**注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。**

國立清華大學 109 學年度碩士班考試入學試題

系所班組別：核子工程與科學研究所

科目代碼：3203

考試科目：近代物理

## —作答注意事項—

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 作答中如有發現試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「▼由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

# 國立清華大學 109 學年度碩士班考試入學試題

系所班組別：核子工程與科學研究所

考試科目（代碼）：近代物理(3203)



$c = 3.00\times10^{8}$ m/s, $k_B = 1.38\times10^{-23}$ J/K, $h = 6.63\times10^{-34}$ J·s, $e = 1.60\times10^{-19}$ C,
Mass of electron: $9.11\text{x}10^{-31}$ kg; mass of proton $1.67\text{x}10^{-27}$ kg

1. What is the approximate velocity _____of a proton at the exit of a 10 MeV baby cyclotron (please estimate the result to within 10% of uncertainty)? The proton (hydrogen ion) was injected into the cyclotron at 3 eV at beginning. The amplitude of RF microwave to accelerate the proton is 1000 V. The gap of cavity is 10 mm. The baby cyclotron is a kind of accelerator used in the nuclear medical division of a hospital. (10%)

2. A $^{137}$Cs radioisotope emitting a 662 keV gamma ray. We use a high purity germanium detector to measure this gamma ray. We observed the Compton effect with scattering gamma ray escapes from the detector and only the energy of the recoiled electron was collected by the detector. Please tell me what is the maximum energy of the recoiled electron can be observed _____ by the detector. The formula of Compton effect is $\lambda'-\lambda_0 = (h/m_e c)(1-\cos\theta)$ (10%)

3. Find the de Broglie wavelength of the waves associated with an electron that has been accelerated from rest thorough a potential difference of (a) 50 V, _____(5%) (b) 200,000 V. _____(5%)_The 50 eV electron is suitable for low energy electron diffraction and the 200 keV electron is installed in a typical transmission electron microscopy.

4. Determine the mass _____of a free particle whose wave function is the plane wave

$$\Psi(x,t) = A\,e^{\,i(2..8\times10^{11}x - 2.0\times10^{13}t)},$$

where distance ($x$) is in meters and time ($t$) in seconds. (10%)

5. A ruby laser emits light of wavelength 694 nm. If this light is due to transitions from n=2 state to n=1 state of an electron in a box, find the width _____ of the box. You can consider the box as an infinite square well. (10%)

6. Please write down the ordering of subshells by energy (from 1s to 5d) _____ (10%)

7. The four quantum numbers of atom are n, l, ml and $m_s$ or n, l, j and $m_j$. What is the difference between these two sets of quantum numbers? The difference is due to _____effect. (5%)

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8. When we applied 1 T of magnetic field on a hydrogen with an electron at n=2 state. If the Zeeman energy is $5.8 \times 10^{-5}$ eV measured by the microwave absorption. Please tell me what is the Larmor frequency _____ of the electron. (5%)

9. If I operate an X-ray generator (X-ray tube) at 45 kV, The X-tube consists of a Cu target and the K-edge of Cu is 8.9 keV. What is shortest wavelength _____ of X-ray I can get through the Bremsstrahlung? (5%)

10. What is the name of X-ray _____if this fluorescence photon is emitted from M shell to K shell of an excited atom? (5%)

11. Write down the equations of uncertainty principle. (in x, p, E, t) _____(5%)

12. Write the meaning of degeneracy? _____(5%)

13. What is the magnetic potential energy U? _____ If atom is in the magnetic field of B and the magnetic moment is μ. (5%)

14. Please write down the electronic configuration _____(2%)_of Gd atom at ground state and show why Gd always form $Ge_2O_3$ after oxidation_____(3%). The atomic number of Gd is 64. The neighboring close shell element is Xe with atomic number of 54.