國立交通大學 101 學年度碩士班考試入學試題

科目：近代物理(4023)　　考試日期:101 年 2 月 16 日 第 3 節

系所班別：電子物理學系　　組別：電物系乙組　　第 / 頁,共 2 頁

【不可使用計算機】＊作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符！！

Part A 論述題 (50 points)

1. 下列各單位的定義為何?
   (a) 貝克(Becquerel, Bq) (3 points)
   (b) 居里(Curie, Ci) (3 points)
   (c) 侖琴(Roentgen, R) (3 points)
   (d) 格雷(Gray, Gy) (3 points)
   (e) 西弗(Sievert, Sv) (3 points)

2. 說明下列名詞的意義。
   (a) spin-orbit interaction (4 points)
   (b) LS coupling (3 points)
   (c) jj coupling (3 points)

3. (a) 說明 Landé (splitting) g-factor 的意義。(5 points)
   (b) 寫出它與角動量的關係式。(5 points)

4. 在特殊相對論的發展史上，Michelson-Morley 實驗扮演很重要角色。請說明此實驗。 (15 points)

Part B 計算題 (50 points)

5. A tungsten sphere with a diameter of 1.0cm is heated to 2227°C. At this temperature tungsten radiates only about 50% of the energy that is radiated by a blackbody of the same size and temperature.
   (a) *Calculate* the temperature of the perfectly black spherical body of the same size that radiates at the same rate as the tungsten sphere. (5 points)
   (b) *Calculate* the diameter of a perfectly black spherical body at the same temperature as the tungsten sphere that radiates at the same rate. (5 points)

   Note: $(0.5)^{1/2}\sim0.7$, $(0.5)^{1/4}\sim0.8$, $(0.5)^{2}\sim0.25$, $(0.5)^{4}\sim0.06$, $2^{1/2}\sim1.4$, $2^{1/4}\sim1.2$

6. Consider a particle of mass m in an infinite one dimensional well of width L.
   (a) *Determine* all possible normalized eigenstates $\Psi_n(x,t)$ and the corresponding eigenenergy E_n by solving the Schrödinger wave equation. (10 points)

   Assuming the particle is described initially by a wave that is superposition of the ground and first excited states of the well: $\Psi(x,\ t=0) = 4C\psi_1(x) - 3C\psi_2(x)$ where the ground and first excited spatial wavefunctions ψ_1 and ψ_2 are normalized.
   (b) *Find* the probability ratio of the particle in its ground state to its first excited state. (3 points)
   (c) *Find* $\Psi(x,t)$ for any later time, $t>0$. (5 points)
   (d) *Find* the average energy (expectation value of energy). (7 points)

7. The radial and spherical parts of the wavefunction for an electron of a Hydrogen atom is in the 3d state are given by $R_{3,2}(r) = Ar^2 e^{-r/3a_o}$ and $Y_{2,1}(\theta,\phi) = B\sin\theta\cos\theta e^{i\phi}$ where A and B are negative constants and a_o is the Bohr radius.
   (a) *Determine* the value of B. (5 points)
   (b) *What* are the expectation values of L_z and $|\vec{L}|$? (4 points)
   (c) *Sketch* the probability density versus r and *indicate* the radius at which the electron is mostly likely found in terms of a_o in the sketch. (6 points)