

University of Wales Trinity Saint David

Wales Institute of Science and Art



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Energy in a Flywheel

Further Science for Engineers (ACHA4007)

Dafydd Pughe

2401243

Date (03/2025)

Table of Contents:

Table of Contents:.....	i
1. Introduction:.....	1
2. Experimental Procedure:	2
3. Results:.....	4
4. Analysis:.....	5
4.1. Calculations:	5
4.2. Graph:	6
4.3. Completed Table of Data	7
5. Conclusion:.....	8
6. Evaluation:	9
7. Further Work:.....	10
8. References:	11
References	11

1. Introduction:

In this experiment, the plan was to see how different weights would react to drop from a specific height by using a flywheel pulley. The purpose of a flywheel is “that it absorbs rotational energy during the power stroke.” (Kumar, 2021) ,during the time that it is working. This is a main aim of this experiment to calculate and read the energy that is being produced from the flywheel. The weights were connected by using a piece of string connected to the pulley to see the time and reaction of the weights and the string by dropping from the height. The aims of this experiment was to prove the theory of energy in a flywheel determined by different weights that varied from 0.1kg to 0.5kg. The group, decided to do 3 tests of the same weight and calculate the average time of dropping and the reaction of the string to make the experiment fair and have a good understanding of the results. The aim of this experiment is to discover the moment of inertia of the flywheel and pulley to discover the potential and kinetic energy that is being produced when mass is dropping from a height.

2. Experimental Procedure:

The procedure of making this experiment was to put all the materials needed for the experiment together. This was found in the TecQuipment Energy in a Flywheel kit. The group connected the flywheel base onto a vertical metal wall to provide the most accurate environment for a drop test. After the base was connected to the base, the next step was to connect a piece of string to the flywheel and a hook on the bottom to allow the weights to stand evenly to provide the best results. Then, collected the correct amount of weights for every test session and made sure that they were added weights onto the hook, that they were stable and wouldn't affect the final results. To make sure the setup was correct and accurate, the group followed a picture of the experiment set up from the TecQuipment booklet.

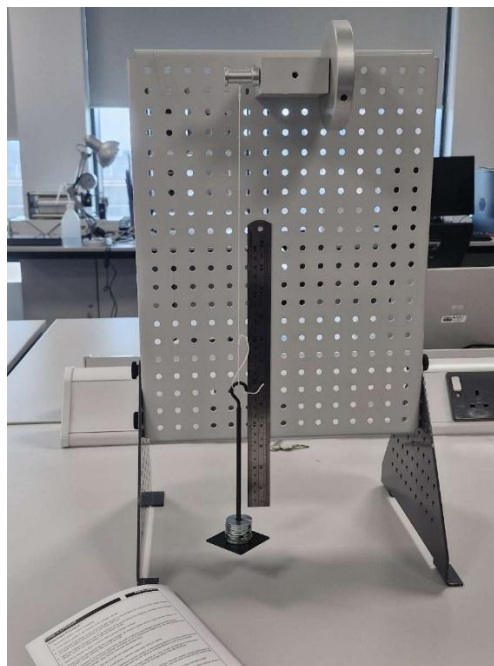


Figure 1- Correct layout of experiment

In the group, there was had 2 people which made it a lot easier to communicate and work better to have more of an understanding while communicating and completing the experiment. A decision was made in the group that one member would calculate the timing of the dropping and rising and also measure the reaction of the weights and string after reaching full length. When the other member, would add the different

weights onto the hook and make sure that the weights from the flywheel was getting dropped from the correct height.

After repeating the procedure 3 times per different group of weight, calculating the average distance travelled from the dropping point and peak bounce back after dropping, and also measure the average time it took to reach maximum height in this process.

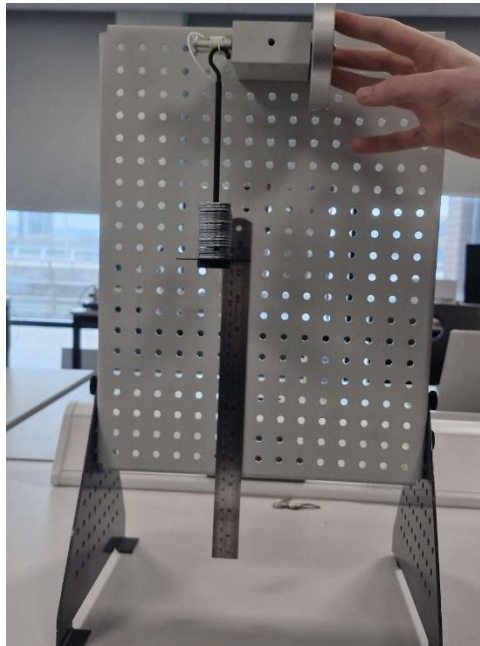


Figure 2 - Correct height for experiment

In this image, it shows the correct setup of the experiment that was followed as in the booklet, (TecQuipment Ltd, 2012), to get the correct setup for the tests. In the picture, the mass weight is positioned at the correct initial height to be dropped ready for the test. Also, the ruler was in a clear position to make correct reading of the results when the weights make a rise. The string was set in a position that there wasn't any problems that would effect the results while doing the experiment, this was a factor that the group had to double check before every test to make sure that the results that was being recorded was at a consistent state.

3. Results:

The group decided to do 3 tests for every group of weights to get a fair average and to showcase clear results to read and understand.

Table 1 - Raw results of Experiment

Mass (kg)	Time to fall and rise (Seconds) First Test	Time to fall and rise (Seconds) Second Test	Time to fall and rise (seconds) Third Test	Height (m) First Test	Height (m) Second Test	Height (m) Third Test
0	0	0	0	0	0	0
0.1	3.71	4.31	4.45	0.24	0.245	0.24
0.2	3.11	3.11	3.19	0.249	0.255	0.25
0.3	2.59	2.97	2.71	0.255	0.252	0.2515
0.4	2.33	2.70	2.59	0.252	0.2495	0.252
0.5	2.73	2.32	2.44	0.24	0.239	0.24

4. Analysis:

The equations needed for this experiment were found in the Potential and Kinetic Energy kit ES9 booklet. (TecQuipment, 2012). To find the initial mass of the weights and the initial height of drop from the booklet.

4.1. Calculations:

To calculate the initial Potential Energy of the flywheel, $mass \times 9.81 \times initial\ height$. By using the initial measurements from the TecQuipment booklet to know what is the initial height that the difference masses needed to drop from which was as a height of 0.20m.

To calculate mg , $Mass \times 9.81$.

To calculate potential energy lost, $Mg (Height1 - Height2)$. Using the initial height of the mass being drop, and the peak height reached after dropping, it was able to calculate the potential energy lost in the process of the test.

To calculate falling time of the weights, $(total\ time \times Height1) \div (height1 + height2)$. By using this equation, it was able to figure out how long it took for the mass to drop from 0.2m and to see the acceleration on the mass while falling, also can solve the torque needed to accelerate while dropping.

To calculate the acceleration of the weights, $2 \times Height2 \div Falling\ time^2$. By calculating the acceleration of the mass falling, it can help solving the following equations such as velocity, ω and α .

To calculate Velocity, $Acceleration \times Total\ time$.

To calculate angular velocity ω , $(2\pi \times velocity) \div c$. They value of c was giving from the booklet which was 0.0408m which is the circumference of the pully attached to the flywheel.

To calculate the torque of the mas, the equation that was used was, $(mg - ma) \times r$. This was an important figure to discover since it would help discover the equation needed from the graph for KE.

To discover the figure of α , the calculation was $Height2 \div r$. The value of r , 0.0065m, was giving on page 13 of the booklet.

Using the equation of $0.5 \times I\omega^2$ to calculate KE, which meant that the sum of + the Inertia equation that was discovered after creating the graph showing torque again α which came to 0.0005776095kgm^2 . This equation was found on page 24 of the TecQuipment booklet that was provided as the start of the experiment.

4.2. Graph:

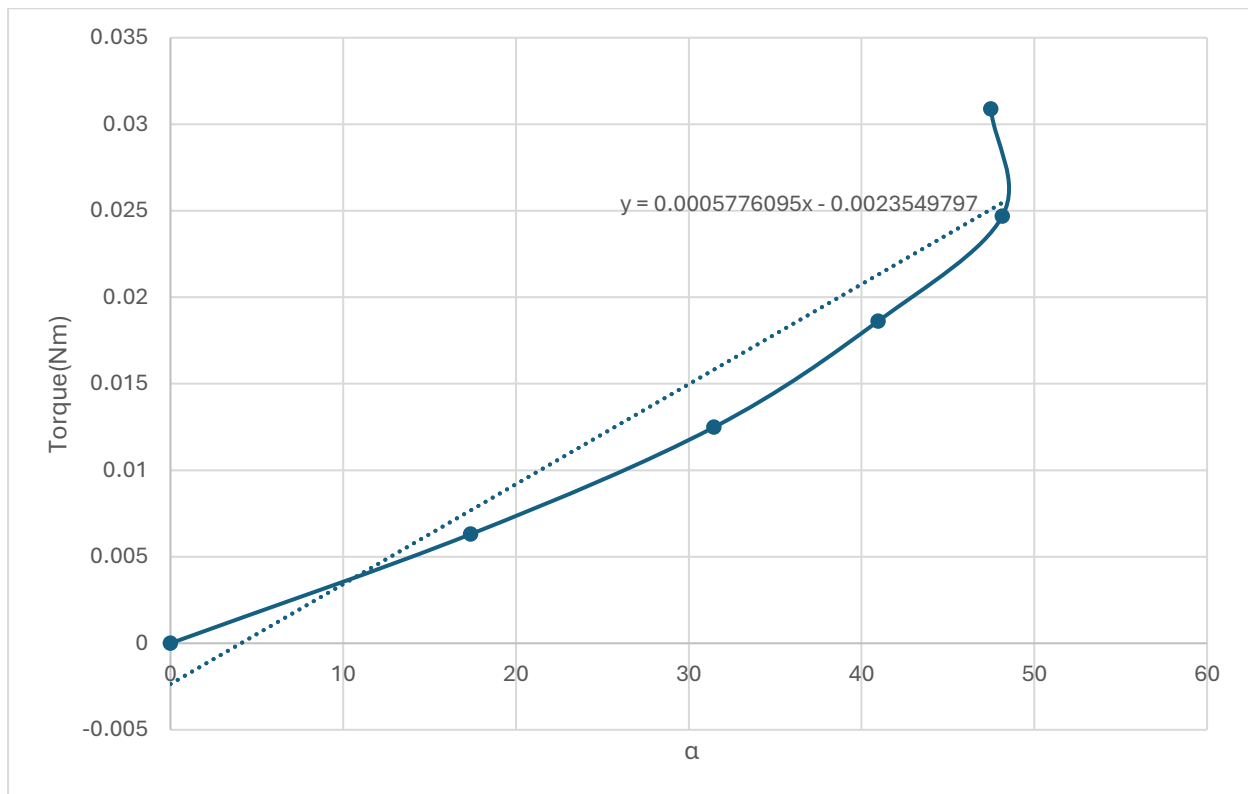


Figure 3-Graph to show Torque against α

4.3. Completed Table of Data

Table 2 - Completed data of experiment

Mass (kg)	Initial PE (J)	Time to fall and rise (Seconds)	h2 (M)	mg	PE loss Adjusted (J)	Falling Time (Seconds)	Acceleration (m/s ²)	Velocity (m/s)	ω (Rad/s)	Torque (Nm)	α	KE
0	0	0	0	0	0	0	0	0	0	0	0	0
0.1	0.27468	4.16	0.243	0.981	0.019432428	2.227151052	0.112898632	0.251442308	38.72202484	0.006303116	17.36902	0.433032458
0.2	0.54936	3.14	0.2513	1.962	0.029675573	1.654808859	0.204499523	0.338407643	52.1146552	0.012487151	31.46147	0.784375589
0.3	0.82404	2.76	0.2528	2.943	0.042068108	1.45045045	0.266184175	0.386086957	59.45725227	0.018610441	40.95141	1.0209724
0.4	1.09872	2.54	0.2517	3.924	0.058479925	1.337596389	0.312995326	0.418661417	64.4737075	0.024692212	48.15313	1.200520612
0.5	1.3734	2.5	0.2397	4.905	0.106499942	1.346930922	0.308672103	0.41576	64.02689028	0.030879316	47.48802	1.183986518

5. Conclusion:

The Kinetic Energy, Potential Energy and Moment of Inertia was looked into to discover the kinetic energy that a flywheel would generate. To make sure the moment of inertia is correct, it was compared the inertia of the flywheel and pulley in comparison with the equation that was found when having a trendline on the graph of torque against α . The equation that was on the trendline of the graph was $0.0005776095 - 0.002354979$. Compared to the flywheel and pulley equation, $3.862 \times 10^{-4} + 0.834 \times 10^{-4}$. The inertia from the pulley and flywheel came out to be 0.0004696 kgm^2 where as the inertia that came from the graphs equation came to be $0.0005776095 \text{ kgm}^2$.

6. Evaluation:

To minimize errors that could occur when taking part in this experiment, the group made sure to double checked that everything was secure before every drop test that was completed. One factor that we checked, was to make sure that the mass was getting dropped at the same height to provide correct and fair results for the tests. Also made sure that the correct amount of 0.01kg of weight was added every time to make sure that that the correct equipment was being used to get the correct results. The team also made sure that the string wasn't tied to itself before every drop to make sure that the string travelled freely from the pulley and not being too short or too loose before dropping to get the correct results. Overall, the team double checked every possible fault during this experiment to make sure to get the correct results for this test.

7. Further Work:

In this experiment, if there was more facilities available then there would've made changes to compared with the facilities that was available at the time of the experiment. One aspect that could be changed in this experiment would be the scale of the flywheel and see the reaction and energy that the flywheel would have provided in different sizes and also could add extra weight to see the different reactions and energy than what was available.

Another aspect that could be changed if the same experiment would happen again would be the material of the flywheel to test the durability and the strength of different materials and compare to what was provided, also it would change the energy provided and given out to rebound the weights from the maximum distance achieved when dropping with the different weights. The different type of material of a flywheel can change the energy that the flywheel is producing, by looking online, flywheels work better when the material is "Strong, lightweight materials turn out to be the best for flywheels", which is something that the group could compare when doing this experiment again and using different material for the flywheel. (Woodford, 2023).

The weights is also something that could change to see the reaction of greater weights and the energy that the flywheel needs to provide the correct tests. Another factor that could be improved for next time, is more accurate measurement to make sure the results are accurate and persist.

8. References:

References

Kumar, E. A., 2021. *The mechanical engineering*. [Online]

Available at: <https://themechanicalengineering.com/flywheel/>

TecQuipment Ltd, 2012. 3. Energy in a flywheel. In: *Potential and Kinetic Energy Kit ES9*. s.l.:s.n., p. 3.

TecQuipment, 2012. Potential and Kinetic Energy Kit ES9. In: *Engineering Science Guidance Book*. s.l.:s.n., pp. 13, 24-27.

Woodford, C., 2023. *explainthatstuff*. [Online]

Available at: <https://www.explainthatstuff.com/flywheels.html>