One of the items that boy children like playing with the toy gun. To please his child a father bought a toy gun as birthday gift. In the evening, while the child was playing with his friends, the toy gun stopped working and the child started crying. When the father saw his child crying. He picked up the toy gun and took it to a mechanic for repair. On opening the toy gun, the mechanic found that the spring in the toy gun of force constant, $20Nm^{-1}$ was damaged. The father asked the mechanic to replace the damaged spring with another suitable spring but the only available spring had no specifications.

TASK

As a learner of physics, carryout a scientific investigation to determine where the available spring is suitable

Solution

Aim: Experiment to determine the force constant of the spring to replace the damaged spring in the toy gun.

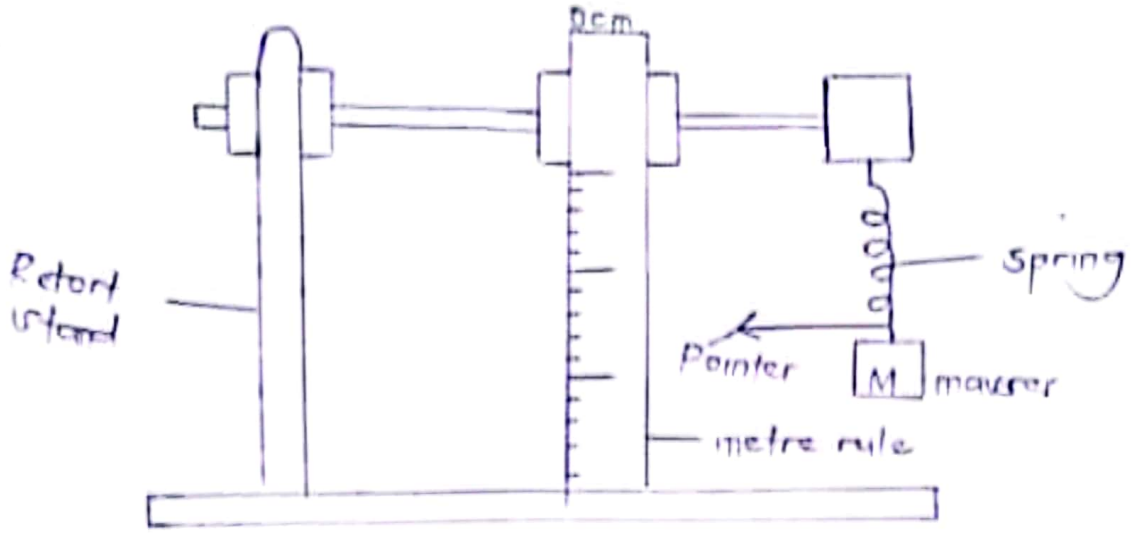
Hypothesis: The force constant of the spring is $20Nm^{-1}$ and it can be used to replace the damaged spring in the toy gun.

Variables

Independent variable : Mass loaded on the spring.
Dependent variable : Extension of the spring.
Control variable : Initial position of the pointer
Original length of the spring
Cross-sectional area of the spring.

Apparatus

Metre rule
Small wooden block
Retort stand
Pointer
Known masses
spring



Procedures

The apparatus is setup as shown in the figure above.

The spring is clamped vertically from a retort stand with the pointer fixed at its lower end and the initial position of the pointer on the metre rule is read and recorded as X_0

A mass $m = 0.100kg$ is suspended at the lower end of the spring and the new position of the pointer on the metre rule is read and recorded as X_1.

The extension of the spring produced by a mass is determined from $e = (x_1 - x_0)\,m$

The procedures is repeated for values.

$M = 0.200, 0.300, 0.400, 0.500$ and $0.600kg$

The result result is tabulated in a suitable including values of load $F = mg$, where $g = 10ms^{-1}$

DATA PRESENTATION AND RECORDING

Table of results

Initial position of the pointer

$X_0 = 0.265m$

M (kg)	y_0 (m)	x_1 (m)	e (m)	F (N)
0.100	0.265	0.300	0.035	1.00
0.200	0.265	0.335	0.070	2.00
0.300	0.265	0.371	0.106	3.00
0.400	0.265	0.409	0.144	4.00
0.500	0.265	0.445	0.180	5.00
0.600	0.265	0.475	0.210	6.00

A graph of load F against extension e is plotted obtaining a straight line graph shown in the figure below

DATA ANALYSIS AND INTERPRETATION

The slope, S, of the graph is determined

$$S = \frac{\text{Change in load } F}{\text{Change in extension } e}$$

$$= \frac{y_2 - y_1}{x_2 - x_1}$$

$$S = \frac{6.2 - 0.8}{0.22 - 0.0275}$$

$$= \frac{5.4}{0.1925}$$

$$= 28.0 \text{ Nm}^{-1}$$

CONCLUSION

The force constant of the spring is 280 Nm^{-1}, therefor it can not be used to replace the damaged spring in the toy gun.

ERRORS AND PRECAUTIONS

- Parallax error
- Resistance from suspension points.
- Poor recording and reading.

- Rough surfaces

Precautions

- By positioning the eyes such that they are perpendicular to the pointer that is to be read
- Using flat smooth surfaces
- Clear recording and computing of the results

A graph of load F against extension e.