Factors affecting the stretching of springs and rubber bands essay sample

Scientific Knowledge:

Before doing the experiment I came to the conclusion that this experiment relates to Hooke's Law which states that extension is proportional to the load, meaning that if you stretch something with a steadily increasing force, then the length will increase steadily too. By looking at various sources I have also found out that if a mass m on a spring is displaced from the equilibrium position (x0 = 0) to a new position x, Hooke's law states that the spring will exert a restoring force on the mass Fr = -kx. The "-" sign indicates that the direction of the spring force is in the direction opposite to the direction of the displacement. The value " k" is a constant for a given spring, but different springs have different " k-values." Thus, the force exerted by a spring is variable, specifically the greater distance it is stretched from equilibrium; the greater is the spring force attempting to restore the spring to its equilibrium position. This relationship holds up to a point called the elastic limit. Each spring has its own value of this limit. If you stretch a spring beyond its limit, then the spring will not return to its original shape, but will remain stretched out.

Not all " springy" things obey Hooke's Law. When a rubber band is stretched, the rubber will exert a restoring force. The amount of this force depends on the amount that the rubber is stretched, but perhaps not in the same simple way as the spring.

The F= k*x expression used to calculate the spring constant leads to other uses of the spring constant. Once k is known, we can use the displacement of the spring to determine the force applied to it. Then the spring constant becomes useful as a force measurement. As such, springs are used to measure the weight of objects in common household scales.

Regarding a rubber band, the spring constant will depend on the nature of the rubber; some varieties are stiffer than others. It will also depend on the thickness of the band. Thicker bands will tend to have higher spring constants. Also the length of the band will have an effect. For a given thickness, the longer the band, the less force it will produce for a given displacement. This is because there are a greater number of inter-molecular bonds to participate in the stretching so each bond suffers less strain. Rubber is sensitive to temperature changes so its spring constant will change with temperature, probably increasing as temperature decreases up to a point where it becomes inelastic at very low temperatures.

Prediction

In my experiment I predict that only the spring will obey Hooke's Law and the extension will increase directly proportional to the force applied to it, as from my scientific knowledge I have learnt that if you stretch something with a steadily increasing force then the length will increase steadily too. I also predict that the results will give me straight-line graph. This is how I think the graph for the extension of spring will look: –

Apparatus

§ Clamp

§ Ring stand

§ Table

§ 3 Springs

§ 3 Rubber bands

§ Meter stick

§ Various masses

§ Notebook

§ Pen

Diagram

Method

1) Firstly set up apparatus as shown. The clamp should be resting on the table and the ring stand must be attached to the clamp, there should be another clamp connected to the ring stand where the meter stick can hang down. The meter stick should be parallel to the ring stand. To ensure the results are accurate everything must be precise and levelled out.

2) Start by attaching a spring onto the clamp next to the meter stick, the spring must be new and one that has not reached its elastic limit. Using the meter stick measure the bottom of the spring without any weights added and record your results on a clear table.

3) Then gradually start adding weights to the spring going up in 50g e. g. 50g, 100g, etc. the weights must be securely hooked on and the extension

must be recorded at each stage, taking readings off the meter stick. For accurate results it is important that eyelevel results are taken, and results should be taken beneath the lowest point the spring is stretching.

4) After each stage check if the spring retains its original shape, if it doesn't the elastic limit has been reached and at this point you should stop adding the weights. If it does not reach its elastic limit continue adding weights until you get up to 500g.

5) Once you have reached up to 500g replace the spring with a rubber band. Repeat the whole test again in exactly the same way to make it a fair test. Record all your results and compare.

6) Repeat the whole test again with the spring and rubber band at least 3 times. This is so you have accurate and reliable results and so you can account for any anomalies or inconsistent results.

7) Now you must find out the average of all your results and then work out the spring constant using this formula: –

K= F/E

Spring constant = Force/ Extension

This will prove how accurate your results really are.

Fair test

In this experiment we are measuring the extension in cm and the force applied will be in grams but will later be changed to Newton's. To make this experiment fair many factors need to be considered. The factors that need to be kept constant are the height at which the spring is hung and the overall amount of weight added to the spring (500g). The spring and rubber band also have to be brand new and unused. The factor that needs to be changed is the amount of force added to the spring and rubber band at one time. This will be added using weights and will gradually be increasing. I also need to make sure that the work surface is completely level and not slanted. All results should be taken at eyelevel and there should be no draft or light breeze affecting the results so all doors and windows must be closed.

Safety

While doing the experiment it is important to consider aspect of safety. To ensure the experiment is carried out in a safe way I have to firstly tie back long hair and lose clothing to prevent distractions and interference and I have to clear the work surface so that there is enough space to do the experiment. A stool should also be placed beneath the spring/rubber band in case they brake. I need to be concentrating on the experiment at all times and bags, books, etc need to be moved out of the way.

Conclusion

By doing the experiment I determined that only the spring and rubber band obeyed hook's law. Hooke's law can also be expressed as a formula:

Force = a constant x extension

F = ke

My prediction was correct and from my graph you can see an increasing slope, which shows that the extension increased proportionally to the amount of force applied to it. This is because according to Hooke's law if you double the load the extension is doubled too. This law is only true if the elastic limit has not been reached. In my experiment the spring and rubber band did not reach their elastic limit, therefore Hooke's law could be applied, this is because the elastic limits of the two objects were much higher and they could withstand the force that was applied.

My predicted graph was also similar to the graph I drew from my results, by making a line of best fit I was able to have a straight-line graph. In my results I also included the spring constant, this also turned out as expected.

Each time I added a 50 g weight; the spring stretched a couple of centimetres. The spring had a higher extension than the rubber band; this may be because of the natural elasticity of both materials or it could depend on the stiffness, thickness or quality of the spring/rubber band.

The rubber band however, did not obey Hooke's law. From my results you can see that the results for the rubber band produce a curve graph. I have notice that the rubber band did obey Hooke's law for very small masses. The curve can be due to the fact that rubber bands can't endlessly be exerted, because they have a maximum exertion and so when the exertion force becomes really high the rubber band loses its property of following Hooke's law. Rubber bands are not really elastic, but only stretchy. When a rubber band stretches it gets thinner and longer, but something else happens as well. The rubber band gets warmer as it stretches. The rubber band is unable to do as much work because it loses energy.

Evaluation

I think the experiment went well because the results agreed with my prediction. However there were a few anomalies, the most obvious was the result taken for the spring without any weights added to it. The result was quite low compared to the others and even went below the rubber result. This may have occurred because of a lack of concentration while recording the results or I may not have taken an eyelevel recording. Also my results may not have been that accurate, if we could use electronic technology the results would be a lot more accurate and reliable, whereas by doing it manually, mistakes can easily be made.

Although my prediction was proved I still don’t think I had enough results. If I had more time I would have taken at least 5 sets of results rather than 3, this would give me a lot more results to work with and I could have made a better conclusion.

The method I followed was a good way to carry out the experiment but can be improved. Firstly another ruler needs to be used underneath the spring/rubber band while its stretching to record the results more accurately and the weights need to be removed regularly to check if the spring/rubber band goes back to its original shape and whether or not it has reached its elastic limit. Also we should have looked at more stretchy materials to compare them with each other. This would have given a wider variety of results.

To extend the experiment I could look at the elastic limit of different stretchy materials and add weights until the spring/rubber band does not go back to its original shape, by doing this I will be able to compare how much weight the different materials can withstand and what factors affect their strength by looking closely at the inter-molecular bonds within their structures.