Materials 2

Have a go at the following exam questions.

WJEC, 1325/01, JUNE 2010

(Some of this question may be tricky if you don't study WJEC – in that case just miss out any parts you're not familiar with and have a go at the later questions)

C9. *(a)* (i) By drawing simple diagrams showing positions of atoms, give a detailed description, in terms of dislocations, of plastic deformation in a ductile material such as a pure metal. [4]

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(ii) Describe at the atomic level **one** method of making pure metals stronger and stiffer. [2]

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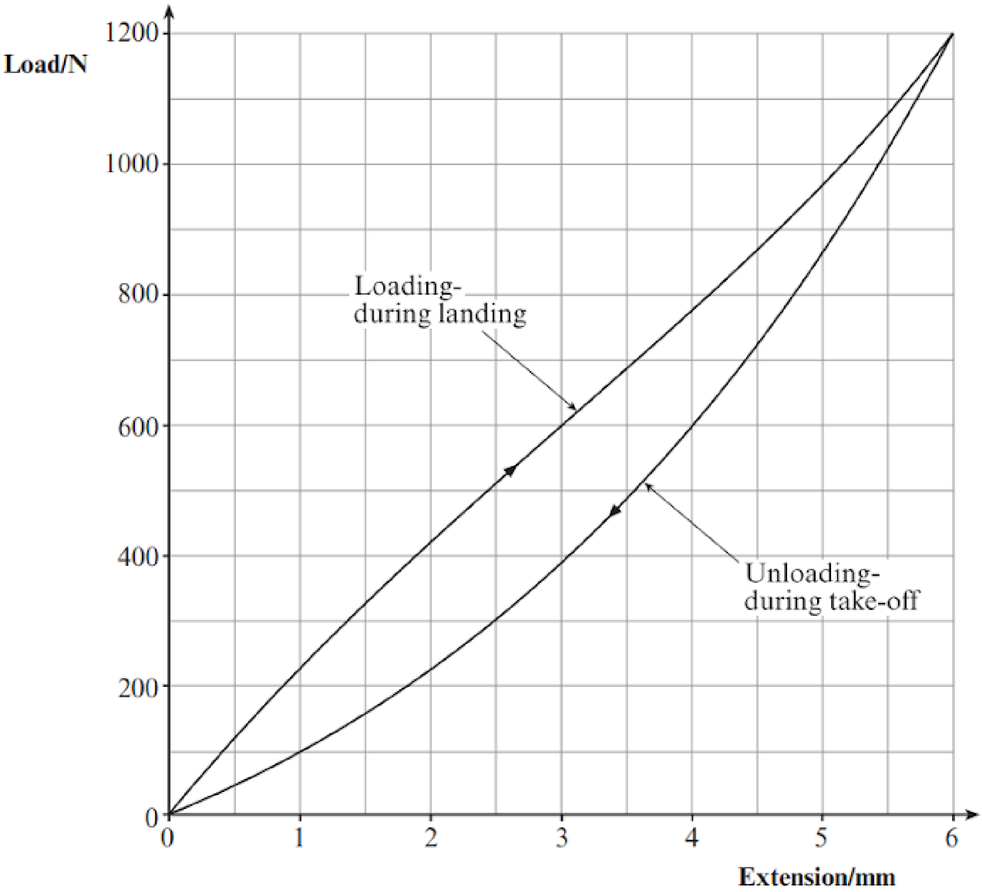
(b) A kangaroo stores much of its kinetic and potential energy in its achilles tendons during 'hopping'. The achilles tendon is, in fact, well suited to serve as an effective spring (or rubber band) for energy recovery. During one 'hop', **most** of the energy that is used to stretch the tendon during 'landing' can be recovered elastically to aid 'take off' thus helping to offset the work the muscles have to do.

A typical Load-extension graph for a kangaroo achilles tendon is shown for one complete 'hop'.



(i) The tendon returns to its original length after unloading, but not along the same curve as during loading. What is this effect called? [1]

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(ii) Compare the energy stored in the tendon after loading with that recovered form it after unloading and account for the difference. [No calculations are required here]. [2]

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(iii) Estimate the percentage efficiency of the tendon in re-using the energy stored in it. [3]

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(iv) I. If it is assumed that the tendon obeys Hooke's law, show that

$$W = \frac{F^2 l}{2AE}$$

Where W is the energy stored during loading, A is the mean cross-sectional area of the tendon, l is the original length, F is the load on the tendon and E is the Young Modulus. [3]

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II. The cross-sectional area of the tendon is 0.55cm^2 and its original length is 30 cm. Hence estimate the Young modulus for the tendon. [3]

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(v) What particular mechanical properties should scientists look for in order to make artificial tendons? [2]

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OCR, G481, JUNE 2010

7 **(a)** Fig. 7.1 shows stress against strain graphs for two materials **X** and **Y** up to their breaking points.

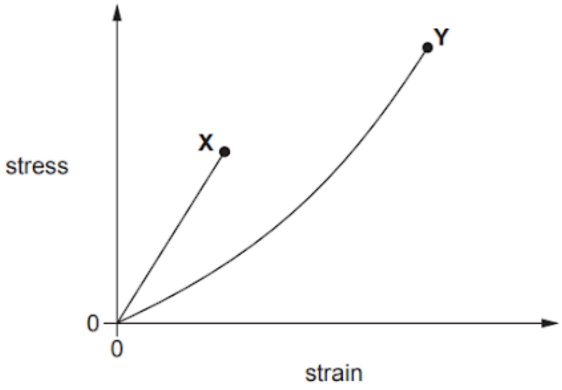

Fig. 7.1

Put a tick (✓) in the appropriate column if the statement applies to the material.

Statement	X	Y
This material is brittle.		
This material has greater breaking stress.		
This material obeys Hooke's Law.		

[1]

(b) Kevlar is one of the strongest man-made materials. It is used in reinforcing boat hulls, aircraft, tyres and bullet-proof vests. Sudden impacts cause this material to undergo plastic deformation.

(i) Explain what is meant by *plastic deformation*.

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.... **[1]**

(ii) One particular type of Kevlar has breaking stress 3.00×10^9 Pa and Young modulus 1.30×10^{11} Pa. For a Kevlar thread of cross-sectional area $1.02 \times 10^{-7}\,m^2$ and length 0.500 m, calculate

1 the maximum breaking force

force = ... N

2 the extension of the thread when the stress is 1.20×10^9 Pa.

extension = ... m
[4]

[Total: 6]

CIE JUNE 2009 PAPER 2 (VERSION 1)

4 A spring having spring constant *k* hangs vertically from a fixed point. A load of weight *L*, when hung from the spring, causes an extension *e*. The elastic limit of the spring is not exceeded.

(a) State

(i) what is meant by an *elastic deformation*,

....

....

.... [2]

(ii) the relation between *k*, *L* and *e*.

.... [1]

(b) Some identical springs, each with spring constant *k*, are arranged as shown in Fig. 4.1.

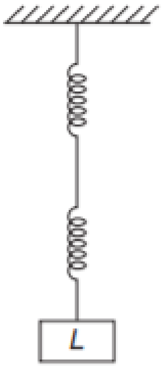
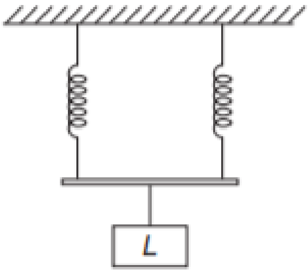
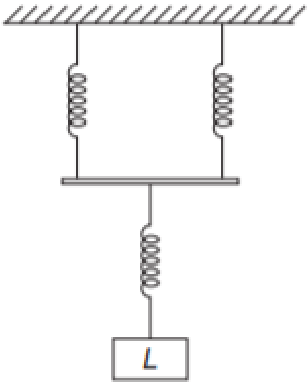
arrangement	total extension	spring constant of arrangement
	....	....
	....	....
	....	....

Fig. 4.1

The load on each of the arrangements is *L*.

For each arrangement in Fig. 4.1, complete the table by determining

(i) the total extension in terms of *e*,

(ii) the spring constant in terms of *k*.