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Energy in a flywheel

Further Science for Engineering (ACHA4007)

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1. Introduction

In a flywheel experiment energy is contained in the flywheel originating from motion as it rotates creating kinetic energy. The kinetic energy can be accurately calculated using the formula... $KE = 0.5I\omega^2$ considering the flywheels moment of inertia and its angular velocity.

The energy generated in the flywheel can be used in a variety of different applications such as storing excess energy during low demand periods and releasing it during peak demand helping maintain stability within the power supply. Flywheels can also be integrated into uses such as renewable energy.

Flywheels are capable of delivering consistent speeds to machinery. The aim of the experiment is to demonstrate the principles of energy storage and conversion, allowing us to further understand how kinetic energy is generated and measured in rotary systems. This experiment also lets us explore the connections between mass, gravity, radius and velocity and how they interact with one another during testing compared to theoretical research.

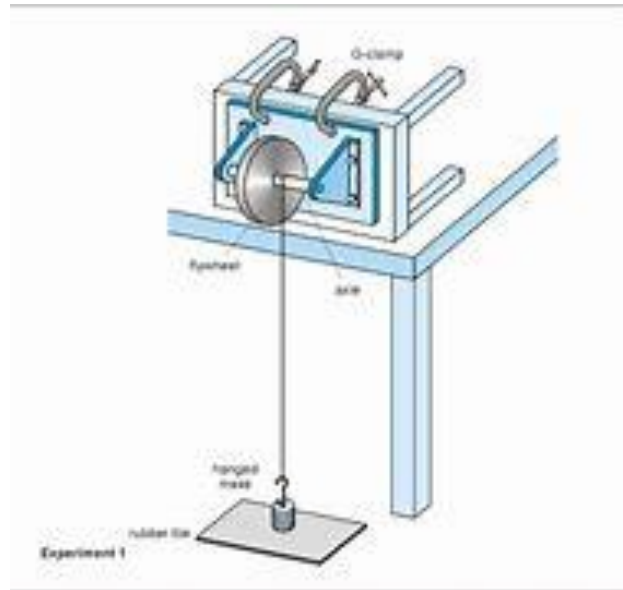


Figure 1: Ranjan,S. (2013), Moment of Inertia of a flywheel by falling weight method [Blog/forum]

Although the experiment is very beneficial in terms of research and further understanding in rotation energy, the fly wheels can store a significant amount of kinetic energy based on how it is set up. This can be a safety hazard in the event of failure or malfunction during operation leading to potential injury to the person operating.

Another disadvantage to performing the experiment is the friction loss and the limited energy storage this is due to the friction in the bearings and air resistance influencing the accuracy of the experiment meaning the results may vary based of the quality of materials and equipment and the limited storage is due to them being inferior to other methods of generating and storing energy such as batteries further restricting the capability of the experiment.

2. Experimental Procedure

The first step in the experimental procedure is to gather the materials needed after researching the requirements. Typically, these are the materials needed:

- A fly wheel
- A motor capable of spinning the flywheel
- A power supply for the motor/pulley

- Speed sensor to measure rotational speed (if required)
- A scale to measure mass
- Safety gloves and goggles (PPE)
- A ruler for dimensions

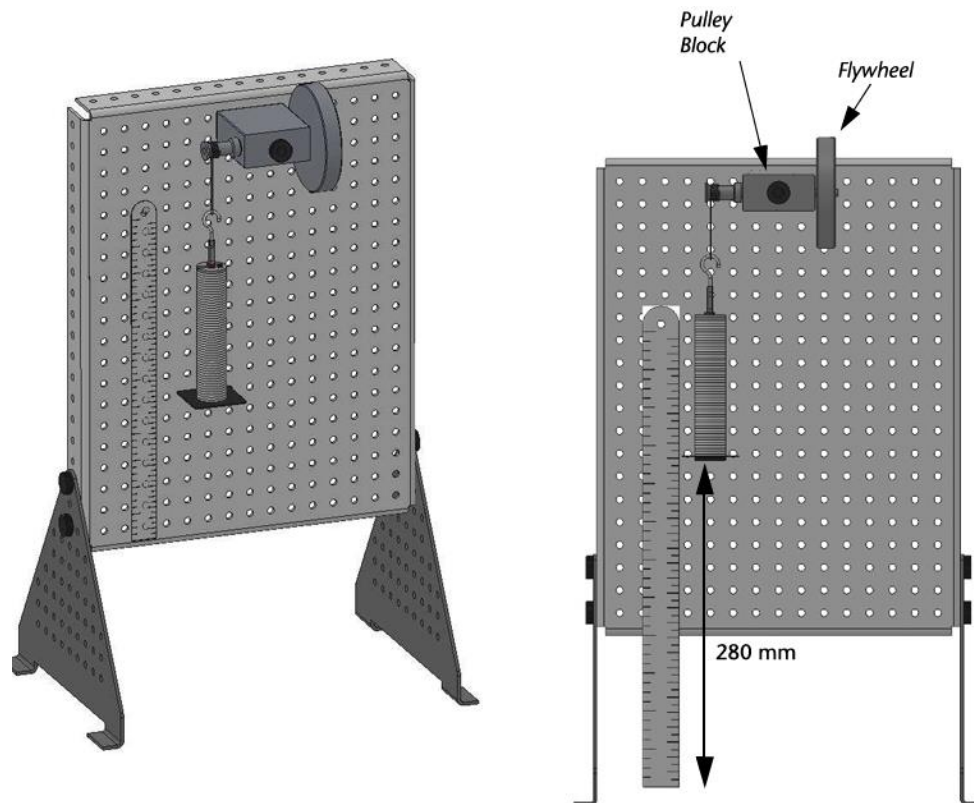


Figure 2: tecquipment. (year unknown), Engineering science worksheet, potential and kinetic energy kit ES9, 3. energy in a flywheel.

Once the materials are gathered and PPE is equipped the next step in the procedure is to use the scale gathered previously to measure the mass of the flywheel. Along with this the radius can be calculated using the ruler. Once this is completed the calculating the flywheels moment of inertia using the correct formula.

After this is completed setting up the apparatus is the next priority. Securely attach the flywheel to the motor shaft ensuring it is mounted in a position that allows for rotational movement without catching or obstructions. Ensure the motor is connected to the power supply. If required place and accurately position the speed sensor and ensure it is set at 0 before the experiment commences.

To conduct the experiment, turn on the power supply gradually increasing the voltage to reach a stable rotational speed. Once the flywheel reaches a stable speed use the speed sensor to make a recording of the initial rotational speed.

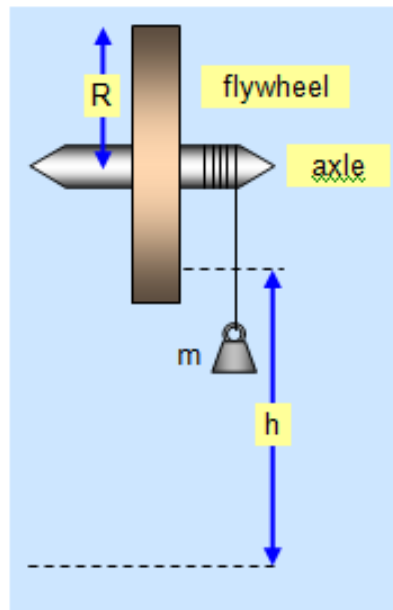


Figure 3: Ranjan,S. (2013), Moment of Inertia of a flywheel by falling weight method [Blog/forum]

Once the flywheel is stable and the speed has been recorded calculating the kinetic energy using the correct formula is the next necessary step.

Its good practice to repeat the experimental procedure numerous times to guarantee accuracy and reliability in the results.

Using different speeds and different flywheels at different masses and radius can also be beneficial to allow us to compare energy storage capacities.

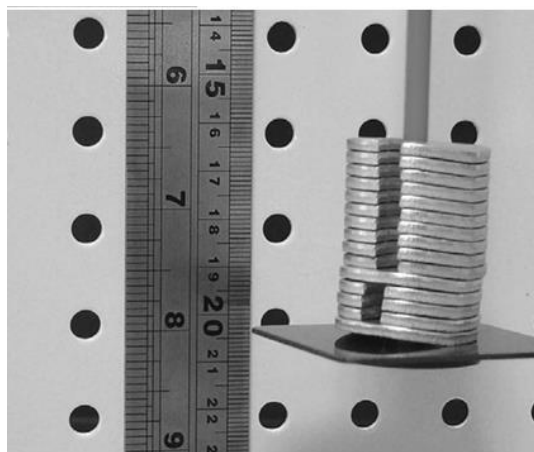


Figure 4: tecquipment. (year unknown), Engineering science worksheet, potential and kinetic energy kit ES9, 3. energy in a flywheel.

3. Results and Analysis

	tt1	tt2	tt3
0.1	4.16	3.71	4.23
0.2	2.85	2.72	2.66
0.3	2.41	2.34	2.53
0.4	2.01	2.07	2.27
0.5	2.13	1.68	2.2

Figure 5: Chiputura, A . (2025), excel spreadsheet

Here are the raw results from the experiment the mass ranges from 0.1 to 0.5 m/kg and the highest time in seconds was 4.23 with the lowest time recorded being 1.68 seconds.

h1	0.28
g (m/s ²)	9.81
c (m)	0.0408
r (m)	0.0065
l (kgm ²)	0.0005

Figure 6: Chiputura, A . (2025), excel spreadsheet

Here is a table containing important key data such as gravity, circumference and radius. These will be used in the equations and are very essential to completing the other tables and graphs.

mass (m/kg)	initial PE (J)	Time to fall and rise (tt/seconds)	h2 (m)	mg	PE loss adjusted (J)	falling time (tf/seconds)	acceleration (a/m.s ⁻²)	velocity (v/m.s ⁻¹)	velocity(w/rads.s ⁻¹)	(mg-ma)r	a/r	KE
0	0	0	0	0	0	0	0	0	0	0	0	0
0.1	12.58	4.16	0.248	1.258	0.016647273	4.408	0.014410361	0.063520871	9.782191281	0.008083	2.216979	0
0.2	2.4628	2.85	0.255	0.49256	0.025671028	3.105	1.017526663	3.15942029	486.5495869	-0.00341	156.5426	-173.93
0.3	1.9735	2.41	0.265	0.59205	0.02268	2.675	0.005701808	0.015252336	2.34885432	0.003811	0.877201	0.004179
0.4	1.4025	2.01	0.255	0.561	0.051342056	2.265	0.001267001	0.002869757	0.441941571	0.003638	0.194923	0.000167
0.5	0.747	2.13	0.247	0.3735	0.08600038	2.377	8.84936E-05	0.000210349	0.032393698	0.002427	0.013614	4.52E-07

Below is the graph required to find the moment of inertia in the flywheel and is important as it quantifies how difficult it is to change the rotational motion of the flywheel.

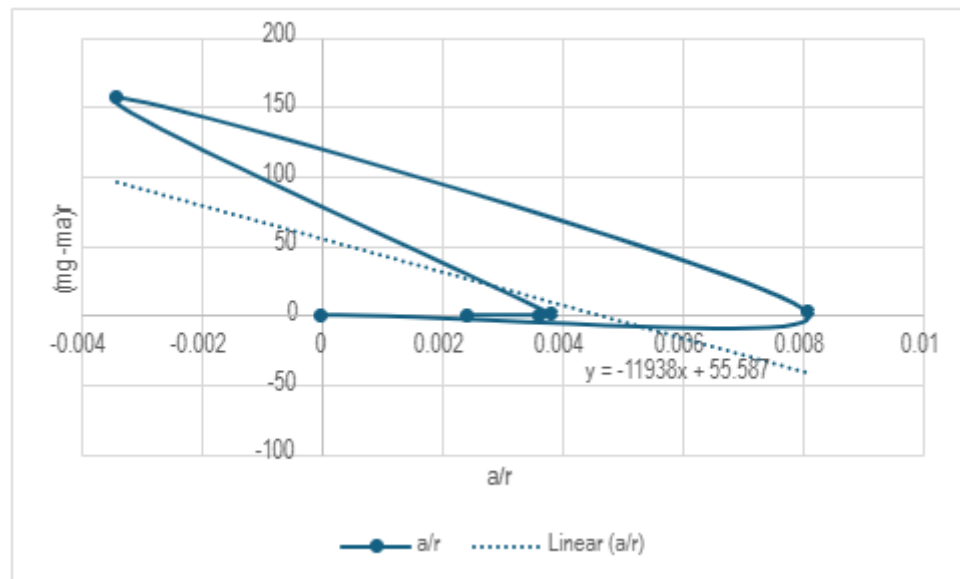


Figure 7: Chiputura, A . (2025), excel spreadsheet [graph]

4. Conclusion and evaluation

In conclusion, there were many factors that contributed to the experiment not being as successful as it could potentially be, and several actions could have been implemented to reduce the chance of failure such as, ensuring that all the measuring instruments and equipment has been calibrated and set to 0 before taking any readings. Being satisfied that all the recording devices has been set to 0 allows us to obtain an accurate reading.

Using the same method for measuring the speed and mass of the flywheel each time the experiment commences adds consistency to the results and helps reduce the amount of discrepancies and inaccuracies between each set in the experiment.

Being able to control environmental factors would further add to the accuracy of the test. Factors such as the temperature, humidity and air resistance all influence the experiments results, having a suitable lab to conduct the experiments would help improve the conditions of the environment.

In some cases, appropriate lubricants maybe needed to guarantee that there is minimal unnecessary friction in the system in addition to this making sure the flywheel is properly aligned is essential for proper operation.

Another precaution that could have been implemented to allow for a better experiment is to use data logging equipment to continuously record measurements to reduce the amount of human error that can occur.

5. Further work

Purchasing a professionally manufactured flywheel apparatus would significantly improve the results and outcomes of the experiment. Professionally manufactured apparatuses are designed by engineers with heavy amounts of precision and accuracy in the dimensions. Having a well manufactured apparatus allows for a more balanced flywheel and operates more smoothly and in some cases can reach higher velocities. Professionally manufactured apparatuses reduce errors like misalignment and uneven weight distribution.

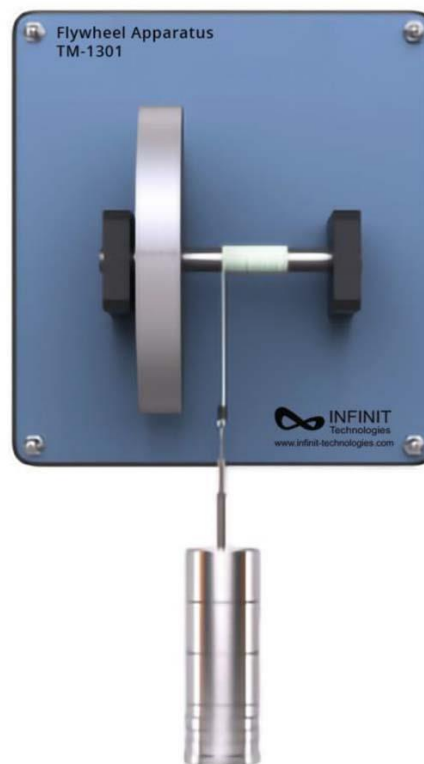


Figure 8: infinit-technologies. (2024), TM-1301 Fly Wheel Apparatus

These professionally made apparatus are often constructed from high quality materials minimising the temperature and wear. In addition to this a large majority of these high quality professionally made apparatuses usually have standardized measurement tools with built-in calibration features making taking results more reliable and consistent throughout the experiments.

Using this apparatus can save time when setting up and making adjustments, allowing us to input more resources into conducting the experiment, logging the data and analysing the results.

Making multiple configurations of the experiment with varying sizes, shapes and mass would also further improve the quality of the experiment by being able to study how these factors influence the performance of the experiment. Given unlimited resources partnering with engineers, physicists and materials experts to gain knowledge and insight on optimising the design and execution of the experiment as a whole.

By implementing these enhancements, the experiment could produce more accurate results and provide a more indepth insight into the principles of rotational dynamics and energy stored within a fly wheel.

6. References

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Figure 6: Chiputura, A . (2025), excel spreadsheet

Figure 7: Chiputura, A . (2025), excel spreadsheet

Figure 8: Chiputura, A . (2025), excel spreadsheet [graph]

Figure 9: infinit-technologies. (2024), TM-1301 Fly Wheel Apparatus