Work Sheet

Student Name: ______________________________

Team members:

1.- ______________________ 2.- ______________________

3.- ______________________ 4.- ______________________

Instructor: ______________________________

Note: *Show your work.*

Introduction

Analysis

Derive equation (10.7) from the Lab Manual

1. In this lab, we neglect energy losses and assume that all gravitational potential energy is converted into kinetic energy. The novelty is that kinetic energy has two forms: translational and rotational. Start from the statement of energy conservation as given in equation (10.6) and derive equation (10.7).

Derive equation (10.9) from the Lab Manual

In this experiment, the rolling object's acceleration is due to a component of the gravitational force along the ramp. Therefore, *the object's acceleration is constant with time* .

Just like the velocity of the center of mass is related to its change in position with respect to time,

$$v_{cm} = \frac{ds}{dt}, \tag{1}$$

the acceleration of the center of mass is related its change in velocity with respect to time.

$$a_{cm} = \frac{dv_{cm}}{dt}. \tag{2}$$

2. Integrate equation (2), from 0 to t and show that for a object starting from rest, its velocity is proportional to time and is given by

$$v_{cm} = a_{cm}t. \tag{3}$$

3. To derive equation (10.9), substitute equation 3 into equation 1 and integrate the resultant equation from 0 to t.

Solid Disk:

4. Determine the average traveling time for the solid disk.

5. Use equation (10.10) from the lab manual, the distance traveled by this object, and the average time found in the previous question to obtain its center of mass acceleration.

6. Use your data and the previous result to determine the velocity of the object's center of mass at the end of the ramp.

7. Combine your previous result with the height dropped by the center of mass to determine the value of the constant k in equation (10.4).

8. Find the percent difference between your calculated value and the accepted one, given in Table 10.1.

Solid Sphere:

9. Similarly to the Solid Disk case, determine the value of the constant k in equation (10.4) for the solid sphere.

10. Find the percent difference between your calculated value and the accepted one for this case.

Metal Hoop

11. Determine the value of the constant k in equation (10.4) for the metal hoop.

12. Find the percent difference between your calculated value and the accepted one for this case.

Conclusion

(Write a short paragraph to explain what you have learned from the experiments. In particular, tell us if the theoretical predictions give you at least ballpark estimates for your observations? Comment on the differences between the accepted and observed values of the constant k.)