Factors That Affect Acceleration

Inquiry Investigation Laboratory Report

<u>Section 1: Introduction and Guiding Question</u>

Abstract

One can observe the motion of all different types of objects throughout everyday life. Whether it is cars traveling down the road, athletes running on a track, or even birds flying in the sky, objects are constantly moving and changing their position or direction. Acceleration "is defined as the rate at which an object changes its velocity" ("Acceleration," n.d.).

Galileo Galilei observed the motions of objects rolling down inclines over a period of 20 years in his experiments on motion. Isaac Newton attempted to explain this concept of acceleration but he had to develop his understanding of forces prior to any conclusion on this topic of study. Newton eventually developed his second law of motion in which "he clearly demonstrated that acceleration is caused by an unbalanced force (commonly called a push or a pull) acting on an object" (Acceleration - History - Newton, Motion, Force, and Time - JRank Articles. (n.d.).

Newton's second law states that "the acceleration produced by a net force on an object is directly proportional to the magnitude of the net force, is in the same direction as the net force, and is inversely proportional to the mass of the object" (Hewitt, 2012, p. 88)

The relationship can be written as: (Hewitt, 1998, p.88)

$$a \approx \frac{net\ force}{mass}$$

Goal of the Investigation:

To determine the factors that affects the acceleration of an object.

Guiding Question:

What are two factors that affect the acceleration of an object? Are those factors proportional or not?

Section 2: Method

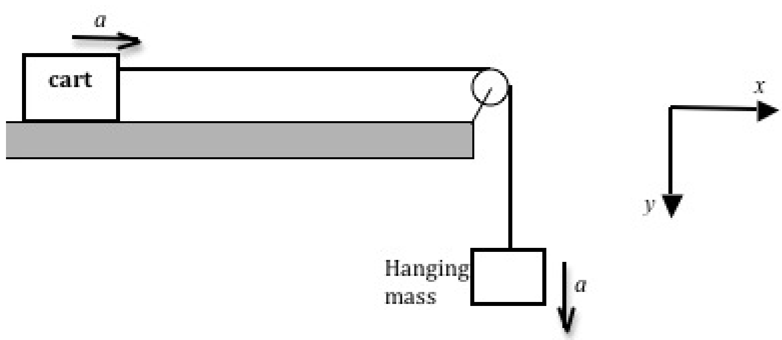
Procedure:

Students will test various factors to determine if they affect acceleration of an object (the change in the motion of a cart). Students will use Vernier Low-g Accelerometers (shown below in Figure 1) to determine the acceleration of a cart with great precision.

Students will choose and test an independent variable (test variable) and do at least five trials changing that variable. Students will record the test variable and the results of the dependent variable (acceleration).

Students will repeat using a different independent variable (test variable) to determine again the results of the dependent variable.

Figure 1:



Data:

Experiment A:

During Experiment A, the mass on the hanging mass or force of weight was manipulated while the mass of the cart was held at a constant value. The dependent variable measured by the Vernier accelerometer was the acceleration in meters per second squared (m/s^2). The results are recorded in Data Table A.

Data Table A:

Test Variable	Test Variable	Control	Responding Variable
Hanging Mass (kg)	**Force of Weight (N)**	**Mass of cart (kg)**	**Acceleration of Cart (m/s^2)**
0.05	0.50	0.50	0.81
0.07	0.70	0.50	1.20
0.09	0.90	0.50	1.45
0.11	1.10	0.50	1.75
0.13	1.30	0.50	2.23

Experiment B:

During Experiment B, mass of the cart in kilograms was manipulated while the force of weight of the hanging mass was held at a constant value. The dependent variable measured by the Vernier accelerometer was the acceleration in meters per second squared (m/s^2). The results are recorded in Data Table B.

Data Table B:

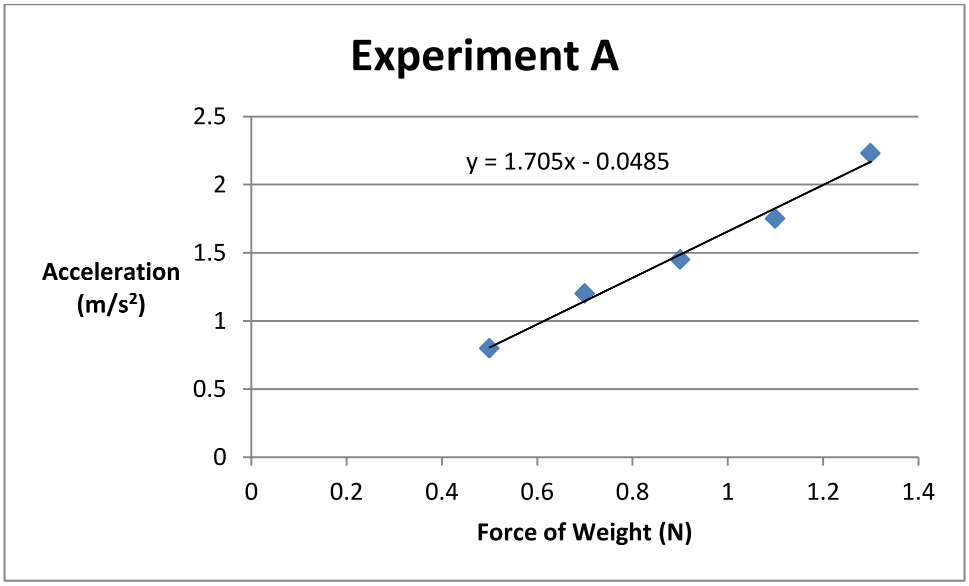
Control	Control	Test Variable	Responding Variable
Hanging Mass (kg)	**Force of Weight (N)**	**Mass of cart (kg)**	**Acceleration of Cart (m/s^2)**
0.05	**0.50**	**0.50**	**0.85**
0.05	**0.50**	**0.60**	**0.69**
0.05	**0.50**	**0.70**	**0.60**
0.05	**0.50**	**0.80**	**0.53**
0.05	**0.50**	**0.90**	**0.49**

Section 3: The Argument

Experiment A:

The data recorded in Experiment A are shown in the graph in Graph A.

Graph A:



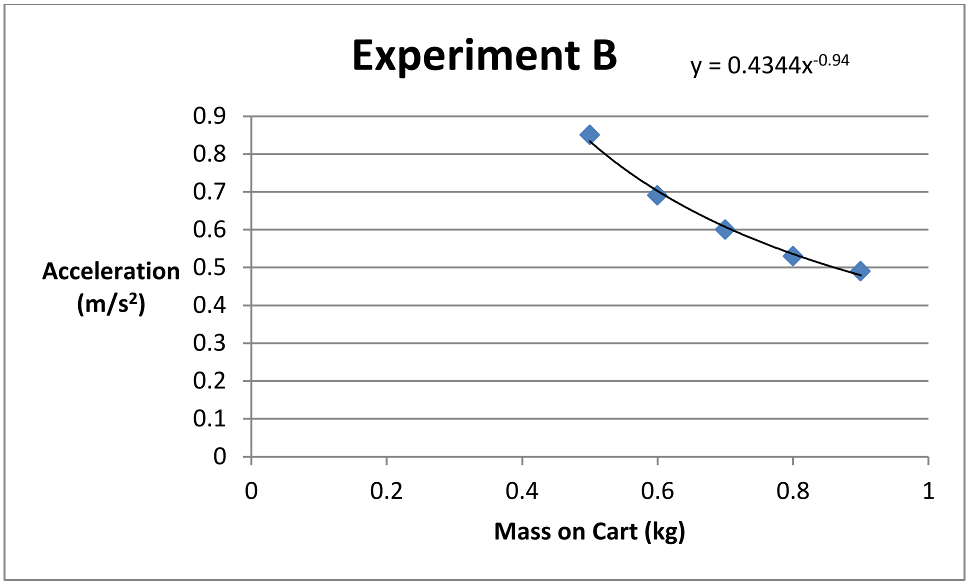
It is clearly demonstrated through the data found in Data A and the Graph in Experiment A that the force of weight (N) is directly proportional to the acceleration of the cart. As the force of weight increases the acceleration increases proportionally. Therefore, the relationship between force and acceleration can be determined to be:

$$a = F$$

Experiment B:

The data recorded in Experiment B are shown in the graph in Graph B.

Graph B:

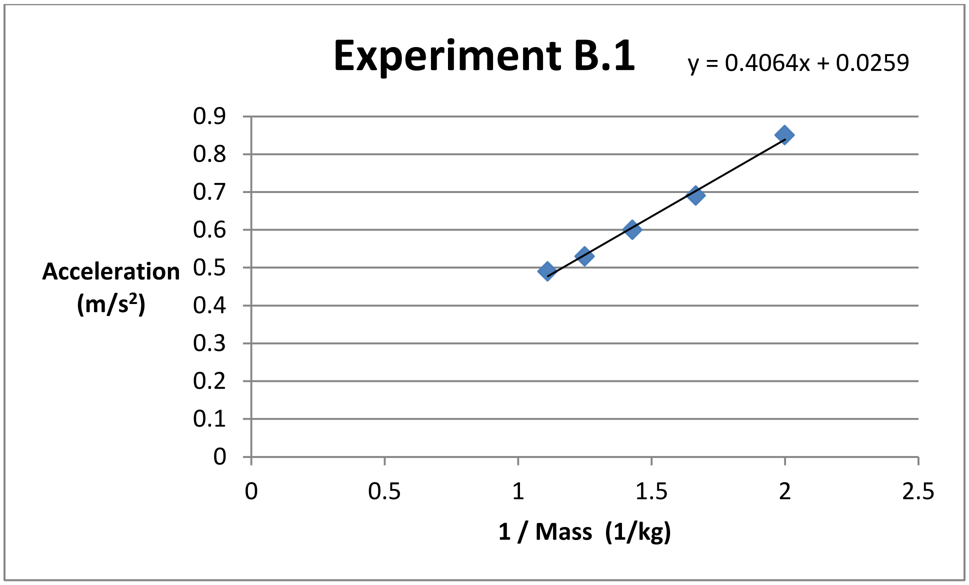


It is clearly demonstrated through the data found in Data B and the Graph in Experiment B that mass on the cart in kg is not directly proportional to the acceleration of the cart. As the mass of the cart increased, the acceleration decreased. To determine if this relationship is in fact inversely proportional, the acceleration will be graphed versus the inverse of the mass of the cart (refer to Data Table C).

Data Table B.1:

Test Variable	Test Variable	Responding Variable
Mass of cart (kg)	**1 / Mass of cart (kg)**	**Acceleration of Cart (m/s^2)**
0.50	**2.00**	**0.85**
0.60	**1.67**	**0.69**
0.70	**1.43**	**0.60**
0.80	**1.25**	**0.53**
0.90	**1.11**	**0.49**

Graph B.1



It is clearly demonstrated through the data found in Data C and the Graph in Graph C that mass on the cart in kg is inversely proportional to the acceleration of the cart. As the mass of the cart increased, the acceleration decreased. Therefore, the relationship between mass and acceleration can be determined to be:

$$a = \frac{1}{m}$$

Through Experiments A and B, the mathematical relationship of acceleration can be determined to be:

$$a = \frac{F}{m}$$

This laboratory confirms Newton's Second Law.

Sources of Error:

In Experiment A, all points of data did not fall directly on the line when investigating force of weight versus acceleration. The y-intercept was at -0.0485 and not at 0 which demonstrates that there was some source of error when investigating an applied force and its effects on acceleration. The largest source of error would be the frictional force in the string which would apparently lessen the amount of force applied by the hanging weights. Lesser force would result in less acceleration. Therefore, the measured acceleration would have been slightly less (when the frictional forces were greater). Taking frictional forces into effect would result in more precise results. Although the general relationship was clearly seen through the data that was collected.

In Experiment B, the only points that were slightly aberrant were the first and last points (see Graph B.1.). Therefore, as mass is very small or very large on the cart, it will greatly affect the acceleration of the cart. The largest source of error in these aberrant points would be the frictional forces on the track that were coming into play during the large mass on the cart. The very small mass on the cart may have been affected by other sources of error.

References:

Acceleration. (n.d.). Retrieved from http://www.physicsclassroom.com/class/1DKin/Lesson-1/Acceleration

Acceleration - History - Newton, Motion, Force, and Time - JRank Articles. (n.d.). Retrieved from http://science.jrank.org/pages/8/Acceleration-History.html

Hewitt, P. G. (2012). *Conceptual physics*. Boston: Pearson Education, Inc.