Date of Lab 13/12/17 Date of Submission 16/01/18

Laboratory Report

Title Hooke's Law and Moment of Inertia

| Homeroom | Section | Name | |
|---|---|---|---|
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| Summary |
|---|
| In the first lab, we have checked the Hooke's Law using spring pendulum. We determined a spring constant in two different ways of using the Hooke's Law apparatus $F = kx$ and by measuring the period using the equation $T = 2\pi\sqrt{\frac{m}{k}}$. In the second lab, we have checked the moment of inertia of the rotational motion. By graphing the data, we could prove that the two equations $I = \frac{\tau}{a}$ and $I = \frac{1}{2}MR^2$ are both correct. |

· Meet a deadline · Write logically · Write clearly · Write with your own words

Teacher's Comments

You should compare two values of k (Hooke and ~~spring~~ oscillation)
Graphs are beautiful.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Due | Summary | Intro. | Method. | Results | Table/Fig. | Discussion | Clearness | General |
| + | | | | | +++ | - | + | ++ |

* Use this form as a cover sheet.
* Submit your reports by the seventh day after your lab.

## *Hooke's Law and Spring Pendulum*

**Introduction**

**Objectives:** 1) To determine a spring constant k [N/m] using the Hooke's Law apparatus

2) To determine a spring constant k [N/m] by measuring the period

**Theory:**

$$F = kx \qquad T = 2\pi/\omega = 2\pi\sqrt{\frac{m}{k}}$$

ω : omega (angular velocity)

m : mass of the weight

k : spring constant

F : elastic force

x : elongation

t : period for the 20 bounces

T : period for 1 bounce

T : period squared

**Experiment**

**Materials:**

1. 3 types of hookes
2. Hooke's Law stand with measurement
3. Weights (prepare necessary amount for each experiment)
4. Stopwatch

**Procedure:**

1. Prepare all of the materials shown above.
2. Hang one of the 3 types of hooke's from the top of the stand.
3. Hang the weight on the bottom end of the hooke and measure the distance of the extended spring.
4. Put a little bit power downward to the weight so that the weight will bounce thanks to the hooke, and measure the time taken for the weight to bounce 20 times.
5. Repeat #3 and #4 with different amount of weight at least 3 times.
6. Repeat #3 to #5 with other 2 types of hookes.
7. Put all of the materials away to the place where they were before the experiment.

**Result**

Time for 20 vibrations $\frac{t}{20}$

**Table of Hooke #1:**

| m [$\times 10^{-3}$kg] | F [N] | x [$\times 10^{-2}$m] | t [s] | T [s] | $T^2$ [$s^2$] |
|---|---|---|---|---|---|
| 200 | 1.96 | 0.500 | 5.47 | 0.274 | 0.0751 |
| 300 | 2.94 | 1.50 | 6.50 | 0.325 | 0.106 |
| 400 | 3.92 | 2.70 | 7.37 | 0.369 | 0.136 |
| 500 | 4.90 | 3.50 | 8.71 | 0.436 | 0.190 |

**Table of Hooke #2:**

| m [$\times10^{-3}$kg] | F [N] | x [$\times10^{-2}$m] | t [s] | T [s] | $T^2$ [$s^2$] |
|---|---|---|---|---|---|
| 200 | 1.96 | 6.70 | 10.2 | 0.510 | 0.260 |
| 300 | 2.94 | 10.1 | 12.3 | 0.615 | 0.378 |
| 400 | 3.92 | 13.3 | 14.2 | 0.710 | 0.504 |
| 500 | 4.90 | 16.6 | 16.8 | 0.840 | 0.706 |

**Table of Hooke #3:**

| m [$\times10^{-3}$kg] | F [N] | x [$\times10^{-2}$m] | t [s] | T [s] | $T^2$ [$s^2$] |
|---|---|---|---|---|---|
| 200 | 1.96 | 5.50 | 10.93 | 0.547 | 0.299 |
| 300 | 2.94 | 8.70 | 11.84 | 0.592 | 0.350 |
| 400 | 3.92 | 11.6 | 13.41 | 0.671 | 0.450 |
| 500 | 4.90 | 14.4 | 14.86 | 0.743 | 0.552 |

**Graph**

Drawn on different paper

**Discussion and Conclusion**

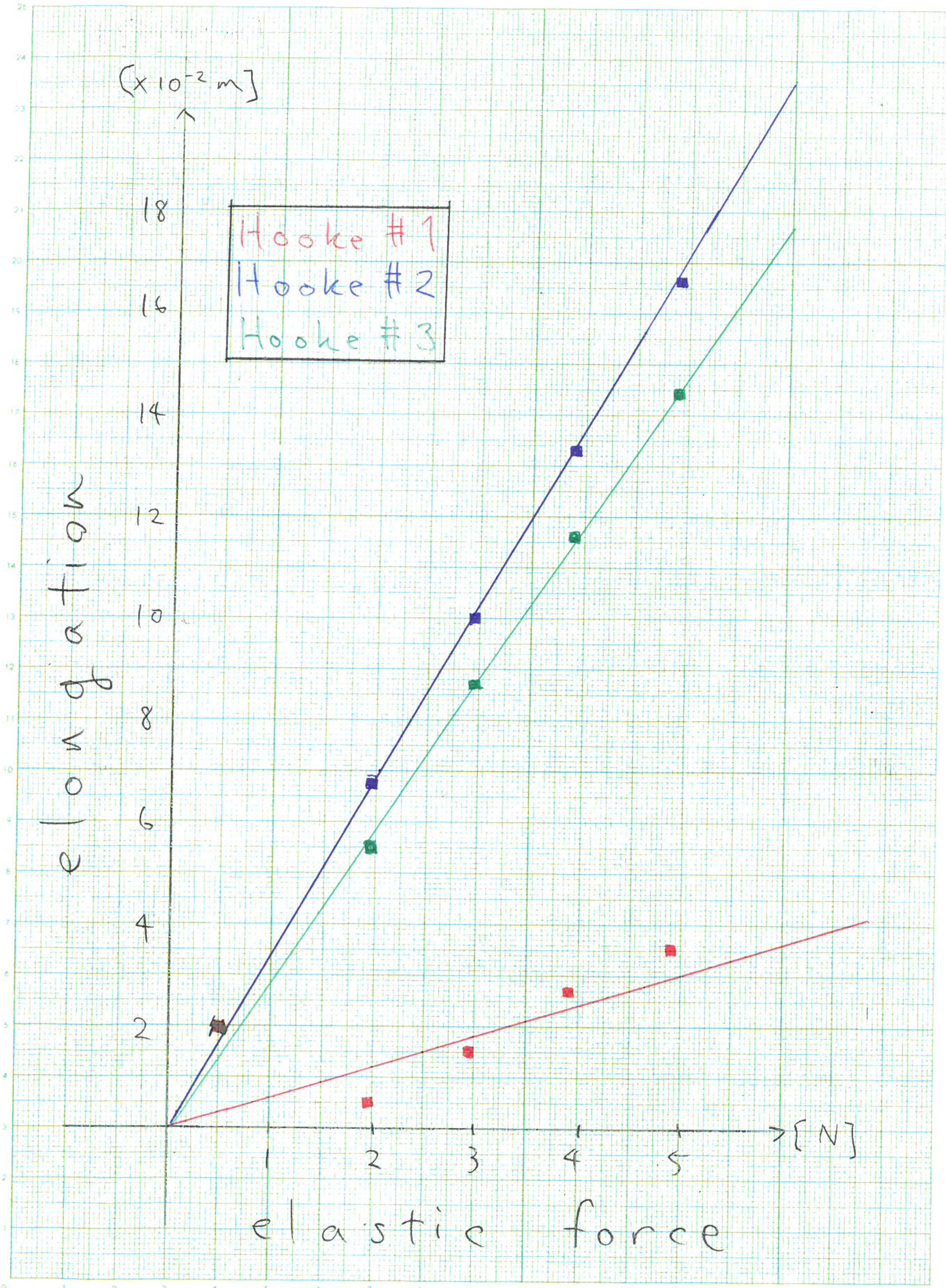
As you can see from the graph #1, elongation of each hooke are increasing as the elastic force increases. This means that they are directly proportional to each other. So, it is proved that the equation of $F = kx$ is correct. Also, Hooke #2 had the longest elongation compared to the Hooke #1 which had the least. Therefore, it is estimated that the Hooke #1 is stronger than the Hooke #2.

As you can see from the graph #2, period squared of each hooke is increasing as the mass of the weight increases. This means that they are directly proportional to each other. So, it is proved that the equation of $T = 2\pi\sqrt{\frac{m}{k}}$ is correct. Also, Hooke #2 had the longest period squared compared to the Hooke #1 which had the least. In addition to the estimation from graph #1, it is proved that the hooke is stronger to weaker in order of #1, #3, #2.

Toti!

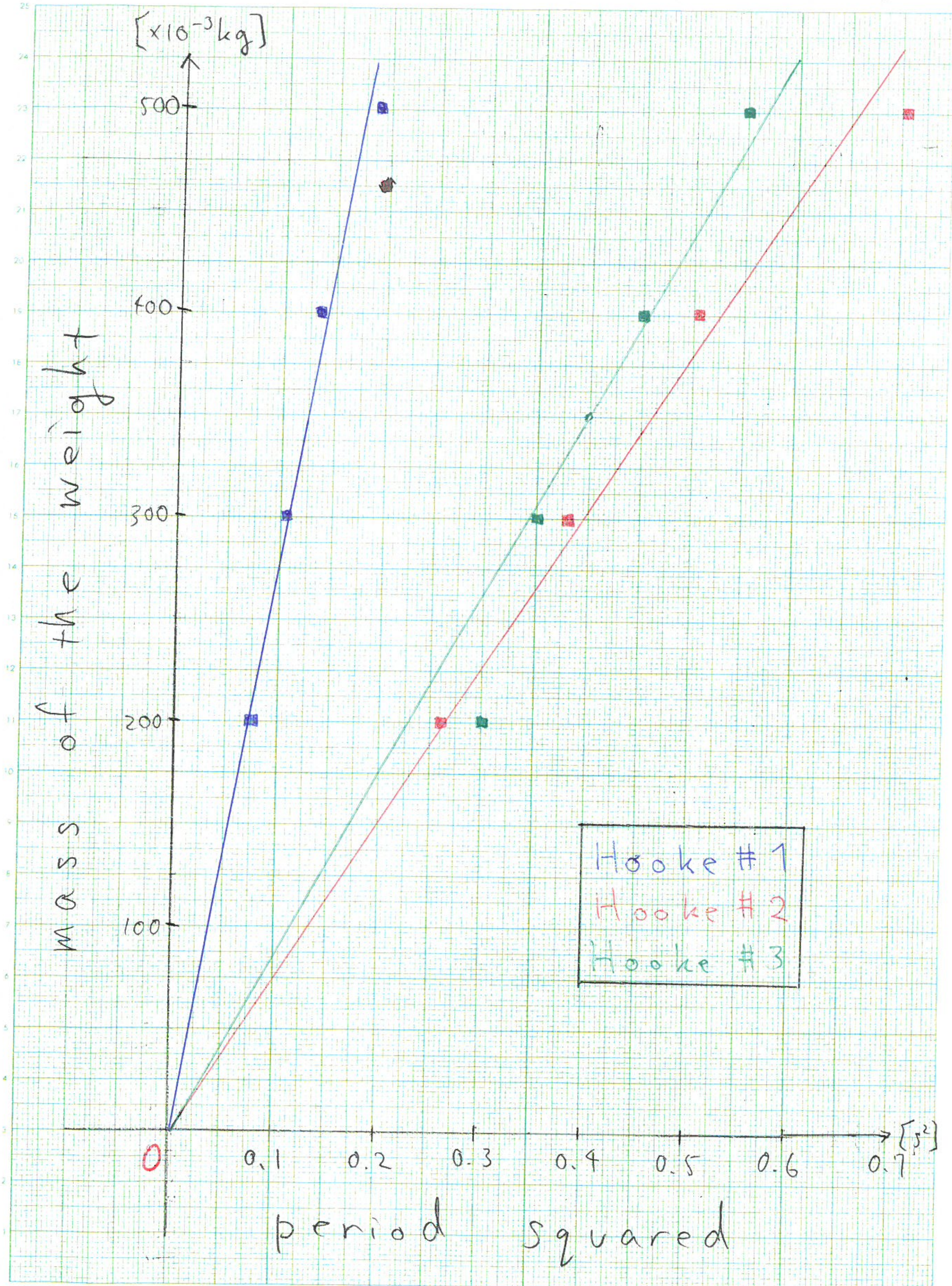
#1

# Spring Constant $\left(\frac{1}{K} = \frac{x}{F}\right)$



#2

# Spring Constant $\left(k = \frac{4\pi^2 m}{T^2}\right)$



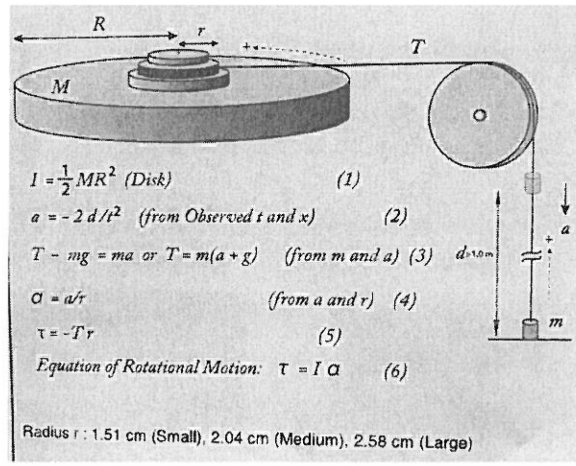
## *Moment of Inertia and Rotational Motion*

## Introduction

### Objective:

To investigate the equation of rotational motion

### Theory:




r : radius of the disk
d : distance that the acceleration took place
m : mass of the weight
t : time taken for the acceleration
a : acceleration of the weight
T : tensional force
*t* : torque
α : angular acceleration
M : mass of the disk
R : radius of the disk
I : inertia of the disk
I = *t*/α

## Experiment

### Materials:

- Rotational motion apparatus
- Pulley
- String
- Tape
- Ruler
- Weight
- Stopwatch

### Procedure:

1. Prepare all of the materials shown above. (Do this experiment on the desk)
2. Measure 1 m from one of the end of the string, and put the tape for the mark.
3. Put the string through the pulley that is already prepared, so that the end of the string with the tape is left under the pulley.
4. Hang the other end of the string to one of the three different disks. (don't forget to measure the radius of the disk.)
5. Hang the weight from another end of the string. (50g would supposedly be good)
6. Reel the string to the disk until the weight is placed at the height of the table or desk.
7. Release the string so the weight free falls and measure the time taken for the tape to pass the top of the desk.
8. Repeat #5 to #7 with 100g and 150g weight.
9. Repeat #4 to #8 with two another disk with different radius.
10. Put all of the materials away to where they were before the experiment.

**Result**

**Table:**

| Exp # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| r [$\times 10^{-2}$m] | 1.51 | 1.51 | 1.51 | 2.04 | 2.04 | 2.04 | 2.58 | 2.58 | 2.58 |
| d [m] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| m [$\times 10^{-3}$kg] | 50.0 | 100 | 150 | 50.0 | 100 | 150 | 50.0 | 100 | 150 |
| t [s] | 9.18 | 7.00 | 5.40 | 7.44 | 5.18 | 4.31 | 6.32 | 4.44 | 3.69 |
| $a = \frac{2d}{t^2}$ a [m/s$^2$] | 0.0234 | 0.0408 | 0.0686 ~~0.07~~ | 0.0361 0.04 | 0.07 | 0.11 | 0.05 | 0.10 | 0.15 |
| T [N] | 0.491 | 0.984 | 1.48 | 0.492 | 0.987 | 1.49 | 0.493 | 0.990 | 1.49 |
| $\tau$ t [Nm] | 0.741 | 1.49 | 2.23 | 1.00 | 2.01 | 3.04 | 1.27 | 2.55 | 3.84 |
| α [rad/s$^2$] | 1.32 | 2.65 | 4.64 | 1.96 | 3.43 | 5.39 | 1.94 | 3.88 | 5.81 |

M = 0.944 [kg]   R = 25 [$\times 10^{-2}$ m]   I = 1/2 MR$^2$ = 0.0295

Graph is drawn on seperate paper

**Discussion and Conclusion**

As you can see from the graph #3, torque of rotational motion and angular acceleration are directly proportional to each other. Since one of them increases when the other one increases, the equation of I = *t*/α should be correct, and the graph is showing the moment of inertia. Also, because the slope of large disk is sharper than the slope of small disk, we know that the moment of inertia is higher as the radius of the disk is higher. This proves that the equation of I = 1/2 MR$^2$ is correct.

#3

# Moment of Inertia ($I = \frac{\tau}{\alpha}$)