Accelerating Atwood Machines Protocol Hints

Physics

There are many ways to make measurements and calculate I (the moment of inertia) of an Atwood Machine. Here is what I would recommend:

1. Hang a small mass (very small – like a few paper clips) from any radius of the Atwood Machine. You'll need to measure the mass and convert into kilograms.
2. Suspend the Atwood Machine from a ring stand.
3. Release the mass and make two measurements (you should do this several times and pick the most accurate or calculate an average of your best trials):
    a. The amount of time it takes to reach the ground (t).
    b. The distance between where the mass begins and the ground (h).

    *** If the mass falls too quickly, try using a different radius of the Atwood Machine.
4. Use the big four equation $x = x_o + v_o t + \frac{1}{2}at^2$ to find the acceleration of the mass:
    a. x_o is 0; x is h.
    b. v_o is 0
5. The acceleration of the mass has to be the same as the acceleration of the string, since they are attached. The acceleration of the string will also be equal to a_t of the Atwood Machine at the edge of the attached radius. That means the acceleration you just found is equal to a_t of the Atwood Machine.
6. Use the equation $\alpha = a_t/r$ to find the angular acceleration of the Atwood Machine.
7. Use the equation $\sum F = ma$ to find the sum of the forces acting on the mass.
8. There are only two forces on the mass – gravity (mg, which you can calculate) and the tension from the string. Since those two forces must be equal to $\sum F$, you can use your answer from #7 to calculate the tension in the string.
9. Use the equation $\tau = F * r$ (with F being the tension in the string and r being the radius of the Atwood Machine where the string is attached) to find the torque being exerted on the Atwood Machine.
10. There is only one torque on the Atwood Machine, so the torque you found in #9 must be equal to $\sum\tau$.
11. Now you know a (the angular acceleration of the Atwood Machine, from #6) and $\sum\tau$ (the sum of the torques acting on the Atwood Machine, from #10). Use these values in combination with the equation $\sum\tau = I\alpha$ to calculate your predicted value for the moment of inertia of the Atwood Machine.

Your goals today should be a) to make this calculation (and compare to your classmates to see how close your estimates are), b) to understand how and why this process is mathematically accurate given the concepts we've discussed in class, and c) to extend this procedure (using variable expressions) so that you could use a similar process to make measurements and calculations when there are TWO masses hanging from different radii of the Atwood Machine (like there are in the picture shown in the lab protocol).