MC-9: Angular Acc. & Moments of Inertia **Name________________________**
Lab Worksheet **Group member names_______________________________**

This sheet is the lab document your TA will use to score your lab. It is to be turned in at the end of lab. To receive full credit you must use complete sentences and explain your reasoning clearly.

1. Set up the rotational inertia apparatus according to the Experiment I section of the lab manual following steps 1 through 4.

Draw a free body diagram for just the hanging mass in terms of its mass *m*, the acceleration of gravity *g* and the string tension *T*.	Using Newton's 2nd Law solve for *T* in terms of a_y (the acceleration of the hanger), *m* and *g*.
Using a top view perspective, draw a FBD for the heavy gray disk in terms of the hub radius *r* and string *T*	Using Newton's 2nd Law for rotational motion, solve for T in term of α_z (the angular acceleration of the disk), in terms of *r, M* and *R*.

2. How are a_y and α_z related?____
3. Eliminating *T* and a_y, obtain an expression that relates α_z to *r, M, g* and *R*. Show your group's expression here:

4. Measure these quantities and estimate the error:
   Mass of gray disk, *M*: ________±___________
   Radius of gray disk, *R*:________±___________
   Rotational inertia of gray disk, I = ________________
   Radius of middle hub, *r*:________±___________

5. Use these numbers and a value of m = 100 g and g = ________ to obtain your "expected" values for α_z =________ and a_y =________ (a value of a_y = 0.015 m/s^2 is typical)
6. Now following the lab manual procedure (steps 5 through 7) and measure a_y three times.
7. Measurements of a_y:

Mean value of a_y =________________

8. How well do your values compare?

____

____

9. Perhaps you will do better if you eliminate two systematic errors, frictional forces and the effective hub radius (i.e., the string itself has a finite radius and so if may be expected that your hub radius, *r,* value is small than the actual value).
10. Measure m_0, the mass necessary to balance the frictional forces and the effective hub radius following step 9 in the manual.
    m_0:________±____________
    # revolutions:________±____________
    h_1:________±____________
    h_2:________±____________
    r':________±____________
    Using m_0 and r' obtain your "corrected" values for α_z =________ and a_y =________
11. How well do these values compare?

____

____

12. Now increase m to 150 grams and repeat step 7 above.
    m:________±____________
    Run the same experiment and compare the calculated a_y =________
    to the measurements of a_y:

Mean value of a_y =________________

13. How well do these values compare?

____

____

Work-Energy: If you were only interested in the angular velocity then you could have used the Conservation of Energy principle directly.

14. Arrange for 150 grams to descend a distance of 60 to 70 cm and record the maximum velocity when starting from rest.
    h_1:________±____________
    h_2:________±____________
    Δh:________

    Run the same experiment and measure v_y:

    Mean value of v_y =________________

15. How much work was done by gravity?

    $W_{gravity}$= ________________

16. How much rotational energy does the gray disk have?

    $K_{rotational}$=________________

17. How much translational kinetic energy does the falling mass have?

    $K_{translational}$=________________

18. How much work was done by non-conservative forces?

    $W_{non\text{-}conservative}$=________________

Measuring moments of inertia: The expression in step 3 above can be rearranged so that only the moment of I appears in the left hand side. Write down I in terms of m, g, r and a_y.

19. Now remount the gray disk so that it stands on end. Changing the axis of rotation changes the moment of inertia. Do you expect the moment of inertia to increase or decrease? Explain your reasoning.____

    ____

    ____

20. Using m = 150 gm measure a_y.

Mean value of a_y =________________

21. Does a_y indicate that the moment of inertia has increased or decreased?_____________________

____

____

22. Now remount the gray disk in the original horizontal position and then mount the heavy black ring in the available groove.
23. Using m = 150 gm measure a_y.

Mean value of a_y =________________

24. Use this value of to calculate the moment of inertia.

I =___________________

25. Use this value and the moment of inertia you found earlier to calculate the moment of inertia for the black metal ring.

$I_{black\ ring}$=___________________

26. Alternatively we can calculate the moment of inertia using M $[(R_1 + R_2)/2]^2$

Mass of black ring, M: ________±____________

Inner radius of ring, R_1:________±____________

Outer radius of ring, R_2:________±____________

Rotational inertia of black ring, $I_{black\ ring}$ = _________________

27. How well do these two values compare?____

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