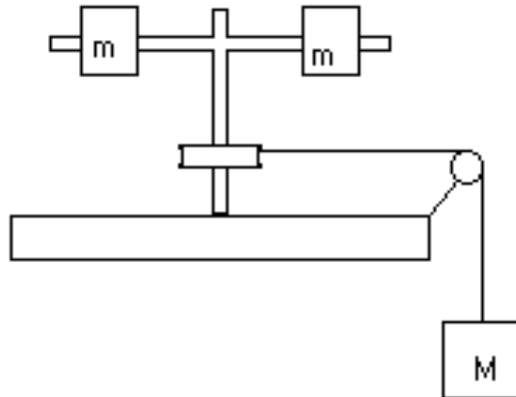# Physics Exploration Homework Supplement

Angular Dynamics: The Angular Acceleration Machine and the Moment of Inertia Batons

Go to the Physics Exploration Center. Enter through the resource room 311/312 Thaw Hall.

(1) Go to the apparatus that consists of two adjustable masses m on a light horizontal rod which can rotate about a central vertical axis. The distance of masses m from the axis of rotation can be adjusted. The central rod is attached by a string to a mass M which provides a tension in the string. This tension force in turn causes a torque about the central axis which results in an angular acceleration of masses m.

(a) Play with the apparatus. Rotate the horizontal rod with your hand to wind the string around the central axis. When the string is sufficiently wound, let go of the horizontal rod. Describe some features that you find interesting (don't worry about whether it is "relevant" to the formal concepts you are learning about rotation).

(b) Predict whether the masses m should be placed closer or farther from the central axis to give the largest angular acceleration. Justify your answer. Then, verify your prediction by putting masses m in the position predicted, then winding the rope and letting go.

(c) Where should the masses be placed to give the smallest angular acceleration?

(d) Calculate the torque by identifying the relevant force that is causing the torque and the lever arm corresponding to that. Is the torque the same whether the masses m on the horizontal rod are closer or farther from the central axis? Justify your answer.

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(e) What are the largest and smallest values of the angular acceleration? To assist you in determining this, a "smart" pulley, which can measure the angular displacement or velocity as a function of time, is provided. Directions for operating the computer are provided nearby. From your measurement of the angular velocity at different times you should be able to calculate the angular acceleration. (Be sure to attach a print out of your angular velocity vs. time plot.)

(2) You are given two batons, both of which have the same mass (You can test this by holding both batons at the center with your two hands and by moving them back and forth without rotating. They will both appear equally heavy.). Now, by holding the batons from the center, try to rotate them back and forth 180 degrees. Which baton is easier to rotate? By playing with the batons in this way, can you make any inferences about how the mass is distributed in the two batons?

(3) Your job is to balance a long stick on the tip of your finger as long as possible. The stick has a mass attached to it closer to one end. Predict whether it is easier to balance the stick on your finger if the end that has the attached mass is closer or farther from your finger when you are balancing it. Now perform the experiment. Explain the reasoning for what you observed and reconcile any differences in your prediction and observation.

(4) Can you explain how your observation in question (2) may be related to why a tight rope walker holds a long rod in her hand while walking on the rope? You must explain the relevant physics principles that are applicable to this exploit.