29/9/2021

20XC18 - APPLIED PHYSICS LAB

EXP 2 : SPRING MASS SYSTEMS

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AIM :

1. To find out spring constant, k of springs
2. To find frequency of oscillation of spring mass system

APPARATUS :

Springs of different spring constants, weight hanger, slotted weights, stop watch.

FORMULA :

Spring constant, $k = \frac{\text{Restoring force}}{\text{Extension}}$ N/m

Time period, $T = 2\pi\sqrt{(m/k)}$

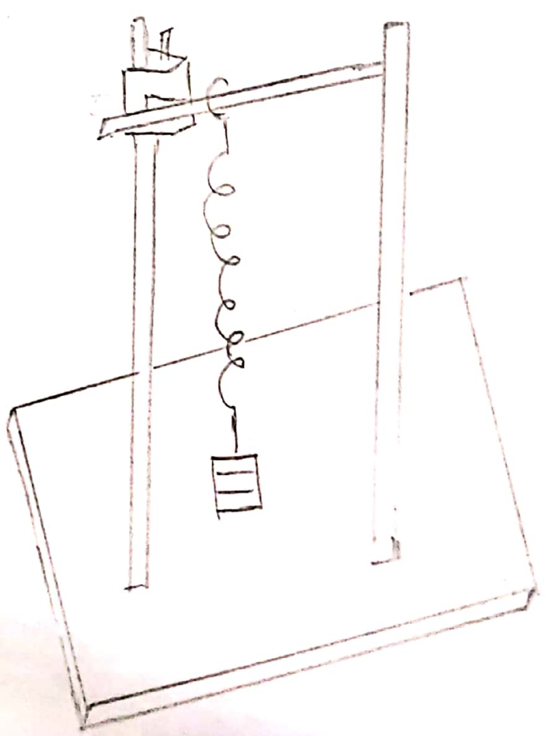
where,

m = mass (kg)

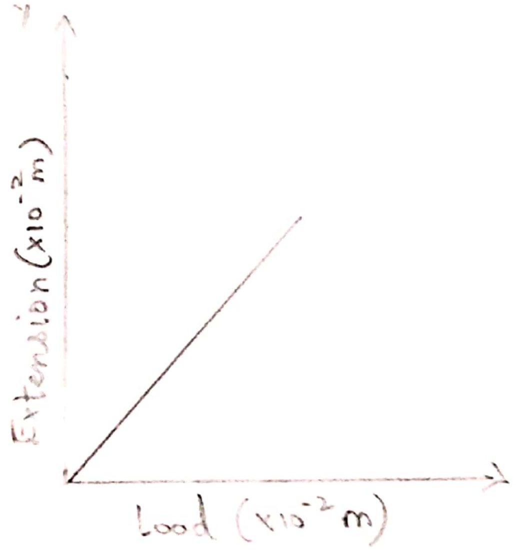
k = spring constant (N/m)

Frequency, $F = \frac{1}{T}$ Hz

DIAGRAM :



MODEL GRAPH :



PROCEDURE : (To calculate spring ~~constant~~ constant)

- The spring is suspended vertically from the rigid support.
- A meter scale is kept vertically parallel to the spring.
- A dead weight (W_0) is suspended to the spring and the reading on the meter scale is noted.
- Now slotted weights (50g) are loaded one by one and the loading reading is noted for each case.
- Weights are added till maximum load is reached.
- Now, weights are removed one by one and the unload reading is noted fore each case.
- The mean is calculated for noted readings.
- Extension 'l' is calculated by subtracting reading of dead weight from reading of corresponding slotted mass.
- For each case, spring constant 'k' is calculated.
- Their average gives the spring constant in (N/m).
- A graph is drawn with load along x axis and extension along y-axis. The inverse of slope of graph gives k.

PROCEDURE : (To calculate frequency of oscillations)

- Note initial position of spring using a meter scale when a dead weight is hanged.
- Pull the string downwards and note the final position and let it oscillate.
- Using a stopwatch, note time taken by the spring for a fixed number of oscillations.
- Repeat the same procedure for various slotted weights and note it in the table and calculate frequency of oscillations.

TABULATION :

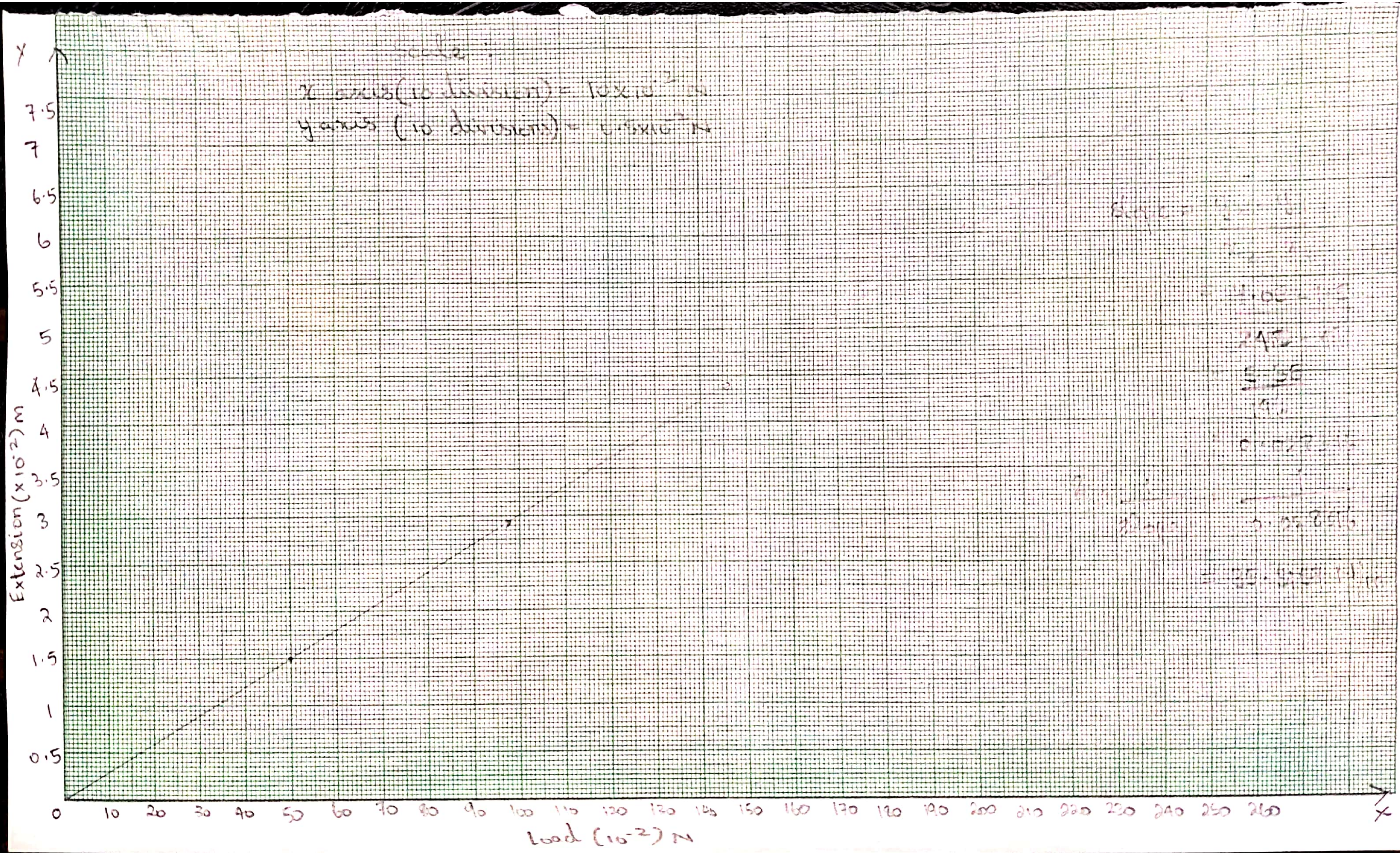
Determination of spring constant :

S.NO	Mass (g)	Mass (Kg) m	Load mg (N)	Pointer Reader 'x' cm	Pointer Reading 'y' cm	Mean $Z = \frac{x+y}{2}$	Extension 'l' in cm	Extension 'l' in m	Spring Constant $k = mg/l$ (N/m)
1.	Wo	0	0	1.5	1.4	1.45	0	0	0
2.	Wo+50	0.05	0.49	2.9	3	2.95	1.5	0.015	32.667
3.	Wo+100	0.1	0.98	4.3	4.3	4.3	2.85	0.0285	34.386
4.	Wo+150	0.15	1.47	5.7	5.7	5.7	4.25	0.0425	34.588
5.	Wo+200	0.2	1.96	7.1	7.2	7.15	5.7	0.057	34.386
6.	Wo+250	0.25	2.45	8.5	8.5	8.5	7.05	0.0705	34.752

Mean spring constant = 34.1558 N/m

To determine frequency of oscillation of spring mass system :

S.NO	Mass (kg)	Time Period for 20 oscillations			Time period for 1 oscillation (s)	Time Period for 1 oscillation $T = 2\pi\sqrt{\frac{m}{k}}$ (s)	Frequency of oscillations $F = 1/T$ Hz
		Trial 1	Trial 2	Mean			
Spring 1	1	14.7	14.7	14.7	0.735	0.7398	1.3517
Spring 2	1	12.6	12.6	12.6	0.63	0.6312	1.5842
Spring in series	1	19.3	19.3	19.3	0.965	0.9724	1.0283


Scale:
x axis (10 division) = 10×10^-2 N
y axis (10 divisions) = 0.5×10^-2 m
Extension (×10^-2) m
Load (10^-2) N
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
X
Y

CALCULATION:

Determine spring constant:

$W_0 = 0kg$; $g = 9.8\ m/s^2$

i) Load $= mg$

$= (0 \times 9.8)\ kg\ m/s^2$ or N

$= 0N$

Mean $= \frac{x+y}{2} = \frac{1.5+1.4}{2} = 1.45$ cm

ii) $W_0 + 50 = 0.05$ kg

Load $= (0.05 \times 9.8) = 0.49$ N

Mean $= \frac{x+y}{2} = \frac{2.9+3}{2} = 2.95$ cm

$l = 2.95 - 1.45 = 1.5$ cm. $= 0.015$ m.

$k = 0.49/0.015 = 32.667$ N/m

iii) $W_0 + 100 = 0.1$ kg

Load $= mg = 0.98$ N

Mean $= \frac{x+y}{2} = \frac{4.3+4.3}{2} = 4.3$ cm

$l = \cancel{2.8}\ 4.3 - 1.45 = 2.85$ cm $= 0.0285$ m.

$k = mg/l = 0.98/0.0285 = 34.386$ N/m

iv) $W_0 + 150 = 0.15$ kg

Load $= mg = 1.47$ N

Mean $= \frac{x+y}{2} = \frac{5.7+5.7}{2} = 5.7$ cm

$l = 5.7 - 1.45 = 4.25$ cm $= 0.0425$ m

$k = mg/l = 1.47/0.0425 = 34.588$ N/m

v) $W_0 + 200 = 0.2kg$

Load = $mg = 1.96N$

Mean = $\frac{x+y}{2} = \frac{7.1+7.2}{2} = 7.15cm$

$l = 7.15 - 1.45 = 5.7 \text{ cm} = 0.057 m$

$k = mg/l = 1.96/0.057 = 34.386$

vi) $W_0 + 250 = 0.25 kg$

Load = $2.45 N$

Mean = $\frac{x+y}{2} = \frac{8.5+8.5}{2} = 8.5 cm$

$l = 8.5 - 1.45 = 7.05 \text{ cm} = 0.0705M$.

$k = mg/l = 2.45/0.0705 = 34.752 N/m$.

Mean spring constant =

$$\frac{32.667 + 34.386 + 34.588 + 34.386 + 34.752}{5} = 34.1558 N/m$$

To determine frequency of oscillation of spring mass system

Spring 1 :

i) $m_1 = 1kg$;

Time period for one oscillation = $\frac{14.7}{20} = 0.735 s$.

$l = 13.6 \text{ cm} = 0.136 m$.

$k = \frac{mg}{l} = \frac{9.8}{0.136} = 72.0588 N/m$

Time period for 1 oscillation = $2\pi\sqrt{\frac{m}{k}} = 2 \times 3.14 \times \sqrt{\frac{1}{72.0588}}$

$= 6.28 \times 0.1178$

$= 0.7398 s$.

Frequency $= \frac{1}{T} = \frac{1}{0.7398} = 1.3517 Hz$

spring 2 :

Time period for 1 oscillation $= \frac{12.6}{20} = 0.63\ s$

$l = 9.9\,cm = 0.099\ m$

$k = mg/l = \frac{9.8}{0.099} = 98.9898\ N/m$

Time period for 1 oscillation $= 2\pi\sqrt{\frac{m}{k}} = 2 \times 3.14 \times \sqrt{\frac{1}{98.9898}}$

$= 6.28 \times 0.1005$

$= 0.6312\ s.$

Frequency $= 1/T = \frac{1}{0.6312} = 1.5842\ Hz.$

Both in series :

Time period for 1 oscillation $= \frac{19.3}{20} = 0.965\ s$

$l = 23.5\ cm = 0.235\ m.$

$k = mg/l = \frac{9.8}{0.235} = 41.7021\ N/m$

Time period for 1 oscillation $= 2\pi\sqrt{\frac{m}{k}} = 6.28 \times \sqrt{\frac{1}{41.7021}}$

$\doteq 6.28 \times 0.1548 = 0.97248$

Frequency $= 1/T = \frac{1}{0.9724} = 1.0283\ Hz.$

$\therefore$ Experimental value of m_1, m_2, m_3 = Theoretical value of time period.

RESULT :

Mean spring constant of spring = 34.1558 N/m

Theoretical value of spring constant is approximately equal to the experimental value.

Spring 1 :

Time period for 1 oscillation = 0.7398 s

0.7398 s is approximately equal to experimental value 0.735 s.

Frequency of spring 1 ≈ 1.3517 Hz

Spring 2 :

Time period of 1 oscillation = ~~0.9724 s~~ 0.6312

~~0.97248~~ 0.6312 is approximately equal to experimental value ~~0.9658~~ 0.638

Frequency of spring 2 = 1.5842 Hz.

Both in series :

Time period for 1 oscillation = 0.9724 s.

0.9724 s is approximately equal to experimental value 0.965 s

Frequency of both springs in series = 1.0283 Hz.

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