

淡江大學 100 學年度碩士班招生考試試題

20

系別：物理學系

科目：近代物理

考試日期：2 月 28 日(星期一) 第 2 節

本試題共 4 大題， 1 頁

※ 第 1 題：40 分； 第 2 題：20 分； 第 3 題：20 分； 第 4 題：20 分

1. (a) What is the difference between Positronium atoms and Hydrogen atoms?
(b) What is the difference between Davisson-Gemer experiment and Thomson experiment?
(c) Sketch roughly the spectral distribution of black body radiation at 6000K and 300K.
(d) Sketch roughly the X-ray spectrum emitted from a copper target.
(e) Describe the Frank-Hertz experiment and its significance.
(f) Describe the Stern-Gerlach experiment and its significance.
(g) Explain one shortcoming for the Rutherford's and Bohr's atomic model, respectively.
(h) Explain the two remarkable aspects of the photoelectric effect.
2. An one-dimensional potential well is given in the form of a delta function at $x = 0$,
 $V(x) = -V_0\delta(x)$, $V_0 > 0$.
(a) Derive the energy of the bound state.
(b) Derive the transmission coefficient, when a beam of particles, each of mass m and energy $E > 0$, is incident from the left.
3. The wavefunction of first excited state of the harmonic oscillator is $\psi_1(x) = A_1xe^{-\alpha x^2}$, where α and A_1 are constants.
(a) Find A_1 in terms of α .
(b) Find Δx and Δp . Is the result consistent with the uncertainty principle?
$$\left[\int_{-\infty}^{\infty} dx e^{-\alpha x^2} = \sqrt{\frac{\pi}{\alpha}}; \int_{-\infty}^{\infty} dx x^2 e^{-\alpha x^2} = \frac{1}{2\alpha} \sqrt{\frac{\pi}{\alpha}}; \int_{-\infty}^{\infty} dx x^4 e^{-\alpha x^2} = \frac{3}{4\alpha^2} \sqrt{\frac{\pi}{\alpha}} \right]$$
4. (a) Calculate $\langle 210 | \lambda \vec{s} \cdot \vec{\ell} | 210 \rangle = ?$ for the hydrogen electron.
(b) Calculate $L_x L_y |2, 1, 1\rangle = ?$, $L_y L_x |2, 1, 1\rangle = ?$ and $(L_x L_y - L_y L_x) |2, 1, 1\rangle = ?$
$$\left[L_{\pm} \equiv L_x \pm iL_y \text{ and } L_{\pm} |\ell, m_{\ell}\rangle = \sqrt{(\ell \mp m_{\ell})(\ell \pm m_{\ell} + 1)} |\ell, m_{\ell} \pm 1\rangle \right]$$