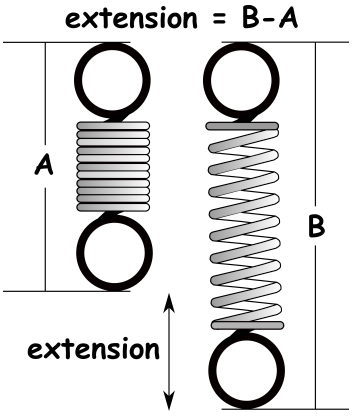
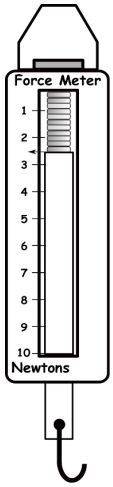
Hooke's Law



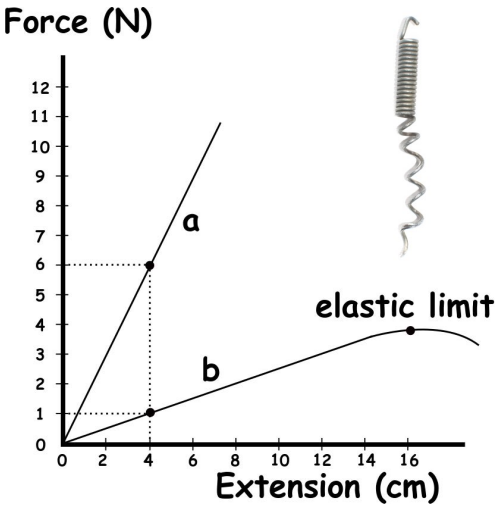
Stretching force (N)	Increase in length / extension (cm)
1	4
2	8
3	12
4	16
5	20

Hooke's law tells us something you may have already noticed. When you stretch something like an elastic band, the more you stretch it the harder it gets. The table shows a set of results for an elastic band being stretched that is obeying Hooke's law. You can see that as the force increases by 1 N each time the length increases by 4 cm. Or we can say that doubling the force doubles the extension, trebling the force trebles the extension and so on. This relationship (connection) between two quantities is called being **directly proportional**. When an object stretches like this we say it is obeying Hooke's Law. Plotting results that are directly proportional on a graph gives a straight line through the origin (0,0).

Spring Balance or Force Meter



A spring balance or force meter uses Hooke's law. A weight attached to the end of the force meter causes a spring to stretch. The greater the weight added the more the spring stretches. The force meter has a scale on the front. When you pick up an object you can read off the size of the force, this is equal to the weight of the object you are lifting. You can also pull objects with a force meter to see how much force is needed to make them move, this is great for investigating friction.



Elasticity and Stiffness

An object like an elastic band, is very elastic, it can stretch a long way and when we remove the stretching force it returns to its original length. We call this **elastic behaviour**. You can also squash (compress) springs like those in your bed mattress and they return to their original length when the force is removed, just like stretching objects. Most objects will stretch and then return to their original length after removing the force even if just a tiny bit. We see elastic behaviour every where; your bed mattress, settee, car seats, your trainers, trampolines …. There is a limit though, if an object is stretched too much it won't return to its original length after the force is removed. This is called the **elastic limit** (see spring above left). Stretch an object too far and it stays permanently longer, we call this **plastic behaviour**. Keep stretching and it will break. Blu tack quickly goes past its elastic limit and shows plastic behaviour by staying stretched when you let go. It also breaks if you keep stretching it.

The graph shows two springs being stretched **a** and **b**, the graph for spring **'a'** is steeper, this is because it is **stiffer**. Spring **'a'** requires 6N to cause an extension of 4cm, spring **'b'** only requires 1N. Stiffness is how difficult it is to stretch an object, by plotting graphs for different objects we can compare them.

A man using jumping stilts

WHAT?

Your skin becomes less elastic as you get older. Ask an older person to pull up some skin on the back of their hand and compare how long it takes to go back to its original length with a young person's, it's very different!

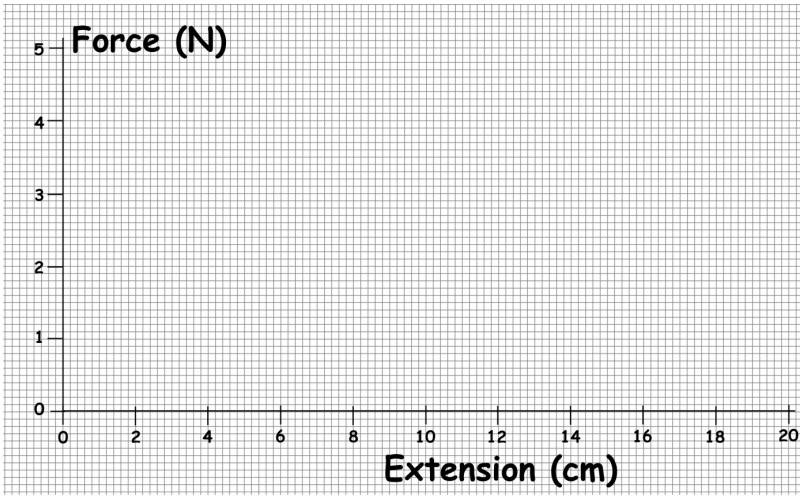
Questions on Hooke's Law

Comprehension

1. What happens the more you stretch an elastic band?
2. When you double or treble one quantity and the related quantity doubles or trebles, what is this called? (like force and extension)
3. If you plot a graph of this sort of relationship what does it look like?
4. What is another name for a spring balance?
5. Inside a force meter, what is it that stretches?
6. If you pick up an object with a force meter, what will the size of the force tell you?
7. If you pull objects along with a force meter, what can you investigate?
8. What do we call it when an object goes back to its original length when the force is removed?
9. What will most objects do?
10. Give two examples of where we see elastic behaviour?
11. What do we mean by the elastic limit?
12. If an object stays permanently stretched after the force is removed what do we call this?
13. Why is the graph for spring '**a**' steeper?
14. What does stiffness mean?

Additional tasks

1. Plot the results opposite on the graph below, draw a straight line and predict what extension 2.5 N and 4.5 N will produce by drawing across to your line and down.



2. Look at the numbers in the tables below and decide if the 'Y' values are **directly proportional** to the 'X' values for **A**,**B**,**C** and **D**.

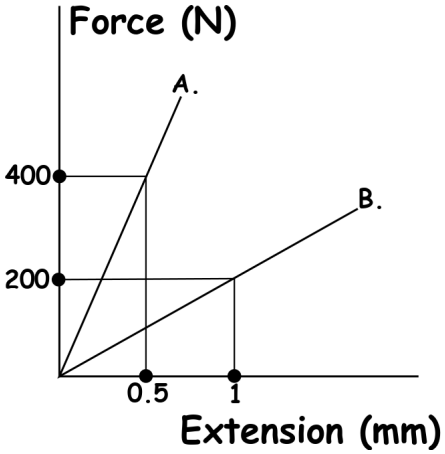
A.	
X	Y
1	2
2	4
3	6
4	8

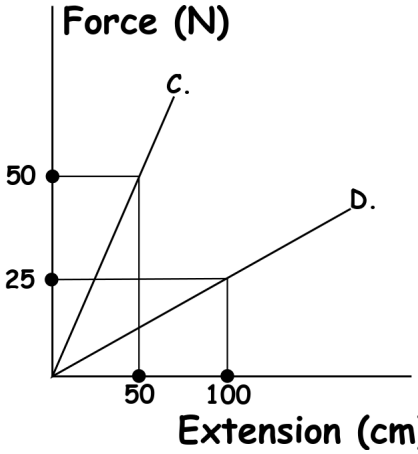
B.	
X	Y
1	6
2	8
3	10
4	12

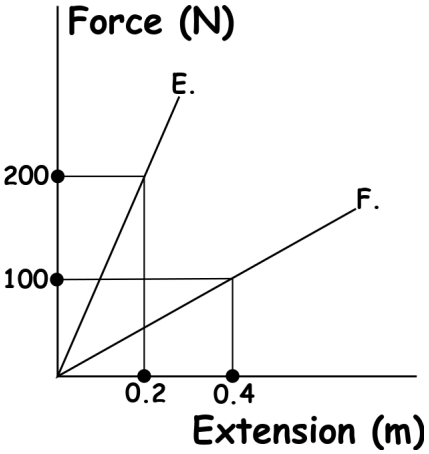
C.	
X	Y
2	10
4	20
6	30
8	40

D.	
X	Y
1	4
2	7
3	10
4	13

3. Use the force and extension values **in the table below the graphs** to work out which line **A** to **F** matches the numbers in the table.







Line?						
Force	400N	25N	12.5N	100N	800N	150N
Extension	2mm	25cm	50cm	0.125mm	0.8m	0.6m