國立中央大學 108 學年度碩士班考試入學試題

所別： 光電類

科目： 近代物理

本科考試可使用計算器，廠牌、功能不拘

計算題需計算過程，無計算過程者不予計分

Part A (50%)

Boltzmann constant = 1.38×10^{-23} m^2 kg s^{-2} K^{-1}

elementary charge = 1.6×10^{-19} coulombs

electron mass = 9.1×10^{-31} kg

1. For gold metal with Fermi energy of 5 eV, calculate the mean speed of the conducting electrons at room temperature (T=300 K) by using classical and quantum statistics. (10%)

2. For an infinite one-dimensional well (Assume potential V=0, $0 \le x \le L$)
   (a) If N (>>1) fermions are placed in the well, each with a mass m and considering the spin condition, what is the Fermi energy? (5%)
   (b) If N (>>1) bosons are placed in the well, each with a mass m, find the critical temperature. (Hint: expression by the product of gamma function $\Gamma(n)$ and zeta function $\zeta(n)$ according to the following equation) (10%)

$$\int_0^\infty \frac{x^{n-1}dx}{e^x - 1} = \Gamma(n)\zeta(n)$$

   (c) Continue (b), what is the total energy of N bosons at 0 K? (5%)

3. Use Hund's rule to find the ground-state total orbital and spin quantum numbers of nitrogen (Z=7). (5%) If use nitrogen beams for Stern-Gerlach experiment, how many components will the beam split into? (5%)

4. If a particle with a mass m is placed in a finite potential energy well,

$$V(x) = \begin{cases} 0 & 0 \le x \le L \\ V_0 & x < 0, x > L \end{cases}$$

   what will be the condition for only one energy state in the well? (10%)

注意:背面有試題

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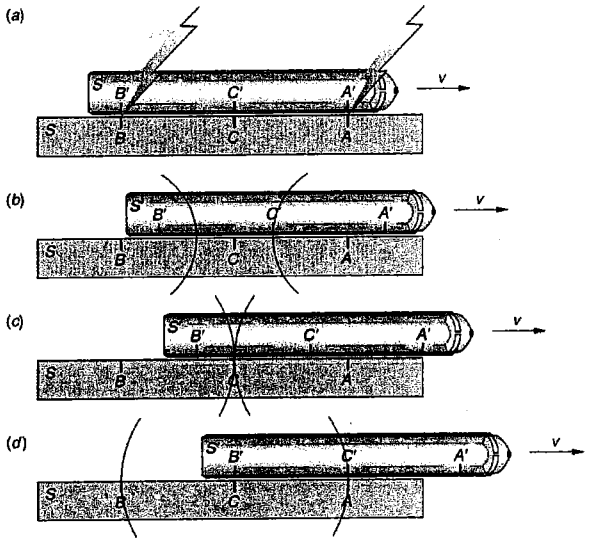
Part B (50%) 計算題需計算過程，無計算過程者不予計分

1. (10%) Assume that the train shown in Figure is 1.0km long as measured by the observer at C' and is moving at 200km/h. What time interval between the arrival of the wave fronts at C' is measured by the observer at C in S?



2. (15%) At what value of u/c does the measured mass of a particle exceed its rest mass by (a) 20% (b) a factor of 10 and (c) a factor of 20?
3. (10%) Suppose that you seal an ordinary 100W lightbulb and a suitable battery inside a transparent enclosure and suspend the system from a very sensitive balance. Compute the change in the mass of the system if the system if the lamp is on continuously for one year at full power.
4. (5%) Under optimum conditions, the eyes will perceive a flash if about 60 photons arrive at the cornea. How much energy is this in joules if the wavelength of the light is 550nm?
5. (10%) The longest wavelength of the light that will cause emission of electrons from cesium is 653nm. (a) Compute the work function for cesium. (b) If light of 250nm (ultraviolet) were to shine on cesium. What would be the energy of the ejected electrons?

注意:背面有試題