Good example of preliminary questions essay

Business, Company

Introduction

The purpose of this experiment was to verify Newton’s second law of motion. The force and acceleration data was collected by Logger Pro for a cart moved back and forth. This data was used to analyse the relationship between force, acceleration and mass. It was hypothesised that the acceleration would directly be proportional to applied force but inversely proportional to the mass of the cart.

- When you push on an object, how does the magnitude of the forces affect its motion? If you push harder, is the change in motion smaller or larger? Do you think is a direct or inverse relationship?

The rate of change in the motion of an object increases with increase in the magnitude of the force applied on the object. This relationship is direct.

- Assume that you have a bowling ball and a baseball, each suspended from a different rope. If you hit each of these balls with full swing of baseball bat, which ball will change its motion by greater amount?

The bowling ball has a larger mass than a baseball. When these two balls are hit by baseball bat, baseball changes its motion with a greater amount compared to bowling ball because it has a smaller mass. Mass is inversely proportional to acceleration.

- In absence of friction and other forces, if you exert force F, on the mass, m the mass will accelerate. If you exert the same force on mass 2m, would you expect the resulting acceleration to be twice as large or half as large? Is this direct or inverse relationship?

If the object mass is doubled from m to 2m, the acceleration is reduced to half its original magnitude. This is inverse relationship.

Materials

- LabQuest 2
- PC
- Cart
- Wireless Dynamics Sensor System
- 0. 25 kg mass
- Dynamics Track
- Mini-USB cable
- Digital Scale

Procedure

- LabQuest 2 was attached to the PC using MiniUSB cable. The logger Pro was started and 09 Newton’s Second law file was opened.
- Wireless Dynamics Sensor system was attached to the dynamic cart by use of long hex screw and threaded barrel. A small hook was screwed on the WDSS. The mass of the cart and WDSS were measured and using a digital scale and recorded on the table.
- The cart was placed on a horizontal level surface to zero the sensors.
- The WDSS hooked to the cart was grasped and the cart was moved back and forth on the table. The motion was varied by applying moderate and small forces on the cart.
- Acceleration and force data captured in graphs were saved and graphs sketched.

- A force versus acceleration was plotted on Logger Pro and results saved.
- The force versus acceleration curve was fitted into a line by selecting a Linear as a fit Equation in the Pro Logger. The generated regression result was saved.
- The regression equation in step 7 was used to find the acceleration of the cart when a force of 0. 1N acts on it.
- Step 8 was repeated using a force of -0. 1N
- 0. 25 kg mass was attached to the cart and the mass of the system measured and recorded
- The steps 4 to 9 was repeated for the new system with additional mass

Results

Trial 1

Trial 2

Analysis

- Comparison of graphs

Force versus time graph for trial 1

Acceleration versus time graph for trial 1

The patterns of force versus time and acceleration versus time graphs for trial 1 were similar. The crest and the troughs of these graphs displayed identical pattern even though the crest of acceleration versus force graph had was not smooth. The values of force and acceleration remained constant at the beginning of the experiment. This is demonstrated by the flat section between 0 s and about 1. 4 s. The values of force and acceleration then increased to a maximum value and then decreased to zero before increasing again in the negative direction. The positive and negative parts of the two graphs represent the back and forth movements of the cart. The magnitude of acceleration was higher than that of the corresponding force. However, the increase in force led to an increase in acceleration as shown by the two graphs.

Force versus time graph for trial 2

Acceleration versus time graph for trial 2

The patterns of force versus time and acceleration versus time graphs for trial 2 were similar. The crest and the troughs of these graphs display identical pattern. The values of force and acceleration remained constant (zero) at the beginning of the experiment. This is demonstrated by the flat section of the graph between 0 s and about 1. 2 s. The values of force and acceleration then increased to a maximum value and then decreased to zero before increasing again in the negative direction. The positive and negative parts of the two graphs represent the back and forth movements of the cart. The magnitude of acceleration was higher than that of the corresponding force. However, the increase in force led to an increase in acceleration as shown by the two graphs. Generally, the force used in trial 2 was higher than that used in trial 1for specific acceleration. This was because trial 2 used a higher mass than trial 1.

Force versus acceleration time graph for trial 1

Force versus acceleration graph for trial 2

The force versus acceleration graph for both trial 1and 2 was a straight line graph as predicted by Newton’s second law equation F = ma. However, the two graphs had negative y-intercepts contrary to F = ma prediction. These intercept represent the initial force that perhaps was used to overcome friction between the cart and the surface. This friction prevented the cart from accelerating even though a force was applied. It was observed that this force acted in the opposite direction of the applied force and it increased when the mass of the system was increased. The slope of trial 2 graph was greater that the slope of trial 2 graph. This was in line with the change in the mass of the system.

- Units of the slope of the force versus acceleration graph

The regression equation was Y = m X + b

Where the slope m is a constant

Dimension analysis can be used to prove that m was mass

The SI units for force and acceleration are N and Kg

Replaying these units in the equation Y = m X + b gives;

N = B ms-2 + N where B = m

Combining the units for force gives;

N = B ms-2

But F = mg

N = Kg ms-2

Kg ms-2 = Bms-2

B = Kg which is the SI unit for mass.

- Comparison of slopes of regression lines to the accelerated mass

Trial 1

Regression line slope = 0. 2638

Accelerated mass = 0. 2610

Difference = 0. 2638 - 0. 2610

0. 0028

% Uncertainty = X 100

1. 07%

Trial 2

Regression line slope = 0. 5449

Accelerated mass = 0. 5241

Difference = 0. 2638 - 0. 2610

0. 0208

% Uncertainty = X 100

3. 97%

- General Equation

F = ma

Where F = force, m = mass, and a = acceleration

- Determination of acceleration using regression equation

Y= 0. 2638X – 0. 2353

For 0. 1N force

- = 0. 2638X – 0. 2353

0. 2638X = 0. 3353

X = 1. 271

Acceleration = 1. 271ms-2

For -0. 1 N force

-0. 1 = 0. 2638X – 0. 2353

0. 2638X = 0. 1353

X = 0. 513

Acceleration = 0. 513ms-2

Extension

The force used = 1. 20 N

The corresponding acceleration = 1. 40 ms-2

F = ma

Mass m = F/a

0. 8571kg

The measured mass = 0. 7634 kg

Difference in mass 0. 8571 – 0. 7634

0. 0937

% Uncertainty = X 100

12. 27%

The high uncertainty of 12. 72% was brought by the fact that Newton's second law of motion was not modified to account for resistive forces.

Conclusion

The Newton's second law of motion was successfully verified by the experiment. It was established that force was directly proportional to acceleration and inversely proportional to mass as was hypothesised. The force versus time graphs consistently demonstrated that any increase in force results into an increase in acceleration. The uncertainty in measured mass and calculated masses was below 4% for both trial 1 and 2. The low uncertainty was an indication that the experiment was very successful.