**ECEN1008**

**Experiment Report**

**Moment of Inertia and Angular Acceleration**

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1. Objective

To determine the moment of inertia of a rotating disk from its angular acceleration.

II. Procedure

1.To determine the angular displacement as a function of time under constant acceleration.

The angle is determined by moving the light barrier. Make sure that the electronic counter stops when the sector mask blocks the light barrier. Denote t as the measured time. The measurements of t1 should be repeated for five times at a particular angle. We should measure t1 for four different angles.

2. To measure the angular speed as a function of the time under constant acceleration.

Push STOP-INVERT key so that the electronic timer stops when the back edge of the sector mask leaves the light barrier. Denote t2 as the measured time. The measurements of t2 should be repeated for five times. The average speed at that angle is

w=Δq/Δt

where Δq (15°) is the angle of sector mask and t is the duration when the light was blocked (Δt=t2-t1). We should measure t2 for four different angles (same angles as pt. 1), and then the angular speed at different time can be calculated.

3. To measure the angular acceleration as a function of applied force.

The angular acceleration is found from angular speeds. Repeat pt.1-2 for four different values of slotted weight.

1. Data

Angular Displacement: 30°

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass (g) | 50 | | 60 | | 70 | | 80 | |
| Time | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) |
| trial1 | 1.036 | 1.263 | 0.95 | 1.145 | 0.869 | 1.057 | 0.817 | 0.984 |
| trial2 | 1.038 | 1.265 | 0.951 | 1.158 | 0.871 | 1.068 | 0.811 | 0.987 |
| trial3 | 1.038 | 1.27 | 0.951 | 1.159 | 0.875 | 1.068 | 0.813 | 0.996 |
| trial4 | 1.032 | 1.262 | 0.953 | 1.153 | 0.879 | 1.075 | 0.813 | 0.992 |
| trial5 | 1.037 | 1.267 | 0.953 | 1.152 | 0.879 | 1.067 | 0.817 | 0.989 |
| Tavg(s) | 1.0362 | 1.2654 | 0.9516 | 1.1534 | 0.8746 | 1.067 | 0.8142 | 0.9896 |
| T1-T2(s) | 0.2292 | | 0.2018 | | 0.1924 | | 0.1754 | |
| (T1+T2)/2(s) | 1.1508 | | 1.0525 | | 0.9708 | | 0.9019 | |
| w(rad/s) | 1.1431 | | 1.2983 | | 1.3617 | | 1.4937 | |

Angular Displacement: 45°

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass (g) | 50 | | 60 | | 70 | | 80 | |
| Time | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) |
| trial1 | 1.23 | 1.435 | 1.142 | 1.307 | 1.042 | 1.222 | 0.998 | 1.148 |
| trial2 | 1.238 | 1.434 | 1.132 | 1.307 | 1.052 | 1.213 | 1.001 | 1.148 |
| trial3 | 1.229 | 1.427 | 1.136 | 1.308 | 1.032 | 1.2 | 0.996 | 1.147 |
| trial4 | 1.24 | 1.432 | 1.133 | 1.307 | 1.052 | 1.202 | 1.007 | 1.147 |
| trial5 | 1.238 | 1.435 | 1.132 | 1.304 | 1.053 | 1.206 | 0.995 | 1.144 |
| Tavg(s) | 1.235 | 1.4326 | 1.135 | 1.3066 | 1.0462 | 1.2086 | 0.9994 | 1.1468 |
| T1-T2(s) | 0.1976 | | 0.1716 | | 0.1624 | | 0.1474 | |
| (T1+T2)/2(s) | 1.3338 | | 1.2208 | | 1.1274 | | 1.0731 | |
| w(rad/s) | 1.3259 | | 1.5268 | | 1.6133 | | 1.7775 | |

Angular Displacement: 60°

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass (g) | 50 | | 60 | | 70 | | 80 | |
| Time | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) |
| trial1 | 1.466 | 1.627 | 1.329 | 1.501 | 1.22 | 1.362 | 1.146 | 1.273 |
| trial2 | 1.467 | 1.63 | 1.324 | 1.497 | 1.228 | 1.375 | 1.154 | 1.283 |
| trial3 | 1.463 | 1.629 | 1.333 | 1.479 | 1.225 | 1.366 | 1.153 | 1.275 |
| trial4 | 1.455 | 1.615 | 1.329 | 1.477 | 1.217 | 1.366 | 1.148 | 1.275 |
| trial5 | 1.473 | 1.629 | 1.334 | 1.527 | 1.22 | 1.367 | 1.151 | 1.279 |
| Tavg(s) | 1.4648 | 1.626 | 1.3298 | 1.4962 | 1.222 | 1.3672 | 1.1504 | 1.277 |
| T1-T2(s) | 0.1612 | | 0.1664 | | 0.1452 | | 0.1266 | |
| (T1+T2)/2(s) | 1.5454 | | 1.413 | | 1.2946 | | 1.2137 | |
| w(rad/s) | 1.6253 | | 1.5745 | | 1.8044 | | 2.06951 | |

Angular Displacement: 75°

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass (g) | 50 | | 60 | | 70 | | 80 | |
| Time | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) | T1(s) | T2(s) |
| trial1 | 1.63 | 1.806 | 1.523 | 1.654 | 1.401 | 1.54 | 1.317 | 1.432 |
| trial2 | 1.622 | 1.81 | 1.518 | 1.65 | 1.405 | 1.527 | 1.317 | 1.433 |
| trial3 | 1.663 | 1.808 | 1.526 | 1.651 | 1.408 | 1.525 | 1.323 | 1.435 |
| trial4 | 1.665 | 1.805 | 1.516 | 1.652 | 1.401 | 1.529 | 1.318 | 1.442 |
| trial5 | 1.668 | 1.808 | 1.51 | 1.66 | 1.411 | 1.531 | 1.318 | 1.451 |
| Tavg(s) | 1.6496 | 1.8074 | 1.5186 | 1.6534 | 1.4052 | 1.5304 | 1.3186 | 1.4386 |
| T1-T2(s) | 0.1578 | | 0.1348 | | 0.1252 | | 0.12 | |
| (T1+T2)/2(s) | 1.7285 | | 1.586 | | 1.4678 | | 1.3786 | |
| w(rad/s) | 1.6603 | | 1.9436 | | 2.0927 | | 2.1833 | |

1. Analysis

Inertial

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mass(g) | 0.05 | 0.06 | 0.07 | 0.08 |
| Acceleration(m/s2) | 0.9568 | 1.0471 | 1.3271 | 1.365 |
| I (kgm2) [Measurement)] | 0.016332 | 0.017908 | 0.016484 | 0.018316 |
| IAvg[Measurement)] | 0.017260066 | | | |
| IAbs | 0.01269 | | | |

%Error = Abs(0.01726-0.0126)/0.01268\*100%=36.0126%

V. Error analysis

1. System error.

-(a)In this experiment, the effects of air resistance and pulley friction are not completely eliminated, which causes systematic errors

-(b) Mass error of weights: Slotted weight has a relatively large mass due to surface rusting, or a partially worn and relatively small mass.

1. Human error.

-(a)The release starter is not adequately calibrated and there is friction between its tip and the underside of the inserted sector mask

-(b)When operating the experiment, if the position of Silk thread in Precision pulley is not found to be offset in time, the error will be generated in the end due to the rising friction.

-(c)In the calculation, the gravitational acceleration is an approximate value of 9.8m/s2 rather than a more accurate result. Moreover, taking 15 degree as 0.262 rad is another approximation.

(3) Random error.

Inevitably, several results in a set of tests are significantly higher or lower than several other data, affecting the average value

VI. Conclusion

The larger the mass of the Slotted Weight, the less time it takes to perform an equal amount of angular displacement. Moreover, the angular displacement of a certain object is directly proportional to the square of time.

The angular speed of a certain object is directly proportional to the time.

The angular acceleration is directly proportional to the mass.

The moment of inertia in this experiment is about 0.01726 with 0.004573 relative error （36%error）