**PHYSICS 1D03 LAB 1 WRITE-UP**

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**   **Lab Section:\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Student No:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** **Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Partner:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Lab Section:\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Student No:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**RESULTS**

**PART 1: SIMPLE PENDULUM**

**PART A: PRELIMINARY STUDY**

Uncertainty in time = ± \_\_\_\_\_\_\_\_\_\_\_\_\_\_( )

**CHECKPOINT: Have the T.A check your uncertainty in time.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Swings | Lab partner 1, time values           (     ) | Lab partner 1, period and uncertainties ( ) | Lab partner 2, time values           (     ) | Lab partner 2, period and uncertainties( ) |
| 1 |  |  |  |  |
| 5 |  |  |  |  |
| 10 |  |  |  |  |

**PART B: VARIATION WITH AMPLITUDE**

Length = \_\_\_\_\_\_\_\_\_$\pm $\_\_\_\_\_\_\_\_\_\_\_\_( )

|  |  |  |
| --- | --- | --- |
| Amplitude (degrees) | Time for 10 swings ± ( ) |  Period ± ( ) |
|  |  |  |
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Part B: Variation with Amplitude Graph

Place your graph from the procedure for Part B here.

**PART C: VARITATION WITH LENGTH**

Amplitude=\_\_\_\_\_\_\_ ( )

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Length ± ( ) | Time for 10 swings ± ( ) | Period *T ±* ( ) | $T^{2}\pm δ\left(T^{2}\right)$ ( ) | $g=\frac{4π^{2}l}{T^{2}}\pm δg$(ms-2) |
|  |  |  | $$\pm $$ | $$\pm $$ |
|  |  |  | $$\pm $$ | $$\pm $$ |
|  |  |  | $$\pm $$ | $$\pm $$ |
|  |  |  | $$\pm $$ | $$\pm $$ |
|  |  |  | $$\pm $$ | $$\pm $$ |

Average $g$=\_\_\_\_\_\_\_\_\_\_\_\_( )

Average $δg$=$\pm $\_\_\_\_\_\_\_\_\_\_( )

Note that the uncertainty is determined from the *measured* values of total time (10*T*), and that the error in *T* is *calculated* from this result. In this instance, the calculation is simplified in that the integer 10 has no error. The error in $g$ is determined from uncertainties in length $l$ and period $T$ by successive use of the rules for error propagation (multiplication and division).

**CHECKPOINT: Have the T.A check your formula for the uncertainty in *g* and if it matches the Excel value.**

Part C: Variation with Length Graph

**CHECKPOINT: Have the TA check your graphs**

Place your graph from the procedure for Part C in the space below.

**RESULTS**

**PART 2: PHYSICAL PENDULUM**

**Length (from end hole to end hole): +/- ( )**

**Distance between the holes: +/- ( )**

|  |  |  |  |
| --- | --- | --- | --- |
| Hole number from end of rod | Distance to centre of mass *x* ±  ( ) | Time for 10 swings ± ( ) | Period *T* ±  ( ) |
| 0 |  |  |  |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |

Physical Pendulum Graph

Place your graph from the procedure for the Physical Pendulum in the space below:

**DISCUSSION AND CONCLUSIONS**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**PART 1: SIMPLE PENDULUM**

***Question*** 1. How does having more swings affect the measurement of the time? Does it affect your calculated periods and associated uncertainties? Explain.

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***Question*** 2. Can you eliminate your reaction time between the moment you see the pendulum and the moment you press the stopwatch? Does it help if two different people do the timing?

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***Question*** 3. Does the non-rigidity of the pendulum support affect the measurement? Explain why or why not.

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***Question*** 4. Is period independent of amplitude for the simple pendulum? Refer to your Excel plot from worksheet Part B in your answer. If you had timed only a single swing for each amplitude, would it have affected your answer to this question? Explain why or why not.

Hint: Does equation (1) hold true for all angles, or only for a given range?

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***Question*** 5. Recall that to derive Equation (1), we assumed a small amplitude. Based on your plot generated in Excel for PART B, how large can your amplitude be before this small-amplitude approximation begins to breakdown? Explain, using your graph to justify your answer. Hint: You can see that if your measurements were more precise (smaller error bars) the maximum amplitude value would be both smaller and more clearly defined.

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***Question*** 6. To what point on the mass do you measure $l$? (The theory assumes a point mass, but does it make any difference which point is used?)

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***Question*** 7. Compare the average value of $g$you obtained in the table for Part C, to the accepted value of $g$(9.81m/s2). Calculate the percent difference between experimental and theoretical values (see hint below). Does the average error in $g$that you calculated account for this difference? List some reasons why your value of $g$ would have been different from the accepted value of $g$, regardless of what you calculated.

Hint: To calculate the percent difference between two values, A and B, use the following formula:

$$\frac{\left|A-B\right|}{(A+B)/2}\*100\%$$

If the answer is $\leq 10\%$, then you may conclude that $A=B$ within 10% uncertainty.

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***Question*** 8. Record the $g$ value that you calculated from the line of best fit in your graph in Part C. Is your result for $g$in agreement with the accepted value within uncertainty? Use the average value of uncertainty from your table in Part C as your uncertainty for $g$. Provide details, and if necessary, give plausible reasons for any disagreement.

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**PART 2: PHYSICAL PENDULUM**

***Question 9***. It can be shown using calculus that the minimum period for this pendulum occurs when $x=\frac{L}{2\sqrt{3}}$ or $x=\frac{L\_{COM}}{\sqrt{3}}$, where $L\_{COM}=\frac{L}{2}$ is the center of mass for the physical pendulum. Does your data and graph agree with the analytic value for the location of the minimum period for this pendulum? Record and compare these two values. Provide some sources of error as to why they might not agree.

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