

**Physics Lab 211**

**Experiment No. 5**

**The Helical Spring**

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Abstract :

Objectives :

In this presentation we are going to study vertical oscillations of a long spring, and to determine the force constant for a soft spring.

Theory :

A helical spring is a simple example of a large class of dynamical structures whose low energy excited states perform simple harmonic motion. In the equilibrium state the forces on a system balance out to zero. When the system is excited out of equilibrium this balance is broken and there is a restoring force which acts to pull the system back towards the equilibrium state. Simple harmonic motion is a periodic motion in which the displacement of the system oscillates about its equilibrium value.

When a weight m is suspended from the end of a soft spring, it will stay in equilibrium under the influence of its weight and the elastic force in the spring. { =-k=m }

If the spring is stretched an additional length y/, and then released, it will oscillate with its equation of motion being : { m }.

The solution of this equation is a simple harmonic motion with angular frequency

So the period of oscillation :{

But the effective mass must be included in the above equation , so the period for small oscillations becomes : :{

The spring mass is usually neglected, while the term{ meff} is introduced into the equation to compensate for the error.

Procedures :

Part I :

{determination the force constant} :

The spring was placed in a vertical position and the pan holder was suspended for weights, then loads were added and the extension vs. the added mass m were recorded. The lower end of the pan was used as the zero point for the

Part II :

[studying oscillations of the spring }:

The spring was loaded with a given mass m, stretched slightly and let to oscillated in small oscillations. The time for 10 oscillations was measured and used to compute the period T.

**Apparatus Used:**

A long helical spring, meter stick and a stop watch.

Data Sheet:

**y0 =**

|  |  |
| --- | --- |
|  |  |
| 0.05 | 0.023 |
| 0.10 | 0.038 |
| 0.15 | 0.057 |
| 0.20 | 0.075 |
| 0.21 | 0.082 |
| 0.25 | 0.097 |

|  |  |  |
| --- | --- | --- |
|  |  | **()** |
| 0.05 | 4.07 | 16.56 |
| 0.10 | 5.04 | 25.40 |
| 0.15 | 5.58 | 31.14 |
| 0.20 | 6.23 | 38.81 |
| 0.21 | 6.29 | 39.56 |
| 0.25 | 6.40 | 40.96 |

**Calculations:**

**From part I:**

The force constant is the slope of (**Graph I**).

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**From part II:**

**K2=31.08**

**Results & Conclusions:**

From the first graph, the y-intercept must equal to zero. So the y-intercept we obtained is an indicative of how accurate the data is.

, since it is relatively small we can predict that our obtained data is highly accurate.

This error in y-intercept is mainly due to the effective mass which was not included in the first part.

The theoretical value of the effective mass:

Discrepancy in:

? 0.005

Thus, our value of is accepted.

 There are many sources of random errors in this experiment. In the first part, the reading of the spring displacement is not so accurate since there is a gap between the spring and the scale. In the second part, the time measured for 10 revolutions has errors, since there is a delay in stopping the stop watch. Also, the oscillations were not completely vertical. As well as, the spring was twisted from the middle which had remarkable effects on the results, and its mass was measured by and old two pan balance which had a significant error.

**Graph I**

|  |  |
| --- | --- |
| **Δy (m)** | **mg (N)** |
| 0.023 | 0.49 |
| 0.038 | 0.98 |
| 0.057 | 1.47 |
| 0.075 | 1.96 |
| 0.082 | 2.058 |
| 0.097 | 2.45 |

|  |  |  |
| --- | --- | --- |
|   | **slope** | **y-int** |
| **Value** | 26.2 | -0.05 |
| **Error** | 0.8 | 0.06 |

**Graph II**

|  |  |
| --- | --- |
| **m (kg)** |  |
| 0.05 | 0.166 |
| 0.10 | 0.254 |
| 0.15 | 0.311 |
| 0.20 | 0.388 |
| 0.21 | 0.396 |
| 0.25 | 0.410 |

|  |  |  |
| --- | --- | --- |
|   | **Slope** | **y-intercept** |
| **value** | **1.27** | **0.012** |
| **error** | **0.11** | **0.002** |