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Energy in a flywheel

Motor Vehicle Engineering Science (ACHA4036)

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March 2026

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2. Introduction

This Report will be looking at an experiment conducted on how energy is stored and used in a flywheel.

A flywheel is a metal wheel which is connected to the crankshaft of an engine, its job is to store rotational kinetic energy. It can store this energy and release it, when necessary. A flywheel provides rotational inertia helping the engine to stay balanced, and to stop the engine from stalling when you lift off the accelerator pedal.

The flywheel is also used to start the engine. in a car it has many teeth surrounding its circumference acting as a big gear. The starter motor spins the flywheel which starts the engine.

The experiment shows how much energy is stored in a flywheel on a low scale. The experiment shows how the flywheel stores different amounts of energy.

Different Weights were connected to the flywheel and dropped from an equal height.

The purpose of the experiment was to show the inertia of the flywheel and how that moment of inertia is affected by the different weights that were used.

Flywheels also have more interesting uses in the motorsport world, for instance, flywheels are normally heavier in road vehicles compared to motorsport vehicles. Lightening the flywheel allows the engine to rev up and down much faster, improving the performance of the vehicle. It also allows for faster shifts, due to there being considerably less rev hang due to less weight.

Flywheels also have a very interesting use in KERS systems on formula 1 cars. An extremely light flywheel is used to store kinetic energy produced during braking. This stored energy can be transferred back to the drivetrain using a CVT or electric motor. “racecar engineering”

3. Experimental procedure

Firstly, the contents of the experiment were placed on the workplace. The work panel was placed on the table, ready for the bearing block to be attached.

The bearing block was then fixed to the work panel using screws, locking it into place. The flywheel was then attached to the bearing block. The assembly together was mounted as high as possible on the work panel to allow the weights to travel free.

A string was then attached and wrapped around the back of the bearing block and hooked at the other end to a weight holder.

An initial measurement of the height from the Weight holder to the base was taken, (240mm). Then the weight hanger was allowed to fall to 0mm, and a magnetic ruler was positioned on the work panel at this point aligning with the weight hanger.

The flywheel was then turned, lifting the weight hanger until it returned to the initial 240mm height. Multiple 10g weights were added until the total amount weighed 100g.

A stopwatch was then used to measure how long it took for the weight hanger to fall from the initial position of 240mm, all the way to 0mm, and then back up to its maximum height. The maximum return height was recorded as H_2 .

This was repeated 3 times to get an average time and height value. The experiment was then repeated with differing values of weight, from 100g all the way to 500g.

All the data was then recorded and put into a table. Using this data, the potential energy (mgh_1) and the potential energy loss.

The velocity and acceleration were also calculated allowing for a nominal Inertial value for the flywheel to be calculated



1.



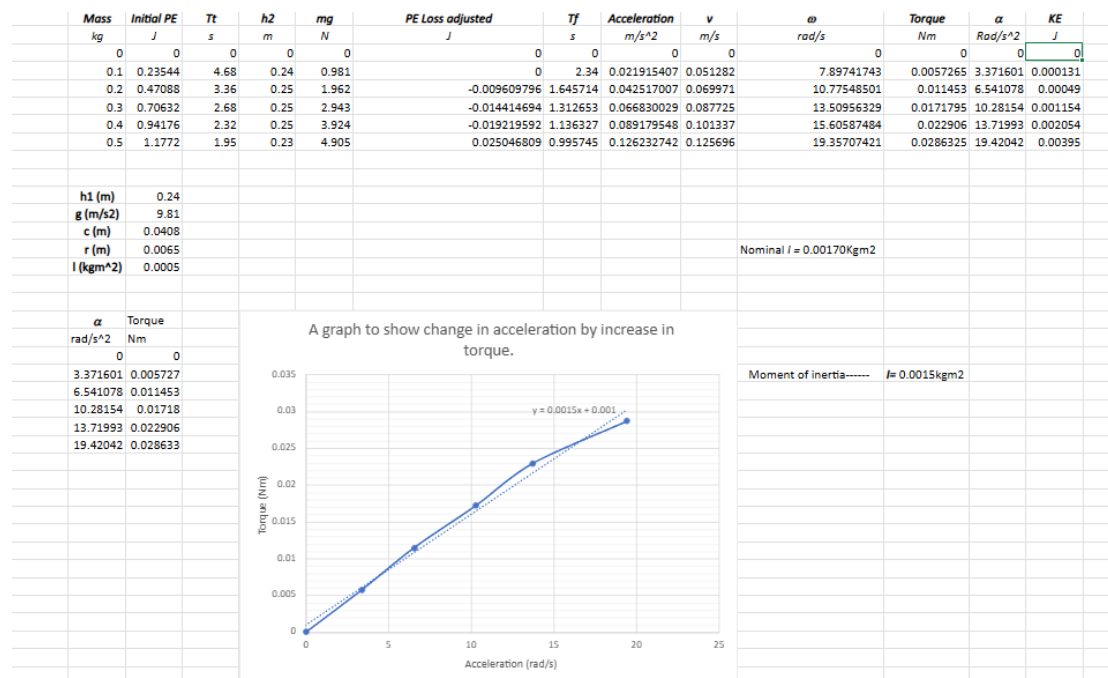
2.

Photo 1 shows the weights, at the lowest position after being released, the flywheel is in motion during this picture. Photo 2 shows the weights reaching the maximum return height.

4. Results.

Mass	Initial PE	Tt	h2	mg
kg	J	s	m	N
0	0	0	0	0
0.1	0.23544	4.68	0.24	0.981
0.2	0.47088	3.36	0.25	1.962
0.3	0.70632	2.68	0.25	2.943
0.4	0.94176	2.32	0.25	3.924
0.5	1.1772	1.95	0.23	4.905

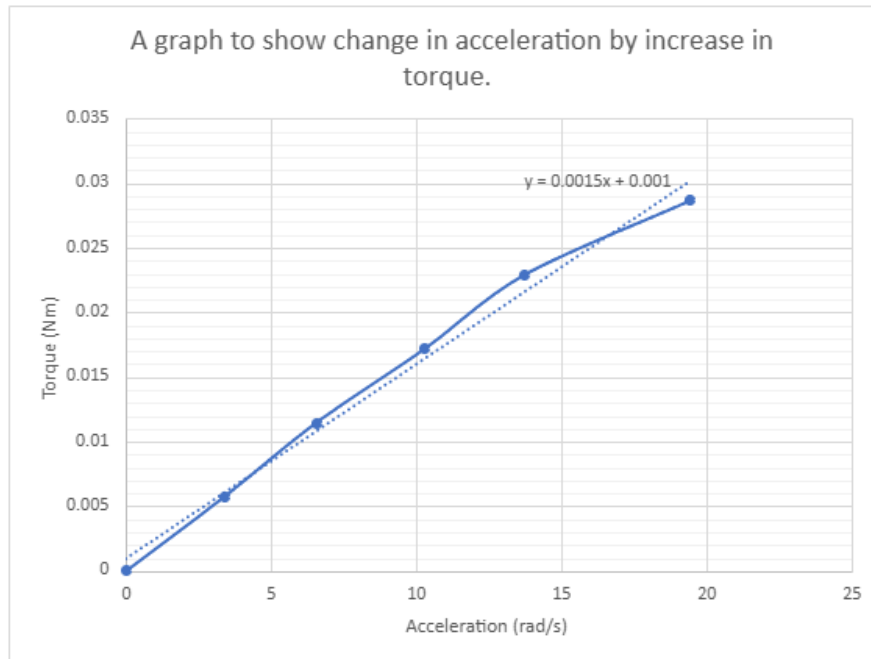
This graph shows the results of the initial potential energy, the time taken, and the return height.



5. Analysis

The data showed some interesting results. Firstly, there is an increase in the acceleration as the mass increases.

<i>Mass</i>	<i>Acceleration</i>
<i>kg</i>	<i>m/s²</i>
0	0
0.1	0.021915407
0.2	0.042517007
0.3	0.066830029
0.4	0.089179548
0.5	0.126232742



This is the graph that shows the change in acceleration by increase in torque. The graph creates a trend line which allows us to calculate the moment of inertia. $I = Y$
The moment of inertia comes out as 0.0015kgm². this number is smaller than the nominal figure suggested of 0.00170Kgm². the two compare decently well and are vastly similar, showing that the recording of the data during the experiment was satisfactory.

Mass	PE Loss adjusted
kg	J
0	0
0.1	0
0.2	-0.009609796
0.3	-0.014414694
0.4	-0.019219592
0.5	0.025046809

The results also show that when the weight of the load on the flywheel is increased, the potential energy loss, is decreasing. It keeps decreasing in the minuses until the mass reaches 500g. At this point, the PE loss increases drastically, coming out of the

negatives. This is strange to look at and could suggest that the flywheel is storing more energy when the mass is higher.

The general take however is that the loss is increasing as weight increases.

Interestingly at 0.1kg there is 0 potential energy loss, this could be an error in the recording of the experiment itself, as the equation used is correct.

<i>KE</i>
<i>J</i>
0
0.000131
0.00049
0.001154
0.002054
0.00395

The Kinetic energy is also increasing as the mass increases, kinetic energy is directionally proportional to mass and velocity, if the mass of the object increases the KE will increase, however an increase velocity has a higher effect on KE than mass. The equation $KE = \frac{1}{2}mv^2$ shows this. "Physics stack exchange"

Another part that can be talked about is how the flywheel resists changes in rotation. When the weight falls, as it's linked to the flywheel it causes rotational motion too, not just the linear motion of the mass falling. The flywheel does not rotate freely it resists changes in its rotational motion due to the flywheel's moment of inertia

6. Conclusion

The results showed that the flywheel stored and released more energy the more mass was applied. The inertial moment of the flywheel was calculated at 0.0015Kgm² which was respectably close to the nominal value given. The results showed that the flywheel gained kinetic energy as the weight was increased.

The data shows that energy transferred in rotational system suffers losses when converted to kinetic energy, likely due to friction and possibly the mass of the flywheel.

The vast majority of the data was consistent with expectations showing that the experiment worked and allowed data to be decently accurate.

7. Evaluation

The experiment could have incorporated an amount of human error, for example recording the time taken for the weights to fall during the experiment. This was done with handheld stopwatches. There is a factor of inaccuracy using this method due to human reaction times, and one's own judgement of when the weights “appear” to have reached the necessary point of travel.

To reduce the effects of this, recordings were taken 3 times, to find an average. Also sometimes recording the 3 attempts again, if one of the times had a vastly different result.

The experiment was carried out using multiple people using multiple stopwatches.

The experiment didn't consider friction throughout the whole assembly of the experiment, which would have had a considerable effect on acceleration and velocity. However the results didn't need to take this into account.

8. Further work

If the experiment was to be carried out again, with unlimited time and budget, it could be improved by maximising the accuracy of the readings. This could be done by using high precision electronic sensors that could pinpoint the exact moment the weights started falling and could pinpoint exactly where they reached the second return height. This would completely eliminate any human error from the recording of data.

Another way the experiment could have been improved would be to use lubricants to drastically lower the friction, this may give us more accurate results and allow a more accurate calculation for the final moment of inertia in the flywheel.

The string could also unravel unevenly, making sure it is as tight as possible would eliminate more friction if it were to jump and skip while unwinding.

9. References

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