Elastic band investigation

Aim: - to find out whether or not it is correct to call a rubber band elastic.

Plan: - The factors affecting the elasticity of a rubber band are:

- Downward force applied to the band
- The type of rubber the band is made from.
- The length of the band
- Cross sectional area of band

The variable I am going to investigate is the effect of weight on the rubber band. This is a continuous variable. I am going to measure the distance the rubber band has stretched after each amount of weight is placed on it. I am going to keep taking lengths until the band brakes.

Pilot test: -

To decide what amount of mass to step up in I am going to run a preliminary experiment. I am going to find the elastic limit of three rubber bands. To do this I added weights until the band snapped.

Test	Number of masses at which band broke
1	22
2	20
3	25

To work out how many masses to go up in I am going to divide the number of masses at which the band broke into 10 equal pieces. This gives me 2.2, 2.0 and 2.5 as 2 is the average round number I will use this.

To make the experiment a fair test I will do the experiment three times to gain a fair average. Each of these times I will also use the same type of rubber band as a different type of rubber could effect how far the band will stretch and therefore my results. I will also try to add the weights gently so that the force of it being applied to the band does not affect my results.

As a safety measure I will wear goggles in case when the rubber band reaches its elastic limit and brakes, it damages my eyes. I will also do my experiment away from others so as not to put them at any risk.

Method: -

Firstly, I will use a clamp stand and boss clamp to suspend a rubber band from. I will then add weights systematically going up in twos measuring the length the band has stretched after each weight has been added using a 30cm ruler.

Equipment list: -

- Clamp stand and boss clamp
- Masses (each weighing 10g)
- A measuring apparatus (30cm ruler)
- Three elastic bands of the same sort

Prediction: -

I predict that the rubber band will stretch more as more weight is applied. This is because extension is proportional to load and so if load increases so does the extension and therefore stretching distance.

Extension = New length – Original length

A material is elastic if it obeys Hooke's law when stretched. Hooke's law states that extension is proportional to the downward force acting on the rubber band.

Hooke's law

$F=kx$

Where: F is force applied
K is spring constant
X is extension caused

Graph

I believe that when force is applied the extension will systematically increase to, therefore obeying Hooke's law and meaning the rubber band is "elastic."

Results: -

1st rubber band		
Weight (kg)	Length (cm)	Extension
0	3.5	-
0.2	7.5	4.0
0.4	14.0	10.5
0.6	22.0	18.5
0.8	23.0	19.5
1.0	24.0	21.5
1.2	26.1	22.6
1.4	26.8	23.3
1.6	27.5	24.0
1.8	28.6	25.1
2.0	29.7	26.2
2.2	30.0	26.5
2.4	30.8	27.3
2.6	31.0	27.5

2nd rubber band		
Weight (kg)	Length (cm)	Extension (cm)
0	4.0	-
0.2	15.1	11.1
0.4	23.0	19.0
0.6	25.6	21.6
0.8	27.9	23.9
1.0	29.6	25.6
1.2	31.5	27.5
1.4	32.3	28.3
1.6	33.6	29.6
1.8	35.0	31.0

3rd rubber band		
Weight (kg)	Length (cm)	Extension(cm)
0	3.6	-
0.2	7.1	3.5
0.4	13.6	10.0
0.6	18.2	14.6
0.8	20.3	16.7
1.0	22.6	19.0
1.2	24.2	20.6
1.4	25.3	21.7
1.6	26.2	22.6
1.8	27.0	23.4
2.0	28.1	24.5
2.2	28.5	24.9
2.4	28.8	25.2
2.6	29.7	26.1

Averages		
Weight (kg)	Length (cm)	Extension (cm)
0	3.7	-
0.2	9.9	6.2
0.4	16.9	13.2
0.6	21.9	18.2
0.8	23.7	20.0
1.0	25.4	22.9
1.2	27.3	23.6
1.4	28.1	24.4
1.6	29.1	25.4
1.8	30.2	26.5
2.0	28.9	25.4
2.2	29.6	25.7
2.4	29.8	26.3
2.6	30.6	26.8

To work out the extensions I have taken the new length away from the original length.

Analysis: -

My graph shows that as more weight is placed on the band the extension gets greater. The shape of the line of best fit shows that, as I predicted in my original prediction, it is correct to call a rubber band elastic as it follows hookes law. Hookes law states that extension is proportional to the downward force acting on the rubber band this means that as the weight is increased the extension should too, therefore a graph line would go upwards as mine does. The line of best fit is very steep at the start, this shows that the band is elastic, as the line begins to go up less steeply and starts to bend this the elastic limit of the band. The elastic limit is the point at which when the downward force is removed the band will no longer return to its original shape, this is because the atoms in the rubber material begin to break there bonds, beyond this point hookes law is no longer followed. The point at which the line levels off is the point at which the band brakes. On my graph there is some anomalous data I think this is because as my graph shows averages, one of the three bands broke earlier than the rest, therefore the average beyond this point is only of two bands which would obviously lower the average. As hookes law means that extension is proportional to downward force, it is possible to predict the time until a band breaks, using this formula:

$K=F/X$

When:

K= spring constant

F=force applied

X = extension caused

Evaluation: -

I believe the resultes I have gathered are reasonably reliable and accurate, most of my average results are very close to the line of best fit, except for one or two anomalous results. My repeats are all similar this shows that they must be reliable as otherwise they would all be totally different. The few anomalies caused on my experiments could have been caused by human error. When placing the masses on the band it is possible not enough care was taken and extra force was applied by the person adding the weight. I think my method was suitable for this experiment though there are a few improvements I would make to it if I was to do the experiment again. I would try to find a better way to add the weights to the rubber band, as I think this would make my results more accurate and possibly eliminate anomalies as I believe this is what caused them in my results. to make the experiment more accurate I would use some form of mechanical measureing device, rather than a ruler as this would meaurse the extension to a much finer degree.