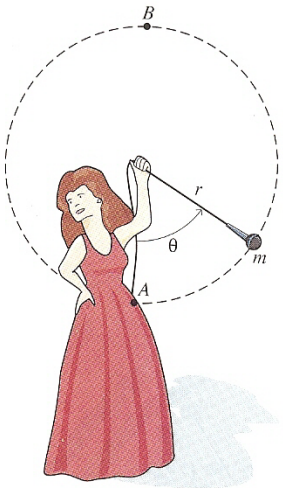
Dynamics Midterm Exam

(21st. Oct. 2008. Tuesday)

Prof. Kyujin Cho.

1. Answer the following questions. (65pts)
   (a) State two things that are conserved in a motion of an object under a conservative central force that can be used to write equations. (10pts)
   (b) Coriolis Acceleration
      i. Write the two conditions that creates coriolis acceleration(10pts).
      ii. Draw the velocity vectors at time t and time t+Δt of a collar moving on a rotating rod. Using these vectors, draw the vectors that represent the coriolis acceleration, and describe in words what they are.(15pts)
      iii. Discuss how this acceleration affects the control of the motor that rotates the rod if you want to maintain a constant angular speed. (10pts)
   (c) Coefficient of restitution
      i. What's the definition? (10pts)
      ii. What is the other equation used in the impulsive motion? (10pts)

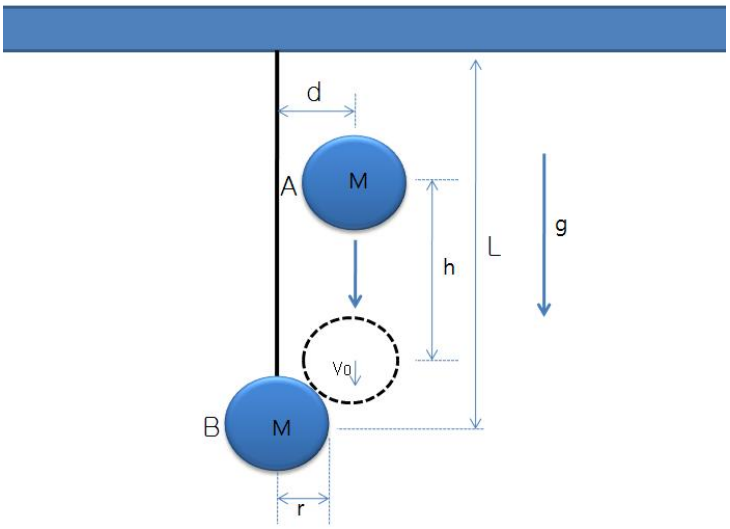
2. (55pts)



A singer swings a microphone of weight *m* in a vertical plane at the end of a *r* m long cord as shown in the figure.

   (a) If the tension in the cord when the microphone is at A is twice the tension in the cord when the microphone is at B, determine the velocity of the microphone and the tension in the cord when the microphone is at A. (15 points)
   (b) If the speed of the microphone is v_A at position A,
      i. Write the speed of the microphone as a function of θ and v_A (10points)
      ii. Write the tension of the cord as a function of θ and v_A. (10points)
      iii. Determine the minimum velocity at A in order for the singer to be able to rotate the microphone in a full circle. (10points)
      iv. Determine the maximum tension in the cord and the angle at which it occurs. (10points)

3.(55points)



Ball B is hanging from a lightweight, inextensible L m long cord as shown in the figure. An identical ball A is released from rest at a height of h m from the center of the ball B. Coefficient of restitution of the ball is e=0.8;

(a) Explicitly write your assumptions, discuss what would happen if you don't make that assumption. (at least two) (10points)

(b) Find the velocity of ball A right before the impact, V_0. (5points)

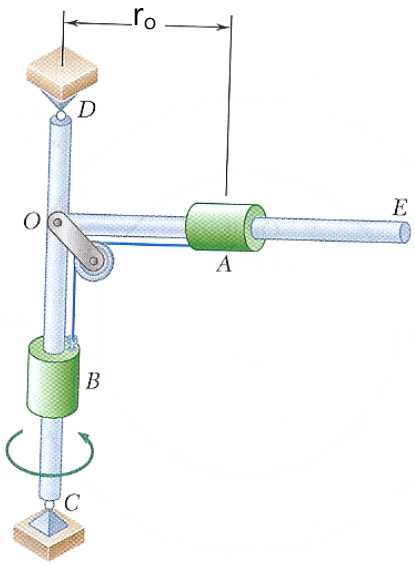
(c) Find the velocity of ball A and ball B right after the impact. (V_B', V_{At}' V_{An}') (15points) (Find θ as a function of d, and use θ to find these velocities.)

(d) Find the amount of energy lost during the impact. (10 points)

(e) Find the maximum height of Ball B after the impact. (5 points)

(f) If you can control the distance of ball A from the cord, discuss how you would find the distance that maximizes the height of ball B after the impact. (10 points)

4.(50pts)



Two **m** kg collars A and B can slide without friction on a frame consisting of the horizontal rod OE and the vertical rod CD, which is free to rotate about CD. The two collars are connected by a cord running over a pulley that is attached to the frame at O and a stop prevents collar B from moving. The frame is rotating at the rate **ω** rad/s and $\mathbf{r_0}$ when the stop is removed allowing collar A to move along rod OE. Neglecting friction and the mass of the frame, determine

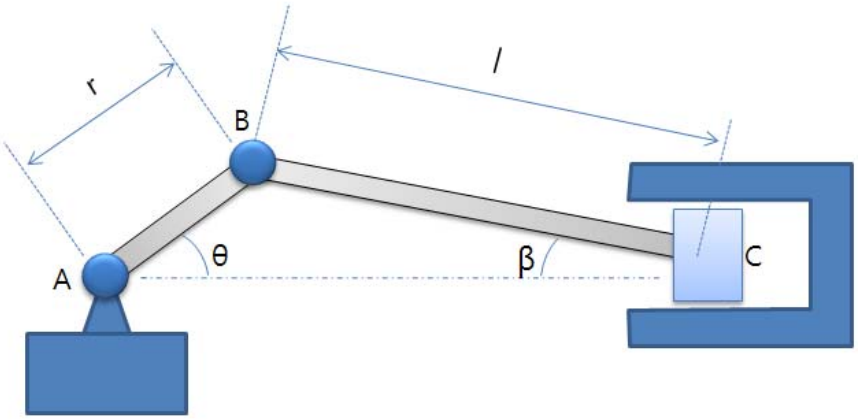
(a) The tension in the cord and the acceleration of collar A relative to rod OE immediately after the stop is removed. (15 points)

(b) What is the angular speed at which the collar will not move even after the stop is removed? (5 points)

(c) If the angular velocity is larger than the one found in (b), find the transverse component of the velocity, and the acceleration of collar A when the collar is at $2r_0$. (15points)

(d) Compare the amount of energy in the system when the collar A is at r_0 and $2r_0$. What is the amount of energy increased? (15points)

5. (40 pts)



In the engine system shown, the piston C is moving at a velocity of v and an acceleration of a. For the crank position indicated,

(a) Determine the angular velocity of rod BC (10 points)
(b) Determine the angular velocity of the crank AB. (10 points)

When you solve (c) & (d), use $\theta=60°$ and $l = \sqrt{3}\,r$.

(c) Determine the angular acceleration of rod BC. (10 points)
(d) Determine the angular acceleration of crank AB. (10 points)