Equations Live Here
Physics 4A

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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.

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

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

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

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

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

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

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 Energy and Momentum

RSS Error

Greatest contributors are used to calculate RSS error

$$\text{RSS\% Error} = \sqrt{\left(\frac{0.00005kg}{0.2156kg}\right)^2 + \left(\frac{0.005m/s}{0.18m/s}\right)^2} \times 100\% = 2.78\%$$

Back-End Error % Difference

$$\text{\% Difference} = \frac{|E_1 - E_2|}{\frac{(E_1+E_2)}{2}} \times 100\% = \frac{|0.11\frac{kgm}{s} - 0.09\frac{kgm}{s}|}{\frac{(0.11\frac{kgm}{s}+0.09\frac{kgm}{s})}{2}} \times 100\% = 19.50\%$$

Percent difference should be used to calculate error because we are comparing the initial momentum versus the final momentum. This explicit calculation was done for Trial#1's momentum values. This was an elastic collision where theoretically the inital momentum and final momentum should be the same, but as shown this is not the case. This shows that there was definitely error involved.

4 - Procedural Errors and Improvements

Procedural Errors

- In regards to errors, there are factors that limit the most precise and accurate readings. One of these factors are the software limiting us to specific decimal places

- Additionally, the scale is limited to four places past the decimal point allowing for error.

- Another factor is the air track we used to simulate a frictionless surface for the carts to glide upon. Of course it would be impossible to get a perfectly frictionless surface in the context of this lab, but without that preciseness, this lab is error prone.

- Finally, in the software itself of data studio, a dfferent selection of data would yield different results. This could lead not only errors, but a biased selection of data.

- ⋆ It is noted that our error was awful for this lab, we re-ran trials multiple times included with your supervision, but still we were getting extremely high error. You advised us to not use this lab as a formal write up.

Improvements

- If I could reccomend something to be improved, it would be a better printed procedural section. Some parts of the print were messed up make it difficult to read and understand.

Rotational Inertia of a Point Mass Lab

"Freebie"

Centripetal Force Lab

"Freebie"

Archimede's Principle Lab

Simple Pendulum Lab