94學年度 工程與系統科學 系（所） 丙、戊 組碩士班入學考試

科目 近代物理 科目代碼 3404 3503 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

常數： $h = 6.63 \times 10^{-34}$ J·s　$c = 3 \times 10^{8}$ m/s　$m_e = 9.11 \times 10^{-31}$ kg　$e = 1.6 \times 10^{-19}$ C

共有5題，每題20分

1. (a) What is the momentum of a photon of wavelength 0.02 Å?
   (b) What is the momentum of an electron that has the same total energy as a 0.02 Å photon?
   (c) What is the de Broglie wavelength of the electron in part (b)?

2. The mass m of a hydrogen atom is $m = 1.67 \times 10^{-27}$ kg. When two are bound together to form a hydrogen molecule (H_2), they will oscillate about their equilibrium separation as a simple harmonic oscillator of mass $\frac{1}{2}m$ (the reduced mass). The effective spring constant is 573 N/m.
   (a) Calculate the energy of the zero-point vibration ($n=0$).
   (b) Calculate the classical amplitude of the zero-point motion.

3. (a) The electron in a hydrogen atom moves into the excited state $n=2$, and remains there for 10^{-8} s before making a downward transition to the ground state. Calculate the uncertainty of the energy of the excited state.
   (b) In the transition of (a), a photon is emitted. What is the wavelength of the photon?
   (c) Estimate the uncertainty of the wavelength of the photon.

4. The atomic number of beryllium is 4.
   (a) Write down the electronic configuration of Be in its ground state, and all possible spectral terms (e.g. $^2P_{\frac{1}{2}}$) that can be formed.
   (b) Write down the electron configuration and spectral terms of Be in its lowest excited states.
   (c) In an energy-level diagram, show the possible transitions between states formed by these two configurations.
   (d) In the presence of an external magnetic field, do (c) again.

5. The K absorption edge of molybdenum is 0.620 Å, and the average wavelengths of the K-series lines are $K_\alpha = 0.712$ Å, $K_\beta = 0.633$ Å, and $K_\gamma = 0.621$ Å.
   (a) Construct the x-ray energy-level diagram of molybdenum.
   (b) What is the least energy required to excite the L-series?
   (c) What is the wavelength of the L_α line?
   (d) If a 25-keV electron struck the molybdenum target in a tube, what is the shortest x-ray wavelength it could produce?