# 國立中央大學八十四學年度碩士班研究生入學試題卷

所別：大氣物理研究所　　組　科目：近代物理學　　共 1 頁 第 1 頁

參考用

1. Find the speed (in units of c) of a 1.53 MeV electron. (20%)

2. Find the radius and energy of the first excited state of a doubly ionized lithium ($Z = 3$). (20%)

3. A particle moves freely in a one-dimensional region $0 \leq x \leq L$, but is excluded completely from $x < 0$ and $x > L$. (a) Find the wave functions and the permitted energy levels. (b) Calculate the expectation values of $x$ and $x^2$ for the ground and first excited states. (40%)

4. Sketch an energy-level diagram that shows the splitting of the 3d and 2p levels in an external magnetic field due to normal Zeeman effect. (20%)

**Some Commonly Used Constants and Conversion Factors**

| | |
|---|---|
| Speed of light | $c = 2.998 \times 10^8$ m/s |
| Electronic charge | $e = 1.602 \times 10^{-19}$ C |
| Boltzmann constant | $k = 1.381 \times 10^{-23}$ J/K $= 8.617 \times 10^{-5}$ eV/K |
| Planck's constant | $h = 6.626 \times 10^{-34}$ J · s $= 4.136 \times 10^{-15}$ eV · s |
| Avogadro's number | $N_A = 6.022 \times 10^{23}$ mole$^{-1}$ |
| Electron mass | $m_e = 5.49 \times 10^{-4}$ u $= 0.511$ MeV/$c^2$ |
| Proton mass | $m_p = 1.007276$ u $= 938.3$ MeV/$c^2$ |
| Neutron mass | $m_n = 1.008665$ u $= 939.6$ MeV/$c^2$ |
| Bohr radius | $a_0 = 0.0529$ nm |
| Hydrogen ionization energy | 13.6 eV |
| | $hc = 1.240 \times 10^3$ eV · nm |
| | $\frac{e^2}{4\pi\epsilon_0} = 1.440$ eV · nm |
| | 1 eV $= 1.602 \times 10^{-19}$ J |
| | 1 u $= 931.5$ MeV/$c^2$ |