B

九十四學年第一學期 普通物理 B 第三次段考試題

[Benson Ch. 18–21 & Ch. 37–38] 2006/01/10, ***8:30AM – 10:00AM***

Part 0.【5 分】**依下面說明在答案卷上作答者，可得 5 分**

(i) 答案卷第一張爲封面，第一張正反兩面**不要作答**。

(ii) 由第二張紙開始算起，**第一頁**依空格號碼順序寫下**所有填充題答案**，**寫在他頁不記分**。

(iii) 計算題之演算過程與答案依題號順序寫在第二頁以後，**每題從新的一頁寫起**。

Part I. 填充題 (每格 3%, 共 48%) 如有單位，必須寫出。

■ A system of a large number of particles is in thermal equilibrium at temperature T. If E_1 and E_2 are two unique energy states of the particles in the system and N_1 and N_2 are the number of particles with energies E_1 and E_2 respectively, then the ratio N_1/N_2 is 【1】.

■ The ends of a steel rod are fixed. The magnitude of the thermal stress in the rod is【2】when the temperature increases by 100 K. The rod is under a 【3】 (tensile or compression) stress. The linear coefficient of expansion and Young's modulus for steel are 11.7×10^{-6} K^{-1} and 2.00×10^{11} N/m^2 respectively.

■ The work done by a system of n moles of ideal gas at temperature T in a quasistatic isothermal expansion from V_i to V_f is【4】.

■ Describe concisely the three laws of thermodynamics: (a) the zeroth law 【5】; (b) the first law【6】; and (c) the second law【7】(Use the entropy statement for (c).)

■ A 5-kg chunk of ice at −10 °C is added to 5 kg of liquid water at 60 °C. If there is no heat exchange with the surroundings, the final temperature of the system is 【8】. When the system reaches thermal equilibrium, the mass of water is【9】. (The specific heat of ice and liquid water are 2.10 kJ/kg·K and 4.19 kJ/kg·K respectively. The latent heat of fusion for water is 334 kJ/ kg.)

■ A yellow light of wavelength 550 nm (in air) is incident normally on a lens (n = 1.52) coated with a film of MgF_2 (n = 1.38). The least thickness of the film that gives minimum reflection is【10】.

■ In the two processes: (a) a reversible engine completes a cycle, and (b) a system of ideal gas doubles its volume by adiabatic free expansion, the change of entropy of the universe for (a) is 【11】, and that for (b) is【12】.

■ A spy satellite in orbit at an altitude of 200 km has a telescope mirror of diameter 50 cm. Assuming that it is limited by diffraction, the closest distance between two bodies on the earth surface that can be resolved is【13】. (Take λ = 400 nm.)

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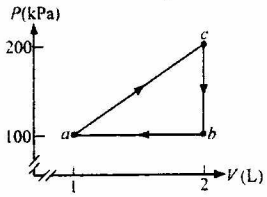
■ In a double slit experiment the width of the slits is a and the distance between their centers is d. The mth order of the double-slit interference maxima occurs at an angle θ_m = 【14】. What is the lowest order of double slit interference maxima that is missing if $d/a = 5$? 【15】

■ A cylinder with a piston contains 0.2 kg of liquid water at 100 °C. When the water is converted to steam at 100 °C at a constant pressure of 1 atm, the change in internal energy of water is 【16】. (The latent heat of vaporization and the molar mass of water are 2260 kJ/ kg and 18g respectively. The universal gas constant R = 8.31 J/K·mole.)

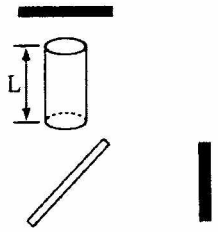
Part II. 計算題 (共 52%) You need to write down the process of your calculation.

1. When a gas undergoes a process depicted as a straight line from a to c in right figure the heat flow into the system is 180 J. (a) Find the work done from a to c. (b) If U_a = 100 J, find U_c. (c) What is the work done by the gas when it returns to a via b? (d) What is the heat transfer in the process cba? [4% each]



2. A heat engine operates between reservoirs at temperature T_H and T_C . In one cycle it absorbs Q of heat and does W of work. Find: (a) the efficiency of the engine; (b) the change in entropy of each of the reservoirs and of the universe; (c) How much work W_C would be done by a Carnot engine that absorbs the same quantity of heat from the hot reservoir? (d) Express second law of thermodynamics in terms of W and W_C. [4% each]

3. One arm of a Michelson interferometer contains a transparent cylinder of length L = 1.5 cm (right figure). The cylinder is evacuated, and the cross hairs of the telescope on a particular bright fringe with light of wavelength 600 nm (in vacuum). When a gas is introduced into it, fourteen fringes move past the cross hair. (a) What is the refractive index of the gas? (b) To move fourteen fringes backwards, how does the mirror on the cylinder side needs to be move? [4% each]



4. Five point sources are equally spaced at a distance d apart along a line, as in right figure. All five sources are coherently emitting light of wavelength λ with the same phase. (a) What is the angular position of the central peak? (b) What is the angular position of the first minimum? (c) What is the total number of principal maxima one can observe if d/λ = 15? [4% each]