Solenoid investigation essay sample



" The moment of a (turning) force about a given pivot is defined as follows.

Moment of a force = force x perpendicular distance from the pivot to the line of action of the force. The unit of moment is the Newton metre (Nm)." 1

Also, "The principle of moments states that for any body in equilibrium, the sum of the clockwise moments about any pivot must equal the sum of the anticlockwise moments about that pivot." 1 (Fig. 1)

" Inside a solenoid, the magnetic field is uniform and its strength can be increased by increasing the current." 2

The principle of moments is used to find attractive force between the magnet and the solenoid.

The unknown force is the one produced with the bar magnet and solenoid. By using the equation of equilibrium previously given, the unknown force can be calculated provided that the system is in equilibrium:

 $F1 \times d1 = F2 \times d2$

 $F1 = (F2 \times d2) / d1$

F1 = Unknown force between the magnet and solenoid. (Newton / N)

F2 = Force produced by mass. (Newton / N)

d1 = Perpendicular distance between pivot and magnet. (metres / m)

d2 = Perpendicular distance between pivot and mass. (metres / m)

Based on the requirements of data for this experiment, the following setup has been derived.

Preliminary Investigation

The first aspect that was investigated was the direction of the current (Fig. 5). It must be noted that " There is an attractive force".

The magnitude of the current that will be used through the solenoid was then investigated. When the resistance of the variable resistor was at its smallest the current through the solenoid was 3. 42A with a 2V supply (a 2V supply was found adequate as higher e. m. f. was found to trip the power supply). However, at this current flow, it was found that the solenoid would heat up very quickly and to a high temperature. By adjusting the variable resistor to a higher resistance it was found that when set so the current on the ammeter was 0. 5A, the solenoid did not heat too much or heat too quickly therefore the resistance of the solenoid would not be affected greatly.

The only meter used was an ammeter. It is not required for the range of the ammeter to be that large, as it will be solely used to keep the current at 0. 5A. This means that high accuracy is a more important factor than a large range. Therefore, a range of 0 to 1 amperes and accuracy to 0. 01A is suitable for this experiment.

Ways that I improved the accuracy of the experiment given to us was firstly to use a spirit level to see when the lever is in balance rather than using an estimate with the naked eye. The pivot that we will use has also been improved, as instead of using a triangular block a paper holder and a stand is used, this will prevent the metre rule from slipping as it did with the block. There was also the problem of the mass being only accurate to 10grams. This was unsuitable for our experiment, as a greater accuracy was needed. A viable solution to this is to use the 10gram masses along with plastacine and measure the mass on scales. These scales should be accurate to 0. 1grames in order to provide a suitable accuracy. A way to stop the current in the coil fluctuating due to it heating up is to turn it off whenever possible so it can cool down. Finally, in order to improve general errors, the experiment can be repeated. This will allow any anomalous readings to be identified and also the averages will " smooth out" any errors produced.

Procedure

1) Setup the apparatus as shown in (Fig. 4), making sure the equipment is to the correct accuracy and range. Make the solenoid 6centimetres long. Take note of the distances between the pivot and the magnet, d1, and the distance between the pivot and the mass, d2.

2) Set the distance from the bottom of the solenoid to the bottom of the magnet, x, to 0cm.

3) Turn the power supply on. Set the variable resistor so the current reading on the ammeter reads 0. 5A

4) Balance the system by adding 10gram masses/plastacine to the other end. Check this equilibrium by very lightly resting the spirit level on top Metre rule 1, as shown in the Fig. 4. 6) Repeat steps 2) to 5) twice.

7) Repeat steps 2) to 6) for the following values of x: 2cm, 4cm, 6cm, 8cm, 10cm and 12cm. This will provide enough readings for an accurate graph to be drawn.

Prediction

Results Table

* F2 can be calculated by $m \times 9.81 = F2$.

* F1 can be calculated by (F2 x d2) / d1 = F1.

Reading 1

Distance, x/ m

Mass, m/ grams

Force, F2/ Newtons

Force, F1/ Newtons

0.00

0. 02

0.04

-	-	-	-	-	
0.06					
0. 08					
0. 10					
0. 12					
Reading 2					
Distance, x/ m					
Mass, m/ grams					
Force, F2/ Newtons					
Force, F1/ Newtons					
0. 00					
0. 02					
0. 04					
0. 06					
0. 08					
0. 10					
0. 12					
Reading 3					

Distance, x/ m

Mass, m/ grams

Force, F2/ Newtons

Force, F1/ Newtons

- 0.00
- 0. 02
- 0.04
- 0.06
- 0.08
- 0.10
- 0.12

Average

Distance, x/ m

Mass, m/ grams

Force, F2/ Newtons

Force, F1/ Newtons

0.00

0. 08

0.02

0.04

0.06

0.10

0.12

Bibliography

1. New Understanding Physics For Advanced Level by Jim Breithaupt (Stanley Thornes).

2. Physics 1 by David Sang, Keith Gibbs & Robert Hutchings (Cambridge OCR).