**General Physics eJournal 7**

**Rotational Motion**

**Instructions:**

Follow the Writeup and fill out the eJournal as you complete the lab activities. Submit your eJournal report by uploading the completed WORD or PDF document to our class Learninghub site. If the Learninghub site is down, email the completed report file directly to a lab TA.

**Preliminaries:**

* Title:
* Name(s):
* Date:
* Time In & Out:

**Plan:**

**Hypothesis**

Consider **any two** of the three objects – solid disk, hollow cylinder, and/or hollow sphere. If they are each rolling without slipping, which has the greater fraction of its total kinetic energy as rotational kinetic energy? If both objects are started simultaneously from rest at the same point on an incline, hypothesize which reaches the bottom of the incline first. Justify your prediction by considering which object has a larger fraction of its mass located close to the axis of rotation.

**Experiment Outline**

Briefly describe your plan for testing your hypothesis.

**Equipment List**

* List
* Equipment
* Here

**Action:**

Describe the techniques used to collect data by responding to the bullet point questions:

* How was the height of the ramp determined?
* How did you record the motion of the rolling objects?
* Why is the ruler included?
* How did you orient the coordinate axes on the video?

*Insert labeled image of your apparatus*

**Results:**

Record the height, h, of the common starting point above the **level** tabletop.

Height: h = \_\_\_\_\_\_\_\_\_\_\_\_ m

After you have marked the path of the rolling objects in Tracker, insert an image from Tracker showing the object and its tracking marks for at least one of the objects.

*Insert Tracker image of the rolling object*

Record the last two locations and times for each object as it is about to exit the inclined plane.

**Table I: (Write appropriate title)**

|  |  |  |
| --- | --- | --- |
| **Object** |  |  |
| **M (kg)** |  |  |
| **x1 (m)** |  |  |
| **x2 (m)** |  |  |
| **t1 (s)** |  |  |
| **t2 (s)** |  |  |
| **vf meas =** $\frac{∆x}{∆t}$ **(m/s)** |  |  |
| **vf theory =** $\sqrt{\frac{2gh}{\left(1+f\right)}}$ **(m/s)** |  |  |
| **%Diff =** $\frac{\left|v\_{f theory}-v\_{f meas}\right|}{v\_{f theory}}×100\%$ |  |  |

**Analysis:**

Calculate the final speed, vf meas, the predicted speed, vf theory, and the percent difference between them. Record these values in Table I.

Use your spring balance to measure the mass, M, of each object. Then calculate the PE and translational and rotational KE of each. Find the percentage of the total KE that is translational and rotational. Calculate the percent difference between the initial potential energy and the final total kinetic energy.

**Table II: (Write appropriate title)**

|  |  |  |
| --- | --- | --- |
| **Object** |  |  |
| **PEinitial = Mgh (J)** |  |  |
| **KEtrans = ½ Mvf2 (J)** |  |  |
| **KErot = ½ fMvf2 (J)** |  |  |
| **KEtotal = KEtrans + KErot (J)** |  |  |
| **%Translational = KEtrans/KEtotal x 100%** |  |  |
| **%Rotational = KErot/KEtotal x 100%** |  |  |
| **Energy %Diff =** $\frac{\left|PE\_{initial}-KE\_{total}\right|}{PE\_{initial}}$ **x 100%** |  |  |

**Conclusion:**

Interpret your results in light of your hypothetical predictions. Which object wins a race down the hill? How do the speeds compare with a block sliding without friction down the same hill or an object in freefall (Eq. 14)? Which object has the least fraction of rotational kinetic energy and the largest fraction of translational kinetic energy? Has the mechanical energy been conserved for the objects that roll without slipping? How might you improve this experiment or explore it further?

The racquetball and the PVC pipe both have a finite thickness, i.e., not all the mass is located at radius R, some is actually located closer to the axis of rotation. How does this affect the moment of inertia and final velocity?

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