Moment of Inertia

The purpose of this laboratory is to determine the moment of inertia of two spinning masses in a rotor system by measurement and by calculation.

Measurement of Moment of Inertia

Measure "I" for your rotor system of two spinning masses held by a spinning rod and inner cylinder by dropping a known mass through a known distance. By measuring the fall time, you can determine the average velocity of the falling mass and thus can determine the final velocity of the mass just before the mass strikes the floor. Then, assuming conservation of total mechanical energy during the fall, you can determine the moment of inertia (or rotational inertia) of the rotating system. Don't forget that both the rotating system and the falling mass carry kinetic energy.

Hints: Make careful distance measurements using the vernier calipers where appropriate. Make several measurements of the fall time so you can use an average value. After you derive an expression for the moment of inertia that depends on the fall distance and fall time, you may wish to enter this formula into an Excel worksheet to make the calculations easier.

Calculations of Rotational Inertia (or Moment of Inertia)

Calculate I for the rotor system, first by approximation as two simple point masses; and second by refining your calculation to include the rotational inertia of the (threaded) cross rod; and third by allowing for rotation of the heavy metal cylinders (no longer treating them as point masses). In the third case you should determine the moment of inertia by direct integration over the volume of the cylinder. You can set up the integration as a one-dimensional situation. What do you notice about the relative size of these terms? You could use a table, listing these three components, their totals, and also the percentage contributions of each component to the total. The contribution to the total rotational inertia from the metal spindle is quite small (if you want to try a calculation, you should assume a mass of 500 grams).

Be sure to compare the measured and calculated moments of inertia.

Calculate where the energy goes in this system. How much of the original potential energy ends up as linear KE of the falling mass and how much ends up as final rotational KE of the rotor system, and how much was lost to friction (is it even possible to estimate the work done by friction from your data???). What are the percentages of each?