國立中央大學104學年度碩士班考試入學試題

所別：光電科學與工程學系碩士班 不分組(一般生)　科目：近代物理　共 2 頁 第 1 頁

本科考試可使用計算器，廠牌、功能不拘　　＊請在答案卷（卡）內作答

參考用

1. What is the minimum photon energy required to create an e^--e^+ pair when a photon collides with a free electron at rest? (10 pts)

2. If the protons were accelerated to a kinetic energy of 6.5 GeV, what magnetic field was needed to keep the protons traveling in a circle of 15 m? (10 pts)

3. A photon having 50 keV scatters from a free electron at rest. What is the maximum energy that the electron can obtain? (10 pts)

4. A muonic atom consists of a muon (mass m=106 MeV/c^2 and charge q=-e) in place of an electron. For the muon in a hydrogen atom, what is the binding energy of the muon in the ground state? (10 pts)

5. For waves with the phase velocity equal to the group velocity, derive the dependence of the phase velocity on the wavelength. (10 pts)

6. A quantum dot (QD) is a nanocrystal made of semiconductor materials that are small enough to exhibit quantum mechanical properties. Assuming a cubic quantum dot has length a on each side as shown in Fig.1. Please try to answer the following questions with clear explanations. A simple answer without explanation will not be scored.
   a. (5 pts) Please use uncertainty principle to estimate the lowest possible energy of a free electron confined in this quantum dot.
   b. (15 pts) Please use Schrödinger equation to obtain the general form of the wave functions and corresponding energy of the energy levels of a free electron confined in this quantum dot.
   c. (5 pts) Explain why the above results of the lowest possible energy are identical or different.
   d. (5 pts) If we applied an magnetic field B along one axis in such a quantum dot with considering the spin of electron(s=1/2, $\mu_B = \frac{e\hbar}{2m_e}$), what is the energy difference between the two lowest possible electron energy levels?
   e. (5 pts) Is it possible for a electron has transition from the lowest possible energy level to the third lowest possible energy level by absorbing a photon?

注意：背面有試題

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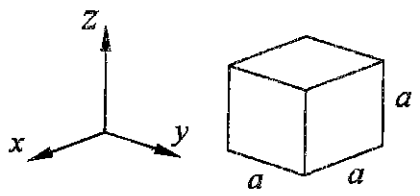

Fig. 1 A cubic quantum dot has length a on each side. Electron can only exist within this quantum dot.

7. (5 pts) In how many different ways can three identical particles be assigned to five states? Please consider both boson and fermion cases.

8. (5 pts) Does energy bands in solid follow selection rules? Why?

9. (5 pts) Give an example in solid for each bonding mechanism. (Van der Waals, hydrogen bond, covalent bond, and metallic bond)