Spinning Things Lab: Rollin' Down the Railway

AP Physics C: Mr. Perkins

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1 Procedure

We placed a ramp of length 1.2 m at a 5° incline, we rolled down three objects: a cart, disk, and ring. We tracked the time it took for each object to reach the bottom of the ramp.

2 Data and Analysis

To calculate the acceleraton of each object, we used $a = \dfrac{2d}{t^2}$.

To calculate the moment of inertia of each object, we used the following formulas:

- $I = mr^2$ for a ring
- $I = \dfrac{1}{2}mr^2$ for a disk

From our set up, $d = 1.2\,\text{m}$ and $\theta = 5°$.

Object	Mass (kg)	Radius (m)	Time (s)	Acceleration (m/s^2)	Moment of Inertia (kgm^2)
Cart	0.26		1.6	0.938	
Disk	0.63	0.075	1.9	0.665	0.0018
Ring	0.63	0.075	2.3	0.454	0.0035

2.1 Theoretical Acceleration

We calculated the theoretical acceleration of each object using the following equation:

$$\begin{aligned} a_{\text{cart}} &= g\sin\theta \\ &= (9.81)\sin(5°) \\ &\approx 0.855\,\text{m/s}^2 \end{aligned} \qquad \begin{aligned} a_{\text{disk}} &= \frac{mgr^2\sin\theta}{mr^2 + \frac{1}{2}mr^2} \\ &= \frac{2g\sin\theta}{3} \\ &= \frac{2(9.81)\sin(5°)}{3} \\ &\approx 0.570\,\text{m/s}^2 \end{aligned} \qquad \begin{aligned} a_{\text{ring}} &= \frac{mgr^2\sin\theta}{mr^2 + mr^2} \\ &= \frac{g\sin\theta}{2} \\ &= \frac{(9.81)\sin(5°)}{2} \\ &\approx 0.427\,\text{m/s}^2 \end{aligned}$$

2.2 Percent Error

We can calculate the percent error of each object by using the following equation:

$$\delta = \frac{a_A - a_T}{a_T} \times 100\%$$

where a_A is the recorded acceleration and a_T is the theoretical acceleration.

The percent error for each object is:

- Cart: 9.7%
- Disk: 16.6%
- Ring: 6.3%