國立嘉義大學九十七學年度
光電暨固態電子研究所碩士班（甲組）招生考試試題

科目：近代物理

1. The lifetime of a typical excited state in an atom is 10^{-8} s. Suppose that the atom emits a photon of wavelength about 6000 Å. (a)What is the energy uncertainty of this photon? (b) What is the wavelength uncertainty of this photon? (Ref: $h = 6.626 \times 10^{-34}$ joule-sec, $\hbar = 1.055 \times 10^{-34}$ joule-sec) (20%)

2. An electron is an infinite potential well whose bottom is titled, as shown in Fig. 1.　 (a) Sketch very carefully an eigenfunction showing qualitatively the variation of both amplitude and wavelength as a function of position in the well. (b) Write a short explanation for the behavior of your eigenfunction. (It must be clear why and how you chose to vary amplitude, wavelength or both or why you chose to keep one or parameters constant.) (20%)
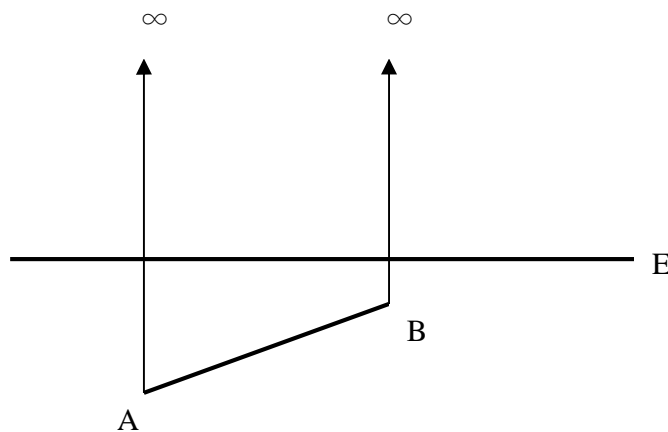

Figure 1

3. In the Franck-Hertz experiment, an atomic hydrogen is bombarded with electrons, and excitation potentials are found at 10.2 eV and 12.1 eV. (a) Plot an energy-level diagram for hydrogen and the observation that three different lines of spectral emission accompany these excitations.(b) Determine the wavelength of the observed spectral lines. (Ref: $h = 6.626 \times 10^{-34}$ joule-sec) (20%)

4. When a hydrogen atom is placed in a very strong external magnetic field, the spin-orbit interaction coupling of its orbital angular momentum $\vec{L}$ to its spin angular momentum $\vec{S}$ has been overcome, and both vectors process independently about the direction of the external field with constant z components. Try to derive the selection rule in spectral measurement by electric dipole matrix element. (Hint: $e^{\pm i\theta} = \cos\theta \pm i\sin\theta$) (20%)

5. (a) What are the indispensable properties for a ferromagnetic material? (10%)

   (b) In a view of quantum theory, how can you explain why the net spin of a magnetic atom or molecule is not zero? (10%)