Physics coursework

In this investigation, instead of using a large, full-size supermarket trolley, we will be using a scaled down version, which will imitate the larger trolley. We will be using weights on a pulley system, hanging over the desk to represent the weight which would be in the shopping trolley.

Introduction: This experiment is to find out the answer to a problem by a pupil. This is as follows- A pupil was pushing a trolley around a supermarket for her parents during a recent shopping trip. Each time she moved the trolley, she was trying to keep it at a constant speed with the least acceleration. She realised that sometimes it was easy, but at other times it was harder. She wondered what it was that is making the trolley easy or hard to push. In this experiment however, we shall be using a smaller version of the shopping trolley, as we do not have access to a full-size shopping trolley.

Discuss Problem: The problem this pupil is having is that she wants to figure out what it is that makes her shopping trolley easier or harder to push. So by understanding it she may be able to reduce or eliminate the problem. What we will need to do is to calculate how the acceleration varies when heavier weights or light weights are used, either the force pushing the trolley or the force acting downwards on the trolley.

Variables

Independent: The independent variable in this experiment is going to be either the weight on the end of the mass holder, pulling the trolley representing the girl pushing it or the weight on top of the trolley representing the shopping pushing down in the shopping trolley. Only one of

these will be used in the experiment and will also be the only thing changed throughout.

Dependent: The dependant variable in this experiment shall be the acceleration, which I will be calculating using the final results that we will get. This is the dependent variable, as it will be changing each time according to changes in the independent variable.

Controlled: This will be the variable which will remain constant throughout the experiment. There are numerous variables which will be kept constant. These include the surface texture, the distance between the start and stop positions, the length of the string, the person timing and the person letting go of the trolley. This evidence will be recorded separately and when needed, recalled for calculations such as acceleration.

Prediction: After much thought, I have decided that I shall be using the change in force pulling the trolley variable. This represents the force the girl is using to push her parents shopping trolley around the supermarket. So what I will need to calculate is the acceleration from the increase in force pushing/pulling the trolley. My prediction shall be that as the force pulling the trolley increases, the acceleration of the trolley shall also increase.

Scientific Info: This shall be some info about different forces other than the weights acting on the trolley. The most obvious force acting on the trolley immediately is the resistance due to friction. This is what will stop the trolley from going faster than it already is. In this experiment we shall not be changing the table so friction should be the same throughout, therefore shall not be a major factor. The other force acting on the trolley is the

gravitational force acting down on the trolley. This is coupled in with the friction of the table, increasing the trolleys resistance to moving forward. Fortunately earth’s gravitational force is constant so it shall not change the trolleys speed in each run as long as the mass of the trolley remains consistent. The gravitational force is also included in the calculation for acceleration. The next force which is about the weights on the mass holder, which is acceleration due to gravity. This means as the weights are descending the acceleration due to gravity is increasing and putting more Newtons on the string and therefore increasing the trolleys speed.

Apparatus List: This is a list of all the apparatus used in the experiment:

Trolley

Mass holder and multiple weights on hand

String

Pulley and table or surface to attach to

Two people, 1 letting go of trolley and 1 recording time

Stopwatch

Start and stop point

Diagram:

Method: The first thing we did to prepare this experiment was to attach the pulley to the table. Then we attached an appropriate length of string to the mass holder and trolley, and then we had to mark the start and stop points.

To do this the start point had to be where the front of the trolley was, when the top of the mass holder was touching the pulley. To work out the stop point we had to mark where the front of the trolley was when the mass holder was just nearly touching the ground. From there the experiment was set up and ready to go, all that was needed now was to take the results. So for that we worked in pairs, one person letting the trolley go and the other taking the time for it. We did this by starting the stopwatch when the trolley was at the starting point and letting go at the same time the watch is started. Then when the trolley reached the stop line, the stopwatch was stopped as fast as possible to achieve accurate results. The theory was that when we would calculate the speed of the trolley from the distance it travelled doubled by the time it tookï¿½, with varying weights pulling it. The first run was using the 100g weight already on the mass holder. We repeated this run 3 times for each person, and using 8 different weights. One person would be there to record the time and the other person would let go of the trolley, and when the trolley reached the end line the person would stop the clock. The person recording the time took the results as his or her own. We recorded this data on a table for further calculations.

Range: As we were limited with time we had to use a limited amount of weight, but we also needed a variety of weights. So we decided to go up in 100-gram weights each time. So the range of weights we ended up with was 1N-8N. This give us enough time to get the experiment done while still having a variety of results.

Treatment of Results: We took each 100g run 3 times each, and got the three results, added them and divided by 3 to get an average result. This

was put into a graph which will be shown along with the table in the next section, obtaining. The formula for acceleration is

2 x Distance

Timeï¿½

Obtaining

Table: This is the table showing the results of the experiment.

Force

(N)

Dis

(M)

Time 1 (Secs)

Time 2

(Secs)

Time 3

(Secs)

Av Time

(Secs)

Accel.

(M/Sï¿½)

1

1

1. 44

1. 64

1. 42

1. 5

0. 89

2

1

0. 82

0. 87

0. 83

0. 84

2. 83

3

1

0. 49

0. 91

0. 78

0. 73

3. 75

4

1

0. 43

0. 41

0. 51

0. 45

9. 88

5

1

0. 39

0. 40

0. 37

0. 39

13. 15

6

1

0. 37

0. 20

0. 26

0. 28

25. 51

7

1

0. 28

0. 30

0. 31

0. 3

22. 22

8

1

0. 30

0. 31

0. 28

0. 3

22. 22

Graph: On the following page is a graph of my results. The graph is plotted as acceleration against force.

Interpretation

Statement: At the end of this experiment the results turned out approximately to how I predicted. My hypothesis was that the velocity of the mini trolley increase as the weight on the end of the mass holder increased. This in turn increased acceleration. This hypothesis was proved right, as, when I increased the weight on the end of the mass holder the intervals between start and stop became shorter. The evidence shows that as the mass is increased, the acceleration of the trouble is increased.

Trend: When I looked at the results, there was a definite trend between the force and acceleration. As the force increased, the acceleration increased. The difference between the results were even, which means the acceleration and force were directly proportional.

Graph: As you can see from the graph, the results are of a positive correlation. The graph would have went in a straight line, if it weren't for Force 3N and Force 6N, and 6N seems to go in rather steep rise and come back down again. This is possibly down to one irregular result in the 6N which has put the average off, thereby causing this steep rise. At the end the last two results are the same, due to the two averages being the same. This is down to the acceleration being too fast to record accurately.

Errors- There were two main errors which I encountered during this experiment. The first one I realised was that, as I was recording the time in which the trolley took to reach the stop mark, I realised that as the acceleration increased with more weights, it was becoming increasingly harder to make an accurate reading using only the human reflexes. The other error, which I foretold before hand, was the factor of friction on the trolley. This becomes a problem as the factor of friction is not constant, but instead increases as the acceleration increases, therefore creating an unpredictable variable.

Improvements: For this experiment there are quite a few improvements to be made. The first and most important one is to get light or infra red gates, which automatically record when the trolley has went past. These are very accurate and will definitely make up for the lose of accurate results due to human reaction response times. The next improvement would be to use a different, smoother surface to reduce friction between the trolley and surface, as this would also make results a lot more accurate. The most obvious idea for this would be a trolley hovering on a bed of air, as friction is greatly reduced. The next improvement would be to get more runs in per

person, as this would give a better average. The only reason we could get 3 in per person was due to time restrictions. Also we should try the experiment with a different variable, I. E weights on top, to see if we would get better or worse results.

Equation- I used various different equations throughout this experiment. To calculate the acceleration of the trolley, I used the equation: 2 x Distance.

Timeï¿½

When I had devised a graph, I used the gradient to work out a formula for the acceleration of the trolley. The gradient was:

13. 4 ï¿½ 5 = 2. 68

Therefore the formula for the acceleration in this experiment was:

Acceleration = 2. 68 x force