

## Chapter 4

### Multiple choice and Quick Questions

A list of terms used by materials scientists is given below.

1. Which one of the terms **A** to **D** below best describes the continuing extension of a material under a constant load?

**A** alloying    **B** annealing    **C** creep ✓    **D** work hardening

2. Which one of terms **A** to **D** below best describes a process which makes a material less stiff?

**A** alloying    **B** annealing ✓    **C** creep    **D** work hardening

3. Which of the following words can be used to describe the physical properties of ceramic tiles?

1      brittle

2      tough

3      stiff

**A** 1 only    **B** 2 only    **C** 1 and 3 only ✓    **D** 2 and 3 only    **E** 1, 2 and 3

4. The calf muscle in the human leg can exert a tensile force of up to 1500 N on the Achilles tendon in the lower part of the leg. The area of cross-section at the centre of the muscle is approximately 7000 mm<sup>2</sup> and the area of cross-section of the tendon is approximately 110 mm<sup>2</sup>.

Which of **A** to **E** below is the best estimate for the maximum tensile stress, in Pa, in the calf muscle?

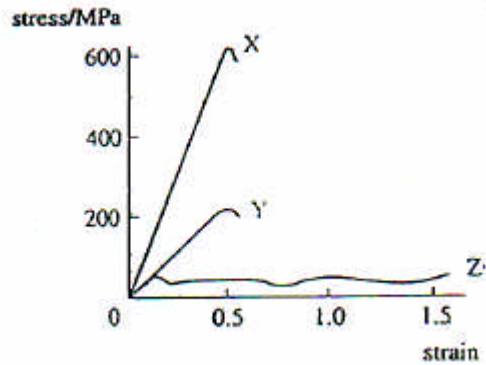
**A** 4.7    **B**  $1.5 \times 10^3$     **C**  $2.1 \times 10^3$     **D**  $1.5 \times 10^5$     **E**  $2.1 \times 10^5$  ✓

5. Which of **A** to **E** below is the best estimate for the ratio  
tensile stress in tendon  
tensile stress in calf muscle ? (Use the data in question 4).

**A**  $2.5 \times 10^{-4}$     **B**  $1.6 \times 10^{-2}$     **C** 64 ✓    **D**  $4.0 \times 10^3$     **E**  $9.5 \times 10^3$

6. Which one of the following could **not** be used as a unit of pressure?
- A Pa                      B  $\text{N m}^{-2}$                       C  $\text{J m}^{-3}$                       D  $\text{kg m}^{-1} \text{s}^{-2}$
- E  $\text{kg m s}^{-2}$  ✓

7.



The graph shows the stress-strain curves for three materials. Which of the following statements is not correct?

- A Y is stiffer than Z for strains up to 0.5.
- B X and Y have constant values for the Young modulus for strains smaller than 0.25.
- C For the same strain Y will have a greater strain than X. ✓
- D For the same stress X will have a smaller strain than Y.
- E Z will stretch to twice its original length without breaking.

8. For a piece of material under tensile stress, the energy stored per unit volume can be calculated from the stress and the strain.

Which one of the following expressions has the right dimensions for the energy per unit volume?

- A (stress) x (strain) ✓    B (stress)<sup>2</sup>    C (strain)<sup>2</sup>    D (stress)<sup>2</sup>/(strain)
- E (strain)<sup>2</sup>/(stress)

9. Copper wires can be made by drawing from solid copper but glass fibres can only be made by drawing from molten glass.

Which comparison below is the best single explanation of this difference?

- A Solid copper has a lower Young modulus than solid glass.  
 B Solid copper shows plastic yielding, but solid glass is brittle. ✓  
 C Solid copper can easily be work-hardened; solid glass cannot.  
 D Copper has a definite melting point; glass has not.  
 E Solid copper extends elastically more than solid glass under the same stress.

10. The diagram (Fig. 1) shows a longitudinal section through a metal wire of circular cross-section which has a diameter  $d$  everywhere except for one region  $CE$  which is thinner than the rest. The minimum diameter of the wire in the thinner section is  $\frac{1}{2} \times d$  at  $D$ .

The end  $A$  is anchored firmly and the wire is stretched but not broken by a force  $F$  applied at  $B$ .

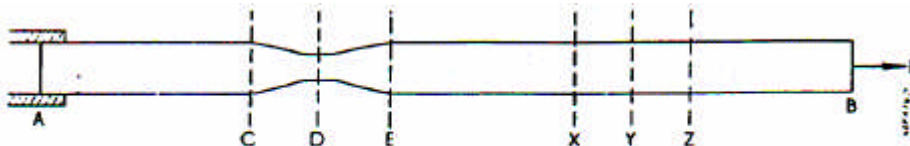


FIG. 1

- (a) What is the tension in the wire at  $D$ ? Explain how you arrive at your answer.

.The tension is  $F$  along all points of the wire

- (b) Calculate the ratio of the stresses in the wire at  $D$  and  $Y$ . Show how you arrived at your answer.

Stress at  $D$  =

$$F \div \pi \left(\frac{d}{4}\right)^2 \Rightarrow \left(\frac{\text{Stress}(D)}{\text{Stress}(Y)} = \frac{16}{4} = \frac{4}{1}\right)$$

$$\text{Stress at } Y = F \div \pi \left(\frac{d}{2}\right)^2$$

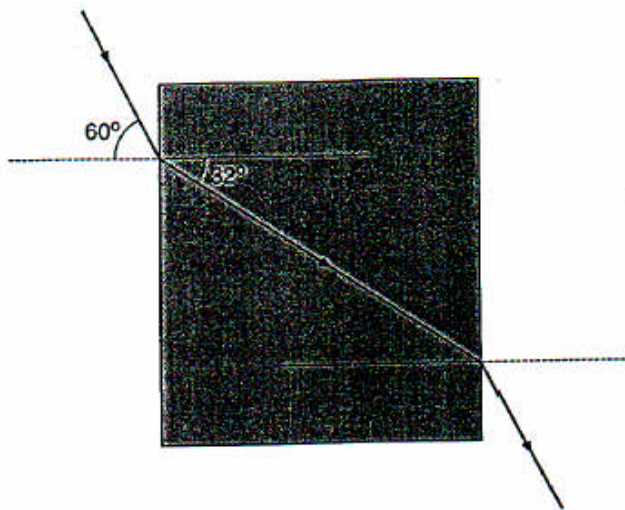
- (c) Consider two equal length sections of the unstretched wire. More energy is stored in the section that stretches to become CE, than the one that stretches to become XZ.

Give an explanation of this in terms of the work done in stretching the wire.

Work done = force x extension.

So larger extension CE means more energy stored.....

11.



The diagram shows the path of a light ray through a rectangular block of glass.

Which one of rows **A** to **D** in the table below correctly describes the changes in frequency, velocity and wavelength of the light as it **enters** the glass?

	<b>frequency</b>	<b>velocity</b>	<b>wavelength</b>
<b>A</b>	increases	increases	constant
<b>B</b>	increases	decreases	constant
<b>C</b>	constant	decreases	constant
<b>D</b>	constant	decreases	decreases ✓

12. Which one of **A** to **D** below is the value of the refractive index of the glass/air surface? (See diagram above).

- A** 0.530      **B** 0.866      **C** 1.63 ✓      **D** 1.88