

國立清華大學 命題紙

97 學年度 奈米工程與微系統研究所 (所) _____ 組碩士班入學考試

科目 物理 科目代碼 1804 共 3 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，請使用小數點。
3. $1 \text{ g} = 9.8 \text{ N/s}^2$, $1 \text{ atm} = 1.01 \times 10^5 \text{ Pa} (\text{N/m}^2)$, $k_B = 1.38 \times 10^{-23} \text{ J/K}$, $R = 8.31 \text{ J/K}\cdot\text{mol}$

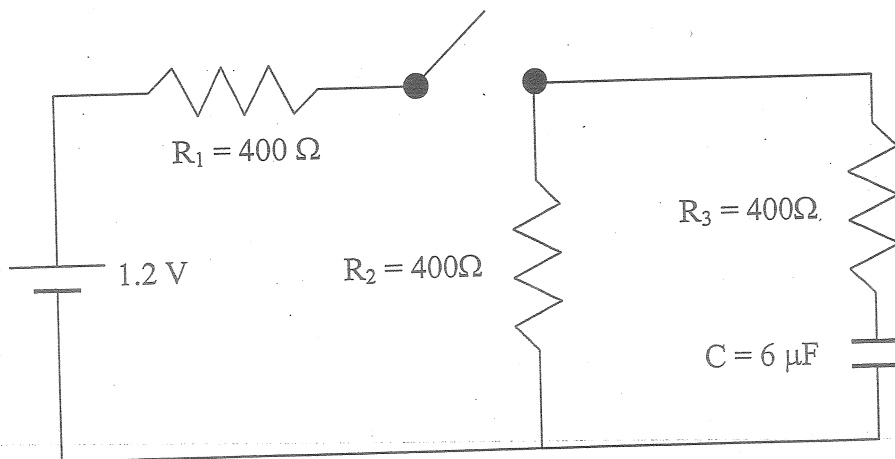
填充題 (60%)：

1. (6%) An atom of gold is 0.288 nanometers in diameter. The lattice constant of FCC gold is 0.408 nanometers. Across 1 micrometer thick gold foil how many gold atoms are roughly packed? (1) atoms.
2. (6%) A student throws a stone vertically downwards with an initial velocity of 10 m/s from the roof of a 30 meter high tower. What is the speed of the stone at impact (onto ground)? (2) m/s.
3. (6%) When a car weighing 18kN accelerates at 3 m/s^2 , what is the magnitude of the net force on it? (3) N.
4. (6%) Two balls A and B have identical properties except stiffness. Ball A is softer than Ball B but the two balls deform elastically during the impact. When the two balls are released vertically downwards from the roof of a tower, which ball bounces higher? (4) .
5. (6%) A sinusoidal wave of frequency 500Hz has a speed of 350m/s. How far apart are two points that differ in phase $\pi/2$? (5) m.
6. (6%) Three Carnot engines operate between temperature limits of (a) 450 and 550 K, (b) 550 and 650K, and (c) 450 and 650K. Each engine extracts the same amount of energy per cycle from the high-temperature reservoir. Rank the magnitude of the work done by the engines per cycle, greatest first. (6) .
7. (6%) Calculate the electric dipole moment of an electron and a proton that are 4.3nm apart. (7) C.m.

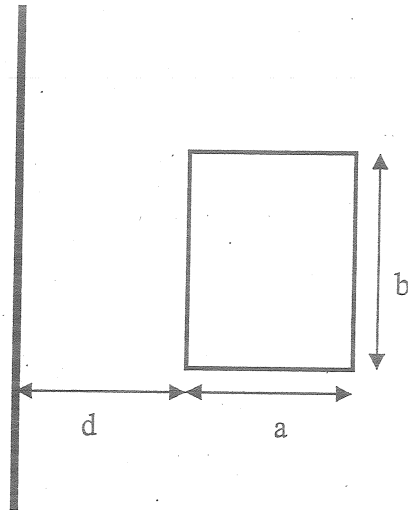
8. (6%) An infinite nonconducting sheet has a surface charge density of 10 nC/m^2 on one side. How far apart are equipotential surfaces whose potentials differ from the sheet by 50 V ? (8) mm.
9. (6%) A small disk whose mass is 1.5 kg is released in outer space with negligible gravity. When a 10 kW laser beam fully illuminates on the disk, what speed will the disk reach in one day due to the momentum carried by the beam? (9) m/s.
10. (6%) The rhinestones in costume jewelry are glass with index of refraction 1.50 . They are often coated with a layer of silicon monoxide of index of refraction 2.00 to make them more reflective. To ensure that green light of wavelength 560 nm and perpendicular incidence will be reflected from the two surfaces of the coating with fully constructive interference, what is the minimum coating thickness needed? (10) nm.

計算題 (40%) :

1. When the capacitor C in the circuit completely uncharged, switch S is suddenly closed (at $t = 0$). Evaluate the following values.
- (a) At $t = 0$, current i_3 in the resistor R_3 ? (5%)
- (b) At $t = \infty$, current i_2 in the resistor R_2 ? (5%)
- (c) Time constant τ . (5%)



2. Calculate the mutual inductance between the rectangular loop and the infinite line current (shown in the figure). (10%)



3. (a) An ideal gas initially at pressure p_0 undergoes a free expansion until its volume is 3 times its initial volume. What is the ratio of its pressure to p_0 ? (5%)
 (b) The gas is then slowly and adiabatically compressed back to its original volume. The pressure after compression is $(3)^{1/3} p_0$. Is the gas monatomic, diatomic or polyatomic? (5%)
 (c) What is the ratio of the average kinetic energy per molecule in this final state to that in the initial state? (5%)