1. A small block of mass m is given an initial speed v_0 up a ramp inclined at angle θ to the horizontal. It travels a distance d up the ramp and comes to rest. (*a*) Determine a formula for the coefficient of kinetic friction between block and ramp. (10%) (*b*) What can you say about the value of the coefficient of static friction? (5%)
2. An engineer is designing a spring to be placed at the bottom of an elevator shaft. If the elevator cable breaks when the elevator is at a height h above the top of the spring, calculate the value that the spring constant k should have so that passengers undergo an acceleration of no more than 5.0 g when brought to rest. Let M be the total mass of the elevator and passengers. (10%)
3. A pendulum consists of a mass M hanging at the bottom end of a massless rod of length ℓ, which has a frictionless pivot at its top end. A mass m, moving as shown in Fig. 3 with velocity v, impacts M and becomes embedded. What is the smallest value of v sufficient to cause the pendulum (with embedded mass m) to swing clear over the top of its arc? (10%)

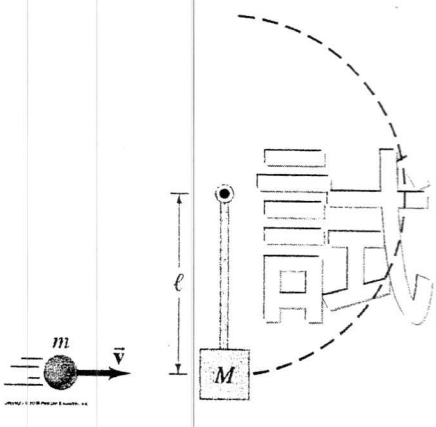

Fig. 3

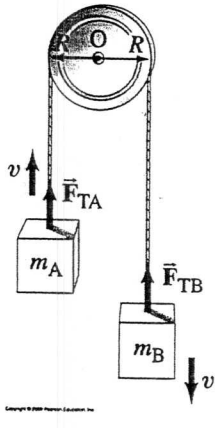

Fig. 4

4. An *Atwood's machine* consists of two masses, m_A and m_B, which are connected by a massless inelastic cord that passes over a pulley, Fig. 4. If the pulley has radius R and moment of inertia I about its axle, (a) determine the acceleration of the masses m_A and m_B, (10%) and (b) compare to the situation in which the moment of inertia of the pulley is ignored. (5%) [*Hint*: The tensions F_{TA} and F_{TB} are not equal.]
5. There is a simple pendulum with the length ℓ and angle θ that the cord makes with the vertical, as shown in Fig. 5. (*a*) Determine the equation of motion (for θ as a function of time), and show that the motion is simple harmonic. (10%) (*b*) Find the period T. (5%)
6. Please find the electric field $\vec{E}(r)$ at points along the axis of a dipole along the same line that contains +Q and –Q, as shown in Fig. 6, for r >> ℓ. (10%)

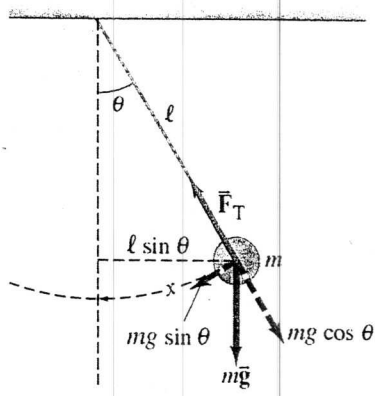

Fig. 5

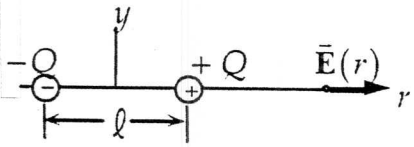

Fig. 6

7. A thin circular ring of radius R has a uniformly distributed charge Q, as shown in Fig. 7. (a) Determine the electric potential at a point P on the axis of the ring a distance x from its center. (5%) (b) Determine the electric field at point P. (5%)

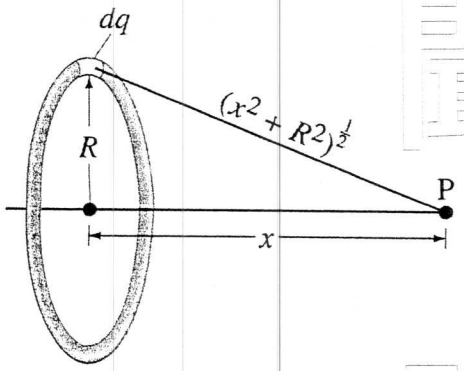

Fig. 7

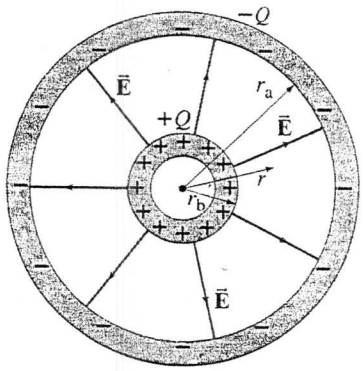

Fig. 8

8. A spherical capacitor consists of two thin concentric spherical conducting shells of radius r_a and r_b as shown in Fig. 8. The inner shell carries a uniformly distributed charge Q on its surface and the outer shell an equal but opposite charge $-Q$. (a) Find the electric field (5%) and (b) the electric potential difference between the two shells. (5%) (c) Determine the capacitance of the two shells. (5%)