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***Energy in a Flywheel***

***Further Science for Engineers (ACHA4007)***

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# Contents

|                                 |   |
|---------------------------------|---|
| 1. Introduction .....           | 1 |
| 2. Experimental Procedure ..... | 2 |
| 3. Results and Analysis .....   | 3 |
| 4. Conclusion .....             | 5 |
| 5. Evaluation .....             | 6 |
| 6. Further Work .....           | 7 |

# 1. Introduction

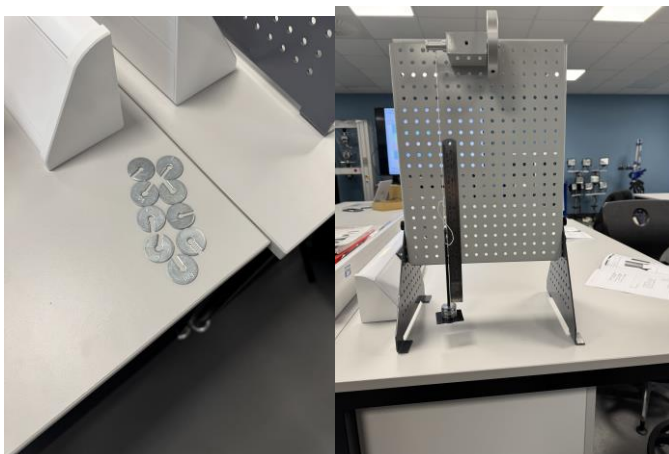
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aim of the flywheel experiment was to prove the theory for energy in a flywheel. A flywheel is a mechanical device which is used to store energy in the form of rotational kinetic energy. A flywheel needs a large amount of force to begin spinning however it also requires a decent amount of force to stop spinning due to the fact it has a lot of angular momentum. When a flywheel requires more energy, it can use its stored energy to keep its momentum going. The theory is that the energy stored in the flywheel is directly related to its rotational motion.

## 2. Experimental Procedure

In order to begin the experiment, the flywheel must be assembled first. The apparatus is constructed using a circular metal flywheel of weight 0.33kg and a metal pulley block. A cord is then attached onto the rotating pole of the pulley block and wrapped around it multiple times allowing a small amount of the cord to hang in freefall. The necessary weights are counted out and put aside for use later. A platform for the weight is hung from the end of the cord with the base of the platform measured 280mm above the surface of the table. Once the platform has been set up the necessary weights can be applied beginning at 0.1kg.

Once the apparatus is set up the measurements are ready to be taken. This experiment is measuring the time it takes for the weight to fall and rise from a predetermined height and its new max height once it has rebounded. The initial weight for measuring is 0.1kg. It is recommended to have at least two people so that one may measure the height and the other may measure the time. The person measuring the height is on eye level with the apparatus to ensure a more accurate height measurement and the person measuring the time has a working stopwatch. Once the weights are dropped have the measurements taken and written down. The measurements required for the experiments are the total time to fall and rise and its max height once risen. This process is repeated a total of 3 times. The entire experiment process is repeated with an additional 0.1kg up to and including 0.5kg with their respective measurements being noted down.



### 3. Results and Analysis

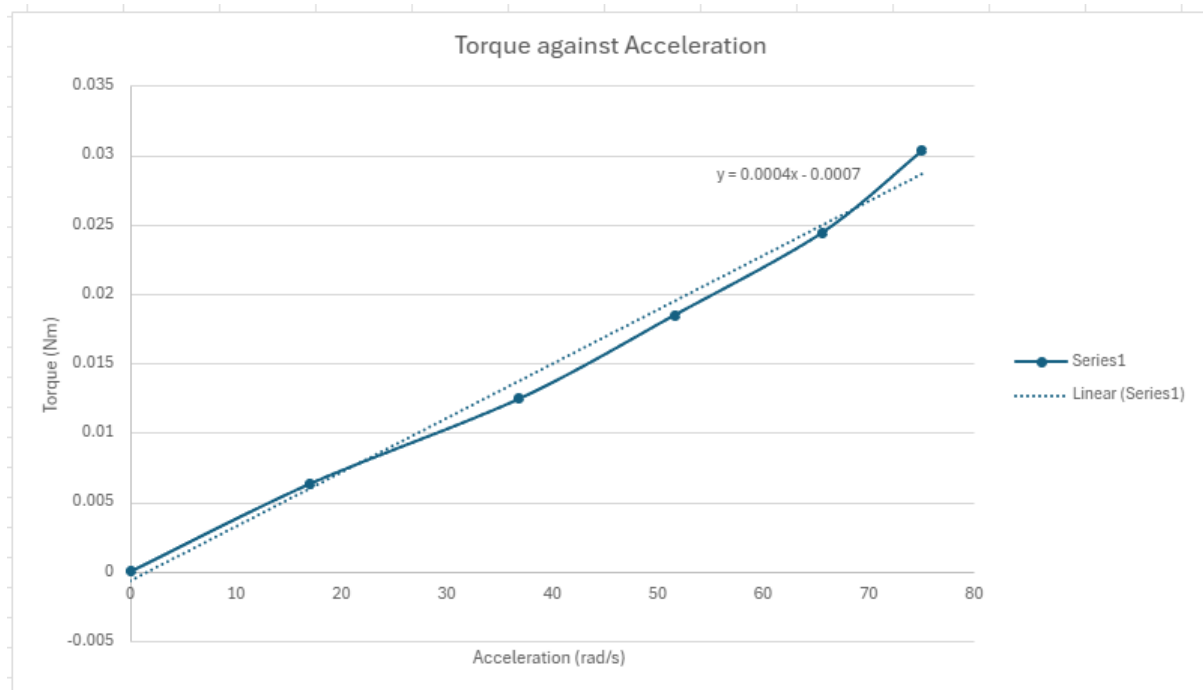
Results:

| Mass (kg) |      | Time (s) |      |         |       | Height (m) |       |         |
|-----------|------|----------|------|---------|-------|------------|-------|---------|
|           | 1    | 2        | 3    | Average | 1     | 2          | 3     | Average |
| 0.1       | 4.34 | 4.21     | 3.93 | 4.16    | 0.236 | 0.237      | 0.237 | 0.237   |
| 0.2       | 3.02 | 2.72     | 2.97 | 2.90    | 0.251 | 0.250      | 0.251 | 0.251   |
| 0.3       | 2.34 | 2.48     | 2.57 | 2.46    | 0.251 | 0.253      | 0.254 | 0.253   |
| 0.4       | 2.29 | 2.01     | 2.20 | 2.17    | 0.250 | 0.251      | 0.249 | 0.250   |
| 0.5       | 2.01 | 1.86     | 2.11 | 1.99    | 0.240 | 0.245      | 0.235 | 0.240   |

Analysis:

| A | B                     | C               | D       | E       | F       | G                     | H        | I                                | J        | K          | L            | M                       | N        |
|---|-----------------------|-----------------|---------|---------|---------|-----------------------|----------|----------------------------------|----------|------------|--------------|-------------------------|----------|
|   | Mass<br>kg            | Initial PE<br>J | Tt<br>s | h2<br>m | mg<br>N | PE loss adjusted<br>J | Tf<br>s  | Acceleration<br>m/s <sup>2</sup> | v<br>m/s | ω<br>rad/s | Torque<br>Nm | α<br>rad/s <sup>2</sup> | KE<br>J  |
|   | 0                     | 0               | 0       | 0       | 0       | 0                     | 0        | 0                                | 0        | 0          | 0            | 0                       | 0        |
|   | 0.1                   | 0.275           | 4.16    | 0.237   | 0.981   | 0.022845725           | 2.252998 | 0.110323083                      | 0.248558 | 38.2778    | 0.006305     | 16.97278                | 0.297846 |
|   | 0.2                   | 0.549           | 2.9     | 0.251   | 1.962   | 0.030002712           | 1.52919  | 0.239477663                      | 0.366207 | 56.39573   | 0.012442     | 36.84272                | 0.579003 |
|   | 0.3                   | 0.824           | 2.46    | 0.253   | 2.943   | 0.041743114           | 1.292308 | 0.33531746                       | 0.433333 | 66.73318   | 0.018476     | 51.5873                 | 0.865743 |
|   | 0.4                   | 1.099           | 2.17    | 0.25    | 3.924   | 0.062191698           | 1.146415 | 0.426092839                      | 0.488479 | 75.22563   | 0.024398     | 65.55274                | 1.161192 |
|   | 0.5                   | 1.373           | 1.99    | 0.24    | 4.905   | 0.105646154           | 1.071538 | 0.487722172                      | 0.522613 | 80.48222   | 0.030297     | 75.03418                | 1.478646 |
|   |                       |                 |         |         |         |                       |          |                                  |          |            |              |                         |          |
|   | h1 (m)                | 0.28            |         |         |         |                       |          |                                  |          |            |              |                         |          |
|   | g (m/s <sup>2</sup> ) | 9.81            |         |         |         |                       |          |                                  |          |            |              |                         |          |
|   | c (m)                 | 0.0408          |         |         |         |                       |          |                                  |          |            |              |                         |          |
|   | r (m)                 | 0.0065          |         |         |         |                       |          |                                  |          |            |              |                         |          |
|   | I (kgm <sup>2</sup> ) | 0.0005          |         |         |         |                       |          |                                  |          |            |              |                         |          |

From using the data collected, multiple calculations could be made which include but are not limited to, acceleration, torque and kinetic energy. A varied number of calculations were required to determine the kinetic energy that the flywheel was storing. These calculations prove the theory that a flywheel stores kinetic energy and the fact that its kinetic energy is higher the more mass is applied. The rest of the results also follow the expected outcomes such as the acceleration increasing as more mass is applied. These results also align with other results of the same experiment. The data is kept to the decimal point given as to give a more accurate number for further equations.



This graph shows the positive relation of torque against acceleration proving that as one increases so does the other. This lines up with the expected outcomes that we would assume to be in the graph as it shows their relations with one another.

## 4. Conclusions

Upon completion of the experiment, the findings do seem to align with the expected outcomes. The theory believed that the more mass applied to the flywheel the more kinetic energy would be stored, and with the results from the table it shows an increase in kinetic energy in relation to the mass of the force.

## 5. Evaluation

The first way to minimize possible errors is to ensure that the same people are taking the measurements each time. This ensures that the reaction times of the measurements stay somewhat consistent. Another way for the errors to be minimized is a limited amount of interaction with the stationary equipment, for example the ruler to ensure that the height measurements stay the same throughout the experiment.

Furthermore, to reduce the risk of errors, there needs to be multiple repetitions of the same weight to get an increased variety of results.

## 6. Further Work

In perfect circumstances where there is no limit to time and funds, to increase the chances of successful and accurate results there are many possibilities. One way to increase the chances for accurate results is to increase the amounts of tests done on each weight and an increased amount of weight ranges to allow a more varied set of results to draw a conclusion from. Another possibility would be to have the entire process automated by highly sophisticated machinery which can have a near instant reaction times and height measurements.