Exam 1
2.003 Dynamics and Vibrations

This is a closed book quiz. Each student may bring one side of a $8\frac{1}{2}$ x 11 inch sheet of self-prepared notes only.

Problem 1 (10pts)

A homogeneous square plate of sides l and mass M is initially supported at points A and B, as shown in figure 1. Calculate the reaction forces at B immediately after the support at A is released.

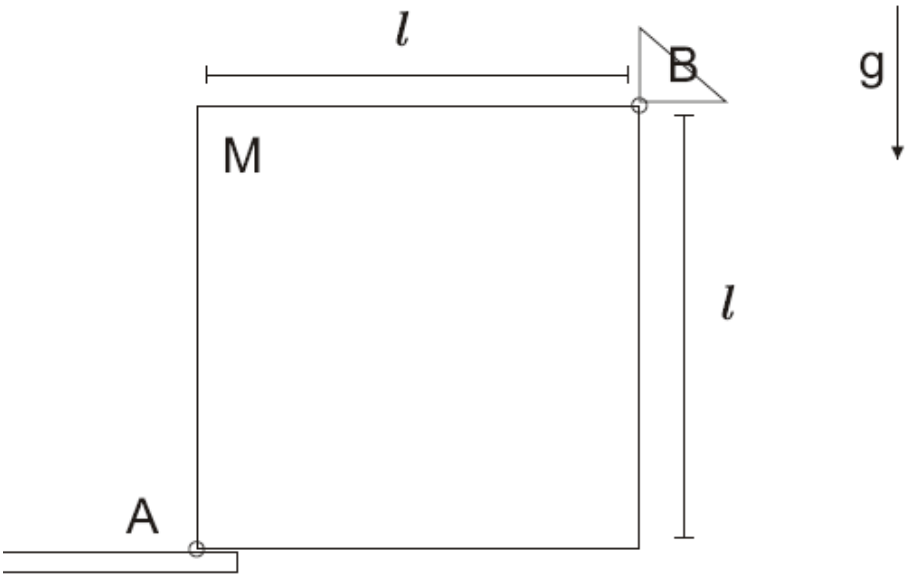

Figure 1

Problem 2 (10 pts)

A bat of length L and mass M rotates freely in a horizontal plane around a pivot in its handle (gravity, which does not play a role in this problem, is directed into the page). The bat has angular velocity ω when it hits a ball of mass m at a distance x from its end. The moment of inertia of the bat about the pivot point is J, and the center of mass is a distance y from the handle. The ball is assumed to be at rest before the hit. This is shown in figure 2.

(i) Determine the maximal speed of the ball, as a function of x, assuming that the coefficient of resitution is e and $\sqrt{J/m} < L$.

(Hint: consider angular momentum principles about the pivot point).

(ii) For $\sqrt{J/m} < L$, determine the location of the center of mass such that there is no reaction at the handle when the struck ball acquires maximal speed.

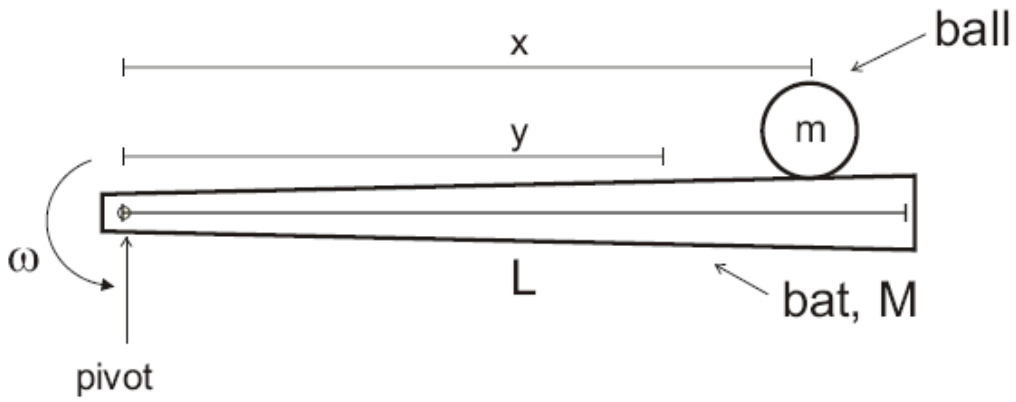

Figure 2

Problem 3 (10pts)

A semi-circular disk of radius r and mass m is released from rest in the configuration shown in figure 3a. Assume the disk falls towards the right and rolls without slipping. Use energy methods (and justify why this is valid) to calculate the angular velocity ω of the disk when it has rolled through 90° (figure 3b).

The center of mass of the body is indicated as G. The distance $OG = \frac{3}{8}r$ and the moment of inertia of the body about point O is $I_0 = \frac{2}{5}mr^2$.

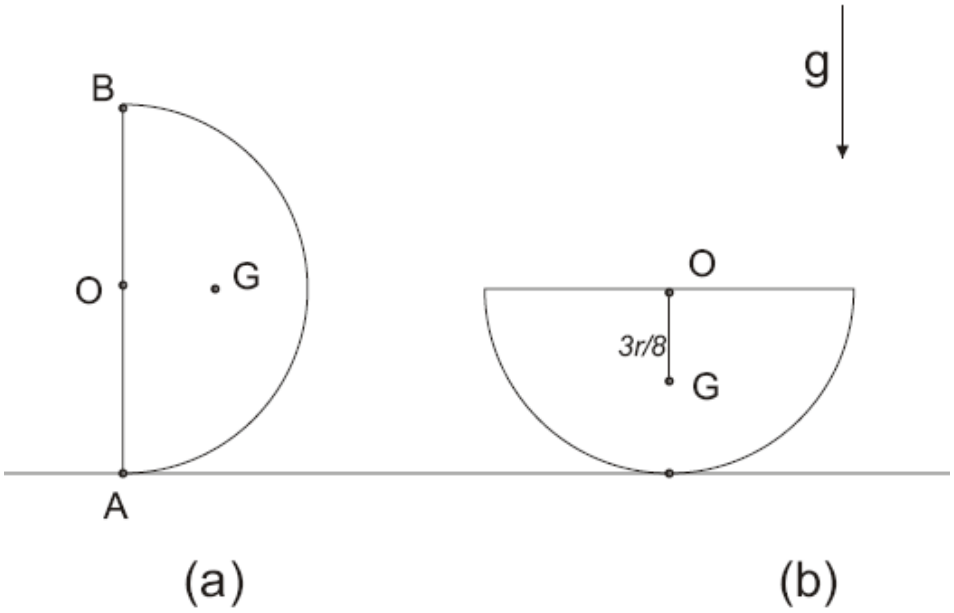

Figure 3