Experiment to Find Acceleration due to Gravity

Aim
The aim of my experiment is to measure the earth's gravitational field strength, which is also the acceleration due to gravity. This involves mass, which is the amount of matter an object contains and weight which is the force of gravity pulling down on an object with a mass. Mass is measured in Kg and weight is measured in Newton's. Gravity is the weakest of the four fundamental forces, yet it is the dominant force in the universe for shaping the large scale structure of galaxies, stars, etc.

The earth's gravitational field strength is calculated by the weight (N) / Mass (Kg), therefore the earth's gravitational field strength (g) is measured in (N/Kg). As an object is in free-fall it accelerates at the rate of g.

Hypothesis
Isaac Newton firstly discovered gravity when an apple fell on his head. He then discovered that every object has a mass and that two masses attract each other. This attraction has a gravitational field strength, Isaac Newton discovered that g = 9.81 N/Kg. This is now a well now fact and is accepted as the earth's gravitational field strength.

Definitions

Gravity Force

The force of gravity is the force at which the earth, moon, or other massively large object attracts another object towards itself. By definition, this is the weight of the object. All objects upon earth experience a force of gravity which is directed "downward" towards the centre of the earth. The force of gravity on earth is always equal to the weight of the object as found by the equation:

Gravitational force (weight) = m * g
where g = 9.8 m/s2 (on Earth)
and m = mass (in kg)

Normal Force,
The normal force is the support force exerted upon an object which is in contact with another stable object. For example, if a book is resting upon a surface, then the surface is exerting an upward force upon the book in order to support the weight of the book. On occasions, a normal force is exerted horizontally between two objects which are in contact with each other.

Friction Force,
The friction force is the force exerted by a surface as an object moves across it or makes an effort to move across it. The friction force opposes the motion of the object. For example, if a book moves across the surface of a desk, then the desk exerts a friction force in the opposite direction of its motion. Friction results from the two surfaces being pressed together closely, causing intermolecular attractive forces between molecules of different surfaces. As such, friction depends upon the nature of the two surfaces and upon the degree to which they are pressed together.

Conclusion

I have concluded from my results that the gravitational field strength of the earth is 9.8 N/Kg. This is only accurate to two significant figures because of the limitations of quality and accuracy of the experiment. If I were to use more accurate equipment I would probably be able to show that the gravitational field strength of the earth is 9.81 N/Kg, though human error in implementation and calculation of the results.

Although I have not found g = 9.81 N/Kg, I have found that my results does fully support the result of g = 9.8 N/Kg. To find "g" I had to find the gradient of the line on the graph, the line on the graph was not a line of best fit, but a line which goes through all the points on the graph which means there are no odd results that may throw off the reading of g partially. There is a full positive correlation, which shows that the experiment was carried out accurately each time the experiment was done and a reading was taken.

My results show and prove that my prediction and scientific knowledge were accurate. I have proved Newton's theories on gravity using a different experiment to the one he did. Newton's experiment didn't need many accurate measurements that required electronic measuring equipment. The strength of g may have been better measured using a simpler experiment that didn't require machines to find measurements as this has less equipment to rely on and less factors that could go wrong. Newton using the pendulum found that g is 9.81 N/Kg so if I had to do the experiment again I would use the pendulum experiment.

As well as the gradient of the line being the gravitational strength, the intercept of the line is equal to the negative friction divided by the mass of trolley. As shown on the graph the intercept is –0.1. I can also conclude from my results that there are many uncontrollable factors that affect the experiment when trying to measure the earth's gravitational field strength. Such as the variations that appear close to the earth's surface, though these won't affect Newton's calculation when put to two significant figures. When measured to 3 significant figures we may not always get 9.81 N/Kg, but this is usually ignored because g is usually rounded down to one significant figure which is 10.00 N/Kg.

In my scientific knowledge it is stated that g is also the acceleration due to gravity so the calculation of g could be acquired simpler if I could measure an object in free-fall and then measure its time and displacement through the following derived equation

$S = ut + ½ at^2$,
Initial velocity is zero so, $S = 0 + ½ gt^2$
Therefore $g = 2S / t^2$.

Though for this to be accurate the only force acting on the object must be gravity and the air resistance must be negligible. The results also show that the force of gravity has not changed over time since Newton first carried out the experiments.

Evaluation

I believe that the experiment that I used to find the earth's gravitational field strength was suitable and was able to accurately show "g". The measurements that needed to be taken were more complex such as the velocity. There were no anomalous results as t reset the apparatus every time I did the experiment, this meant every time the experiment was done the apparatus was checked and re-adjusted.

Overall I feel that the experiment was suitable as it did allow me to find "g" accurate to two significant figures so the limitations of the apparatus and error causing factors were not too great as the effect they had was minimal.

The clock would measure the time and all I would have to do is measure the displacement and then putting these two measurements in the formula, $g = 2S/t^2$, would provide me with the earth's gravitational field strength. I could also have used the original pendulum experiment that Isaac Newton used but I found that it would be even harder to measure than the original experiment, meaning it is likely to be very inaccurate when I try to calculate the results.

As my results came to g = 9.79 N/Kg, which is only off 0.02 N/Kg, I am sure that If I were to rectify the recognised causes of error I would easily get g = 9.81 N/kg. I also believe that the results were off because the trolley wasn't in free-fall; it had a considerable amount of friction and air resistance acting against it. The steel ball from the trap door experiment would be in free-fall as there would be no friction acting against it and the air resistance would be a lot less than that acting on the trolley.