

(1) Write down the two Heisenberg uncertainty relations, one involving energy and one involving momentum. Explain the meaning of each term. (10%)

(2) Estimate the kinetic energy of an electron in a hydrogen atom by the uncertainty principle. (10%)