

(一) 每一空格 5 分，僅需將答案寫出，不須寫步驟。

- What is the change in entropy of 500 g of water as its temperature increases from 10 °C to 25 °C? (1) J/K ? (The specific heat of water is 4.19 kJ/kg·K.)
- The plates of a parallel-plate capacitor carry surface charge density σ C/m². A dielectric slab of thickness t and dielectric Constant κ is inserted into the parallel plate capacitor with plates of area A , separated by distance d , as shown in Fig. 1. Assume that the battery is disconnected before the slab is inserted. What is the total potential difference between the plates? (2) V. What is the capacitance C_1 between the plates? (3) nF. If the dielectric slab is replaced by a metal sheet with the thickness t , compared to the capacitance C_1 , how is the capacitance affected? (increase? decrease? or keep constant?) (4) (Take $d=1$ cm, $t=0.3$ cm, $\sigma=2$ nC/m², $\kappa=5$, $A=40$ cm², $\epsilon_0=8.85 \times 10^{-12}$ F/m.)
- A long, straight wire carries a constant current I . A metal rod of length L moves at velocity v relative to the wire, as shown in Fig. 2. What is the potential difference between the ends of the rod? (5)
- A dipole with a dipole moment p is pivoted freely at its midpoint. It lies in a uniform field. If its moment of inertia about the center is I , what's the angular frequency (ω) of the dipole oscillations for small angular displacements? (6)
- A Cu strip of thickness 0.75 cm carrying a current of 10 A is set normal to a magnetic field. The Hall potential difference is 1.2 μ V. What is B ? (7) T. (Take $n=8.5 \times 10^{28}$ electrons/m³)
- A long solenoid of length l and cross-sectional area A has N turns. Find its self-inductance. (8) (Assume that the field is uniform throughout the solenoid.)
- A small ball of mass m starts from rest at the top of a solid sphere of radius r and slides down its frictionless surface (see Fig. 3). At what angle θ will the small ball leave the sphere? (9), and calculate the speed v of small ball when it leaves the sphere. (10)
- (a) Determine the coordinate for the center of mass (CM) of a uniform cone of height h and radius R , as shown in Fig. 4: (11). (b) If this cone is not uniform with a z -dependent density $\rho = \rho_0 \cdot z$, determine its CM. (12)
- A guitar player tunes the fundamental frequency of a guitar string to 440 Hz. What will be the fundamental frequency if she then increases the tension in the string by 15%? (13) (Hz). What will it be if, instead, she decreases the length along which the string oscillates by sliding her finger from the tuning key *one-fourth* of the way down the string toward the bridge at the lower end? (14) (Hz)
- Two masses, $m_1 = 1.0$ kg and $m_2 = 2.0$ kg, are connected by a rope that hangs over a pulley. The pulley is a uniform cylinder of radius 0.1 m and mass 0.5 kg. Initially m_1 is on the ground and m_2 rests 2.5 m above the ground (see Fig. 5). If the system is released, taking the gravitational acceleration $g = 10$ m/s², what is the acceleration of m_2 just before it strikes the ground? (15). What is the tension T_2 before m_2 strikes the ground? (16)

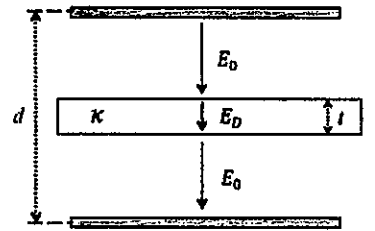


Fig. 1

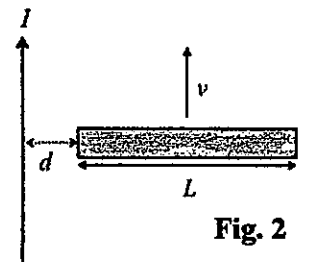


Fig. 2

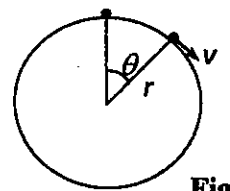


Fig. 3

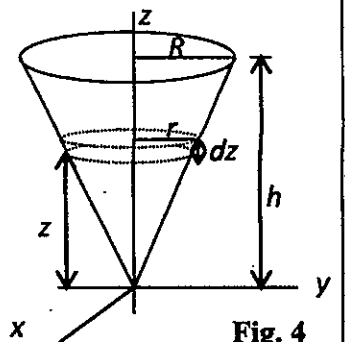


Fig. 4

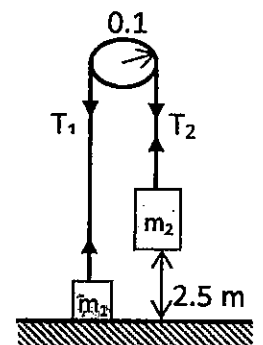


Fig. 5

(二) 每題 10 分，請寫出步驟。

- Two moles of an ideal diatomic gas ($\gamma = \frac{7}{5}$) operate in the cycle of Fig. 6, where $T_a = 400$ K, $T_c = 200$ K, and $P_c = 100$ kPa. Find: (a) $V_b =$ ___ m³ ? (5%) and (b) the work done from a to b ? $W_{a \rightarrow b} =$ ___ J ? (5%)
- If the cube in Fig. 7 has mass $M = 3.0$ kg and edge lengths $d = 6.00$ cm, and is mounted on an axle through its one edge at bottom. A spring ($k = 1200$ N/m) connects the cube's upper corner to a rigid wall. Initially the spring is at its rest length. If the cube is rotated 3° and released, (a) what is the period of the resulting simple harmonic motion (SHM)? (5%) (b) What is the maximum magnitude of angular velocity during the SHM? (5%) [Hint: the rotational inertial I_{com} , being about a rotation axis that passes through the center of the cube, is $Md^2/6$.]

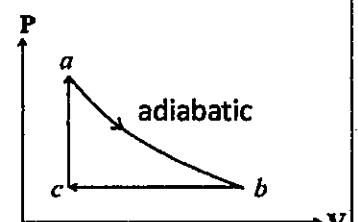


Fig. 6

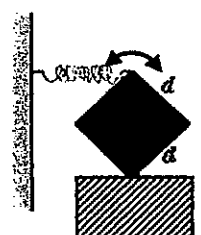


Fig. 7