

國立彰化師範大學 102 學年度碩士班招生考試試題

系所：光電科技研究所

選考乙

科目：近代物理

☆☆請在答案紙上作答☆☆

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Some constants:

- ✓ Planck's constant = 6.626×10^{-34} J-s, Boltzmann's constant = 1.38×10^{-23} J/K or 8.62×10^{-5} eV/K.
- ✓ electron charge = 1.602×10^{-19} C, electron mass = 9.11×10^{-31} kg
- ✓ 該標示單位的答案，一定要寫上「單位」

1. An unknown X-ray strikes a material A and excites photoelectrons from the K shell of this material which has K-shell binding energy of 5 keV. If these photoelectrons are observed to move in a circle of radius 3 cm in a magnetic field of 0.01 Tesla, please answer the following questions : (a) Please calculate the kinetic energy of photoelectrons (in unit of keV) ; (b) Please calculate the wavelength of incident X-ray (in unit of nm). (14%)
2. (a) What is Zeeman effect? (b) Please calculate the Zeeman splitting (expressed in unit of nm) of single-electron atom red line of 650 nm when the atoms are placed in a magnetic field of 0.01 Tesla. Hint: you need to derive the relation between energy shift (ΔE) and the change in wavelength ($\Delta \lambda$) first. (14%)
3. A particle with energy E is moving inside an asymmetric potential well ($0 < E < V_1 < V_2$.) given by

$$V(x) = \begin{cases} V_1 & x > a \quad (\text{region I}) \\ 0 & 0 < x < a \quad (\text{region II}) \\ V_2 & x < 0 \quad (\text{region III}) \end{cases}$$
 - (a) Please write down the wavefunctions of this particle in regions I, II and III with suitable explanation. You need to define all symbols used. (9%)
 - (b) From boundary conditions, please derive the relations for E , V_1 , V_2 and a . (8%)
 - (c) Please compare the probability to find this particle in regions I, II and III. (5%)
4. (a) Please explain "Bragg diffraction" in detail. (10%)
 (b) Please explain "Compton effect" in detail. (10%)
 (c) X-rays of wavelength 10 pm are scattered from a target. Please find the wavelength of the x-rays scattered through 60° . (10%)
 (d) The refractive index (n) of a medium with period structures is 1.6, and the refractive index of the surrounding environments is also 1.6. Suppose the periods a is $0.25 \mu\text{m}$ and the incident angle θ is 60° as shown in Fig. 4(d). Please find the longest wavelength of the diffraction wave. (10%)
 (e) Now the incident angle of the above problem becomes 0° as shown in Fig. 4(e). The refractive index and period structure are the same. Does diffraction occurs? If no, please explain the reason. If yes, please find the longest wavelength of the diffraction wave. (10%)

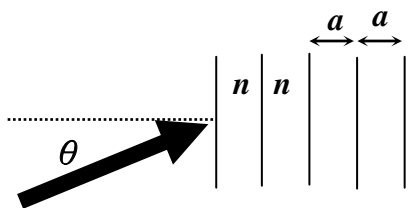


Fig. 4(d)

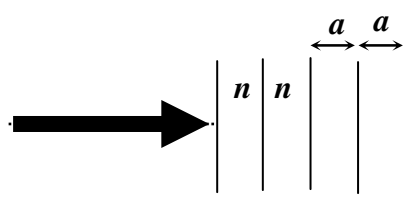


Fig. 4(e)