Galileo’s falling bodies

It is said that Galileo Galilee investigated the laws of motion by dropping cannon balls from the top of the leaning tower of Pisa. In 1604 he deducted that, without friction, all falling objects, light or heavy, would fall with the same acceleration. Galileo’s ideas were not entirely accepted. Our present-day ideas about forces and motion mainly come from Isaac Newton’s laws of motion, which were put forward by him some 80-odd years after Galileo’s observation.

Aim

I am carrying out an investigation to see whether Galileo was right with his observation.

Preliminary experiment

For my preliminary experiment I set up the equipment and measured the distance from the floor to the ground. This was the distance the weights would fall which was 2. 6m. One person then dropped a 500g weight from the ceiling and used a stopwatch to time how long it took to hit the floor. In then did this experiment again for a 1kg weight and then repeated each of the weights five times each in total.

1kg

500g

1

0. 59

0. 69

0. 5

0. 65

0. 65

0. 75

0. 49

0. 69

0. 5

Average

1kg

500g

0. 756

0. 546

1kg velocity= 3. 44 mps

500g velocity= 4. 76 mps

This seems wrong because you would expect the heavier weight to have the quickest speed and highest acceleration. Air resistance, in accurate timing and friction may be factors that affected the speed of the weights. In my

proper experiment I will have to try and cut down these inaccuracies to get fairer more reliable results.

Prediction

From my preliminary experiment results I would predict that the lighter the weights the quicker they fall, however I do not think this will be correct. I predict that as the weights become heavier they will hit the ground quicker therefore the heaviest weight will have the highest acceleration and the lowest weight will have the least acceleration.

I think this due to my scientific knowledge I already have about gravity.

Main experiment

Equipment

Ticker timer- this will be used to count how long it takes for the weight to reach the ground

Ticker tape- the ticker timer will print dots onto this to give us our reading

Sticky tape- this will attach the ticker tape to the weight

Weights (5x 100 gram)- These will be dropped to test Galileo’s observation

Meter ruler- this will ensure we dropped all the weights from the same height

G clamp- this will clamp to the desk to ensure the ticker timers does not fall off

2 V Power pack- To give the ticker timer an electrical supply

Carpet- this will protect the floor

Connecting wires- To connect the power pack and the ticker timer

Clamp stand- to hold the ticker timer

For my main experiment I will make the test more fairer than the preliminary test by using a ticker timer this will enable me to get more accurate readings and there is no room for human in accurate timing as the number of dots on the ticker tape show how long it took for the weight to hit the ground. The ticker timer produces 50 dots each second.

Method:

All equipment must be collected before the experiment begins so no time is wasted. Firstly connect the 2V power pack to the mains and then connect the power pack to the ticker timer using the connecting wires. Next feed through a piece of ticker tape approximately 1m long through the ticker timer, make sure it is fed through the right way. Attach a 100gram weight to the ticker tape using some sticky tape. Measure 1. 5 metres from the ground using the metre ruler and then start the ticker timer. Next drop the weight and let it fall to the ground and onto the carpet, making sure it does not land on your feet. The weights will have pulled the ticker tape through the ticker timer, which would of marked the tape, cut the ticker timer paper where the first dot starts and measure it also measure the distance between two contiguous dots, which have the greatest space between them. Record your findings in a table. After you have done that repeat the experiment using masses of 200 grams, 300 grams, 400 grams, 500 grams. Each time making sure you drop

it from the same height consistently to ensure a fair experiment, and using a new piece of ticker tape each time so that. Once this is completed you must repeat the experiment a minimum of 2 times in the hope that any anomalous results will be corrected and to ensure a wider range of results that can then be averaged so that overall there will be fairer evidence and results collected. The dependent variables in this investigation will be the distance of the last 2 dots, the total number of dots and the length of the ticker tape from where the first and last dots start and end. The independent variables are the mass’s added, 100g, 200g, 300g, 400g and 500g. The controlled variable is the height the weight is dropped from.

I added masses steadily in multiples of 100g, which I repeated twice so to get more accurate results, which I could, then average

Table of results

Weight

(g)

Length of ticker tape

(Cm)

Distance of last 2 dots (cm)

Total number of dots

(50= 1 second)

0

0

0

0

100

92. 5

8

35

200

137

8

32

300

125

10

24

400

140

8. 5

27

500

140

11

21

Repeat 1

Weight

(g)

Length of

Ticker tape

(Cm)

Distance of last 2 dots (cm)

Total number of dots

0

0

0

0

100

115

9. 8

34

200

130

7

33

300

125

7. 5

29

400

135

9

26

500

140

10

25

Repeat 2

Weight

(g)

Length of ticker tape

(Cm)

Distance of last 2

dots (cm)

Total number of dots

0

0

0

100

120

5

33

200

115

6

28

300

130

7. 5

22

400

135

8

26

500

145

9. 5

21

Average results table

Weight

(g)

Length of ticker tape

(Cm)

Distance of last 2 dots (cm)

Total number of dots

Number of seconds

0

0

0

0

0

100

109. 2

7. 6

34

0. 68

200

127. 3

7

31

0. 62

300

126. 7

8. 3

25

0. 50

400

136. 7

8. 5

26

0. 52

500

141. 7

10. 2

22

0. 44

Weight

Speed/Velocity in cmps

Velocity in mps

Acceleration in cmps

Acceleration in mps

0

0

0

0

0

100

160. 6

1. 6

11. 2

0. 11

200

205. 3

2. 1

11. 3

0. 12

300

253. 4

2. 5

16. 6

0. 16

400

262. 9

2. 6

16. 4

0. 16

500

322. 0

3. 2

23. 2

0. 23

Analysis

In my plan I started observing Galileo’s law and from my graph it seems that his law is incorrect and that my prediction is correct.

The graph mainly shows that the higher the mass the higher the acceleration, although it does not show this well as there is not enough data to get an accurate result from. Since larger masses have more weight the size of the downward force will be bigger therefore accelerating more. Looking at my graph of average acceleration I can see that my prediction was correct all though it is not very clear and because there is not much data, was hard to place a line of best fit. I can still see from my graph though that the higher the mass the higher the acceleration.

The conclusion is of course only correct to the range of masses investigated. However from my results I know have some evidence, which suggests that Galileo’s law is incorrect.

Evaluation

I think my experiment went well I got some good results from it. The experiment was carried out in such a way that means we are not confident with our results yet as they do not correspond with Galileo’s observation we need to think of ways the experiment could be improved. Possible ways include guaranteeing that the weights were dropped from the same height, that no extra force was exerted to speed up the falling object and finally that the results were given to a greater level of accuracy. The readings I took where not as accurate as they could have been when measuring lengths and calculating averages I rounded the numbers sensibly to try and stop it from getting to complex although if I hadn’t rounded the numbers I would have got more accurate results. Although you still can pick out some anomalous results from the graph and I think these my have occurred either because of wrong calculations or because of the factors over than gravity, friction and air resistance which may have caused anomalous results if some of the weights got chipped when hitting the floor making there surface areas slightly different.

I repeated my experiment three times and most of the results are mostly similar, generally the lengths and times where no different by a cm or two and 0. 1 of a second. This still could have greatly affected my results. To make my results even more accurate I would have to do more repeats of each mass I investigated and then I could calculate a much more accurate average. Also if I did this I should ignore any anomalous results.

To further investigation and find out for sure whether Galileo’s findings where correct I would have to use a bigger range of mass’s and make sure all my calculations and readings are completely accurate. Overall my results

support my prediction and disagree with Galileo, although this investigation is not proof that, that is the case and I would have to greatly further develop my investigation and investigate more thoroughly the accurateness of results and the mass’s used to find out for sure if Galion was correct or not.