



EXPERIMENT

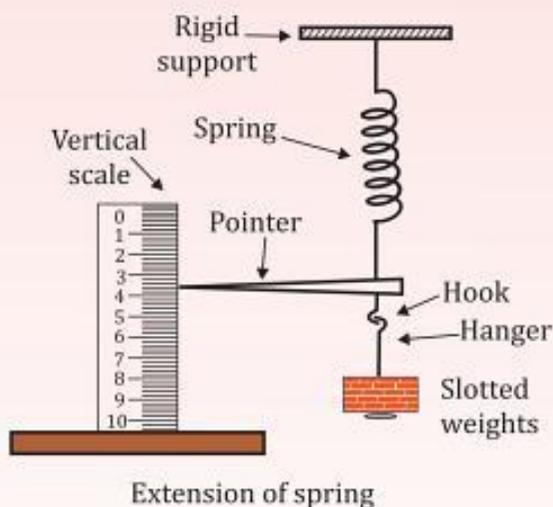
AIM

To find the force constant of a helical spring by plotting graph between load and extension.

MATERIAL REQUIRED

A long (about 30 cm) spring made of thin tempered steel wire, an iron stand with a heavy base, nearly 1 m long rod and two clamps, pointer may be just a piece of rigid metal wire, fevicol, a half meter rule, a hanger with 6-7 slotted weights of 20 g each, a mirror strip and a pair of pliers.

DIAGRAM



THEORY

Place the iron-stand on the table. Fix the half meter rule vertically in the clamps. Straighten nearly 2-3 cm length of spring on either end or firmly fix its one end on the upper clamp rod with the help of pliers so that it hangs vertically on the clamp. Secure its position by putting a few drops of fevicol. On the lower end of the spring, fix the hanger in a similar manner. Attach the pointer just above the hanger on the straight portion of the spring with the help of fevicol so that it freely moves just in front of the scale. Ensure that the pointer is horizontal whereas the scale and the spring are vertical.

Spring constant of a spring is the restoring force per unit extension in the spring. When the upper end of a spring held vertically is fixed and load is applied at its lower end, there is an increase in its length which increases with the increase in load.

i.e., load (F) \propto extension (y)

$$\frac{F}{y} = k$$

The constant of proportionality k , called force constant or spring constant, has dimensional formula $[MT^{-2}]$ and S.I. unit Nm^{-1} .

$$F = ky$$

⇒ The graph between F and y will be a straight line and slope of the graph will give the value of k.

PROCEDURE

1. With the hanger attached to the spring note down the initial position of the pointer on the scale. To ensure that there is no error due to parallax in recording position of the pointer. You can hold a plane mirror behind the scale and holding your eyes in such a position that pointer covers its mirror image.
2. Put 20 g weight on the hanger and let the spring stay in equilibrium. Note the position of the pointer again.
3. Go on adding 20 g weights on the hanger and noting the corresponding positions of pointer. Take eight readings this way.
4. Decrease load in steps of 20 g weight and note the corresponding positions of pointer on vertical scale again.

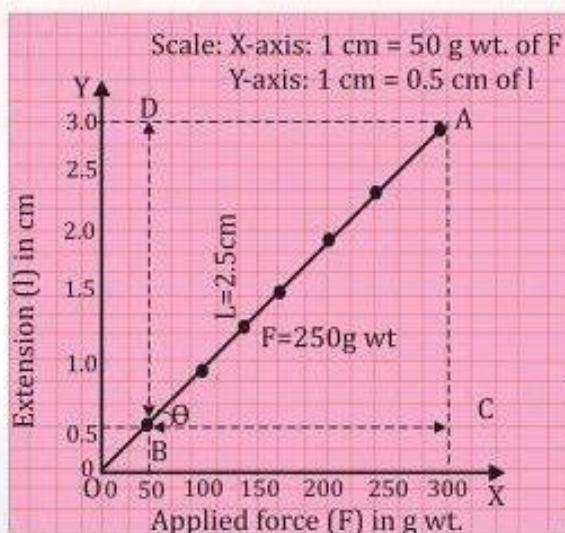
OBSERVATION

Least count of vertical scale = 0.1 cm

TABLE FOR EXTENSION OF SPRING UNDER DIFFERENT LOADS

| S. No | Load on hanger w (g f) | Position of pointer on the vertical scale (cm mark) | | | Extension l (cm) |
|-------|------------------------|---|---------------------------|--------------------------------------|------------------|
| | | Load increasing (y_1) | Load decreasing (y_2) | Mean ($y_0 = \frac{y_1 + y_2}{2}$) | |
| 1. | 0 | | | | |
| 2. | 50 | | | | |
| 3. | 100 | | | | |
| 4. | 150 | | | | |
| 5. | 200 | | | | |
| 6. | 250 | | | | |
| 7. | 300 | | | | |
| 8. | 350 | | | | |

GRAPH



Graph between applied force and extension. It is a straight line.

1. According to the range of data and the dimensions of the graph paper available decide suitable scales for load and extension.
2. Plot a graph between load (W) and extension (l) taking load on y axis and extension on X-axis. The graph will be a straight line.

CALCULATIONS

$$\text{Slope of straight line} = \frac{W}{l} = \tan \theta$$

$$\text{As, we know that, } K = \frac{F}{y}$$

$$\tan \theta = \frac{BG}{AG} = \frac{EF}{CD} = \text{_____ gfc}m^{-1} = \text{_____ } Nm^{-1}$$

RESULT

1. The load extension graph for the given helical spring is a straight line as shown in figure.
2. The value of spring constant for the given spring is _____ Nm^{-1} .

PRECAUTIONS

1. Do not load the spring too much or otherwise it may get stretched permanently.
2. The support of the spring should be rigid and it should be firmly secured with it.
3. Put weights on the hanger gently and wait a while after changing weights so that it may reach its equilibrium state.
4. The pointer should be horizontal. It should move just in front of the vertical scale freely.

SOURCES OF ERROR

1. The lamp from which you suspended the spring may yield slightly under the load.
2. The values marked on slotted weights may not indicate their true mass.

VIVA VOCE

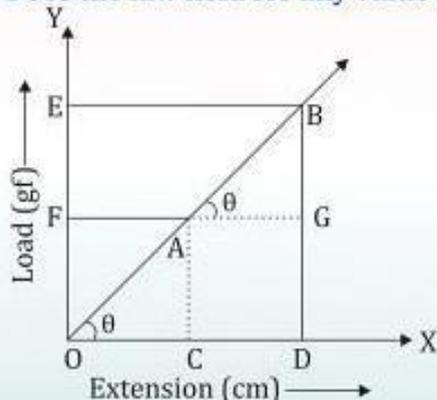
Q1. What does the straight-line graph between load and extension imply?

Ans. It implies that extension is directly proportional to load.

Q2. Which law of physics does it correspond to?

Ans. Hooke's law of elasticity.

Q3. Does the law hold for any value of load?



Ans. No, it is applicable within limit of elasticity for the spring.

Q4. On what factors does the force constant of a spring depend?

Ans. On Young's modulus of elasticity of the materials of the wire the spring is made of. on the length and area of cross-section of the spring.

Q5. If a spring is cut into two equal parts, what is the force constant of each part with respect the original spring?

Ans. If the force constant of original spring is k , the force constant of each half would be $2k$.

Q6. Can you explain how?

Ans. The extension is directly proportional to the length of the spring. For the full spring extension is y , then, $k = \frac{F}{y}$, for the half spring under the same force extension is,

$$\frac{y}{2} \text{ i.e., } k = \frac{F}{\frac{y}{2}} = \frac{2F}{y} = 2k$$

Q7. If the two halves are joined in parallel, what will be the force constant of the combination?

Ans. $2k$.

Q8. When a mass on a spring is pulled and let go, what type of motion does it execute?

Ans. Simple harmonic motion.

Q9. Can you mention any use of the experiment you performed?

Ans. The linear relation between calorimeter forms the principle of working of a spring balance.