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淡江大學96學年度碩士班招生考試試題

系別：物理學系

科目：近 代 物 理

准帶項目請打「V」	
V	簡單型計算機

[※每大題 20 分]

1 The frequency form of the Planck's distribution law is

$$\rho_T(\nu)=\frac{8\pi\nu^2}{c^3}\frac{h\nu}{e^{h\nu/kT}-1}.$$

(a) Discuss the asymptotic results for $\nu \to 0$ and $\nu \to \infty$.
(b) Obtain $\rho_T(\lambda)$, the wavelength form of the spectral energy density, from $\rho_T(\nu)$.
(c) Qualitatively sketch $\rho_T(\lambda)$ versus λ for several different temperatures.
(d) Describe the Wien's displacement law.
(e) Explain the term "ultraviolet catastrophe".

2. (a) Does a television tube (CRT-TV) emit x rays? Why?
(b) Do you observe a Compton effect with visible light? Why?
(c) Can pair production occur in vacuum? Why?
(d) What is the difference between Positronium atoms and Hydrogen atoms?
(e) What is the difference between Davisson-Gemer experiment and Thomson experiment?

3. Answer the following questions for the hydrogen atom eigenfunction ψ_{321}.
(a) Calculate the Bohr radius a_0, based on the Bohr's model.
(b) Write down the total energy in eV.
(c) Write down the expectation value of the radial coordinate in a_0.
(d) Write down the orbital angular momentum.
(e) Write down the z-component of the orbital angular momentum.

4. The infinite square well potential is written as

$$V(x)=\begin{cases}0 & -a<x<a\\ \infty & elsewhere\end{cases}$$

(a) Directly write down the eigenfunctions $\Psi(x,t)$ for the ground state and the first excited state.
(b) Accurately calculate the uncertainties Δx and Δp for the ground state ($n=1$).
(c) Roughly estimate the uncertainties Δx and Δp for the ground state.
(d) Evaluate the expectation value of x and p for a very simple mixed state

$$\Psi(x,t)=[\Psi_1(x,t)+\Psi_2(x,t)]/\sqrt{2}$$

(e) Comment on the relation between $\langle p\rangle$ and $\langle x\rangle$ for the above mixed state.

5. 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) Roughly sketch $\psi(x)$ versus x for the bound state, $-V_0<E<0$.
(b) Derive the energy of the bound state.
(c) Derive the transmission coefficient, when a beam of particles, each of mass m and energy $E>0$, is incident from the left.