OCR A-Level Physics

3.4 Materials

Flashcards

What is meant by extension and compression of a string?

What is extension and compression of a string?

Tensile forces act away from the centre of the spring in both directions and will stretch it out causing the spring to extend.

Forces acting towards the centre of the spring in both directions is called compression.

What happens to the 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 Hooke's law?

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In a material showing Hooke's law, the force applied is directly proportional to the extension in length, up to the limit of proportionality.

$$F = k\Delta x$$

[k = spring constant, Δx = change in length]

What is meant by tensile stress?

What is meant by tensile stress?

The force per unit area.

What is tensile strain?

What is tensile strain?

A measure of how the material stretches: the extension divided by the original length. This value is a ratio, so it has no units.

What is the difference between elastic and plastic deformation?

What is the difference between elastic and plastic deformation?

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?

How is energy stored during elastic deformation?

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

Describe the energy changes that occur during plastic deformation.

Describe the energy changes that occur during plastic deformation.

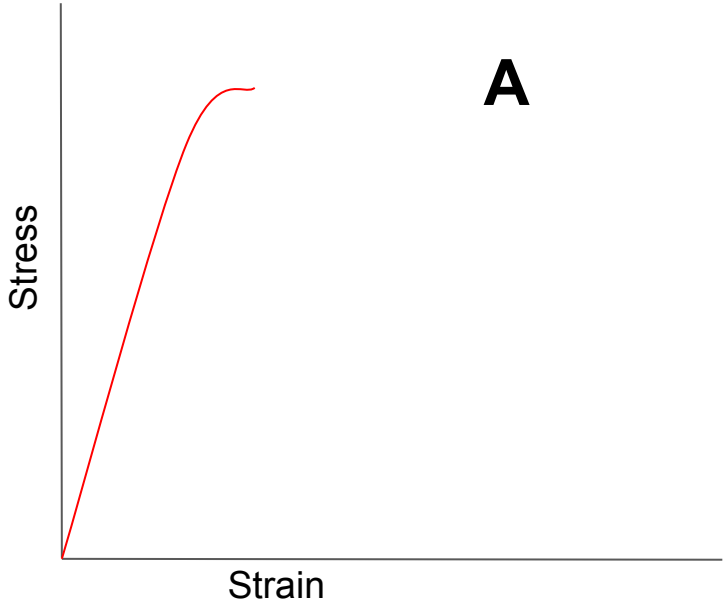
The material is stretched and the energy from the work done is used to break the bonds between the molecules. This causes permanent deformation.

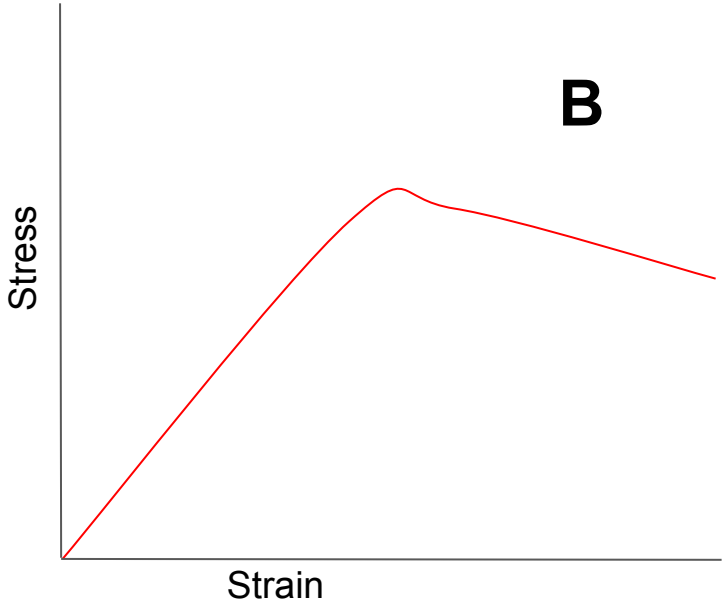
What is breaking stress?

What is breaking stress?

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

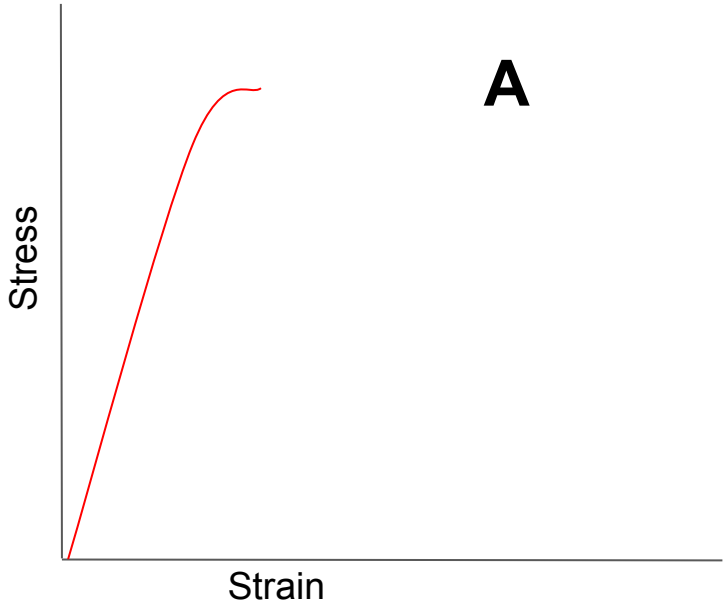
Which of these two graphs represents a brittle material?





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 does not extend much when a force is applied (tensile strain stays low). The material tends to break rather than stretch under a large force.

What is the elastic limit?

What is the elastic limit?

The point after the which plastic deformation occurs. It is sometimes also referred to as the ‘limit of proportionality’.

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

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

The energy stored in the material.

Give the equation that calculates elastic strain energy in terms of spring constant and extension.

Give the equation that calculates elastic strain energy in terms of spring constant and extension.

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

What is Young's modulus?

What is Young's modulus?

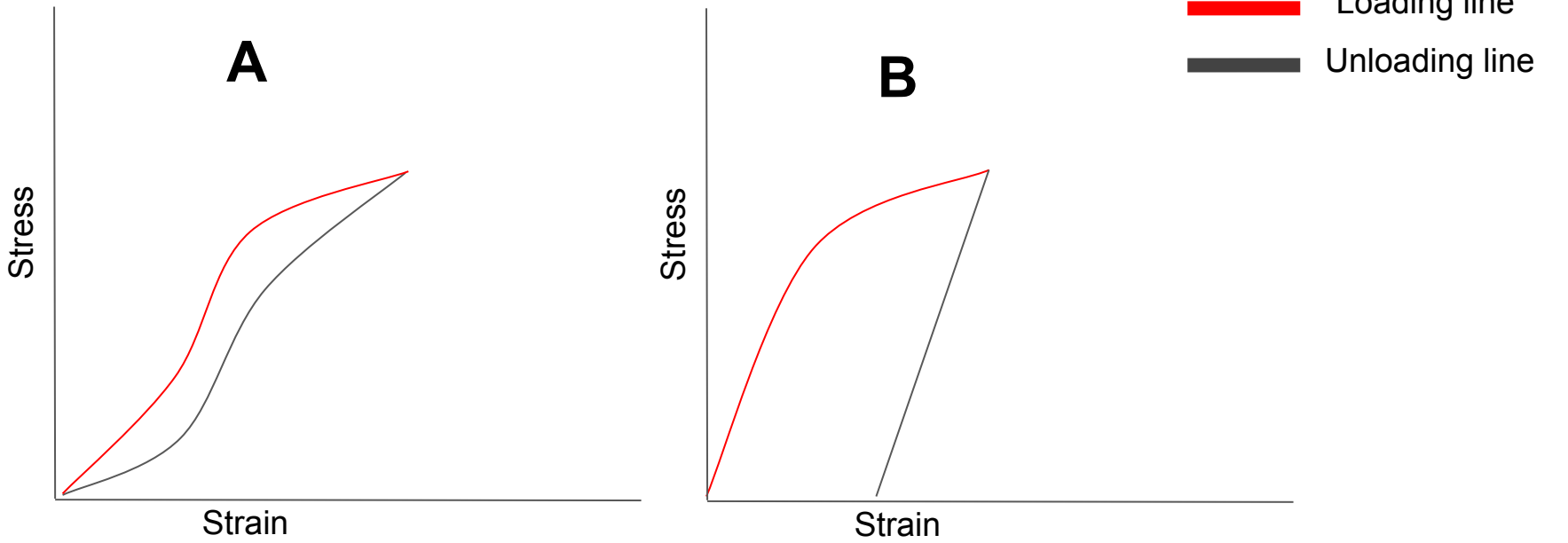
Young's modulus = tensile stress / tensile strain

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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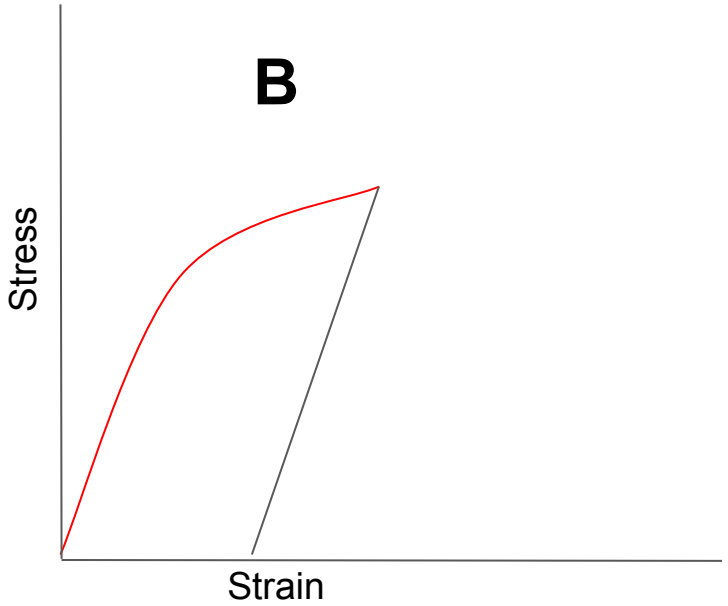
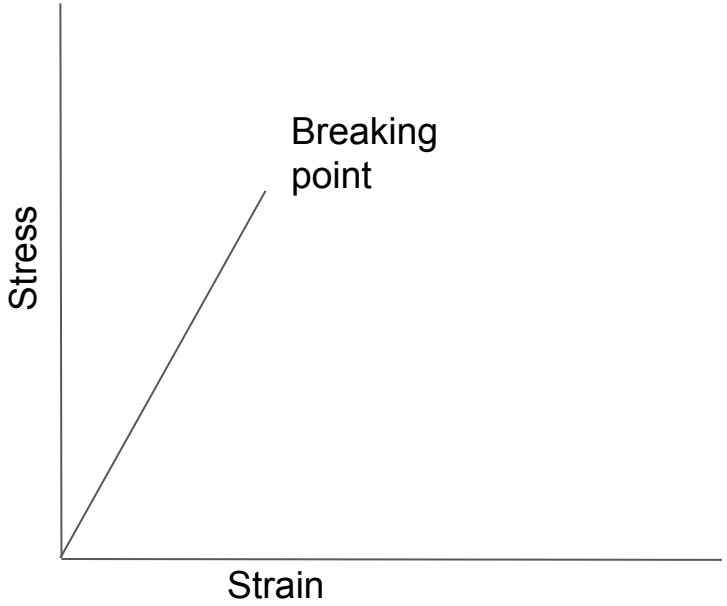


Key

Loading line

Unloading line

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

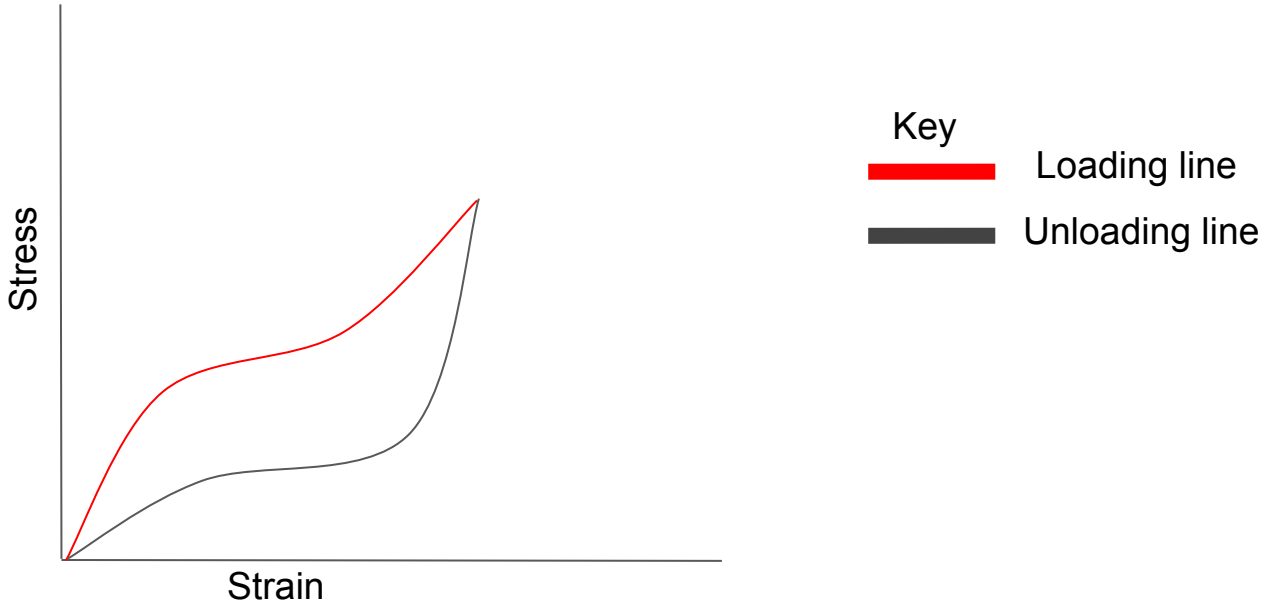


The diagram shows the stress against strain graph for material X. Describe the properties of X.

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.



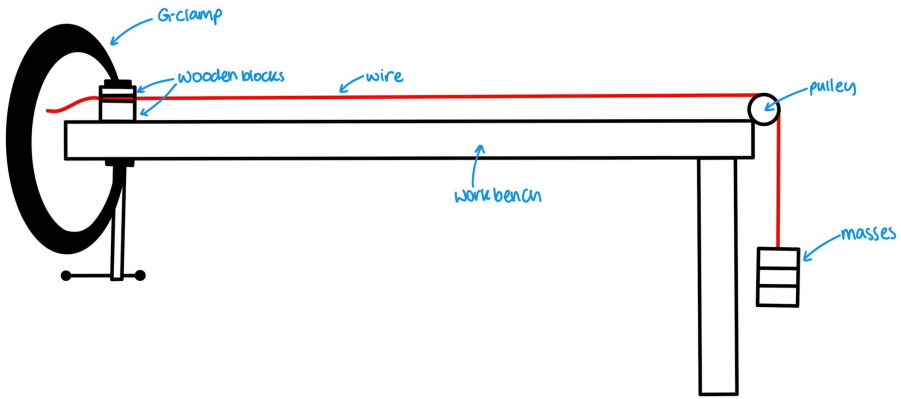
The diagram shows the stress against strain graph for material Y. Describe the properties of Y.

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.

a. Describe the measurements required



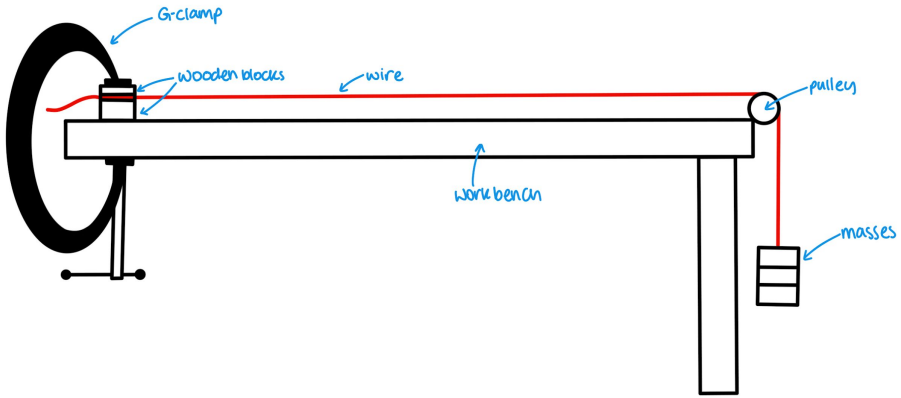
The diagram shows one possible method for determining the Young modulus of a metal in the form of a wire.

a. Describe the measurements required

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

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

b. Describe the equipment required



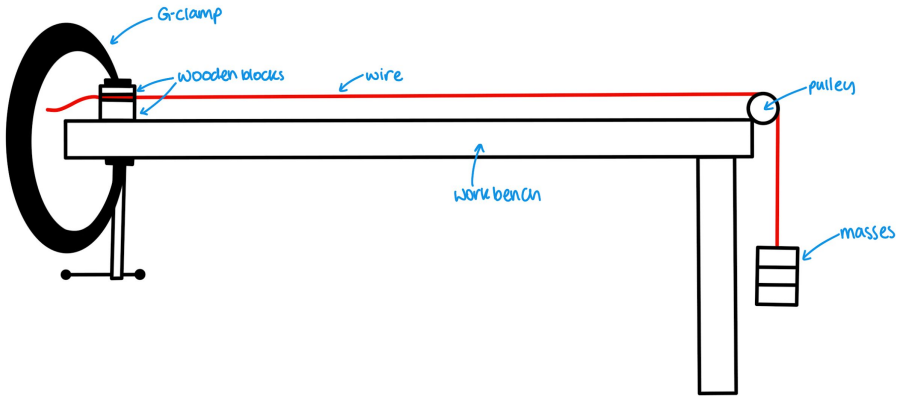
The diagram shows one possible method for determining the Young modulus of a metal in the form of a wire.

b. Describe the equipment required

- Micrometer or vernier calliper (for diameter of wire)
- Rule (for initial length)
- Travelling microscope (for extension)
- Scales (for mass)
- Newtonmeter (for weights of masses)

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

c. 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.

c. 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