Experiment

Title: Hooke's Law

Aim: To determine the spring constant.

Equipment:

- Retort stand (with clamp)

- Spring (with hook)

- Masses (100g, 200g, 300g, 400g, 500g)

- Ruler

Variables:

Independent Variable:

- Changing the mass ∴ Weight force (F).

Dependent Variable:

- The extension of the spring Δx.

Control Variable:

- "Spring" → <u>Dimensions of the spring.</u>

    → <u>Mass of the spring.</u>

    → <u>Radius of the spring.</u>

- "Retort Stand" → <u>Height of the retort stand.</u>

Method:

1. The spring (its dimensions, mass and its radius) were measured in its initial face.

2. The spring was then place in the clamps of the retort stand and was held together tightly enough to hold it in place.

3. At the end of the spring (where the hook is), a mass of 100 grams was placed and as a result the spring started to extend downwards.

4. Its extension after the weight was placed on the hook was measured using a ruler and compared to its initial face.

5. After five continuous trials with the same mass (100 g) a mass of 200 grams was placed on the hook. Five trials were performed for all 100,200,300,400 and 500 grams respectively, following the same procedure stated before.

6. The results were observed and copied in a notebook, were a table was made showing the masses, and the (cm) results of the extensions for each trial.

Method Diagram:
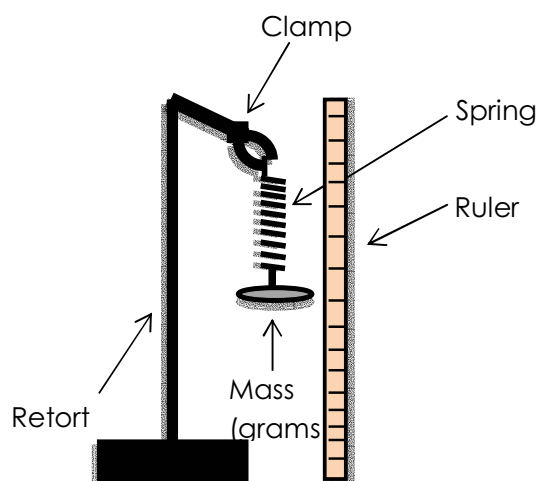
Results Table:

Mass(g)	Weight (N)	Trial 1(cm)	Trial 2(cm)	Trial 3(cm)	Trial 4(cm)	Trial 5(cm)	Δx average
100	0.1 × 9.81= 0.981	14.0	15.0	15.0	14.0	14.5	$\cong 14 \pm 0.5$ cm
200	0.2 × 9.81= 1.962	21.0	20.0	21.0	21.5	21.0	$\cong 20 \pm 0.7$ cm
300	0.3 × 9.81= 2.943	27.5	28.0	28.0	27.5	27.5	$\cong 27 \pm 0.2$ cm
400	0.4 × 9.81= 3.924	33.4	34.5	34.5	33.5	34.0	$\cong 33 \pm 0.6$ cm
500	0.5 × 9.81= 4.905	39.0	38.6	38.6	40.5	40.0	$\cong 39 \pm 1$ cm

Calculations to find averages:

$$\frac{14 + 15 + 15 + 14 + 14.5}{5} = \boxed{14.5 \pm 0.5}$$

$$\frac{21 + 20 + 21 + 21.5 + 21}{5} = \boxed{20.9 \pm 0.7}$$

$$\frac{27.5 + 27.8 + 28 + 27.5 + 27.5}{5} = \boxed{27.6 \pm 0.2}$$

$$\frac{33.4 + 34 + 34.5 + 33.5 + 34}{5} = \boxed{33.7 \pm 0.6}$$

$$\frac{39 + 39 + 38.6 + 40.5 + 40}{5} = \boxed{39.4 \pm 1}$$

Calculations to find uncertainties:

$$\frac{15 - 14}{2} = 0.5$$

$$\frac{21.5 - 20}{2} = 0.7$$

$$\frac{28 - 27.5}{2} = 0.2$$

$$\frac{34.5 - 33.4}{2} = \cong 0.6$$

$$\frac{40.5 - 38.8}{2} = \cong 1$$

Conclusion:

A spring was hung vertically with a hook attached to the lower end of the spring, and masses from 100g to 500g were added. The downward location of the spring was measured once it came to rest. Two equal and opposite forces acted on the hanging mass: gravity directed downward and the spring's elastic restoring force directed upward, in the opposite direction of displacement. Using Hooke's Law ($F = -kx$), a spring constant was calculated for each measurement. The spring constant is not always the same, and it will change whenever there is more or less force is applied on the spring. The data table has shown the changes of the spring constant.

Having said all this, the experiment went well, because there was co-operation between all of the participants and we were able to take measurements in a fairly small amount of time. Though there were that we encountered during the lab and they are the source of the errors in the measurements. If those problems didn't exist or could be resolved then the spring constant would be the same in all cases.

Evaluation:

The problems that we encountered during the experiment:

- The spring was not brand new and had been used many times in the past which may have reduced its elasticity and that had an effect on my measurements.

- The results are definitely not totally accurate (as shown in the table), because the measurements were read off the meter stick by eye to the nearest mm .

- Movements in the room by other people caused vibrations which also contributed slightly to the inaccurate results.

Solutions to those problems:

- Using a brand new identical spring could help solve the problem of the elasticity, since the spring can now sustain its elastic restoring force that is directed upward.

- The measurements could be performed using a digital ruler, which would have been a lot more accurate that the measurement performed by a naked eye.

- The solution to the problem of the vibration and the general movement of people in the room, is to perform the experiment in a more isolated and "quiet" area, so there are no interferences whatsoever.