Date of Lab 9/30/2016 Date of Submission 10/06/2016

Laboratory Report

Title
表題 Investigating the Hooke's Law

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Lab Partners
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Summary

In this lab, we investigated the relationships between elongation (x) and force in springs and if springs follow the Hooke's law when they are connected in series or parallel. As a result, it turned out to be that whether they are connected in series or parallel, the Hooke's law applies and that it was consistent to the theory / force applied on spring is proportional to the distance of elongation

・Meet a deadline ・Write logically ・Write clearly ・Write with your own words
・締切り守って ・論理的に ・わかりやすく ・自分のことばで

Teacher Comments
図がわかりやすくて良い。グラフもきれいだ。が、軸のめもりのとり方がわかりにくい。読者がデータを読みとりやすいようにめもりをつけなさい

1	2	3	4	5	6	7	8	9
Due 提出期限	Summary 要旨	Intro. 序	Method. 方法	Results 結果	Table/Fig. 表/図	Discussion 考察	Clearness わかりやすさ	General 全般
+				+	++ −	+		+++

* Write your report in Japanese or in English * Use this form as a cover sheet.
* Submit your reports by the seventh day after your lab.

<Introduction>

Objectives:

1. To understand the Hooke's Law by investigating the relationships between elongation and force

Theory:

W=mg

W: weight (N)

m: mass (kg)

g: gravitational force (9.8m/s^2)

Hooke's Law

F=k • x

F: force [N]

k: spring constant [N/m]

x: elongation [m]

Hypothesis:

The Hooke's law applies to both series and parallel connections of springs.

<Experiment>

Apparatus:

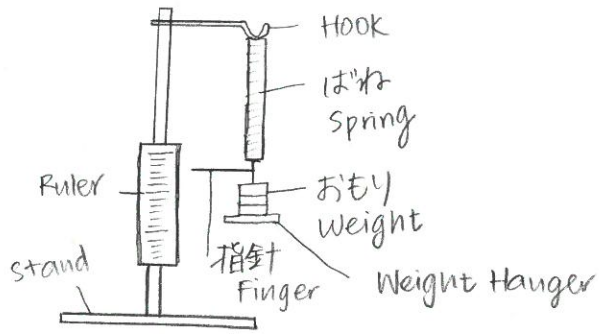
- Weight
- Spring
- Finger
- Weight Hanger
- Stand
- Wire
- Clip
- Ruler

Methods:

<u>Exp-1:</u>

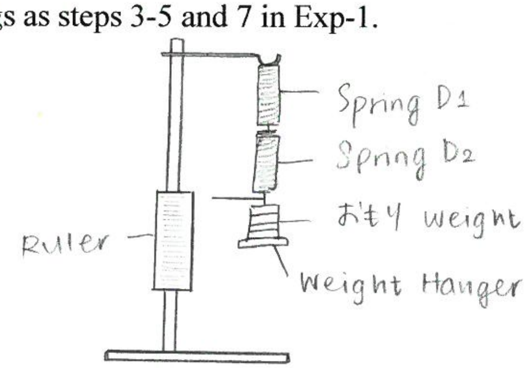
1. Set up a stand and attach a ruler.

2. Hook a spring to the stand.
3. Hook a weight hanger to the spring so that the finger attached to the hanger is positioned at 0 on the ruler.
4. Place weights onto the weight hanger. Start from putting lower weights and then move onto heavier weights.
5. Record how much the spring stretches and the finger moves when changing the weight. However, do not stretch the spring too much because it could cause the spring to lose its elasticity.
6. Repeat 3-5 with 4 different springs.
7. Create a force (F)-elongation (x) graph based on the results.



Experiment 2:

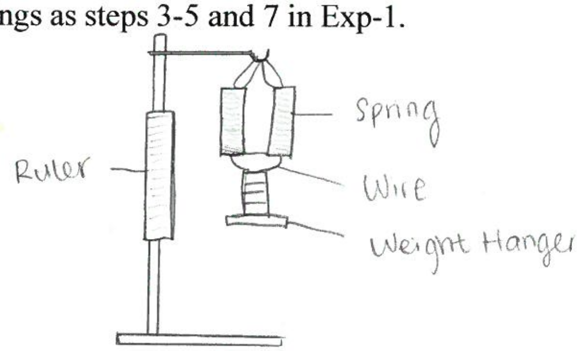
1. Prepare 2 of the D springs and connect them in series to the stand.
2. Do the same things as steps 3-5 and 7 in Exp-1.



図がわかりやすくて良い

Experiment 3:

3. Prepare 2 of the D springs and create a parallel connection.
4. Do the same things as steps 3-5 and 7 in Exp-1.



<Results>

グラフのめもりのとり方がわかりにくいので計算をまちがえているようだ？ OK.

Exp-1:

① Spring A's spring constant:

$F=k \cdot x$

$k=F_f-F_i/x_f-x_i$

$k=(20-1.4) \times 10^{-1}[N] / (13-0) \times 10^{-2}[m]=1.430 \times 10^{1}[N/m]$ 14.3N/m

② Spring C's spring constant:

$k=F_f-F_i/x_f-x_i$

$k=(58-15) \times 10^{-1}[N] / (4.5-0) \times 10^{-2}[m]=9.555 \times 10^{1}[N/m]$ 95.6N/m

③ Spring D_1's spring constant:

$k=F_f-F_i/x_f-x_i$

$k=(41.0-1.80) \times 10^{-1}[N] / (13.0-0) \times 10^{-2}[m]= 3.015 \times 10^{1}[N/m]$ 30.2N/m

④ Spring D_2's spring constant:

$k=F_f-F_i/x_f-x_i$

$k=(40.0-1.50) \times 10^{-1}[N] / (13.0-0) \times 10^{-2}[m]=2.961 \times 10^{1}[N/m]$ 29.6N/m

Exp-2:

① Spring constant of spring D_1+D_2 in series:

$k=(21.0-1.50) \times 10^{-1}[N] / (13.0-0) \times 10^{-2}[m]= 1.5 \times 10^{1}[N/m]$ 15.0N/m

Exp-3:

① Spring constant of spring D_1+D_2 in parallel:

$k=F_f-F_i/x_f-x_i$

$k= (60.0-3.70) \times 10^{-1}[N] / (9.20-0) \times 10^{-2}[m] = 6.119 \times 10^{1}[N/m]$ 61.2N/m

Table 1. Spring constants of the 3 experiments

Experiment	Spring	Spring constant [N/m]
1	A	14.
	C	95.6

	D_1	30.2
	D_2	29.6
2	D_1+D_2 in series	15.0
3	D_1+D_2 in parallel	61.2

<Discussion>

- The two identical D springs, D_1+D_2 had very similar results. A possible reason for the error is that we could have misread the measurements.
- A spring that did not stretch much such as spring C had a steeper slope, meaning that the spring constant (k) was high.
  - The harder it is to stretch the spring, the higher the spring constant happened to be
- A spring that stretched more compared to other springs such as spring A had a shallow slope, meaning that the spring constant (k) was low
  - The easier the spring stretches, the lower the spring constant happened to be
- As you can see in the F-x graph, the slope of experiment 2 is shallower compared to D_1+D_2 spring in experiment 1. When two identical springs are connected in series, ***F*** is half the quotient of the spring constant (k) and the displacement of the spring (x), meaning $F=kx/2$.
- When two identical springs are connected in parallel, ***F*** is 2 times the quotient of the spring constant (k) and the displacement of the spring (x), meaning $F=2kx$.
- However, the Hooke's law did not apply when the weights that were added were too light and did not stretch the spring at all. But as the weights became heavier and the spring began to stretch, it followed the Hooke's law

<Conclusions>

- The Hooke's Law still applies when springs are connected in series or parallel.
- The easier the spring stretched, the lower spring constant turned out to be.

<Opinions>

Overall, I enjoyed this experiment. It was interesting to figure out how the Hooke's Law applies to springs connected in series and parallel and how they differ. I think there were few errors this time compared to the previous experiment all of the points were very close to the line of best fit and there were no outliers. I believe my partner and I were able to conduct a successful lab.

<References>

Shumpei Honjo San's Lab report

Keirinkan P.31

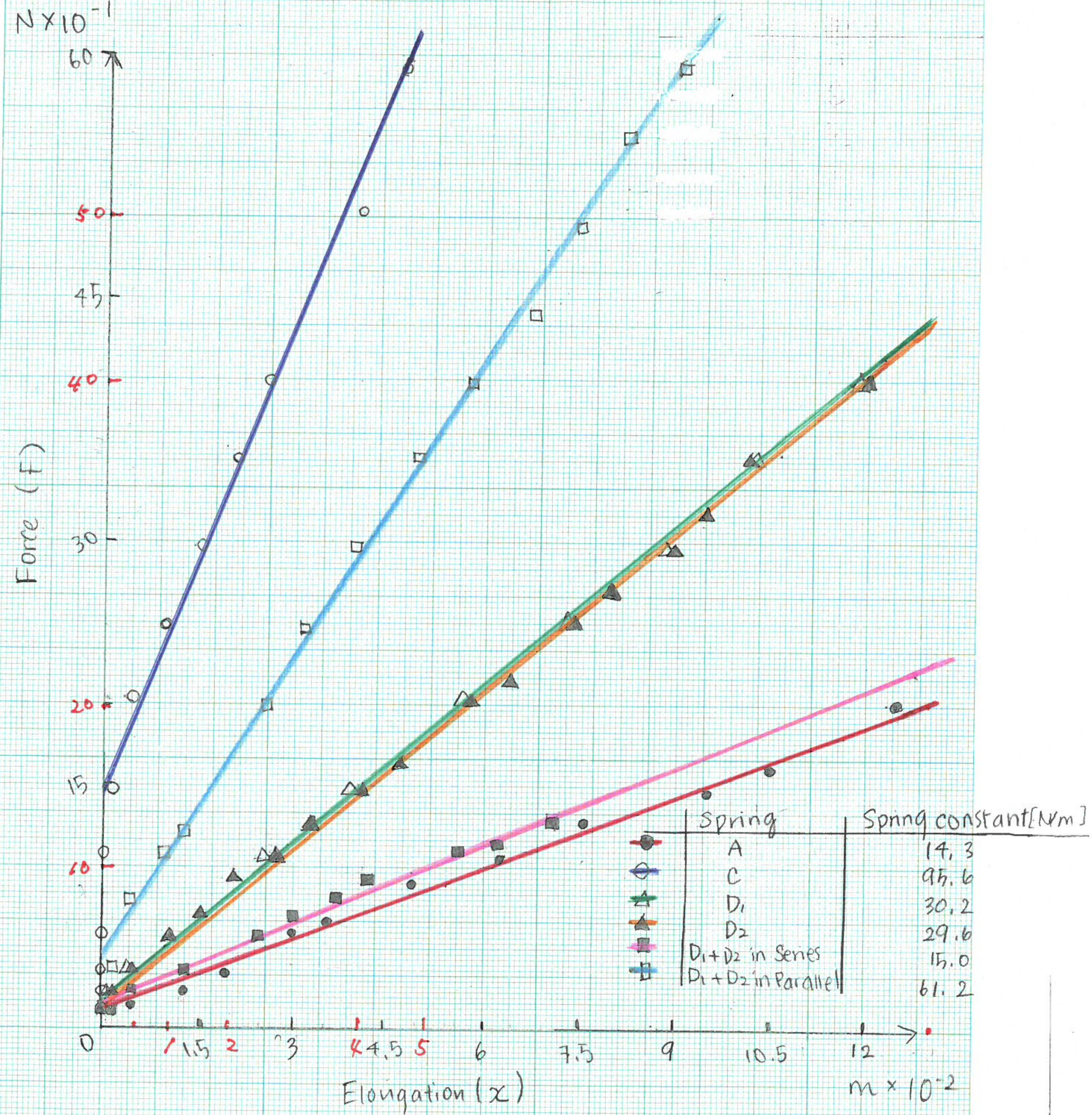


Figure 1. F-x Graph