Equations Live Here

Physics 4A

Connor Darling

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Contents

Chapter 1

Equations for Moment of Inertia Lab

Theoretical Times

Theoretical time for solid cylinder at 5°

$$\sqrt{\frac{2(1+0.5)\cdot 1.000}{9.8\sin(5)}} = 1.8741\ sec$$

Theoretical time for hollow cylinder at 5°

$$\sqrt{\frac{2(1+1)\cdot 1.000}{9.8\sin(5)}} = 2.1641\ sec$$

Theoretical time for sphere at 5°

$$\sqrt{\frac{2(1+\frac{2}{5})\cdot 1.000}{9.8\sin(5)}} = 1.8106\ sec$$

Theoretical time for solid cylinder at 10°

$$\sqrt{\frac{2(1+0.5)\cdot 1.000}{9.8\sin(10)}} = 1.3330\ sec$$

Theoretical time for hollow cylinder at 10°

$$\sqrt{\frac{2(1+1)\cdot 1.000}{9.8\sin(10)}} = 1.5392\ sec$$

Theoretical time for sphere at 10°

$$\sqrt{\frac{2(1+\frac{2}{5})\cdot 1.000}{9.8\sin(10)}} = 1.2878\ sec$$

RSS Error

Greatest contributors are used to calculate RSS error

$$\text{RSS} = \sqrt{\left(\frac{0.00005\ sec}{1.2037\ sec}\right)^2 + \left(\frac{0.0005m}{1.000m}\right)^2 + \left(\frac{0.00005m}{0.0255m}\right)^2} \times 100\% = 1.02\%$$

Back-End Error

Percent error should be used because we are calculating a theoretical value and comparing an experimental value with that number rather than comparing two unknown experimental values.

$$\%\text{error} = \frac{|E-K|}{K} \times 100\%$$

Where E = experimental value and K = theoretical value.

$$\%\text{error for solid cylinder at } 5^\circ = \frac{|1.9279\ sec - 1.8741\ sec|}{1.8741\ sec} \times 100\% = 2.87\%$$

$$\%\text{error for hollow cylinder at } 5^\circ = \frac{|\ 2.1946 sec - 2.1641\ sec|}{2.1641\ sec} \times 100\% = 1.41\%$$

$$\%\text{error for sphere at } 5^\circ = \frac{|1.8141\ sec - 1.8106\ sec|}{1.8106\ sec} \times 100\% = 0.19\%$$

$$\%\text{error for solid cylinder at } 10^\circ = \frac{|1.2564\ sec - 1.3330\ sec|}{1.3330\ sec} \times 100\% = 5.75\%$$

$$\%\text{error for hollow cylinder at } 10^\circ = \frac{|1.4367\ sec - 1.5392\ sec|}{1.5392\ sec} \times 100\% = 6.66\%$$

$$\%\text{error for sphere at } 10^\circ = \frac{|1.2151\ sec - 1.2878\ sec|}{1.2878\ sec} \times 100\% = 5.65\%$$

1.1 More Analysis (Q4)

Using:

$$\Delta t = \frac{1}{R_2}\sqrt{\frac{D(3R_2^2 + R_1^2)}{g \sin\theta}}$$

Calculated Δt for hollow cylinder

Trial using $\theta = 5°$:

$$\Delta t = \frac{1}{0.0285}\sqrt{\frac{1.000(3 \cdot (0.0255)^2 + 0.0285^2)}{9.8 \sin(5)}} = 1.9957\ sec$$

Trial using $\theta = 10°$:

$$\Delta t = \frac{1}{0.0285}\sqrt{\frac{1.000(3 \cdot (0.0255)^2 + 0.0285^2)}{9.8 \sin(10)}} = 1.4138\ sec$$

Comparing Values				
	Theoretical using C as 1	Theoretical using an R_1 & R_2	Experimental	%error
$\theta = 5°$	2.1641 *sec*	1.9957 *sec*	2.1946 *sec*	1.41%
$\theta = 10°$	1.5392 *sec*	1.4138 *sec*	1.4367 *sec*	6.66%

Analyzing these results show that using $C = 1$ was closer to the experimental value than using two radii for the 5° trial. However, for the 10° trial, the result is the opposite. Factoring in the %error, our error was much higher for the 10° trial. This tells me that with minimal error, using $C = 1$ is more accurate is this context.

4 - Procedural Errors and Improvements

Some of the contributing factors the errors in this lab are, inclometer limitations, calliper limitations, and photogate limitations. Though the goal of these devices are to attempt to give the best reading possible, the limitation to a specific decimal places allows room for error, which is why we allowed our data to be +- a certain amount. A big contributor to error could be releasing the ball. It is difficult to release the ball exactly straight which not doing so would default the goal of the lab leading to error. Another factor for error is the initial velocity of the rolled object. It is difficult to realse the object from rest with out triggering the photogate timer, which also could lead to error. I would suggest that students or lab participants use something to help keep the object to roll in a straight line without disrupting its velocity.

Chapter 2

Conservation of Linear Momentum & Kinetic Energy

							Analysis and Error	
Trial #	v_{1i} (m/s)	v_{1f} (m/s)	v_{2i} (m/s)	v_{2f} (m/s)	P_i system (kgm/s)	P_f system (kgm/s)	% diff in P	K_i system (J)
1	c2	c3	c4	c5	c6	c7	c8	c9
2	c2	c3	c4	c5	c6	c7	c8	c9
3	c2	c3	c4	c5	c6	c7	c8	c9
4	c2	c3	c4	c5	c6	c7	c8	c9
5	c2	c3	c4	c5	c6	c7	c8	c9

Error				
Trial #	Theoretical using C as 1	Theoretical using an R_1 & R_2	Experimental	%error
# 1	2.1641 *sec*	1.9957 *sec*	2.1946 *sec*	1.41%
# 2	1.5392 *sec*	1.4138 *sec*	1.4367 *sec*	6.66%
# 3	1.5392 *sec*	1.4138 *sec*	1.4367 *sec*	6.66%
# 4	1.5392 *sec*	1.4138 *sec*	1.4367 *sec*	6.66%
# 5	1.5392 *sec*	1.4138 *sec*	1.4367 *sec*	6.66%

Results				
Trial	Theoretical using C as 1	Theoretical using an R_1 & R_2	Experimental	%error
# 1	2.1641 *sec*	1.9957 *sec*	2.1946 *sec*	1.41%
# 2	1.5392 *sec*	1.4138 *sec*	1.4367 *sec*	6.66%
# 3	1.5392 *sec*	1.4138 *sec*	1.4367 *sec*	6.66%
# 4	1.5392 *sec*	1.4138 *sec*	1.4367 *sec*	6.66%
# 5	1.5392 *sec*	1.4138 *sec*	1.4367 *sec*	6.66%

RSS Error

Greatest contributors are used to calculate RSS error

$$\text{RSS} = \sqrt{\left(\frac{0.00005kg}{0.2155kg}\right)^2 + \left(\frac{0.005m/s}{0.0m/s}\right)^2} \times 100\% = 0.02\%$$