

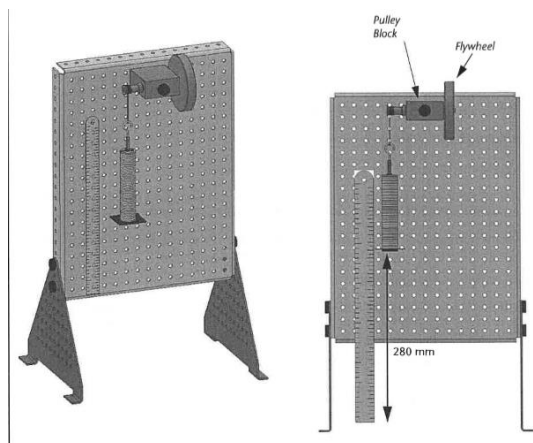
Energy in a flywheel

Introduction

As part of this assignment we were set into groups of 5 and to complete an experiment, the experiment that had to be completed was calculating the energy in a flywheel. Our first step was to assemble the experiment by copying the photo in which we received in the assignment brief, when the experiment set up is complete, we calculated the time taken for the weight on the flywheels to fall and bounce back up. We were then set to complete a table using our results from the experiment. This table helped to create a chart which shows the decrease in time where the amount the weight goes up.

Experiment procedure

Our first step before beginning the experiment was to read through the assignment brief thoroughly to ensure we knew exactly what had to be done and to ensure we don't make any mistakes. The next step was to put the experiment together following the image in the assignment brief.



Our next step was to assign a role to each member of the group, we had 2 people timing the weight to fall and bounce back up, another role was to measure that the weight was measured 280mm up from the table. One of the members role was to ensure that there was 100g added to the weight each time. The last role was for someone to note down every result taken, which saved all of the group members writing it down to save time. When beginning the experiment, the base of the weight weighed 10g on its own which meant we only had to add 90g for the first attempt. The first part of the experiment was to measure out that the base of the weight was exactly 280mm off the base of the table. Another member and I of the group were timing so as soon as the weight was let go, we both began the stopwatches and stopped them as soon as the weight reached its peak. We then compared both of our times and took an average, by doing this it allowed to get as accurate of a time as possible. The member of the group that measured out the 280mm would then have to watch very closely as the weight rises and they would need to get the height that it reaches at its peak. We made sure to repeat the experiment at least twice for each weight, this again allowed us to get an average. Once we completed the attempt with a mass of 100g we then went on to add another 100g of weight. We repeated these steps twice for every time we added 100g until we got to 500g. ,

Results

After completing the experiment numerous times, we came out with times that gradually got quicker where the weight got added. You can clearly see this in the table shown below.

Mass m (kg)	PE mgh (J)	Time to fall and rise tt (seconds)	h_2 (m)	mg	PE loss Adjusted (J)	Falling Time tf (Seconds)	Acceleration a ($m.s^{-2}$)	Velocity v ($m.s^{-1}$)	Velocity ω ($rad.s^{-1}$)	$(mg-ma)r$	a/r
0	0	0	0	0	0	0	0	0	0	0	0
0.1	0.275	4.04	0.239	0.981	0.0046	2.18	0.06	0.1308	20.14	0.98	9.23
0.2	0.549	2.93	0.251	1.962	0.0047	1.55	0.12	0.186	28.64	1.96	18.46
0.3	0.824	2.42	0.254	2.943	0.0057	1.27	0.17	0.2159	33.25	2.94	26.15
0.4	1.099	2.17	0.253	3.924	0.008	1.14	0.22	0.2508	38.62	3.92	33.85
0.5	1.373	1.85	0.247	4.905	0.015	0.98	0.29	0.2842	43.77	4.9	44.62

Mass m (kg)
0
0.1
0.2
0.3
0.4
0.5
Time to fall and rise tt (seconds)
0
4.04
2.93
2.42
2.17
1.85

These results prove that when the mass of the of the weight increases it has a big effect on the time it takes for the weight to fall and bounce back up.

Potential energy

PE <i>mgh1</i> (J)
0
0.275
0.549
0.824
1.099
1.373

The formula to calculate the potential energy was **mass X gravity (9.81) X h1 (0.28)**

Height 2

h2 (m)
0
0.239
0.251
0.254
0.253
0.247

The height 2 was calculated when going through with the experiment, when the weight was decreased one of the members of the group kept a close eye on when the weight bounced back up and would have to measure the height when it was at its peak.

PE loss adjusted

PE loss Adjusted (J)
0
0.0046
0.0047
0.0057
0.008
0.015

The potential energy loss adjusted was calculated by first calculating the **PE loss** by using the formula **$mg(h1-h2)$** , using the results from this equation we then went on to work out

the **PE loss adjusted** using another formula, which was **PE loss x h1(h1+h2)** which gave us the set of results shown in the table above.

Falling time

Falling Time t_f (Sec-onds)
0
2.18
1.55
1.27
1.14
0.98

The **Falling time** was the result reached for the time taken for the weight to reach its lowest point, this was calculated using the formula **(t1)X(h1)÷(h1+h2)**.

Acceleration

Acceleration a ($m.s^{-2}$)
0
0.06
0.12
0.17
0.22
0.29

The table above shows the **acceleration** calculated for each attempt at the experiment, again as you can clearly see by the table as the mass was increased this also increased the acceleration. The formula we used in order to receive these results was **$\alpha=(h1)÷(tf^2)$**

Linear velocity

Velocity v ($m.s^{-1}$)
0
0.1308
0.186
0.2159
0.2508
0.2842

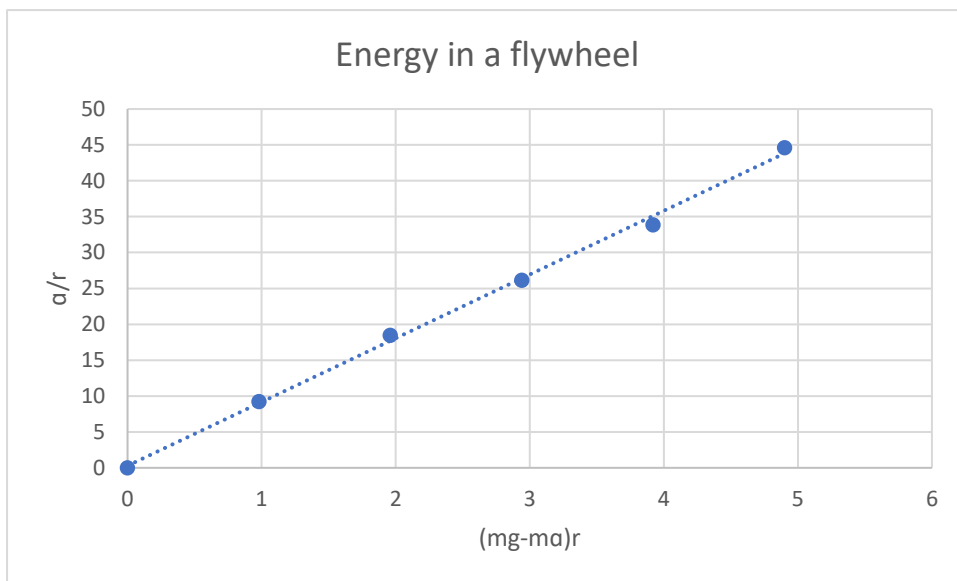
The table above shows the **linear velocity** reading taken from each reading. Which also increased as the weight was added. The formula used to calculate the **linear velocity** is **$v=atf$** .

Angular velocity

Velocity ω ($rad.s^{-1}$)
0
20.14
28.64
33.25
38.62
43.77

The results above shows the angular velocity results received for the experiment, these results were received by using the formula $\omega=(2)(\pi)(v)\div c$, $c=0.0408$

$(mg-ma)r$	a/r
0	0
0.98	9.23
1.96	18.46
2.94	26.15
3.92	33.85
4.9	44.62



The table and graph shown above show a/r against $(mg-ma)r$ and shows when one is increased so is the other.

Analysis

Through completing this experiment all in all I personally think that the experiment came out successful. There are many reasons why this experiment came out as successful as we could get. The first step taken was that we had to people timing therefor if the times were only around 0.5 seconds apart, so we compared both times, added them together, then divided them by 2 which gave us an average time, which led to our times being as accurate as possible. Another reason I think our results are accurate is because for each 100g of mass that got added to the weight we again performed the test twice, then with both the attempts we used the average time from each attempt and then got an overall average time reading for that amount of mass. We also did this with the height where it bounced back up (h_2), we added both heights together and divided them by 2 which gave us the set of (h_2) results. Another reason why the experiment came out successful is because we made sure that every member had a specific role that they would stick to, this would prevent a lot of human errors, things like pressing the stop button on the timer, if we were to change person each time some members of the group may have slower reflexes than others and

some may have faster, doing this could cause a slight difference in the time which could have a big effect in the results. What we did with sticking with one person on that role would ensure that they were consistent with our times. Looking at the times we can clearly see that our times were quite consistently getting faster and there is no major time differences between each mass. There were a few mistakes that were made during this experiment, with things like timing as we were both using stopwatches on our phone because we were talking whilst some of the experiments were running so it effected our concentration, so on some of the attempts some of the timers might have been stopped slightly later, so if we knew we may have been late with pressing the stop button we simply just used the other persons time. This could have had an effect because on some of the times because for ones where something like this had happened we didn't take an average time we simply went with the other time. Another mistake that possibly came up is when the weight has hanging from the string it may not have been completely still and instead swaying slightly, something simple like this could again have quite a large effect on the results of the experiment.

Conclusion

From completing this experiment, it is helped me realise how much of an effect the slightest bit of weight can have such a large effect on the time. It has also shown that how important team work was, for this experiment that were several roles that had to be taken on, if we didn't work as a group to do these roles and communicate to see which member wanted to take which role we wouldn't have gotten very far in the experiment. This could have been a more positive situation for the members if all the members knew each other before beginning the experiment, if we had the chance to meet up before hand, During the experiment you could see that some of the members were very nervous because they are meeting some people for the first time, this could have an effect with the communication during the experiment because they were too nervous to speak out if they knew something was wrong, or if they got set a role that they weren't happy doing. For this experiment we could have met up as a group before hand to get to know each other and to also go over the experiment we would be doing, this would allow us to spend a lot less time during the experiment setting it up because we would know exactly what we would be doing and would also not have to waste time reading through the experiment guide.

Evaluation

By looking at the overall results personally I think the experiment came out successful. Firstly, by looking at the times we can see that the times are decreasing quite consistently mostly dropping by around a second each time. The height readings using a ruler also were very accurate, the largest difference between the readings was 0.012m, which makes me very confident with our readings. Personally, I think the group communicated very well, a lot of the members didn't know each other, but they didn't let that have an effect we made sure that every member knew what we were doing and made sure we started all at the

same time with one of the members counting down. Some mistakes did come, little things like one of the members timing pressing the button slightly late, which could effect the average time. Another human error that was made was that on some of the attempts the weight swinging from the piece of string may not have been completely still, if the weight was swaying at all this could completely throw the balance off which could have a large effect on the results. On some of the attempts members of the group were talking to each other which again could throw off concentration and lead to more errors.

Further work

If we were to repeat this experiment it would be a lot more effective if we were to have more time, this would avoid us rushing through the experiment to ensure that we didn't make any mistakes with things like waiting for the weight to finish swaying and setting up the experiment each time, it would also allow us to complete the experiment numerous times which allow us to get a very accurate average reading. We would also meet up with the members to ensure that every member of the group is comfortable with each other and were not nervous at all during the experiment.