Rotational Kinetic Energy

Name____________________________________TA____________________________________

Partners____

Section#_________________________________Date____________________________________

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1. Velocity of a rolling object I

Please rip off the last page of this data sheet, and look at the formulae to calculate the following.

- Description of Object:

  Shape ____

  Mass M = ____ (kg)

  Radius R = ____ (m)

  Theoretical moment of inertia I = ____________________________ (kg · m^2)

Rolling distance along ramp, d = ________________________________ (m)

Vertical distance, $h = d \sin\theta$ = __________________________________ (m)

t Time between photo gates	$v_{\text{ave}} = d / t$ Average velocity	$v_{\text{final}} = 2v_{\text{ave}}$ Final velocity	$v_{\text{theoretical}}$	$\frac{\lvert v_{\text{final}} - v_{\text{theoretical}} \rvert}{v_{\text{theoretical}}} \times 100$

Question 1-1: Are the experimental and theoretical values close each other?

Question 1-2: Is there any energy loss in this experiment? (*If some of the energy is lost, the experimental final velocity will be below the theoretically predicted values. If the experimental final velocity is larger, what is the significant reason? You can't create energy from nothing!*)

2. Velocity of a rolling object II

Please rip off the last page of this data sheet, and look at the formulae to calculate the following.

- <u>Description of Object:</u>

Shape ____

Mass M = _______________________________________ (kg)

Radius R = ______________________________________ (m)

Theoretical moment of inertia I = ________________________ (kg · m^2)

Rolling distance along ramp, d = ____________________________ (m)

Vertical distance, $h = d \sin\theta$ = ____________________________ (m)

t Time between photo gates	$v_{\text{ave}} = d/t$ Average velocity	$v_{\text{final}} = 2v_{\text{ave}}$ Final velocity	$v_{\text{theoretical}}$	$\frac{\lvert v_{\text{final}} - v_{\text{theoretical}} \rvert}{v_{\text{theoretical}}} \times 100$

Question 2-1: Are the experimental and theoretical values close each other?

Question 2-2: Is there any energy loss in this experiment? (*If some of the energy is lost, the experimental final velocity will be below the theoretically predicted values. If the experimental final velocity is larger, what is the significant reason? You can't create energy from nothing!*)

3. Velocity of a rolling object III

Please rip off the last page of this data sheet, and look at the formulae to calculate the following.

- Description of Object:

  Shape ____

  Mass M = ____ (kg)

  Radius R = ____ (m)

  Theoretical moment of inertia I = ______________________ $(\text{kg} \cdot \text{m}^2)$

Rolling distance along ramp, d = ___________________________ (m)

Vertical distance, $h = d \sin\theta$ = ____________________________ (m)

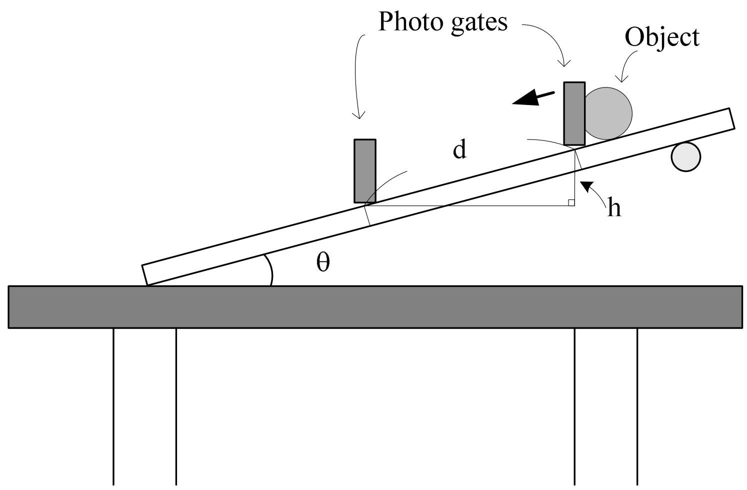
t Time between photo gates	$v_{\text{ave}} = d/t$ Average velocity	$v_{\text{final}} = 2v_{\text{ave}}$ Final velocity	$v_{\text{theoretical}}$	$\frac{\lvert v_{\text{final}} - v_{\text{theoretical}} \rvert}{v_{\text{theoretical}}} \times 100$

Question 3-1: Are the experimental and theoretical values close each other?

Question 3-2: Is there any energy loss in this experiment? (*If some of the energy is lost, the experimental final velocity will be below the theoretically predicted values. If the experimental final velocity is larger, what is the significant reason? You can't create energy from nothing!*)

Special Question:
What is the significant difference between this lab and Work & Energy lab? (If you used a cubic object that has the same mass as one of the above objects for this lab [<u>assuming no friction when the cubic object slides</u>], would you obtain the same result?)

Lab Procedure for Rotational Kinetic Energy



1. **The figure is the basic set up.**
   The object will be a disk, a ring, a sphere, etc.

2. **Measure the mass, diameter of the object.**
   The radius is diameter ÷ 2. Use SI units.

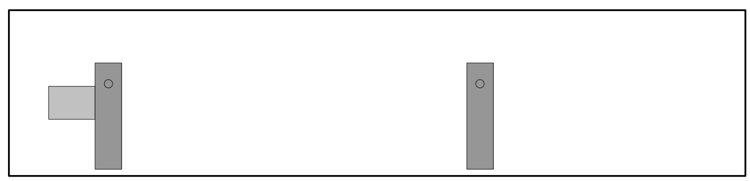
3. **Calculate the moment of inertia.**
   See Appendix (page 5).

4. **Measure the rolling distance along ramp and the inclined angle.**
   The distance must be between photo gates. More precisely, it is between the beams of infrared red. The angle is from the surface of table to the bottom of the plate. Use a protractor.

5. **Calculate the vertical distance, h.**

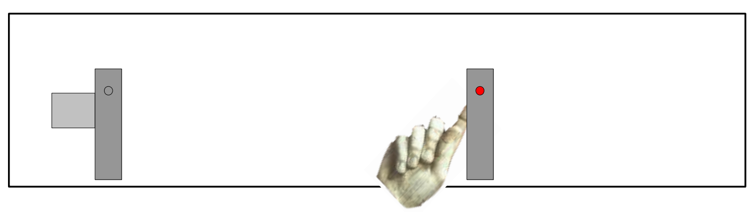
6. **Measure the rolling time for the distance.**
   Since it must start from rest, the following instruction is very important. (Note: The figures are the top view.)

   - Put the object near the first gate.

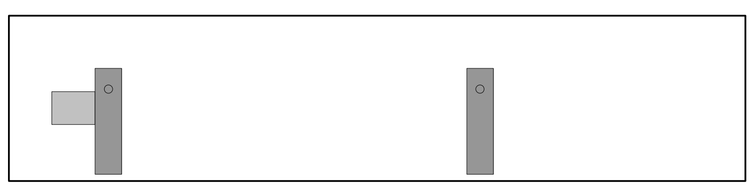


   - When it crosses the beam, the light on the gate will flash.

   - After you get the object back a little, the second gate should be reset by hand if you pressed the record button already.



   - Now, you can release the object.

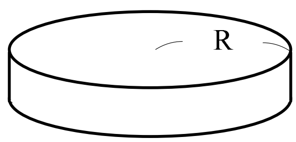


If you have a good partner to ask him or her to press the record button when you are ready to release, you do not have to reset by hand as above.

Appendix:

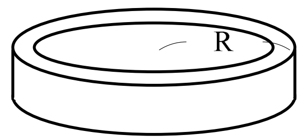
- **Moments of inertia**

Disk



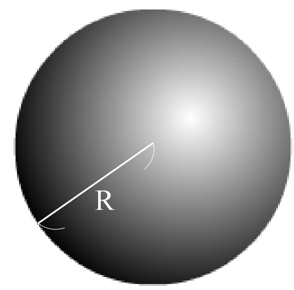
$$I = \frac{1}{2}MR^2$$

Ring



$$I = MR^2$$

Sphere



$$I = \frac{2}{5}MR^2$$

M is the mass of an object.

- **Theoretical Value of Final Velocity**

The theoretical velocity of an object is given as follows:

$$v_{\text{theoretical}} = \sqrt{\frac{2gh}{1+\frac{I}{MR^2}}}.$$

M is the mass, R is the radius, I is the moment of inertia of an object. h is the vertical rolling distance, starting from rest.

Note:

When you use a ring, make a diaphragm so that it can be caught by the photo gate. The easiest way is to make use of a sheet of aluminum foil or masking tape.