Calculation of Spring Constant

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Problem / Question

Does measuring the spring constant with two different methods affect the results?

Hypothesis

- The percentage difference between the values of spring constants calculated by two different approaches or methods should be fairly low.

Project Overview

The experiment consists of two parts. We use two identical springs in both parts.

In the first part, we will use Hooke's Law to calculate the spring constant for one of the identical springs. We will use the calculated constants in the formula for spring systems connected in series and parallels.

In the second part, we will use the formula of period for a spring undergoing SHM (Simple Harmonic Motion) to calculate two spring systems' constants. We will physically construct spring systems connected in parallel and in series for this part. Both spring systems will undergo SHM and we will measure their periods using a chronometer. Periods of both systems will be used in the period formula of springs undergoing SHM. Subsequently, we calculate the spring constant for both systems.

Finally, we will compare the percent difference between spring constants calculated in Part 1 and Part 2 for springs connected in series. The same comparison will be made for springs connected in parallel as well.

The formulas in Part 1 are Hooke's Law and the formula of spring constant k for spring systems. However, the formula in Part 2 (period of spring for a spring undergoing SHM) combines Hooke's Law with SHM formulas and Newton's Second Law. Therefore, reflecting upon percent differences will give insight about the validity of the formulas involved in the calculations other than Hooke's Law, which is the objective of our experiment.

Variables / Research

Controlled variables

- Spring constants of two springs (they were cut from the same spring
- Medium where the experiment is conducted

Independent variable

- The masses on the springs

Dependent variable

- For the first part of the experiment: The displacements
- For the second part of the experiment: The period of the springs' simple harmonic motion

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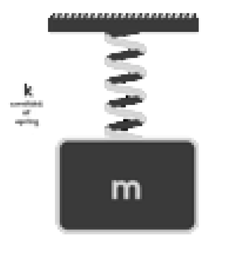
Materials

Materials (detailed list)	Quantity (be specific)
Weight Hanger	x1
Slotted masses	x7
Ring Stand	x1
Ruler	x1
Springs	x2
Electronic Scale	x1
Video Recorder	x1

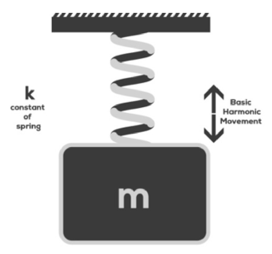
Procedure

Step 1



Measure the displacement

Step 2



Measure the period

Step 3

Draw graphs for the measurements ,find spring constant,compare constants

Data / Observations

Mass (kg)	Oscillations	SHM period (s)
45 x 10^(-3)	1	0.762
	2	0.804
	3	0.900
65 x 10^(-3)	1	1.029
	2	1.008
	3	1.012
85 x 10^(-3)	1	1.724
	2	1.801
	3	1.893
105 x 10^(-3)	1	1.154
	2	1.145
	3	1.192

Table 8: Raw Data Table for Simple Harmonic Motion (SHM) of the spring system constructed by connecting Spring 1 and Spring 2 in series (where mass is the independent variable and SHM period is the dependent variable)

Mass (kg)	Average Period T (s)	T^2 (s^2)
45 x 10^(-3)	0.822	0.676
65 x 10^(-3)	1.016	1.03
85 x 10^(-3)	1.806	3.26
105 x 10^(-3)	1.164	1.35

Table 9: Processed Data Table for Simple Harmonic Motion (SHM) of the spring system constructed by connecting Spring 1 and Spring 2 in series

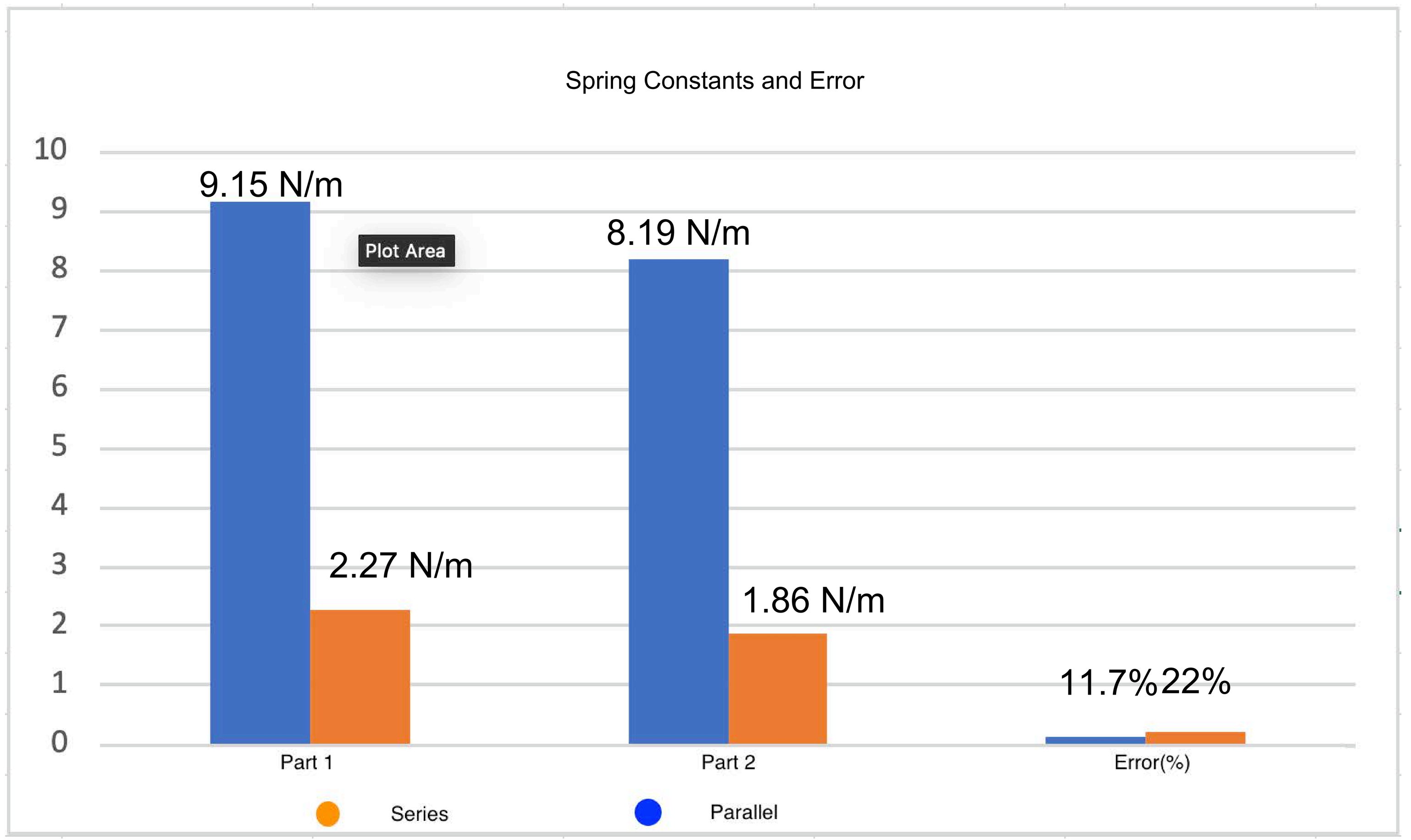
Mass, m (kg)	Weight, W (N)	Extension, x_0 (m)
5 x 10^(-3)	(49.1) x 10^(-3)	4 x 10^(-2)
25 x 10^(-3)	(245.3) x 10^(-3)	10 x 10^(-2)
45 x 10^(-3)	(441.5) x 10^(-3)	15 x 10^(-2)
65 x 10^(-3)	(637.7) x 10^(-3)	19 x 10^(-2)
85 x 10^(-3)	(833.9) x 10^(-3)	24 x 10^(-2)
105 x 10^(-3)	(1030.1) x 10^(-3)	27 x 10^(-2)
125 x 10^(-3)	(1226.3) x 10^(-3)	30 x 10^(-2)
145 x 10^(-3)	(1442.5) x 10^(-3)	34 x 10^(-2)

Table 4:The variation of the extension in Spring 2 over the changing mass or weight attached on it

Mass, m (kg)	Weight, W (N)	Extension, x_0 (m)
5 x 10^(-3)	(49.1) x 10^(-3)	4 x 10^(-2)
25 x 10^(-3)	(245.3) x 10^(-3)	10 x 10^(-2)
45 x 10^(-3)	(441.5) x 10^(-3)	15 x 10^(-2)
65 x 10^(-3)	(637.7) x 10^(-3)	19 x 10^(-2)
85 x 10^(-3)	(833.9) x 10^(-3)	24 x 10^(-2)
105 x 10^(-3)	(1030.1) x 10^(-3)	27 x 10^(-2)
125 x 10^(-3)	(1226.3) x 10^(-3)	30 x 10^(-2)
145 x 10^(-3)	(1442.5) x 10^(-3)	34 x 10^(-2)

Table3: The variation of the extension in Spring 1 over the changing mass or weight attached on it (where mass or weight is independent variable and extension is dependent variable)

Results



Conclusion

The objective of this experiment was to calculate spring constants k for parallel and series spring systems using two different methods involving Hooke's Law and to compare these methods. For the parallel spring system, the percent difference for spring constants found in Part 1 and Part 2 was 11.7 %. For the series spring system, the percent difference for spring constants found in Part 1 and Part was 22.0 %.With regard to the validity of the equations involved in the calculation (encompassing all Equations involved from 2-8 excluding Hooke's Law), it is not possible to evaluate their extent of validity one by one. However, considering the limitati ons we had while performing the experiment, these percent differences are acceptable to reinforce their validity. The difference between percent differences of parallel spring system (11.7 %) and series spring system (22.0%) is notable as one is about two times larger than the other. The reason for this might be that while tape has a role in the transmission of force that makes spring system undergo simple harmonic motion in series spring systems whereas in the parallel system (as it connects the two springs' ends), the tape does not have such a role in the transmission of force.

Works Cited

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