*請清楚標示你的答案

1. (15%) Referring to Figure 1, a ball of mass m is thrown with an initial velocity of V by a degree of θ at point A on a $30°$ slope. Suppose the ball strikes the slope at the first time on point B_1.

   (a) (5%) What is the achievable maximum height, and the corresponding degree θ?

   (b) (5%) Calculate the distance $\overline{AB_1}$ in terms of θ and V.

   (c) (5%) Derive the maximum achievable distance $\overline{AB_1}$.

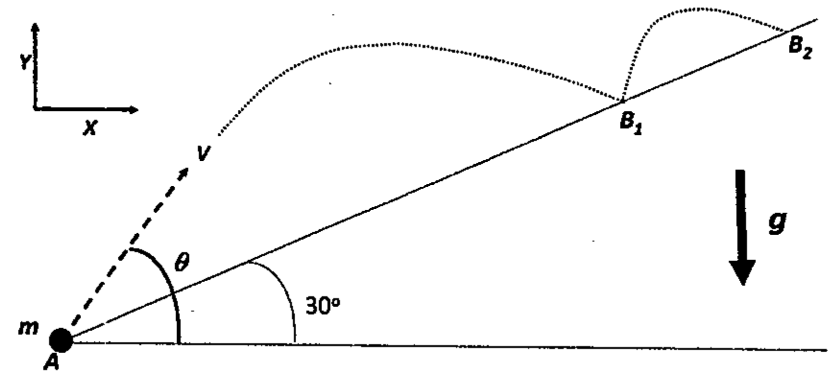

Figure 1

2. (25%) Consider Figure 1 with $\theta = 60°$,

   (a) (5%) Find the kinetic energy of the ball right before it strikes the slope the first time at B_1.

   (b) (5%) Suppose the coefficient of restitution at B_1 is e=0.5, calculate the rebound velocity at B_1?

   (c) (5%) Suppose e=0.5, estimate the energy loss during the impact at B_1.

   (d) (5%) Suppose e=0.5, calculate the total travel on the slop $\overline{AB_2}$ when the ball strikes the slope at the second time at B_2.

   (e) (5%) Derive the required coefficient of restitution at B_1 so that the ball achieves the maximum height after the rebound at B_1.

3. (10%) Referring to Figure 2, a pendulum of mass M is released from rest at $\theta = 30°$ and rotates about point A with a massless rod of length L.

   (a) (5%) Derive the angular acceleration $\ddot{\theta}$ in terms of θ.

   (b) (5%) Calculate the system's angular momentum about A when $\theta = 120°$.

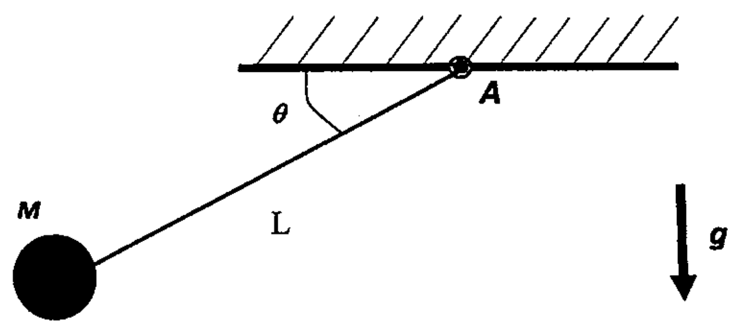

Figure 2

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4. (33%) Referring to Figure 3(a), a rectangular block of mass m_2 is initially rest on a triangular block of mass m_1.

(a) (5%) Assuming surface S_2 is frictionless and the triangular block is motionless, derive acceleration of the *rectangular* block $\ddot{x}_2$. In addition, derive minimum coefficient of friction $\mu_{1\ min}$ between the triangular block and floor (i.e., surface S_1).

(b) (5%) Assuming the surface S_2 has friction of coefficient μ_2 and the triangular block is motionless, derive the acceleration of the *rectangular* block $\ddot{x}_2$. In addition, derive the minimum coefficient of friction $\mu_{1\ min}$ between the triangular block and the floor (i.e., the surface S_1) and compare the result with that derived in 4(a).

(c) (10%) Assuming the surfaces S_1 and S_2 are frictionless, derive acceleration of the *triangular* block $\ddot{x}_1$.

(d) (5%) Assuming the surface S_2 has the friction of coefficient μ_2 and the surface S_1 is frictionless, derive the acceleration of the *triangular* block $\ddot{x}_1$.

(e) (8%) Now, assuming (i) the surface S_1 is frictionless and (ii) the rectangular block is now replaced by a homogeneous cylinder of mass m_2 and radius r which can roll on the surface S_2 without slippage as shown in Figure 3(b), derive acceleration of the *triangular* block $\ddot{x}_1$.

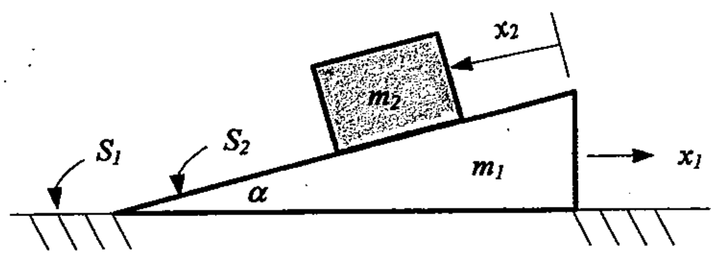

Figure 3(a)

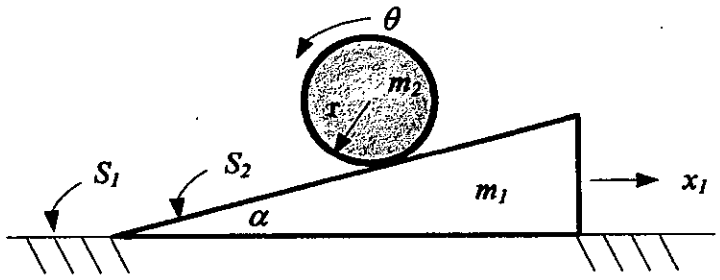

Figure 3(b)

5. (17%) A mechanism shown in Figure 4 is a widely used mechanism that can transform continuous rotational motion to swing motion. The input disk of radius $r = 0.5\ m$ rotates about a fixed axis through point O with a *clockwise* angular velocity $\omega_o = 20\ rad/s$ and a *counterclockwise* angular acceleration $\alpha_o = 5\ rad/s^2$ at the instant of consideration. Pin A is fixed to the disk but slides freely within the slotted member BC.

(a) (6%) Determine the velocity and acceleration of A relative to slotted member BC.

(b) (6%) Determine the angular velocity and angular acceleration of BC.

(c) (5%) Assuming the member BC has mass $1\ kg$ and radius of gyration $r_G = 0.5\ m$ with respect to point B, determine the force between the pin and the slot.

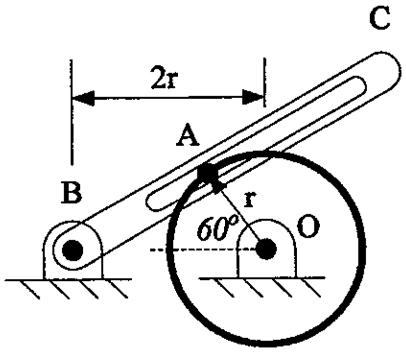

Figure 4

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