1. A block of mass m_t is put on top of a block of mass m_b. To cause the top block to slip on the bottom one while the bottom one is held fixed, a horizontal force of magnitude at least F_0 must be applied to the top block. The assembly of blocks is now placed on a horizontal, frictionless table (Fig. 1). Find the magnitudes of (a) the maximum horizontal force that can be applied to the lower block so that the blocks will move together, (5%) and (b) the resulting acceleration of the blocks. (5%)

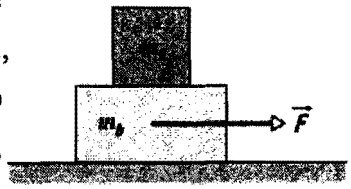

Fig. 1

2. In Fig. 2, a small block of mass m can slide along the frictionless loop-the-loop, with loop radius R. The block is released from rest at point P, at height $h = 5R$ above the bottom of the loop. What are the magnitudes of (a) the horizontal component and (b) the vertical component of the net force acting on the block at point Q? (5%) (c) At what height h should the block be released from rest so that it is on the verge of losing contact with the track at the top of the loop? (5%)

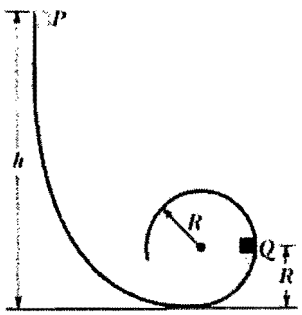

Fig. 2

3. In Fig. 3, a dog of mass m stands on a flatboat of mass M at a distance D from the shore. He walks d relative to the boat, toward the shore, and then stops. Assuming no friction between the boat and the water, find how far the dog is then from the shore. (10%)

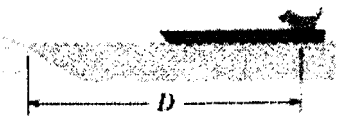

Fig. 3

4. (a) Prove that the rotational inertia of a rod of mass M and length L about an axis at one end and perpendicular to the rod is $ML^2/3$. (5%)
(b) Fig. 4 shows a rigid assembly of a thin hoop (of mass m and radius R) and a thin radial rod (of length L and also of mass m). The assembly is initially upright, but we nudge it so that it rotates around a horizontal axis through the lower end of the rod. What is the assembly's angular speed about the rotation axis when it passes through the upside-down (inverted) orientation? (5%) (The rotational inertia of a hoop of mass M and radius R about its own diameter is $MR^2/2$)

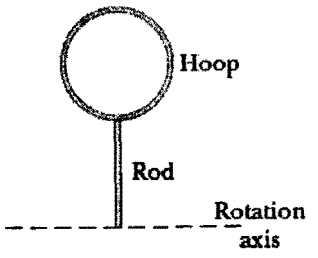

Fig. 4

(背面仍有題目,請繼續作答)

5. One planet has a core of radius R and mass M surrounded by an outer shell of inner radius R, outer radius $2R$, and mass $4M$. What is the gravitational acceleration $\overrightarrow{a_g}$ of a particle at points (a) 1.5 R and (5%) (b) 3 R from the center of the planet? (5%)

6. Prove that in a quasi-static adiabatic process, the ideal gas will follow the rule: PV^{γ}=constant, where P is the pressure of the gas, V is the volume of the gas, and γ is the ratio of molar specific heat at constant pressure to molar specific heat at constant volume. ($\gamma=C_p/C_v$) (10%)

7. A long, nonconducting, solid cylinder of radius R has a nonuniform volume charge density ρ that is a function of radial distance r from the cylinder axis: $\rho = Ar^2$. Find the magnitude of the electric field at (a) r <R (5%) and (b) r >R (5%).

8. In Fig. 5, current is set up through a truncated right circular cone of resistivity ρ, left radius a, right radius b, and length L. Assume that the current density is uniform across any cross section taken perpendicular to the length. What is the resistance of the cone? (10%)

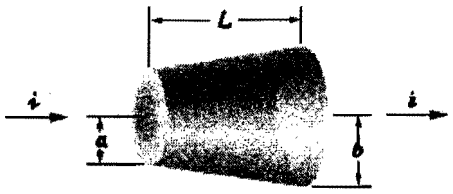

Fig. 5

9. Find the magnitude of the magnetic field produced at the center of a rectangular conducting loop of length L and width W, carrying a current i. (10%)

10. Fig. 6 shows a uniform magnetic field $\vec{B}$ confined to a cylindrical volume of radius R. The magnitude of $\vec{B}$ is decreasing at a constant rate C_B. In unit vector notation, what is the initial acceleration of an electron released at (a) point a (radial distance r) (5%) and (b) point b (center)? (5%)

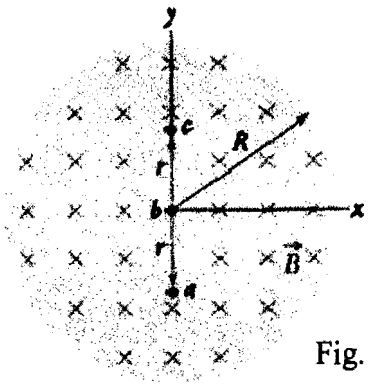

Fig. 6