(OS1-2) Hooke`s Law

Aim of experiment

Determination of the Acceleration due to gravity and the effective mass (m) of the helical spring

Apparatus

Helical Spring to Which a Light Pointer is Attached, Rigid Stand and Clamp, Meter Rule, Scale-Pan and Masses, Stop Watch.

Theory of experiment

A helical spring subject to extension by an applied load conforms to Hook's law, which states that, in the elastic region, the stress is proportional to the strain, i.e. *the load is proportional to the extension it produces*. If a graph is drawn, after the initial loading, where some force is required to separate the turns of the spring, which are pressed against each other, a straight line is obtained of extension against load, *Hook's law*. From this portion, the extension, *n*, in *m/kg* of a load can be obtained from the slope of *Figure 1;*

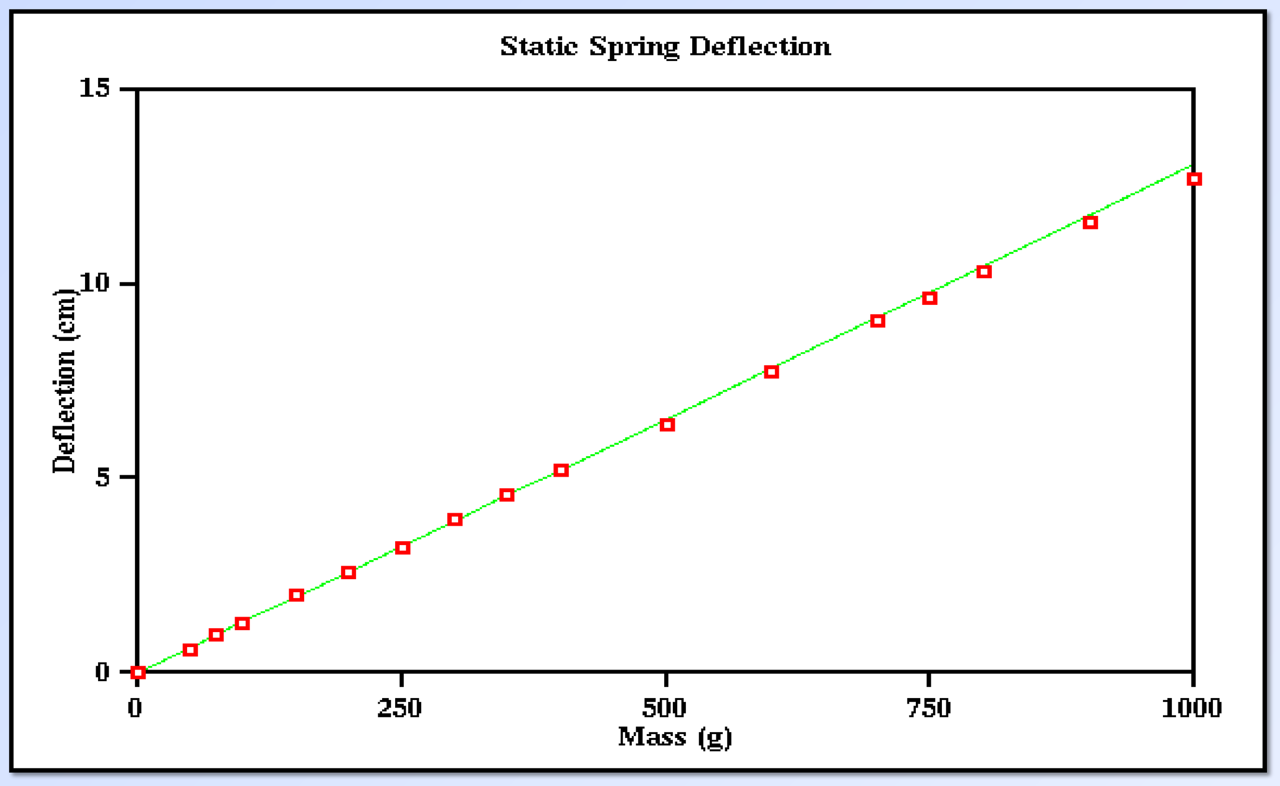

Figure 1. Extension as a function of the applied mass

If, now, a mass M is attached to the spring, and the spring extended a further distance x, a restoring force of $\frac{x}{n}\cdot g$ is called into play. g is the gravitational acceleration. The spring on being released executes vertical oscillations, the equation of motion of mass is being

$$M\ddot{x} = -\frac{x}{n}\cdot g \qquad or \qquad \ddot{x} + \frac{g}{M\,n}x = 0$$

The motion is thus simple harmonic and the periodic time T is

$$T = 2\pi\sqrt{\frac{M\,n}{g}}$$

The above analysis assumes the spring to be weightless. The load M must be increased by an amount m equal to the effective mass of the spring.

Then

$$T = 2\pi\sqrt{\frac{(M+m)n}{g}}$$

If a graph of T^2 against M is drawn, a straight line is obtained from which g and m can be found .The slope of this line

$$Slope = \frac{T^2}{M} = \frac{4\pi^2 n}{g}$$

$$g = \frac{4\pi^2 n}{slope}$$

The intercept on the axis of M gives the effective mass *(m)* of the spring.

Procedures

1. Let the initial position of the mark to be the zero point, y_o.
2. Put a 50 gm load in the scale ban and note the new mark position, y_i, and deduce the extension $\Delta y = y_i - y_o$.
3. Repeat the above step with different loads and note the extension Δy, for each load and tabulate these results.
4. Plot the relation between load, *M (kg)* and extension, *Δy (m)* and calculate *n*.
5. A load, *M*, is added to the pan, which is set in vertical vibration by giving it a small additional displacement.
6. The periodic time *(T)* is obtained by timing 20 vibrations, three times at least.
7. This is repeated with different loads and a graph of T^2 against load is plotted, from which *g* and *m* are found as mentioned above.

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Results

Mass, M (Kg)	*Extension , Δy (m)*

n= *m/kg*

Mass, M (Kg)	*Time of 20 vib. (s)*	*T (s)*	*T^2 (s^2)*

$$g = \frac{4\pi^2 n}{slope} = \quad m/s^2$$

m= *kg*

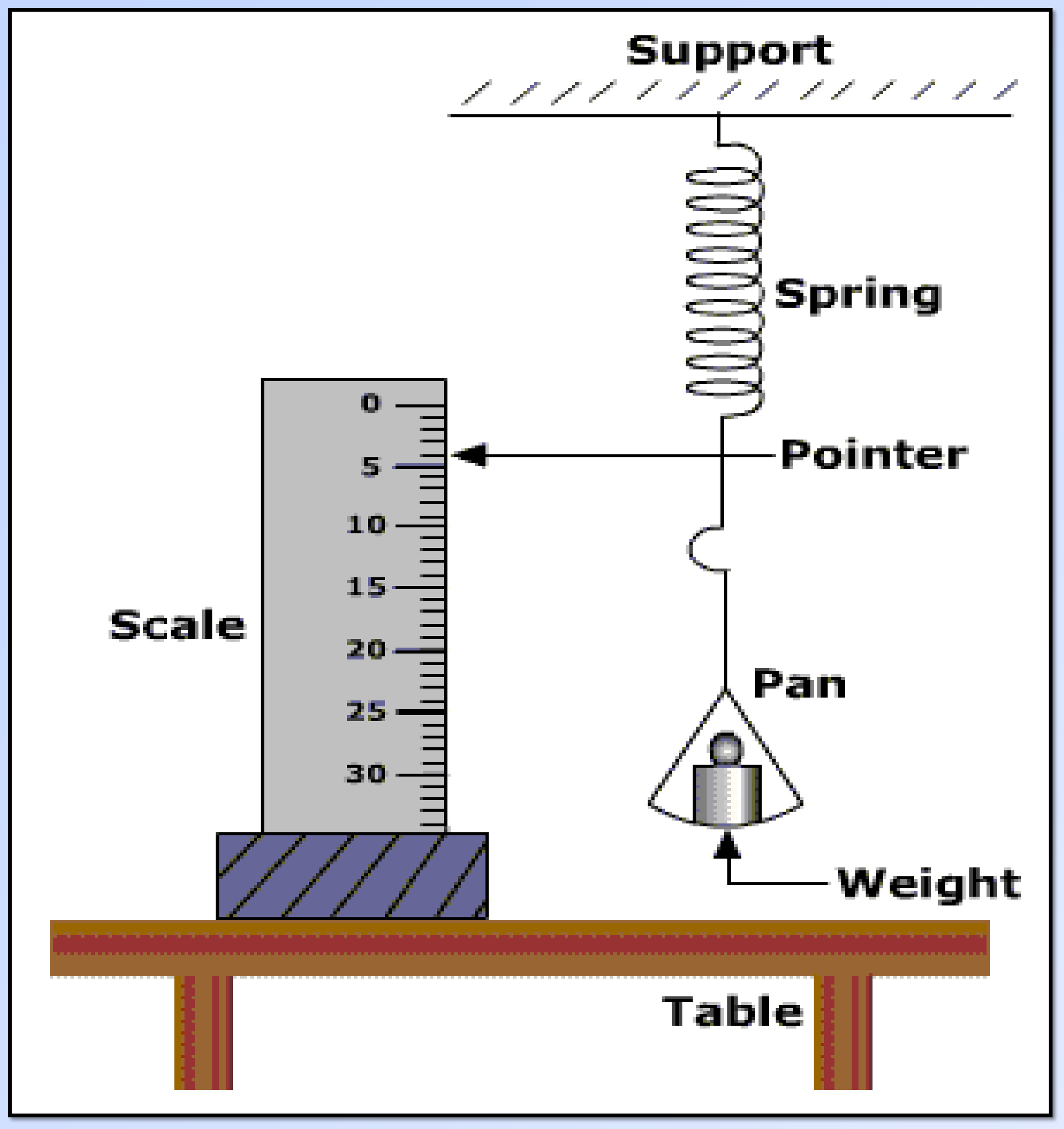

Figure 1. A schematic diagram of Hooke's law apparatus.