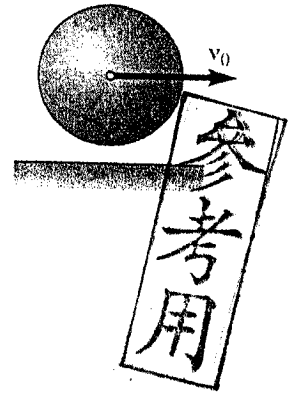1. (25%) A uniform sphere of mass m and radius r is projected along a rough horizontal surface with a linear velocity v_0 and no angular velocity. Denoting by μ_k the coefficient of kinetic friction between the sphere and the floor, determine (a) the time t_1 at which the sphere will roll without sliding, (b) the linear velocity and angular velocity of the sphere at time t_1.

2. (25%) A 10-kg block is suspended from a cord wrapped around a 5-kg disk. If the spring has a stiffness $k = 200$ N/m, determine the natural period of vibration for the system.

$k = 200$ N/m
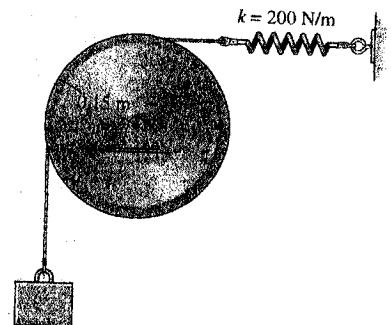
3. (25%) The slotted disk sector rotates with a constant counterclockwise angular velocity $\omega = 3$ rad/s. Simultaneously the slotted arm OC rotates about the y axis so that θ changes at the constant rate of 2 rad/s. Find the acceleration of the pin A when $\theta = 30°$ and $\dot{\theta}$ is positive (clockwise).
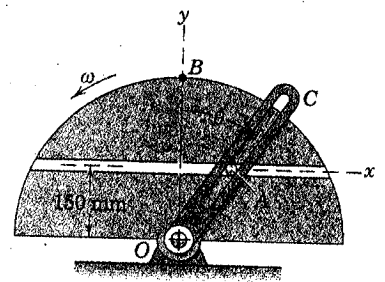
4. (25%) Two men A and B, each having a weight of *80 kgf*, stand on the *240-kg* raft. Each can run with a speed of *2 m/s* measured relative to the raft. Turning of the raft and water resistance are neglected.

   (a) Please determine the final speed of the raft if A runs and jumps off, then B runs and jumps off. (10%)

   (b) Please also determine the final speed of the raft if both run at the same time and jump off. (10%)

   (c) Besides, please discuss in brief how you deal with above two problems! (5%)