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PHYSICS

INTERNAL ASSESSMENT

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Investigating relationship between the force required for the shopping basket to move and the mass in the shopping basket

Introduction

In this laboratory, the force that is used to push a shopping basket is going to be related to the weight in the shopping basket. It is well known that a light load in a shopping basket is easier to push than a heavy load. The experiment will involve the use of two identical shopping baskets, the first with one pack of soda while the second with six packs of soda. The same force will be used to push both shopping baskets and the acceleration and force in both cases compared using the equation in Newton's second law, $F_{net}=ma$

The variables of the experiment are mass, distance traveled, time, and the surface (ground). The independent variable is the force used to push the shopping baskets and the distance to be covered, since I will choose them. The dependent variables are the distance travelled and the time taken to travel the distance since these will rely on the force applied. The constant in the experiment is the mass of the shopping basket and the mass of the soda packs. The research question in this experiment is to determine if there is a linear & proportional relationship between the force applied and the mass of the object being moved.

Therefore, the function of the experiment would be F=ma, where F is the force applied, m is the mass of the shopping basket and soda packs and “a” is the acceleration (dependent variable)

Design

The equipment and materials required for this experiment are two shopping baskets, 7 packs of soda, a mechanical hanging scale, a tape measure, stop watch and a chalk.

First, the mass of one of the shopping baskets and the mass of one soda pack will be determined using the mechanical hanging scale. One pack of soda will then be placed in one shopping basket and the other six packs will be placed in the other basket. I will then draw a start line and a finishing line 10 meters away from the start line using the chalk. Afterwards, I will position the two baskets containing the soda packs at the starting line. I will then give a push on each basket using similar force. Immediately after giving the basket a push, I will use the stop watch to note the time it takes to cover the distance of 10 meters. To improve the accuracy and quality of the measurement, I will repeat the experiment three times and get the average time taken.

Data and Analysis

This section contains all the data collected and recorded from the experiment. It also contains relevant calculations using Newton’s second law of motion (Force = mass * acceleration)

Raw data from mechanical weighing scale

	Kgs (Uncertainty ± 0.05 Kgs)
Mass of 1 soda packs	1.8
Mass of 6 soda pack	10.8
Mass of Shopping Basket	1.5
Mass of Shopping Basket + 1 soda pack	3.3
Mass of Shopping Basket + 6 soda packs	12.3

Raw data from stop watch

	Trial 1 (Sec)	**Trial 2 (Sec)**	**Trial 3 (Sec)**
	(Uncertainty ± 0.1 Seconds)		
Time for shopping basket with 1 pack from start to finish line	4	4.1	3.9
Time for shopping basket with 6 packs from start to finish line	7.7	7.8	7.7

The uncertainty in the measured mass was estimated to be 0.05Kgs. This is because the measuring scale was measuring to the 0.1Kgs and this was divided by 2. The uncertainty in the measured time was estimated to be 0.1 Seconds. This was arrived at by taking the difference between the longest and shortest time for each experiment and dividing by 2.

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Calculation of Averages into Processed Data

Since the time measurement was taken three times, the average time for the first experiment with one pack of soda was calculated as below. Through averaging, it is expected that the uncertainty should reduce. Therefore, the uncertainty for the averaged time was reduced by half to ± 0.05 Seconds

Time for basket with one pack of soda = (4.0+4.1+3.9)/3 =**4.0 Seconds** (± 0.05 Sec)

The average time for the second experiment with six packs of soda was calculated below.

Time for basket with six packs of soda = (7.7+7.8+7.7)/3 =**7.73 Seconds** (± 0.05 Sec)

	Time in Seconds (Uncertainty 0.05 Sec)
Time for shopping basket with 1 pack from start to finish line	4
Time for shopping basket with 6 packs from start to finish line	7.73

Data Analysis

The main aim of this experiment is to find out the force used to push each shopping basket. Since the force was not measured, it has to be calculated by using the data from the experiment. What is known or assumed is that an equal force was used to push each of the shopping baskets containing different masses.

From the introduction, we understand that it will be harder to push a shopping basket that is carrying more weight. Therefore, if the formula F_{net}=ma is used to compare the two baskets, it is expected that the basket with 6 soda packs will have a slower acceleration than the one with 1 pack. Also, to prove that there is a proportional relationship between the force applied and the

mass, the calculations should reveal the force applied on each of the shopping baskets was actually the same.

Calculating Acceleration of Basket with One Pack of Soda

Acceleration= m/s^2 = Distance/ (Time*Time) = 10/ (4X4) = **0.625 m/s^2**

Calculating Acceleration of Basket with Six Packs of Soda

Acceleration = m/s^2 = Distance/ (Time*Time) = 10/ (7.73X7.73) = **0.1676 m/s^2**

Calculating Force used to push Basket with One Pack of Soda ($F_{net} = ma$)

F_{net}= ma = 3.3*0.625 = **2.0625 N (± 0.05N)**

Calculating Force used to push Basket with Six Packs of Soda ($F_{net}=ma$)

F_{net}= ma = 12.3*0.1676 = **2.0614 N (± 0.05N)**

The analysis of the results reveals that the shopping basket with one pack of soda experienced more acceleration than the one with six packs. The experiment also reveals that both shopping baskets actually experienced nearly the same force of push (about **2.0625N**)

Problems with the Analysis

In the analysis, it is notable that the force applied on the two shopping baskets has been found to be slightly different although it was expected that they should be exactly the same. This may have been caused by the multiplication of uncertainties in the different units of measurements during the calculations. This uncertainty has been estimated to be about **± 0.05N** as indicated above.

Conclusion

The experiment was quite simple and successful. It was expected that the heavier shopping basket would be harder to push and thus would move more slowly than the lighter basket with the same force applied to both. The analysis indicated that the acceleration of the heavier shopping basket was indeed much slower than that of the lighter basket.

To prove that the experiment was accurately done, it was expected that if we worked backwards to calculate the force from the formula F_{net} =ma by applying the calculated acceleration, we would get that the same force was actually applied on both shopping baskets. The calculations indeed indicated that the force applied on both shopping baskets was nearly the same and this proves that there is a proportional relationship between the force applied and the mass of the object. A heavier object would accelerate more slowly compared to a lighter one if exactly the same force was applied to both objects and the frictional conditions were held constant.