UPDATES ON THE ROTATIONAL MECHANICS EXPERIMENT

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Introduction

Main Objective

- Measure frictional losses and
- moment of inertia of the disc *(I)*.

Secondary Objective

- To examine the relationship between speed and rotational friction.

Old Experimental Arrangement

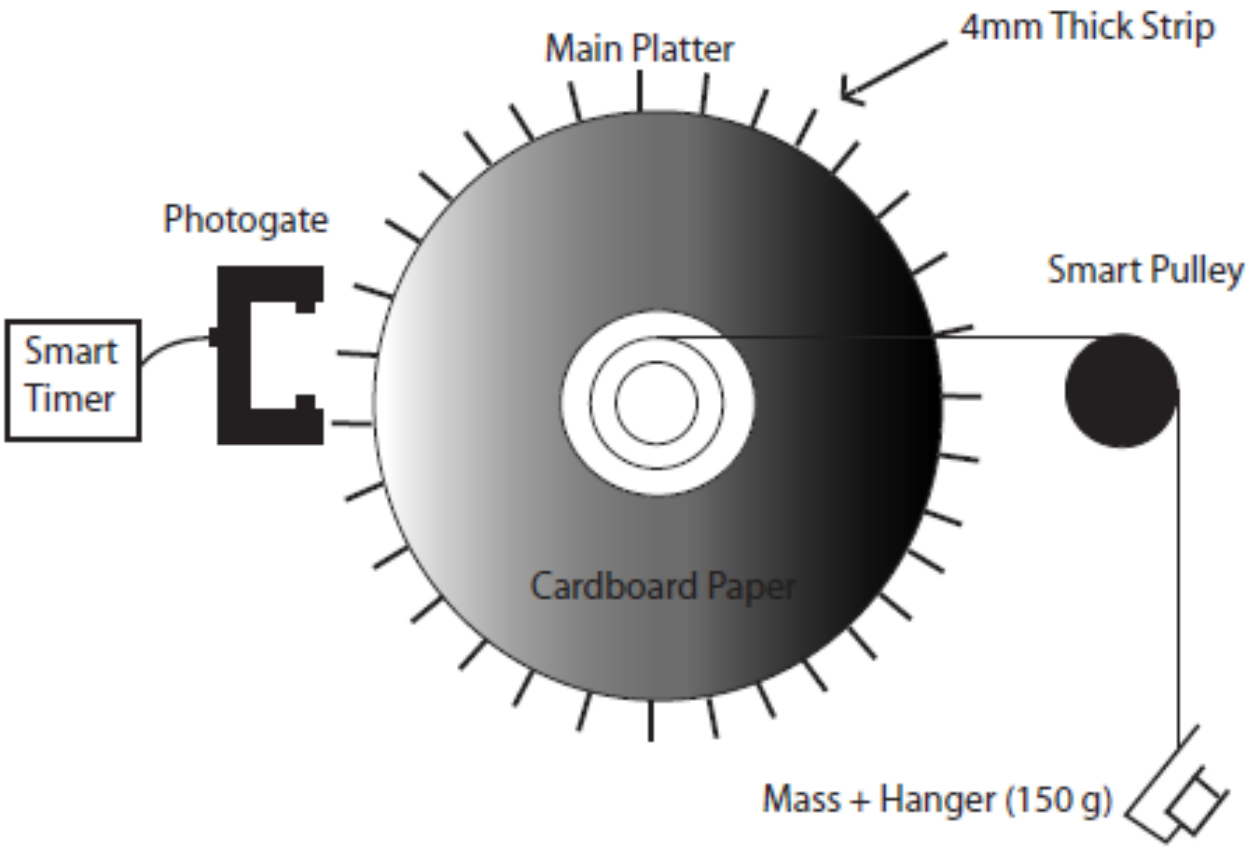
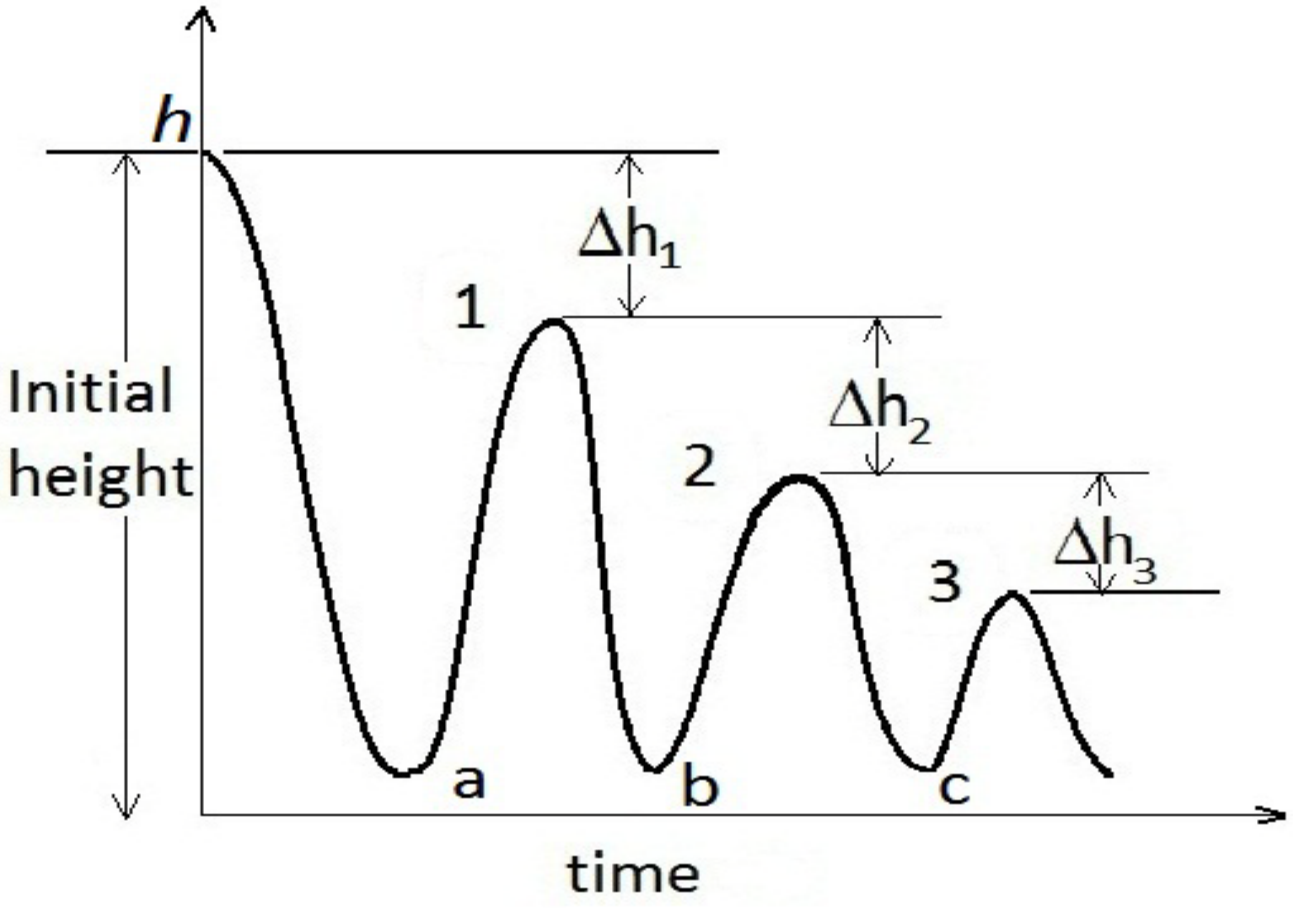


Figure 1

Decay of angular speed



Basic Scheme: Old Experiment

- Drive a disc with a thread tied to a hanger loaded with weights. Thread is tied to a screw on the step pulley.
- Using smart timer in count mode, measure the counts and calculate the loss in rotations of the disc.
- From loss in rotations find vertical height loss, Δh, and subsequently energy loss per rotation, ΔE_R.
- Measure the maximum angular speed, ω, achieved by the disc when the weight is allowed to fall down to calculated I.

Basic Scheme: Old Experiment

- From energy loss per rotation, frictional loss for any number of rotations can be found.

- $\Delta E = N \times \Delta E_R$, where N is the number of rotations.

- Moment of inertia of the disc can be calculated using the following expression.

$$mgh = \frac{1}{2}I\omega^2 + \Delta E = \frac{1}{2}I\omega^2 + \Delta E_f + \Delta E_m$$

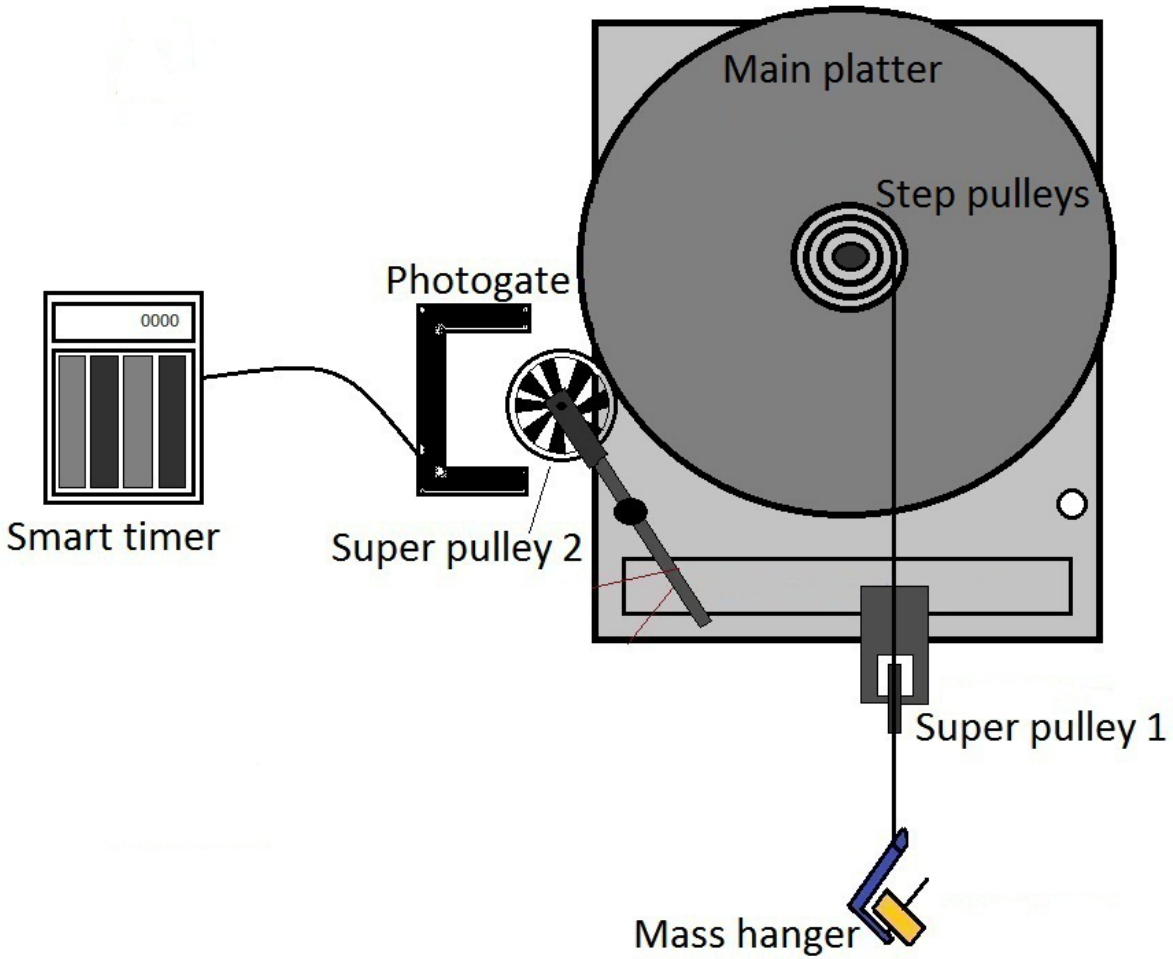
Limitations in Old Method

- We assume energy loss per rotation to be a constant quantity.
- Friction is assumed independent of the speed of rotation.
- The apparatus has to be adjusted once again for moment of inertia measurement.
- There is still room for improvement in accuracy of height and angular speed measurements.

Updated experiment

- Instead of a handmade cardboard, we use another super pulley to measure the rotations.
- Maximum angular velocity is also measured for the first cycle of mass-hanger.
- Different weights are used to achieve different angular velocities
- A relationship between the average angular speed and friction is established.

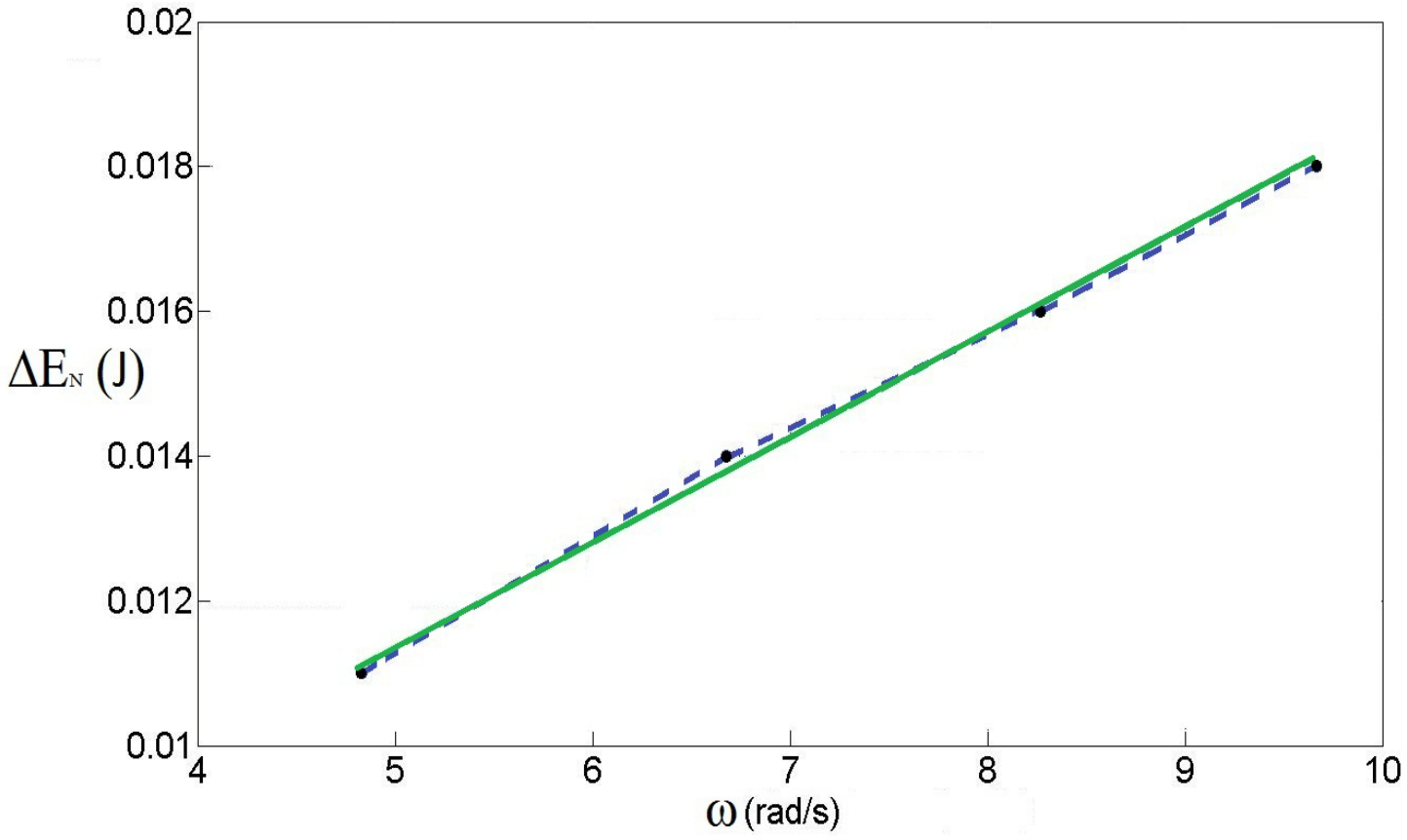
Updated experiment: Apparatus



Updated experiment: Improvements

- Angular measurement is improved from 11.25 to 7.2 degrees, that is one count per 7.2^{o} of rotation.
- No modification is needed for moment of inertia measurement.
- Nearly instantaneous angular speed of the disc can be measured instead of an average over the whole rotation.
- Speed vs. friction graphs are plotted.

Updated experiment: Results



Updated experiment: Results

Cycle 'n'	C ±1	ΔC ±2	Δh ±0.003 (m)	ΔE_B ±0.003 (J)	N ±0.02	ΔE_R ±0.0003 (J)
0	564					
1	483	81	0.153	0.157	11.28	0.0139
2	416	67	0.126	0.129	9.66	0.0133
3	359	57	0.107	0.110	8.32	0.0132
4	312	47	0.089	0.092	7.18	0.0128
5	271	41	0.077	0.079	6.24	0.0126
6	238	33	0.062	0.064	5.42	0.0118
7	209	29	0.055	0.056	4.76	0.0117
8	183	26	0.049	0.050	4.18	0.0119
9	162	21	0.039	0.040	3.66	0.0109
10	143	19	0.036	0.037	3.24	0.0114

Updated experiment: Results

- Average angular speed when the mass-hanger was allowed to fall = 6.614 rad/s
- Energy loss per rotation for the measured speed from speed vs. friction graph = 0.0137 J
- Total energy loss = (0.077 + 0.004) J
- Moment of inertia = 0.0075 kg m^2

Thank You

Questions please!