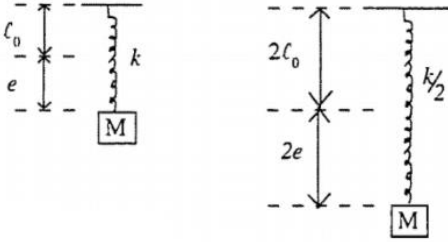
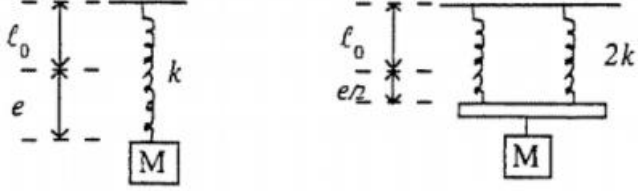
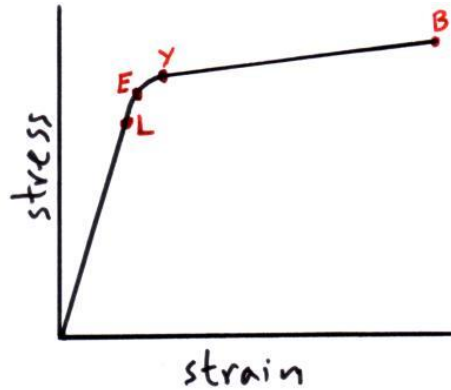


U4 - Materials

<p>What is Hooke's Law?</p>	<p>Provided the limit of proportionality is not exceeded, the extension of a spring/wire \propto the force applied.</p> <p><i>The graph of load against extension of a spring obeying Hooke's Law will have a line of constant gradient passing via the origin. These are two features.</i></p>
<p>What is the equation for Hooke's law in series and why?</p>	$\frac{1}{k_T} = \frac{1}{k_1} + \frac{1}{k_2}$ <p>There is a force of Mg pulling on BOTH springs \Rightarrow overall extension is double (as there are two springs) \Rightarrow the overall spring constant has to be $\frac{k}{2}$.</p>  <p><i>On the load-extension graph, you have a greater extension on the equivalent spring for less force so the line is shallower. You can think of this as a long bungee rope stretching more than a shorter one.</i></p>
<p>How does Hooke's Law work on springs in parallel and why?</p>	$k_T = k_1 + k_2$ <p>The same force of Mg is shared between both springs \Rightarrow extension on each is $\frac{1}{2}$ the original \Rightarrow spring constant has to be $2k$.</p>  <p><i>On the load-extension graph, you're getting half the extension for the same force so the line is steeper. You can think of this as using muscle building equipment using multiple parallel springs, the more springs, the harder it is to compress (and hence stiffer).</i></p>

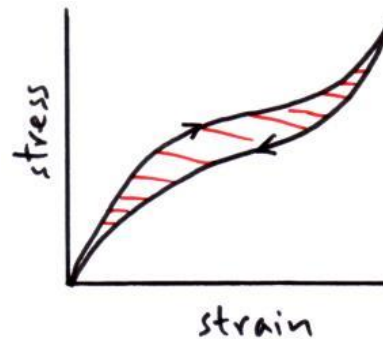
What is the elastic limit?	The point beyond which a material is permanently deformed.
What is elastic strain energy?	The stored potential energy in an elastic object - all the work done in stretching it.
What is plastic and elastic behaviour?	<ul style="list-style-type: none"> • Plastic behaviour - doesn't return to its original shape after forces removed. • Elastic behaviour - returns to its original shape after forces removed.
What are brittle and malleable materials?	Brittle materials don't stretch far beyond their elastic limit. They break. Malleable materials will stretch far.
What is tensile stress (σ)?	<p>The force applied by unit area CROSS-SECTIONAL AREA:</p> $\text{stress} = \frac{F}{A}$ <p><i>This differs from pressure in that an object under stress is pulled rather than pushed.</i></p>
What is the 'breaking stress'/'ultimate tensile stress' and what can it represent?	<ul style="list-style-type: none"> • The maximum stress a material can hold before it breaks. • Represents the strength of a material.
What does 'tensile' mean?	The material is under tension - it's being stretched.
What is tensile strain (ϵ)?	Extension per original length.
What does ductile mean?	<p>It can be deformed plastically.</p> <p><i>Plastically meaning that it WON'T return to its original length.</i></p>

Sketch and label the 4 points of the stress-strain graph for a ductile material (such as copper)



- L - limit of proportionality,
- E - elastic limit.
- Y - yield point (where a small increase in force leads to a large increase in length).
- B - breaking point / breaking stress.

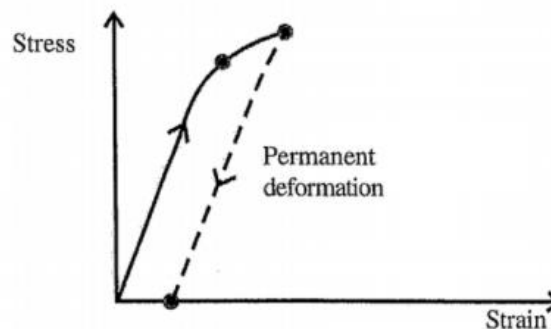
Sketch and describe the loading-unloading stress-strain graph of rubber



- The difference in area is the **energy lost** per unit volume due to internal friction.
- This is called a hysteresis loop.

You know this shape because when pulling a rubber band, it starts off hard to pull, becomes easier, then becomes harder again.

Sketch and describe the loading-unloading stress-strain graph for a metal wire obeying Hooke's Law past the elastic limit



	<ul style="list-style-type: none"> • Wire has been permanently stretched \therefore longer for a given load. • Area between is the energy required to permanently deform the wire as this energy isn't recovered.
When is Hooke's Law used and when is Young's Modulus used?	<ul style="list-style-type: none"> • Hooke's Law is for specific devices (e.g., springs or some length of wire). • Young's Modulus is used for materials (as it's independent of dimensions).