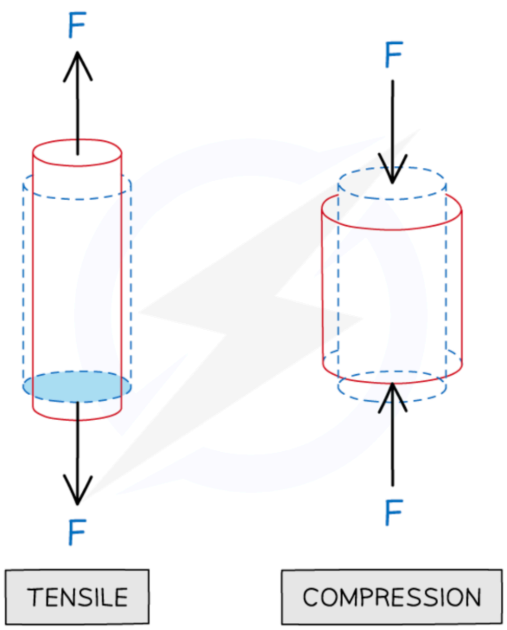
DEFORMATION OF SOLIDS

Compressive & Tensile Forces

- Forces don't just change the motion of a body, but can change the **size** and **shape** of them too. This is known as **deformation**
- Forces in opposite directions stretch or compress a body
  - When two forces **stretch** a body, they are described as **tensile**
  - When two forces **compress** a body, they are known as **compressive**

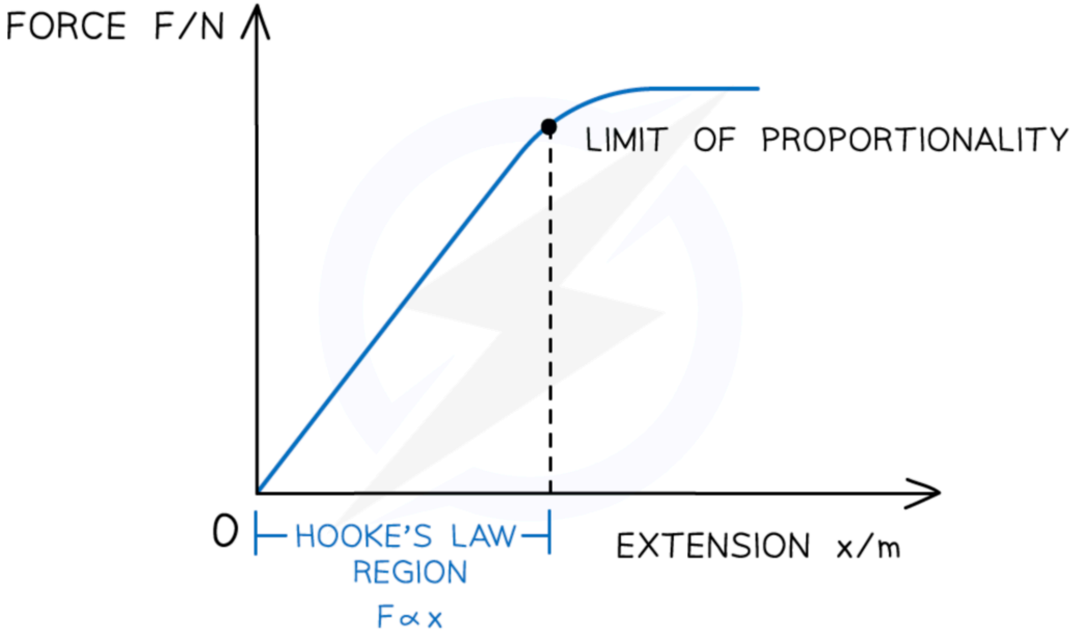


Hooke's Law

- If a material responds to tensile forces in a way in which the extension produced is proportional to the applied force (load), we say it obeys **Hooke's Law**

$$F = kx$$

- This relationship between force and extension is shown in the graph below



- The extension of the spring is determined by how much it has **increased** in length
- The **limit of proportionality** is the point beyond which Hooke's law is no longer true when stretching a material i.e. the extension is no longer proportional to the applied load
    - The point is identified on the graph where the line is no longer straight and starts to curve (flattens out)
- Hooke's law also applies to **compression** as well as extension. The only difference is that an applied force is now proportional to the **decrease** in length
- The gradient of this graph is equal to the **spring constant *k***.

Calculating effective spring constants:

Series	Parallel
$\frac{1}{K_T} = \frac{1}{K_1} + \frac{1}{K_2} \ldots\ldots \frac{1}{K_n}$	$K_T = K_1 + K_2 + K_3 \ldots\ldots K_n$

Stress,Strain and Young's Modulus

Stress: Force applied per unit cross-sectional area.

$$\sigma = \frac{F}{A} \quad in\ Nm^{-2}\ Pascals$$

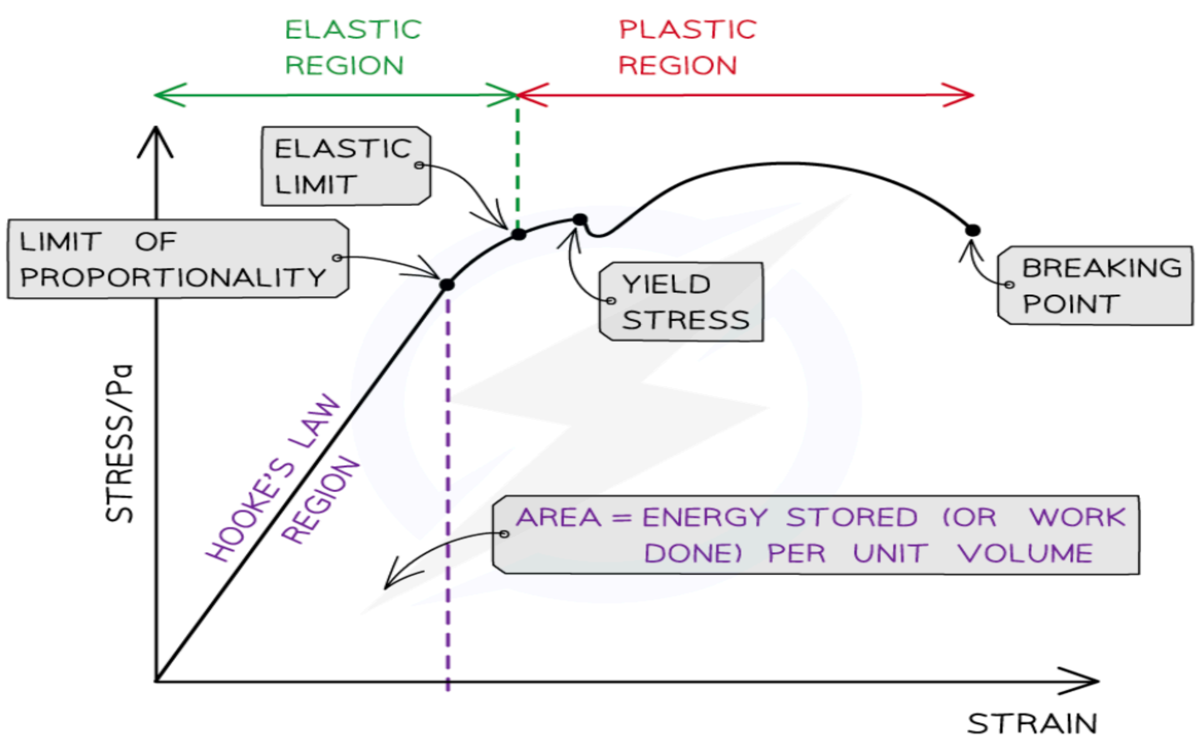
Strain: Fractional increase in original length of wire

$$\varepsilon = \frac{e}{l} \quad no\ units$$

Young's Modulus: Ratio of stress to strain

$$E = \frac{\sigma}{\varepsilon} \quad in\ Nm^{-2}\ or\ Pascals$$

Stress-Strain Graph:



Elastic deformation: When deforming forces removed, spring returns back to original length.

Plastic deformation: When deforming forces removed, spring does not return back to original length.

Strain energy: The potential energy stored in or work done by an object when it is deformed elastically

- Strain energy = area under force-extension graph

$$W = \frac{1}{2}F\Delta x$$

$$\therefore W = \frac{1}{2}k(\Delta x)^2$$