國　立　清　華　大　學　命　題　紙

95 學年度 微機電系統工程研究所 系（所） 組碩士班入學考試

科目 物理 科目代碼 2404 共 4 頁第 1 頁 *請在【答案卷卡】內作答

注意：

1. 請按題目順序作答。
2. 填充題不需要寫計算過程。
3. 1 atm = 1.01×10^5 Pa (N/m^2), k_B = 1.38×10^{-23} J/K, R = 8.31 J/K·mol

填充及選擇題(30%):

1. (5%) Positive charge Q is placed on a conducting spherical shell with inner radius R_1 and outer radius R_2. A point charge q is placed at the center of the cavity. The magnitude of the electric field at a point outside the shell, a distance r from the center, is: (1)

2. (5%) The hydraulic automobile jack illustrates: A. Archimedes' principle, B. Pascal's principle, C. Hooke's law, D. Newton's third law, E. Newton's second law (2)

3. (5%) Which of the following types of electromagnetic radiation travels at the greatest speed in vacuum? A. Radio waves, B. Visible light, C. X rays, D. Gamma rays, E. All of these travel at the same speed (3)

4. (5%) Three polarizing sheets are placed in a stack with the polarizing directions of the first and third perpendicular to each other. What angle should the polarizing direction of the middle sheet make with the polarizing direction of the first sheet to obtain maximum transmitted intensity when unpolarized light is incident on the stack? (4) (in degrees)

5. (5%) The index of refraction of a substance is: A. the speed of light in the substance, B. the angle of refraction, C. the angle of incidence, D. the speed of light in vacuum divided by the speed of light in the substance, E. measured in radians (5)

6. (5%) J. J. Thompson's measurement of e/m for electrons provides evidence of the A wave nature of matter, B. particle nature of matter, C. wave nature of radiation, D.particle nature of radiation, E. transverse wave nature of light (6)

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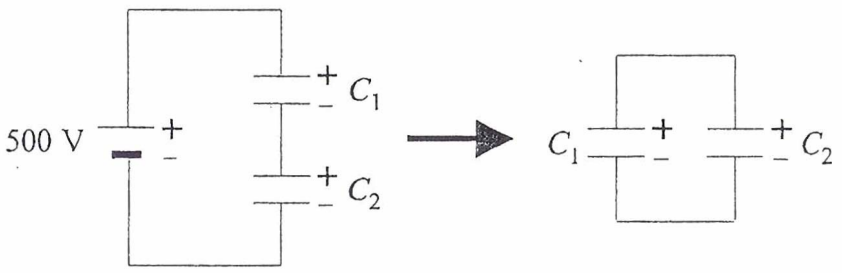
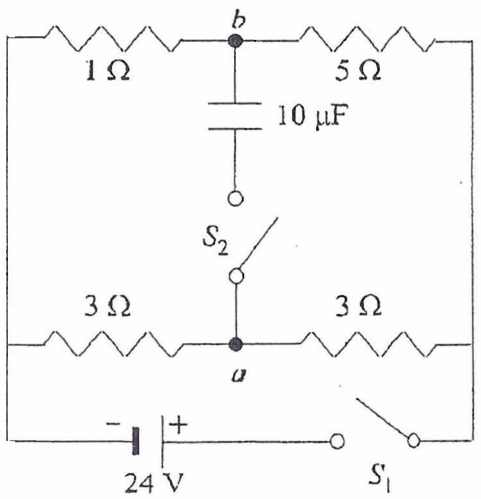
科目 物理 科目代碼 2404 共 4 頁第 2 頁 *請在【答案卷卡】內作答

計算題(70%)：

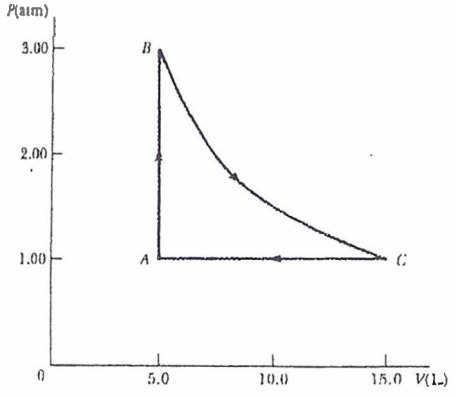
1. (**a**) A potential difference of 500 V is applied to a series connection of two capacitors, of capacitance C_1 = 2.0 μF and capacitance C_2 = 8.0 μF. What are the charge on and the potential difference across each capacitor? (**b**) The charged capacitors are then reconnected as shown below. What are the charge and the potential difference for each capacitor now? (**c**) What percentage of electrical energy is lost during the second step? (15 %)



2. In the circuit shown below switch S_1 is *initially closed* and S_2 is *open*. (**a**) Find $V_a - V_b$; (**b**) After S_2 is *also closed* for a long time, what is $V_a - V_b$? (**c**) When S_1 is *opened* and S_2 is *left closed*, what is the time constant for the capacitor to discharge? (15 %)

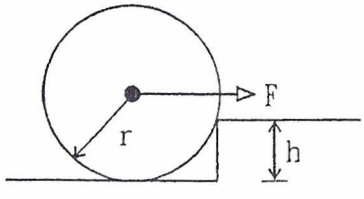


3. A sample of a monoatomic ideal gas occupies 5.00 L at atmospheric pressure and 300 K (point *A* in the figure). It is heated at constant volume to 3.00 atm (point *B*). Then, it is allowed to expand isothermally to 1.00 atm (point C) and at last is compressed isobarically (constant pressure) to its original state. (**a**) Find the number of moles in the sample. (**b**) Find the temperatures at points *B* and *C*. (**c**) Assuming that the specific heat does not depend on temperature, so that $E_{int}=3nRT/2$, find the internal energy at points *A*, *B*, and *C*. (**d**) Tabulate *P*, *V*, T, and E_{int} at the states at points *A*, *B*, *C*. (**e**) For the whole cycle $A\rightarrow B\rightarrow C\rightarrow A$, find *Q*, *W*, and ΔE_{int}. (20%)



volume in liter

4. What magnitude of force *F* applied horizontally at the axle of the wheel is necessary to raise the wheel, with a radius *r* (meter) and a weight *W* (newton), over an obstacle of height $h = r/3$? Express your answer in terms of *W*. (10%)



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5. A uniform plank, with a length L (meter) and a weigh W (Newton), rests on the ground and against a frictionless roller at the top of a wall of height $h = 2L/3$. The plank remains in equilibrium for any value of $\theta \geq \theta_0$ but slips if $\theta < \theta_0$. (**a**) Find the magnitude of the force on the plank from the roller. Express your answer in terms of W and θ. (**b**) Find the coefficient of static fiction μ_s between the plank and the ground. Express your answer in terms of θ_0. (10%)