AQA Physics A Level

Topic 4.2 Materials

Flashcards

What is Hooke's law?

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Extension (ΔL) is directly proportional to force applied (F), given that the environmental conditions are kept constant.

$F = k\Delta L$ k is the stiffness constant in Nm^-1

What equation is used to calculate density?

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Density = Mass / Volume

Density units: kgm^-3

Mass: kg

Volume: m^3

What is meant by tensile stress?

What is meant by tensile stress?

The force applied per unit cross sectional area.

Stress = force / CSA

Stress units: Nm^{-2}

Force units: N

Cross sectional area units: m^2

What is tensile strain?

What is tensile strain?

A measure of how the material stretches: the extension (ΔL) divided by the original length (L), strain has no units.

$$Strain = \Delta L / L$$

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.

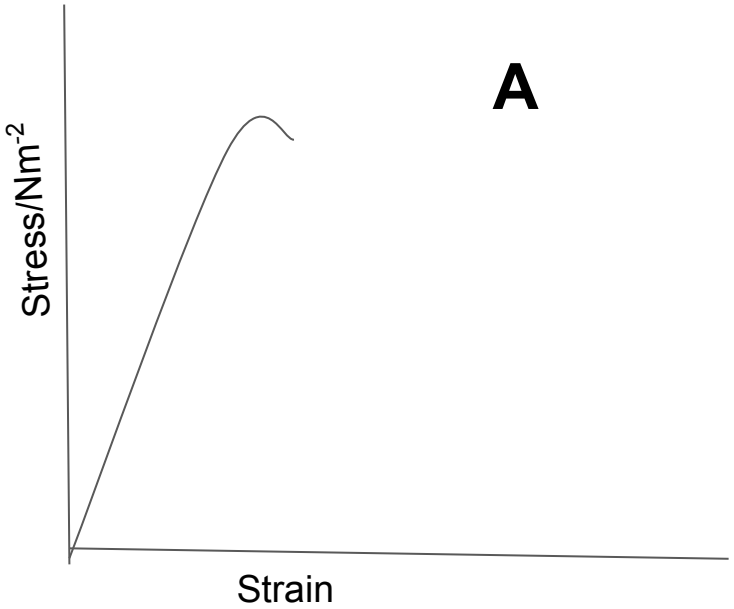
Plastic deformation: after the load is removed the object will not return to its original shape.

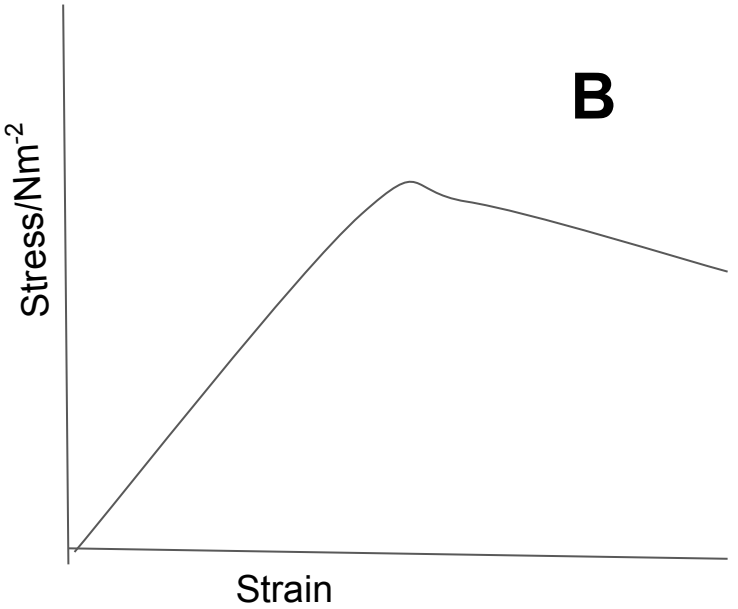
What is breaking stress?

What is breaking stress?

The minimum stress needed to break a material.

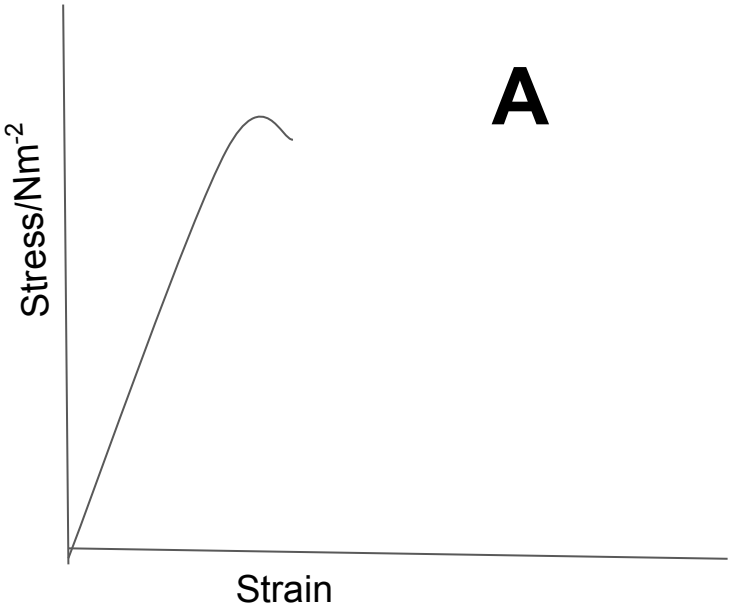
Which of these two graphs represents a brittle material?





Which of these two graphs represents a brittle material?

A



What is meant when a material is described as brittle?

What is meant when a material is described as brittle?

It doesn't deform plastically but breaks when the stress reaches a certain value.

What is the elastic limit?

What is the elastic limit?

The force above which the material will be plastically deformed (permanently stretched).

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

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

The work done to deform the material.

$$Work\ done = \frac{1}{2} \times F \times \Delta L$$

State the equation to calculate elastic strain energy from the spring constant and extension.

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

What is Young's modulus?

What is Young's modulus?

Young's modulus (E) = tensile stress/ tensile strain.

$$E = FL / \Delta LA$$

(by substituting stress and strain equations).

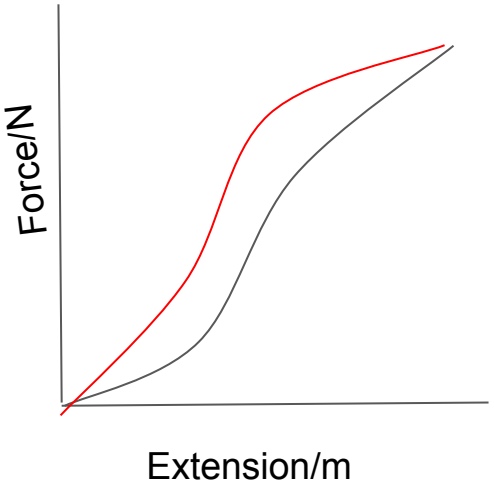
It describes the stiffness of a material.

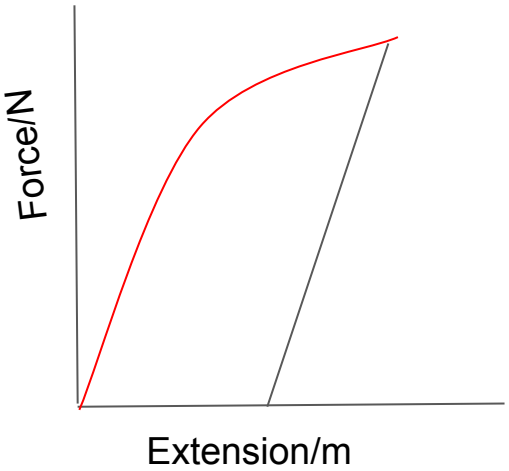
How do you find the Young's modulus from a stress-strain graph?

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

The gradient of the line.

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





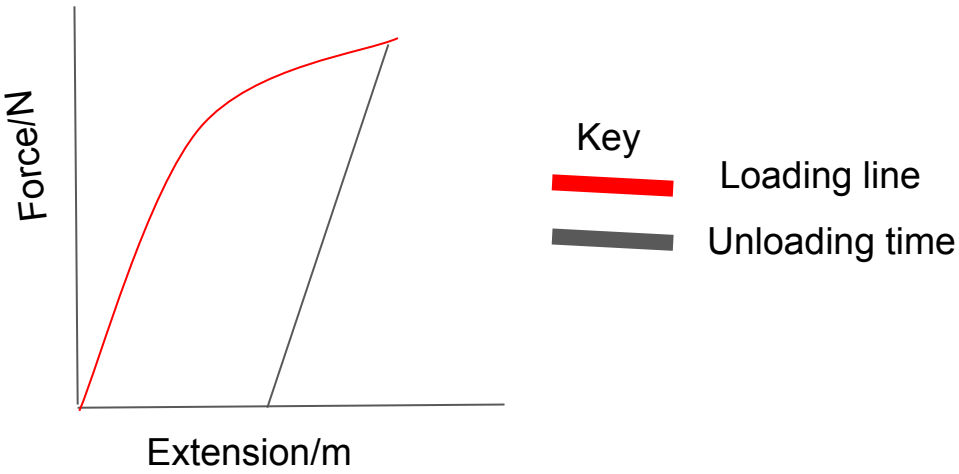
Key

Loading line

Unloading time

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

The unloading line doesn't go through the origin as the material is permanently extended (stretched)



How can a force-extension graph show Hooke's Law is being obeyed?

How can a force-extension graph show Hooke's Law is being obeyed?

When it is a straight line through the origin ie. force and extension are directly proportional.

What is the limit of proportionality and what does it look like on a force-extension graph?

What is the limit of proportionality and what does it look like on a force-extension graph?

The point after which Hooke's law is no longer obeyed, it is shown by the line beginning to curve on a force-extension graph.

How is the work done to stretch or compress a material stored?

How is the work done to stretch or compress a material stored?

Elastic strain energy.

Why are the loading and unloading lines parallel on a force-extension graph for a plastically deformed material?

Why are the loading and unloading lines parallel on a force-extension graph for a plastically deformed material?

The stiffness constant (k) hasn't changed, the forces between the atoms are the same when loading and unloading.

Why isn’t all work done stored as elastic strain energy when a stretch is plastic?

Why isn't all work done stored as elastic strain energy when a stretch is plastic?

Work is done to move atoms apart, so energy is not stored as elastic strain energy but is dissipated as heat.

How is the dissipation of energy in plastic deformation used to design safer vehicles?

How is the dissipation of energy in plastic deformation used to design safer vehicles?

- Crumple zones deform plastically in a crash using the car's kinetic energy so less is transferred to the passengers.
- seat belts stretch to convert the passenger's kinetic energy into elastic strain energy.

Outline the energy changes that occur when a spring fixed at the top is pulled down and released

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The work done in pulling the spring down (stretching it) is stored as elastic strain energy, when the spring is released this is converted to kinetic energy which is converted to gravitational potential energy as the spring rises

Do stress-strain graphs show the behaviour of a material or a specific object?

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Material.

Where would you find the ultimate tensile stress on a stress-strain graph?

Where would you find the ultimate tensile stress on a stress-strain graph?

The highest point on a graph, it is the maximum stress a material can withstand.

What would the stress-strain graph for a ductile material look like?

What would the stress-strain graph for a ductile material look like?

A ductile material can undergo a large amount of plastic deformation before fracturing.