Dynamics Lab Investigation

Research Question: What will be the relationship between the acceleration and mass of object 1 when having two pulleys on either side of a mass on a platform, and the mass of object 2 and object 3 will stay the same (as shown in the diagram)?

Hypothesis: The hypothesis is that the relationship between the acceleration and the mass of object 1 is linear. It is also hypothesized that the slope will be –(total mass)(acceleration) and the y-intercept will be m_3g.

Strategy:

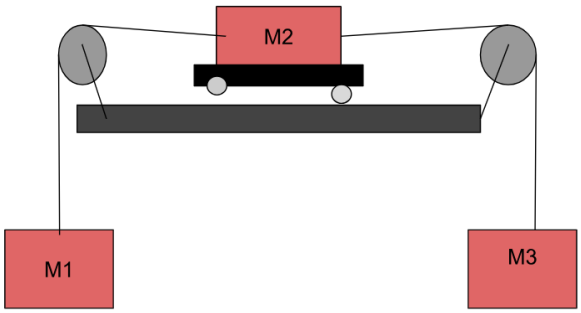

Fig 1: Double Modified Atwood's Machine

- This double modification of the Atwood's Machine was used in this experiment by changing the mass of M1 and keeping the mass of M2 and M3 constant. M2 is the cart while M3 is a block. The mass of M1 was changed by using a hook which was loadable with weight. We would then load it with different weights to test it.
- A velocity vs. time graph was made from this for each measurement by using vernier. The slope of these graphs were the accelerations for each test run.

Data:

Figure 1: Data collected directly from the lab and vernier (masses and acceleration).

Mass3(g)	Mass2(g)	Mass1(g)	Acceleration(m/s^2)
124.7	50	50	1.439
124.7	50	70	0.9963
124.7	50	90	0.5849
124.7	50	110	0.1955
124.7	50	120	0.1655
124.7	50	130	-0.05049
124.7	50	150	-0.3764
124.7	50	160	-0.5614
124.7	50	180	-0.8733
124.7	50	200	-1.151
124.7	50	220	-1.437
124.7	50	240	-2.198
124.7	50	260	-2.537

Analysis:

The Free Body Diagram below shows the forces acting on our system.

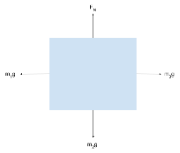

Figure 2: Free Body Diagrams

The friction between cart and the track is negligible meaning that it plays no part in the free body diagram. Positive motion is defined to be towards the right direction.

$$F_{net}=m_3g-m_1g$$

This is an F=ma equation for our free body diagram, and the F can be substituted with the ma, where m is the total mass of the system (m1+m2+m3). After simplifying, the resulting equation is:

$$m_1g=-ma+m_3g$$

This equation shows that the m_1g has a negative linear slope in relation to acceleration. The slope of this equation is opposite of the mass of the entire system. However, the graph below is inaccurate as the mass of the system is consistently changing as m_1 consistently changes. The y intercept in this graph is interpreted as m_3g. The y axis in this graph is m_1g. The x axis in this graph is a.

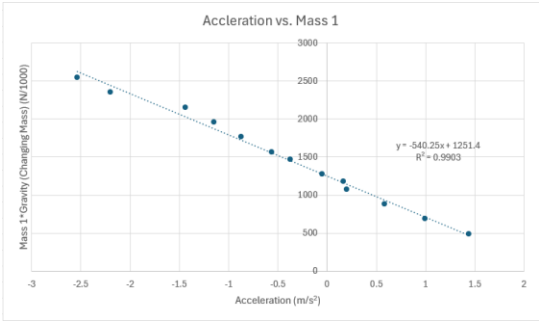

Figure 3: Acceleration vs Mass 1

The actual y intercept in this graph should be 124.7 *9.8, which is equal to 1222.06. This would be our expected value for m_3g. However, the value that we gained is 1251.4. As a result, our percentage of error is 2.4% which means that our lab was successful. Our hypothesis was correct as the slope was –(total mass)(acceleration) and the y intercept was m_3g. The lab was successful as shown by the percent error. Also, the percentage error was found using the y intercept as an alternative method. This is because the ideal method would be to use the slope, however, it is not constant, as the mass of the system is continuously changing, and the average slope only provides the average value, which is not accurate. I believe that some of our percentage error may have come from not measuring the weight of the strings, which meant that it was not included in the model. Another source of error was likely that friction was considered negligible, which is not true.

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