八十九學年度　生命科學系　丙組碩士班研究生招生考試

科目 近代物理 科號 0902 共 1 頁第 1 頁 *請在試卷【答案卷】內作答

※Please use SI units in all the calculations.

1. Use the uncertainty relation to evaluate the ground state energy of the hydrogen atom. (10%)
2. Consider a classical pendulum with mass M and length l, establish the relationship between the quanta number n and the classical amplitude by equating the quantum energy $(n+\frac{1}{2})\hbar\omega$ to the classical energy of the pendulum.
   (a) Calculate the "quanta number" for a pendulum with mass 1.0 gm, length 1m, and amplitude of 0.1 cm. (5%)
   (b) What is the amplitude (using classical energy) of the pendulum when the quanta number is 100? (5%)
3. Consider a hydrogen atom in which an electron jumps from the 2P state to the 1S state emitting light. Calculate the change in the wavelength of light emitted when the atom is subjected to a magnetic field of 2T. (10%)
4. Emission from hydrogen atoms in a far-away galaxy is recorded to have a wavelength of 4340 $\mathring{A}$ on Earth. The same emission line from hydrogen atoms at rest on Earth is found to have a wavelength of 6000 $\mathring{A}$. Calculate the speed of the galaxy relative to Earth. (10%)
5. A ball weighing 1 kg is moving with a velocity of $10^4$ cm/sec, what would the change in velocity be if the kinetic energy of the ball increased by 100 eV ? (10%)
6. Calculate the "pressure" exerted on the walls of a rectangular potential box by a particle inside it. The sides of the box are a, b, and c. (10%)
7. Show that the most probable distance from the origin of an electron in the n=2, l=1 state is 4 $a_o$ . (10%)
8. The crystal barium titanate has a unit cell volume of $(4\text{x}10^{-8}\text{ cm})^3$ and a spontaneous polarization of 26.67 $\mu$Ccm$^{-2}$. Calculate the dipole moment of a unit cell and estimate the shift of the positive ions with respect to the negative ions. (10%)
9. Show that the average of the square of the molecular speeds in an ideal gas is $3k_BT/m$. (10%)
10. In an experiment known as the Frank and Hertz experiment, electrons are raised to an excited state by colliding with a beam of electrons. It is found that, even if the beam of electrons is monoenergetic, after the collision with the atomic electrons the energy of the electrons in the beam has a certain spread.
    (a) Explain this spread. (5%)
    (b) In a particular experiment the energy spread is found to be $10^{-6}$ eV. What is the lifetime of the excited state? (5%)

※ Some useful constants are listed as follows:

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| $\hbar$ | $1.055\text{x}10^{-34}$ J.s | $m_e$ | $9.109\text{x}10^{-31}$ kg | $k_B$ | $8.617\text{x}10^{-5}$ eV/K |
| e | $1.602\text{x}10^{-19}$ C | $m_p$ | $1.673\text{x}10^{-27}$ kg | $N$ | $6.022\text{x}10^{23}$ mol$^{-1}$ |
| eV | $1.602\text{x}10^{-19}$ J | $\varepsilon_o$ | $8.85\text{x}10^{-12}$ F/m | $\mu_B$ | $9.274\text{x}10^{-24}$ J/T |