**ECEN1008**

**Experiment Report**

**Newton’s Law**

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1. Objective

To verify Newton’s Laws of a uniformly accelerated motion in a straight line with the aid of the air track rail.

II. Procedure

1.To determine the distance as a function of time.

The length of travel to be measured is determined by moving the forked light barrier. To do this, the glider is set to the desired distance (taking a reading, say, at the front of the glider) with the air blower switched off. The light barrier is now moved along the track to a position such that the screen attached to the glider just triggers the electronic counter (the bulb flashes). Make sure that the electronic counter stops when the screen blocks the light barrier. Denote t1 as the measured time. The measurements of t should be repeated for five times. We should measure t for four different positions.

2.To measure the speed of the gliders as a function of the time.

Push STOP-INVERT key so that the electronic timer stops when the back edge of the screen leaves the light barrier. Denote t2 as the measured time. The measurements of t2 should be repeated for five times. The average speed of glider at that position is

where Δs (10 cm) is the width of the screen and Δt is the duration when the light was blocked (Δt= t2-t1). We should measure t2 for four different positions (same angles as pt. 1), and then the average speed at different time can be calculated.

3.To determine the acceleration as a function of the mass while the force is kept as the same.

The acceleration is found from average speeds. Repeat pt.1 – 2 for four different values of mass of glider. The mass of the glider is increased successively by adding slot weights on the glider and the added mass on the both sides are the same.

1. Data

**Distance: 10cm**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass (g) | 210.7 | | 230.7 | | 250.7 | | 270.7 | |
| Time(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) |
| trial1 | 0.208 | 0.402 | 0.22 | 0.448 | 0.228 | 0.442 | 0.235 | 0.461 |
| trial2 | 0.21 | 0.4 | 0.22 | 0.445 | 0.223 | 0.433 | 0.237 | 0.447 |
| trial3 | 0.211 | 0.403 | 0.224 | 0.462 | 0.227 | 0.438 | 0.23 | 0.445 |
| trial4 | 0.21 | 0.403 | 0.213 | 0.441 | 0.227 | 0.443 | 0.239 | 0.446 |
| trial5 | 0.21 | 0.403 | 0.232 | 0.424 | 0.228 | 0.44 | 0.235 | 0.449 |
| Tavg(s) | 0.2098 | 0.4022 | 0.2218 | 0.444 | 0.2266 | 0.4392 | 0.2352 | 0.4496 |
| T1-T2(s) | 0.1924 | | 0.2222 | | 0.2126 | | 0.2144 | |
| (T1+T2)/2(s) | 0.306 | | 0.3329 | | 0.3329 | | 0.3424 | |
| v (m/s) | 0.5198 | | 0.4500 | | 0.4704 | | 0.4664 | |

**Distance: 20cm**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass (g) | 210.7 | | 230.7 | | 250.7 | | 270.7 | |
| Time(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) |
| trial1 | 0.394 | 0.563 | 0.416 | 0.594 | 0.348 | 0.618 | 0.446 | 0.646 |
| trial2 | 0.397 | 0.561 | 0.42 | 0.614 | 0.441 | 0.62 | 0.455 | 0.64 |
| trial3 | 0.397 | 0.566 | 0.421 | 0.591 | 0.442 | 0.617 | 0.452 | 0.649 |
| trial4 | 0.4 | 0.565 | 0.414 | 0.587 | 0.44 | 0.621 | 0.45 | 0.631 |
| trial5 | 0.397 | 0.562 | 0.413 | 0.592 | 0.439 | 0.614 | 0.459 | 0.642 |
| Tavg(s) | 0.397 | 0.5634 | 0.4168 | 0.5956 | 0.422 | 0.618 | 0.4524 | 0.6416 |
| T1-T2(s) | 0.1664 | | 0.1788 | | 0.196 | | 0.1892 | |
| (T1+T2)/2(s) | 0.4802 | | 0.5062 | | 0.52 | | 0.547 | |
| v (m/s) | 0.6010 | | 0.5593 | | 0.5102 | | 0.5285 | |

**Distance: 30cm**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass (g) | 210.7 | | 230.7 | | 250.7 | | 270.7 | |
| Time(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) |
| trial1 | 0.557 | 0.708 | 0.579 | 0.736 | 0.613 | 0.775 | 0.632 | 0.805 |
| trial2 | 0.557 | 0.711 | 0.59 | 0.746 | 0.6 | 0.77 | 0.626 | 0.814 |
| trial3 | 0.58 | 0.733 | 0.599 | 0.742 | 0.601 | 0.789 | 0.63 | 0.811 |
| trial4 | 0.556 | 0.717 | 0.579 | 0.757 | 0.603 | 0.778 | 0.635 | 0.81 |
| trial5 | 0.557 | 0.717 | 0.581 | 0.742 | 0.606 | 0.796 | 0.629 | 0.812 |
| Tavg(s) | 0.5614 | 0.7172 | 0.5856 | 0.7446 | 0.6046 | 0.7816 | 0.6304 | 0.8104 |
| T1-T2(s) | 0.1558 | | 0.159 | | 0.177 | | 0.18 | |
| (T1+T2)/2(s) | 0.6393 | | 0.6651 | | 0.6931 | | 0.7204 | |
| v (m/s) | 0.6418 | | 0.6289 | | 0.5650 | | 0.5556 | |

**Distance: 40cm**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass (g) | 210.7 | | 230.7 | | 250.7 | | 270.7 | |
| Time(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) |
| trial1 | 0.711 | 0.847 | 0.756 | 0.888 | 0.78 | 0.936 | 0.796 | 0.969 |
| trial2 | 0.702 | 0.849 | 0.747 | 0.878 | 0.779 | 0.922 | 0.81 | 0.959 |
| trial3 | 0.704 | 0.856 | 0.742 | 0.889 | 0.772 | 0.921 | 0.803 | 0.957 |
| trial4 | 0.721 | 0.847 | 0.734 | 0.886 | 0.765 | 0.92 | 0.798 | 0.956 |
| trial5 | 0.707 | 0.842 | 0.735 | 0.894 | 0.769 | 0.916 | 0.801 | 0.97 |
| Tavg(s) | 0.709 | 0.8482 | 0.7428 | 0.887 | 0.773 | 0.923 | 0.8016 | 0.9622 |
| T1-T2(s) | 0.1392 | | 0.1442 | | 0.15 | | 0.1606 | |
| (T1+T2)/2(s) | 0.7786 | | 0.8149 | | 0.848 | | 0.8819 | |
| v (m/s) | 0.71839 | | 0.6934 | | 0.6667 | | 0.6227 | |

1. Analysis

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1. Error analysis
2. System error.

-(a)In this experiment, the effects of air resistance and pulley friction are not completely eliminated, which causes systematic errors

-(b)Deviation in excitation Catapult release

-(c) Mass error of weights: Slotted weight has a relatively large mass due to surface rusting, or a partially worn and relatively small mass.

1. Human error.

When operating the experiment, if the position of Silk thread in Precision pulley is not found to be offset in time, the error will be generated in the end due to the rising friction.

In the calculation, the gravitational acceleration is an approximate value of 9.8m/s2 rather than a more accurate result.

(3) Random error.

Inevitably, several results in a set of tests are significantly higher or lower than several other data, affecting the average value

VI. Conclusion

Within the allowable error range, the experiment is in accordance with Newton's Second Law.

The larger the mass of the object itself, while keeping the external force constant, the less time it takes to accomplish an give displacement. Moreover, the displacement of a certain object is directly proportional to the square of time.

The velocity of a certain object is directly proportional to time, i.e., it increases with time and vice versa.

The acceleration is inversely proportional to the mass