CAIE Physics A-level

6 - Deformation of Solids

Flashcards

Define the term ‘load’.

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The load is the force that a body is subjected to as a result of a mass being added. Load can therefore be considered as a deformational weight that can be added to a body.

What is meant by the extension and compression?

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Tensile forces act away from the centre of the object on which they act, in both directions, causing extension.

Compressional forces act towards the centre of the object on which they act, in both directions, causing compression.

What happens to a spring when tensile/compressive forces are exerted?

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The spring undergoes ‘tensile deformation’ (for tensile forces) or ‘compressive deformation’ (for compressive forces).

What is stress?

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Stress (σ) is the force per unit area that a body is subjected to. Stress and pressure have the same unit (Nm^{-2}). Stress tends to be used if it is caused by a force is acting in a particular direction, whereas pressure acts in all directions.

What is strain?

What is strain?

Strain (**ε**) is the extension of a body following subjection to a load, divided by its original length. Since it is a ratio of lengths, it is unitless.

What is Hooke's law?

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Hooke's law states that the strain experienced by a solid is directly proportional to the stress applied up until the limit of proportionality for that material.

What is meant by the limit of proportionality?

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The limit of proportionality is the load beyond which the extension of a body is no longer directly proportional to the magnitude of the load.

Using Hooke's law, explain what happens when hanging masses are suspended from a spring?

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When a mass is suspended from a spring, a tensile force is applied, causing extension of the spring that is proportional to the mass added. This applies up to the limit of proportionality for the spring.

$$F = k\,\Delta x$$

(k = spring constant, Δx = change in length)

What is the difference between elastic and plastic deformation?

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Elastic deformation: when the force is removed the object will return to its original shape.

Plastic deformation: after the force is removed, the object will not return to its original shape (limit of proportionality has been exceeded).

How is energy stored during elastic deformation?

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The work done is transferred and stored as elastic potential energy.

Describe the energy changes that occur during plastic deformation.

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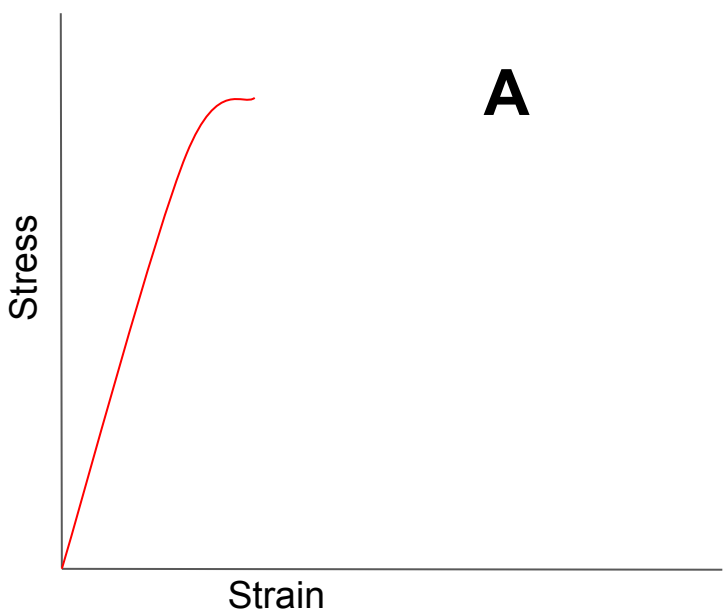
The material is stretched and the energy from the work done is used to break the bonds between the molecules. This causes permanent deformation.

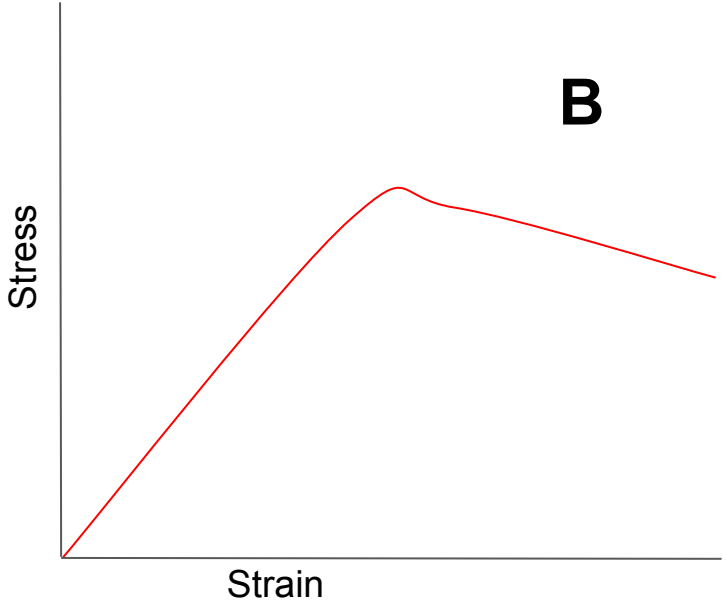
What is breaking stress?

What is breaking stress?

The amount of stress a material can take without it breaking.

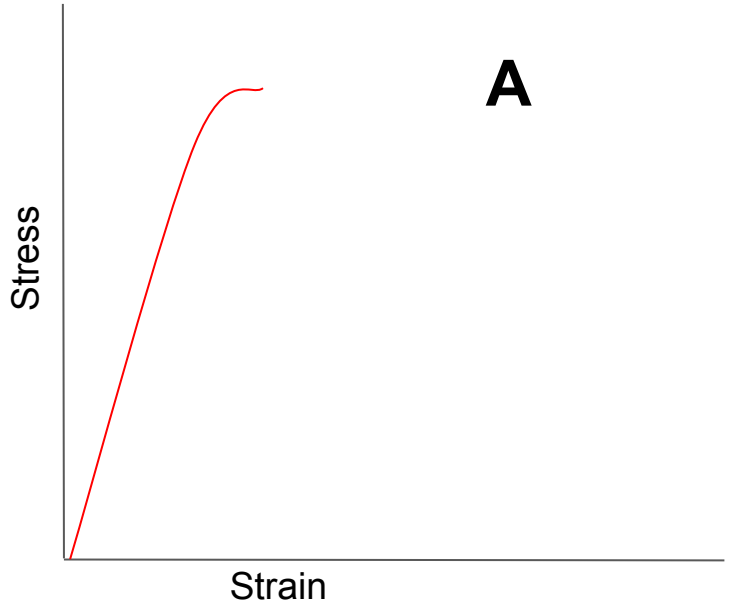
Which of these two graphs represents a brittle material?





Which of these two graphs represents a brittle material?

The material breaks without any noticeable yield.



What is meant when a material is described as brittle?

What is meant when a material is described as brittle?

It means the material tends to break, rather than deforming plastically, shortly after the limit of proportionality is overcome. As a result, the body tends to undergo less extension before it breaks.

What is the elastic limit?

What is the elastic limit?

The point after the which plastic deformation occurs.

If no further load is added beyond the elastic limit, will the subjected body continue to deform?

If no further load is added beyond the elastic limit, will the subjected body continue to deform?

Yes, once the elastic limit has been overcome, the material will continue to extend by plastic deformation, even if the load is not further increased.

What does the area underneath a force-extension graph represent?

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The work done.

Give the equation used to calculate elastic strain energy, in terms of the spring constant and extension.

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$$E = \frac{1}{2} k \Delta L^2$$

What is Young's modulus?

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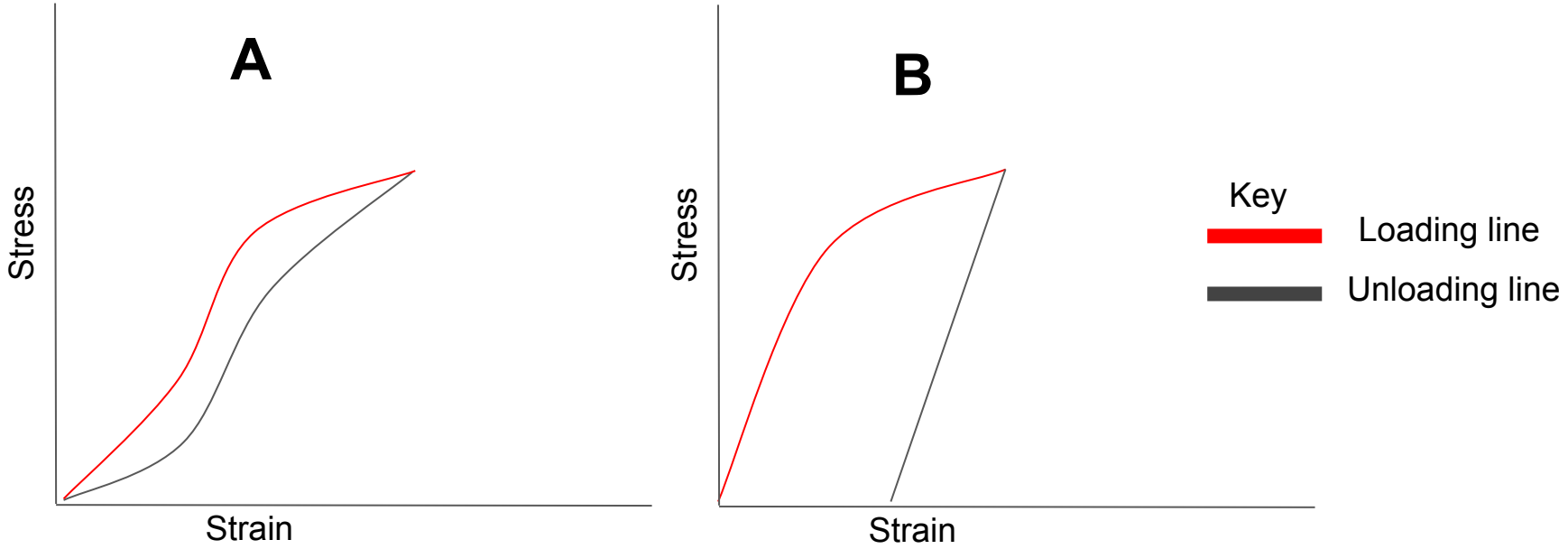
Young's modulus = tensile stress / tensile strain

How do you find the Young's modulus from a stress-strain graph?

How do you find the Young's modulus from a stress-strain graph?

Using the gradient of the line.

Which of these graphs would represent a wire which has plastically deformed?



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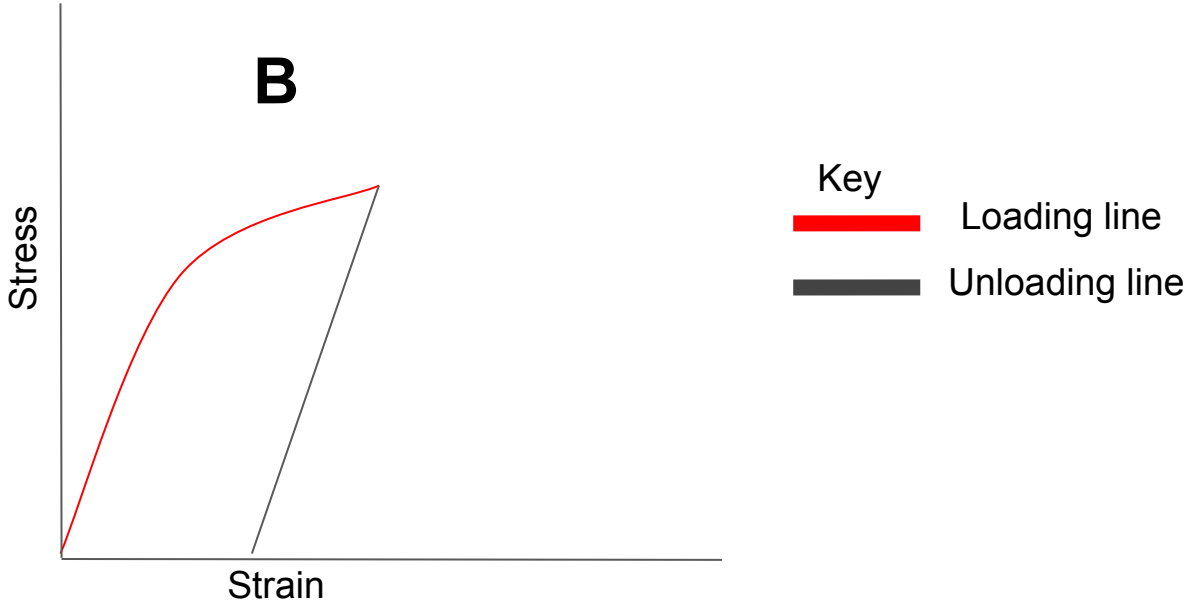
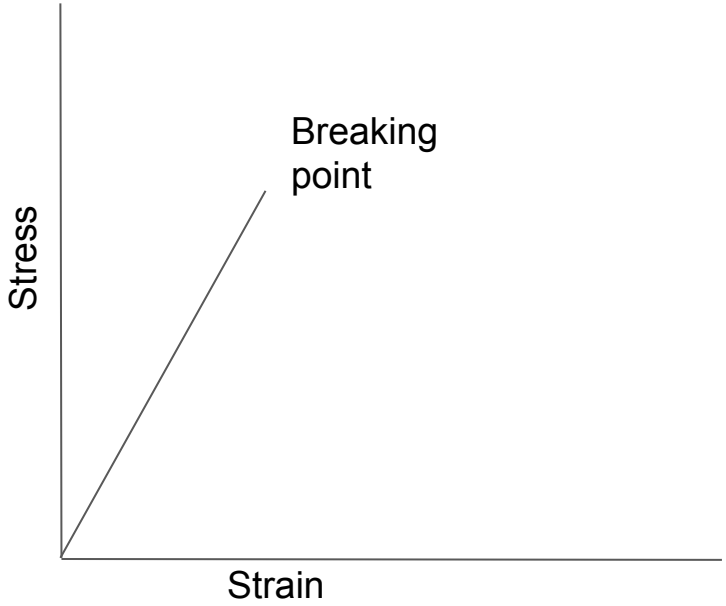


The diagram shows the stress-strain graph for material X. Describe the properties of X.

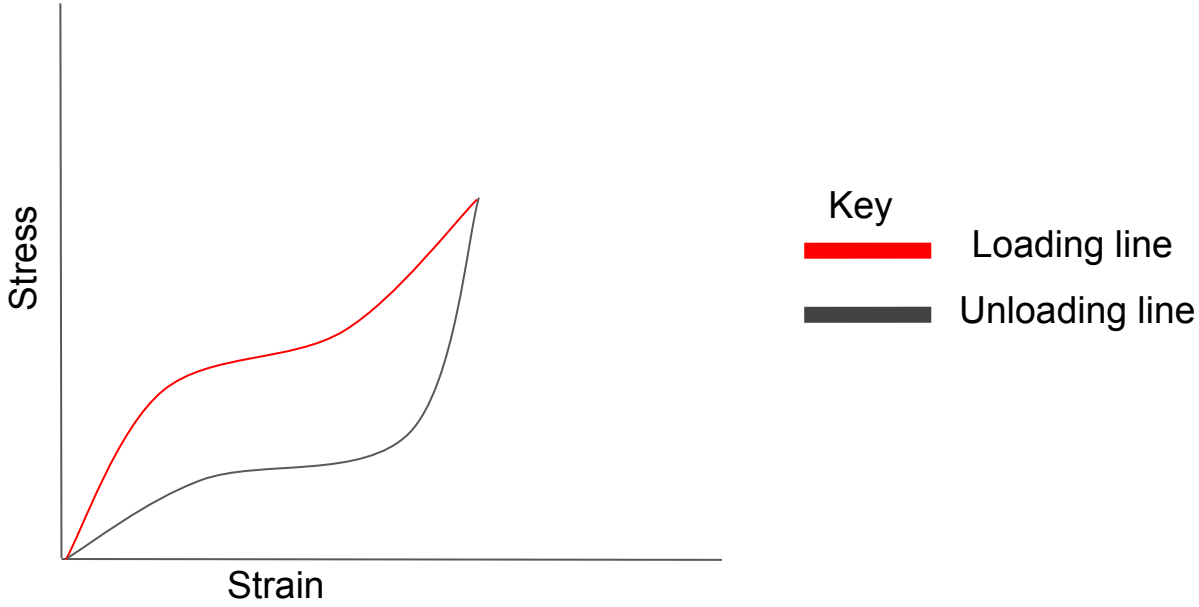


The diagram shows the stress against strain graph for material X. Describe the properties of X.

Material X is brittle. There is no plastic deformation (it is elastic) and returns to the same length when the stress is removed.

It obeys Hooke's law.

The diagram shows the stress against strain graph for material Y. Describe the properties of Y.

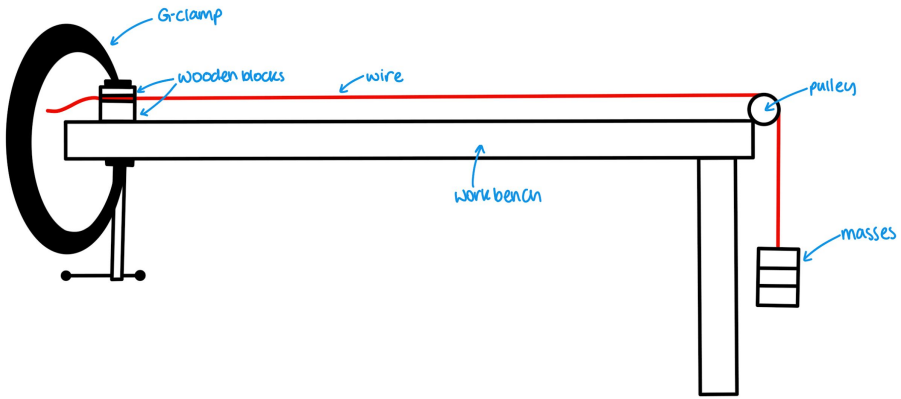


The diagram shows the stress against strain graph for material Y. Describe the properties of Y.

Material Y is a polymer. It is elastic and returns to the same length when the stress is removed.

It does not obey Hooke's law.

The diagram shows one possible method for determining the Young modulus of a metal in the form of a wire. Describe the measurements required.



The diagram shows one possible method for determining the Young modulus of a metal in the form of a wire. Describe the measurements required.

- Initial length.
- Extension (initial and final lengths).
- Weight (calculated from mass x g).

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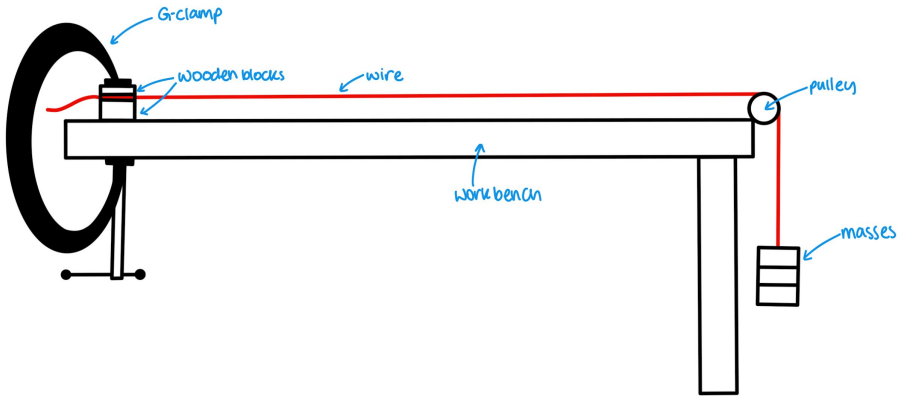
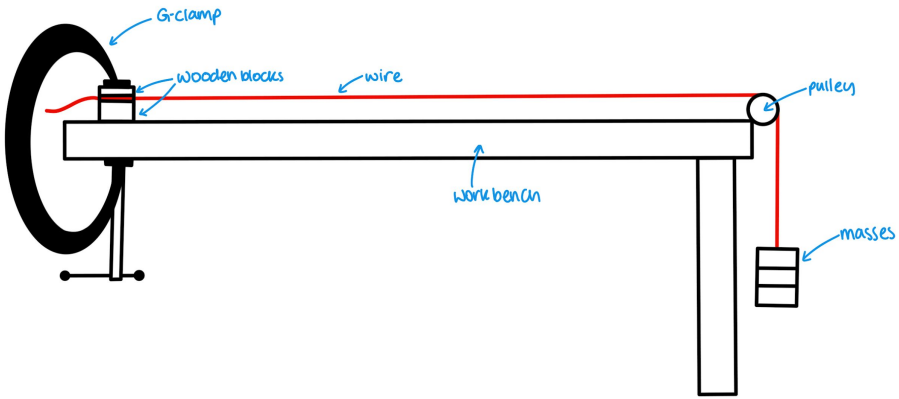


The diagram shows one possible method for determining the Young modulus of a metal in the form of a wire. Describe the equipment necessary.

- Micrometer or vernier calliper (for diameter of wire).
- Ruler (for initial length).
- Travelling microscope (for extension).
- Scales (for mass).
- Newton meter (for weights of masses).

The diagram shows one possible method for determining the Young modulus of a metal in the form of a wire. How can you determine the Young modulus from these measurements?



The diagram shows one possible method for determining the Young modulus of a metal in the form of a wire. How can you determine the Young modulus from these measurements?

- Stress = force / cross-sectional area
- Strain = extension / original length
- Young's Modulus = Stress / Strain
- This is equal to the gradient from the stress-strain graph.