Lab 8: Hooke's Law With Multiple Springs

Name: **Hooke's Law With Multiple Springs**
Class: **PHYS 2125 (15921)**
Date: **2025-03-07**

Objective

To determine the validity of net spring constant of experimental values with the theoretical values.

Equipment

- (1) small A-base
- (1) long metal rod
- (1) clamp
- (1) short rod
- (1) spring set
  - (3) spring with unknown k value
  - (1) 5g hook
- (1) 40g weight
- (1) 1 meter ruler

Theory

$F_a = M_H \cdot g$

$F_s = -kx$

$M_H g = kx$

$K = \frac{M_H g}{x}$

where

g is the gravitational constant ($9.8 m/s$).

F_a is the force of acceleration

F_s is the spring force

k is the spring constant

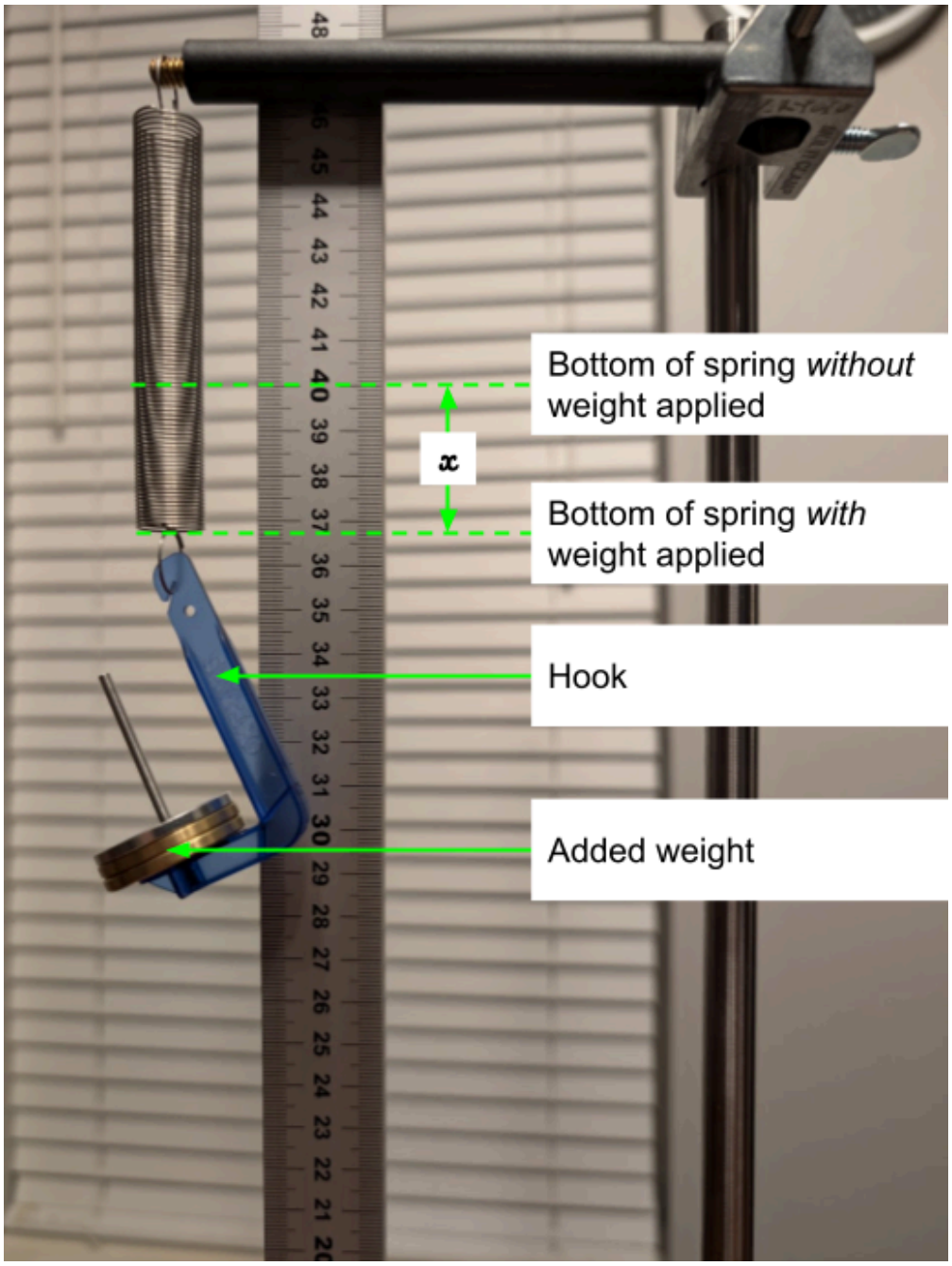
x is the displacement of the hanging weight.

M_h is the mass of the hook ($5g$)

M_a is the mass added to the hook with each trial.

M_H is the total mass of hanging block including the hook and added weight ($M_H = M_h + M_a$)

Critically, when two multiple springs are connected in series then the effective spring constant is the reciprocal of the sum of the reciprocals, e.g. with springs k_1 and k_2 in series the $k_{effective} = (1/k_1 + 1/k_2)^{-}1$.


Bottom of spring *without* weight applied
x
Bottom of spring *with* weight applied
Hook
Added weight

Procedure

The following procedure was followed.

Initial Setup

The pendulum was constructed as follows.

1. A small cast iron A-base was placed on the table.
2. A 45cm steel rod was secured into the A-frame, raised up as much as possible to maximize the height.
3. The vertical mounting side of a steel clamp was secured at the very top of the rod.
4. A 15cm rod was attached to the horizontal side of the same steel clamp, to the far end of the smaller rod.
5. Three different springs were selected and labeled for later identification.

Trial (completed for every combination of springs)

1. The spring(s) were suspended from the rod.
2. The 5g hook was suspended from the bottom spring.
3. A 40g weight was added to the hook, and x was recorded.

Data

Springs	M_a (kg)	x (m)	M_H (kg)	k_e (N/m)	k_e calculated (N/m)	Error %
1	0.04	0.0265	0.045	16.642	16.642	
2	0.04	0.0075	0.045	58.800	58.800	
3	0.04	0.0740	0.045	5.959	5.959	
1 & 2	0.04	0.0490	0.045	9.000	12.971	30.614448
1 & 3	0.04	0.1040	0.045	4.240	4.388	3.372835
2 & 3	0.04	0.0870	0.045	5.069	5.411	6.320458
1 & 2 & 3	0.04	0.1370	0.045	3.219	4.083	21.160911

Calculations

See the preceeding Theory and Data table sections.

Results

The results are evident in the data table above.

Discussion

That data isnt great.