AP Physics 1 Lab

Rotational Kinetic Energy

Objective

Compare the experimental and calculated values for rotational kinetic energy for a solid sphere

Materials

List the materials you will use in the lab. You may want to draw a sketch showing the apparatus.

Data

Describe (*in complete sentences*) 1) the data you will collect (what measurements will you make?) 2) how you will collect the data? (what tools will you use?) and 3) how you will use the data. ***Show any equations you will use to make calculations.*** Record the data in your notebook. It is not necessary to write an entire procedure.

Procedure

1. Find the mass of the steel ball. Record the mass (in kg) in **Data Table 1**.

2. Place the steel ball at the 0.0 cm mark. Measure the vertical height from this mark to the point at which the ball passes through the photogate at the bottom of the track. Record the height (in m) for **Trial 1** in **Data Table 1** .

3. Release the ball from rest and record the time (in s) for the ball to pass through the photogate. Record the time for **Trial 1** in **Data Table 1**.

4. Repeat **Procedures 2-3** for **Trials 2-7** for the additional positions shown in **Data Table 2**.

Calculations

1. Find the speed of the ball through the photogate for each trial. The diameter of the ball is 0.019 m. Record the speeds in **Data Table 2**.

2. Calculate the initial gravitational potential energy at the top of the track and the final translational kinetic energy of the ball at the bottom of the track. Record each value in **Data Table 2**. The difference between the two is the rotational kinetic energy of the ball at the bottom of the track. Record the difference as the experimental rotational kinetic energy in **Data Table 2**.

3. Convert the linear speed of the ball to the angular speed for each trial and record the speeds in **Data Table 2**.

4. Calculate the rotational kinetic energy of the ball for each using the rotational speed you found in **Procedure 3**. The rotational inertia of a solid sphere about its center is $I = \frac{2}{5}mr^2$. Record these values as the calculated rotational kinetic energy in **Data Table 2**.

Analyze (*Answer in complete sentences*)

1. How closely do your values for the experimental and calculated values for rotational kinetic energy compare?

2. Draw a free body diagram showing the forces acting on the sphere as it rolls down the ramp. Draw the forces at the point of contact (if there is one). Which of the forces provides the torque for the rotation of the ball?

3. Suppose the sphere had the same mass and radius, but was hollow instead of solid. Would the rotational kinetic energy for the hollow sphere at the bottom of the track be greater than, less than or the same as the rotational kinetic energy of the solid sphere? Explain.

4. Suppose the ramp were frictionless. Would the change in translational speed of the solid sphere at the bottom of the track be greater than, less than or the same as change in translational speed when the track has friction? Explain.

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Data Table 1

Mass (kg)			
Trial	Position on Track (cm)	Height (m)	Time (s)
1	0.0		
2	10.0		
3	20.0		
4	30.0		
5	40.0		
6	50.0		
7	60.0		

Data Table 2

Trial	Speed (m/s)	U_g (J)	K_{trans} (J)	Experimental K_{rot} (J)	ω (rad/s)	Calculated K_{rot} (J)
1						
2						
3						
4						
5						
6						
7						