**Birzeit University**

**Physics department**

**Physics 211**

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**Experiment number: (3)**

**Experiment name: moment of inertia**

**Date: /2012**

**Instructor: Dr. Wael .Q**

**Main results:**

**I avg=0.0342±0.0003 kg m2**

**Abstract:**

**In this experiment the moment of inertia of a vertical flywheel is measure . amass is attached to the axle of the fly wheel and let to fall from rest, by measuring suitable quantizes (n,N,t,g,R,m,M)**

**Theory:**

**In**[**classical mechanics**](http://en.wikipedia.org/wiki/Classical_mechanics)**, moment of inertia, also called mass moment of inertia, rotational inertia, polar moment of inertia of mass, or the angular mass, (**[**SI**](http://en.wikipedia.org/wiki/SI)**units kg·m²) is a measure of an object's resistance to changes to its**[**rotation**](http://en.wikipedia.org/wiki/Rotation)**. It is the**[**inertia**](http://en.wikipedia.org/wiki/Inertia)**of a rotating body with respect to its rotation. The moment of inertia plays much the same role in**[**rotational dynamics**](http://en.wikipedia.org/wiki/Rotational_motion)**as mass does in linear dynamics, describing the relationship between**[**angular momentum**](http://en.wikipedia.org/wiki/Angular_momentum)**and**[**angular velocity**](http://en.wikipedia.org/wiki/Angular_velocity)**,**[**torque**](http://en.wikipedia.org/wiki/Torque)**and**[**angular acceleration**](http://en.wikipedia.org/wiki/Angular_acceleration)**, and several other quantities. The symbols I and sometimes J are usually used to refer to the moment of inertia or polar moment of inertia.**

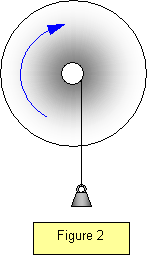
**While a simple**[**scalar**](http://en.wikipedia.org/wiki/Scalar_(physics))**treatment of the moment of inertia suffices for many situations, a more advanced**[**tensor**](http://en.wikipedia.org/wiki/Tensor)**treatment allows the analysis of such complicated systems as spinning tops and gyroscopic motion.**

**Ref: Wikipedia.org**

**A flywheel of radius R is set up on a horizontal axle of radius r. A string of length h is wrapped round the axle with a mass m tied to the end (Figures 1 and 2). The moment of inertia of the flywheel and axle is I. The flywheel is accelerated by the couple applied by the mass m. The mass is allowed to fall through a height h at which point the string leaves the axle. The velocity of the falling mass at this instant is v and the angular velocity of the flywheel w.  
  
The potential energy lost by the weight is converted into kinetic energy of the weight, kinetic energy of the flywheel and heat due to friction in the bearings.  
  
If the energy lost per revolution due to friction is E and the flywheel makes n1 revolutions during acceleration, then:   
  
mgh = ½ mv2 + ½ Iw2 + n1E  
  
The flywheel is then allowed to come to rest due to the frictional couple. If it stops after a further n2 revolutions then:  
  
½ Iw2 = n2E**

**Therefore:**

**http://www.schoolphysics.co.uk/age16-19/Mechanics/Rotation%20of%20rigid%20bodies/text/Moment_of_inertia_measurement/images/2.gif**

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**We could convert linear velocity (v) into angular velocity (w) if we wished using v = Rw.  
  
Now the angular velocity w at the end of the period of the acceleration is given by:  
  
w/2 = 2pn1/t  
  
Since w/2 is the average angular velocity of the flywheel and 2pn1 is the angular distance covered by any point on it in a time t.  
  
Hence the moment of inertia of the flywheel can be calculated.**

**Ref: www.schoolphysics.co.uk**

**Procedure:**

1. **adjust the mass m at a certain height.**
2. **Start the timer as you let g of the flywheel.**
3. **Count how many turns the fly wheel turns (n) before it hits the ground**
4. **Count how many turns the fly wheel turns until it stops (N)**
5. **Repeat the four steps above several times and record your data .**

**Data:**

**M=7.12 ± 0.01 kg**

**m =986 g**

**d= 25.4 ± 0.05 mm**

**R= 9.775 cm**

**h: 60 cm**

|  |  |  |  |
| --- | --- | --- | --- |
| trial | t (S) | n(turn) | N(turn) |
| 1 | 6.16 | 7 | 25 |
| 2 | 6.35 | 7 | 24 |
| 3 | 5.57 | 7 | 24 |
| 4 | 5.69 | 7 | 22 |

**Data analysis :**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| trial | t (S) | n(turn) | N(turn) | I (kg\*m2) |
| 1 | 6.16 | 7 | 25 | 0.0370 |
| 2 | 6.35 | 7 | 24 | 0.0390 |
| 3 | 5.57 | 7 | 24 | 0.0301 |
| 4 | 5.69 | 7 | 22 | 0.03072 |
| ∆ | 0.32 | 0.000 | 1.0 | 0.003 |

**Theoretical y,**

**I=0.5\*M\*R2=0.5\*7.12\*10^3\*(0.09775)^2=0.03401602 kg m2.**

**∆I=2∆r/r+∆N/N+∆n/n+∆h/h+2∆t/t =0.004 kg m2**

**I=mr2(N/N+n)(gt2/2h-1)**

**Experimental I=0.0342 kg m2.**

**Percentage error = abs (theoretical value – experimental value)/theoretical value**

**= [(0.0340- 0.0342)/ 0.0340] = 0.5%**

**R:radius of the wheel , r: (d/2) : radius of the axle**

**n : number of turns the wheel turns before the object hits the ground .**

**N: the number of subsequent turns until the wheel hits the ground .**

**M : mass of the wheel , m : mass of the object .**

**h : height of the object above the ground .**

**Results and conclusion :**

**Main result:**

**I avg=0.0342±0.0003 kg m2**

**Discussion of results:**

**The calculated moment of inertia is very close of that of the one reported theoretically by the test laws of classical physics and within the range of the reported error**

**Sources of error:**

1. **Friction between the string used and the flywheel**
2. **Air resistance**

**Conclusion :**

**The law I=md2/4\*N/(N+n)\*(gt2/2h)-1**

**Is an accepted estimate of the actual moment of inertia .**