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**Physics HL Internal Assessment 5**

**Aim:** To determine the acceleration due to gravity by means of a simple pendulum with a stop.

**Formulae:**

T = -

Where l = (80.0±0.1)cm, and g is the acceleration of freefall, to be found.

**Uncertainty in Instruments**

|  |  |  |
| --- | --- | --- |
| Instrument | Uncertainty | Justification |
| Stopwatch | ±0.2s | The smallest division of the stopwatch is 0.01s. However, human reaction time is such that the uncertainty of pressing the stopwatch is ±0.2s. |
| Meter Rule | ±0.05cm | This is half of the smallest division, 0.1cm. |

**Data Collection**

Table 1: Collected Readings:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| d/cm (±0.1) | Time taken (t) for 10 Oscillations/s (±0.1) | | | Average t/s (±0.1) | Time Period (T)/s (±0.01) |
| T1 | T2 | T3 |
| 20.0 | 16.9 | 16.8 | 16.9 | 16.9 | 1.69 |
| 30.0 | 16.1 | 16.1 | 16.0 | 16.1 | 1.61 |
| 40.0 | 15.8 | 15.7 | 16.0 | 15.8 | 1.58 |
| 50.0 | 14.5 | 14.7 | 14.6 | 14.6 | 1.46 |
| 60.0 | 13.5 | 13.2 | 13.2 | 13.3 | 1.33 |
| 70.0 | 12.2 | 12.5 | 12.3 | 12.3 | 1.23 |

**Data Processing**

Table 2: Processed Data:

|  |  |  |  |
| --- | --- | --- | --- |
| d/m (±0.001) | T/s (±0.02) | d/T | Δ(d/T) |
| 0.200 | 1.69 | 0.118 | 0.002 |
| 0.300 | 1.61 | 0.186 | 0.003 |
| 0.400 | 1.58 | 0.253 | 0.004 |
| 0.500 | 1.46 | 0.342 | 0.005 |
| 0.600 | 1.33 | 0.451 | 0.008 |
| 0.700 | 1.23 | 0.569 | 0.010 |

From Graph: Gradient= -1.00 ± 0.11

T = -

We observe that ;

gradient = -   
-1.00 = -   
g = 1.00   
g = 9.87 ms-1

**Conclusion**

The graph shows that as a best fit line can be plotted, is linearly related to T. Thus, by substituting the value of g;

T = -

However, since the graph does not cut through the origin, it is not directly proportional.

**Accuracy**

The literature value of the acceleration due to gravity is 9.80665 ms-2. [[1]](#footnote-1)

Thus, the accuracy of our derived value of *g* is;

Since the % difference is within the % uncertainty in the value of E, the experimental value of E is rather accurate. A small % uncertainty shows a high precision in the experimental value of E.

**Precision**

This may be calculated by measuring the percentage uncertainty of the final gradient.

The figure of 11% is quite large. This indicates the presence of high random error in the measuring equipment.

**Evaluating Weaknesses**

There is an anomalous data point, suggesting a source of human experimental although there are three points which are randomly scattered near to the best-fit line, suggesting the presence of random errors. Possible sources of error are listed below.

To understand how the reading is affected, it’s necessary to compare the causes of uncertainty with the formula. T = -

|  |  |
| --- | --- |
| **Presence of Systematic Error:** | **Reason for Existence and effect:** |
| 1. Wobbling of retort stand during procedure | The retort stand vibrated during the experiment as a result of the motion of the bob. Momentum is thus lost by the bob.This would have caused decrease in the time T.  This will cause the value of g to be smaller than the actual value.  This may be improved by adding a weight to the stand to make it wobble less. |
| 1. Stretching of the string | The string is made of elastic thread which stretches under pressure. As the experiment carries on, the length of d might have increased.  The increase of the value of d causes the value of *g* to be increased.  This can be improved by using a string less likely to deform, such as copper wire. |
| **Presence of Random Error:** | **Reason for Existence and Effect:** |
| 1. Human reaction time | Human reaction time was a factor in recording down the T. Thus, the value of *g*  is affected both up and down.  This may be solved by taking the average of a larger number of oscillations, decreasing the percentage uncertainty of the value of one oscillation.  Alternatively, one could use a photogate or a similar electronic device to measure when the bob has passed the equilibrium point. |
| 1. Uncertainty of instruments | The instruments such as meter rule are quite inaccurate and have very large uncertainties. When measuring the distance d from top of the string, it is difficult to find the centre of the ball while using the meter rule. This affects the value of d in both directions and thus the value of , thus affecting the final calculations of g.  This would have a varying effect on the deviation of the experimental value from the theoretical value. |

1. http://www.bipm.org/utils/common/pdf/si\_brochure\_8\_en.pdf [↑](#footnote-ref-1)