立中央大學八十九學年度碩士班研究生入學試題卷

所別：　電機工程學系　乙組　科目：　近代物理　

1. In a metal, the conduction electrons are not attached to any one atom, but are relatively free to move throughout the entire metal. Consider a 1 cm × 1 cm × 1 cm piece of copper. (a) What is the uncertainty in any one component of the momentum of an electron confined to the metal? (b) What is the resulting estimate of the typical kinetic energy of an electron in the metal? (c) Assuming the heat capacity of copper to be 24.5 J/mole.K, would the contribution of this motion to the internal energy of the copper be important at room temperature? What do you conclude from this? (15 points) ($\rho_{Cu} = 8.96\ g/cm^3$, $M_{Cu} = 63.5$)

2. Show that the average value of x^2 in the one-dimensional infinite well is $L^2(1/3-1/2n^2\pi^2)$, where L is the well width. (20 points)

3. Point out and explain the revolutionary idea that Max Planck uses to derive the Planck's formula for blackbody radiation. (15 points)

4. An electron moves in a cube whose sides have a length of 0.3 nm. Find values for the energy of (a) the ground state and (b) the first excited state of the electron. (h = 6.62617 x 10^{-34} J-s) (20 points)

5. What's the meaning of the Fermi energy (level)? Please write down an expression (equation) for the Fermi-Dirac distribution. (15 points)

6. The hydrogen molecule comes apart (dissociates) when it is excited internally by 5 eV. Assuming that this molecule behaves exactly like a harmonic oscillator with classical frequency ω=8.277 x 10^{14} rad/s, find the vibration quantum number corresponding to its 5 eV dissociation energy. (15 points)