The first 8 minutes of your oral exam will be to plan your time carefully in answering to the best of your ability one of the following four questions:

1. A disk having mass “M” and radius “a” is connected to a rod of negligible mass and suspended from the ceiling as shown. Assume that the rod exerts a restoring torque \( N_r = -k\theta \). Find the motion of the disk if it is rotated through an initial angle \( \theta_0 \) and then released.

2. Two particles \( m_1 \) and \( m_2 \) are connected by a string passing over a smooth pulley. Prove that, if the inertia of the pulley is neglected, the center of mass of the particles has a downward acceleration \( \left( \frac{m_1 - m_2}{m_1 + m_2} \right) g \).

3. A ball of mass \( m \) and a ball of unknown mass approach each other from opposite directions and have the same velocity \( v_0 \) (but oppositely directed). There is then a head-on collision. The ball having the unknown mass is reduced to rest by the impact, while the ball of mass \( m \) is not. What is the mass of the unknown, and what is the final velocity of the ball of mass \( m \) in terms of the velocity \( v_0 \)? Consider the impact to be perfectly elastic.

4. A double pendulum is given as shown:
   (a) List the generalized coordinates for this example.
   (b) Write down the Lagrangian for each generalized coordinate.
   (c) Explain how you would obtain the equation of motion for each coordinate.
   (d) What would you suspect to be the normal modes of oscillation for this system?

The remaining 7 minutes will be questions from your student examiners. You will be graded on your Oral, and your student examiners will be graded on the quality of their questions.

Good Luck!!  J. Artz