1 **(a)** Fig. 8.1 shows a graph of stress against strain for rubber.

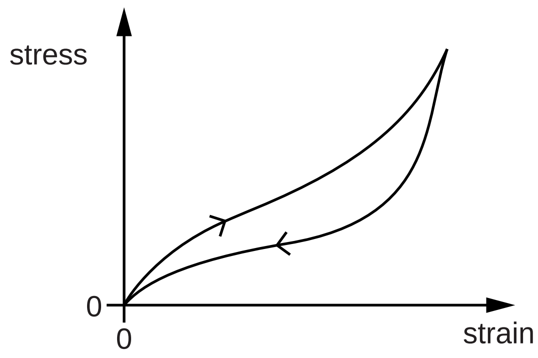


Fig. 8.1

Use Fig. 8.1 to describe the main physical properties of this material.

In your answer, you should use appropriate technical terms, spelled correctly.

....

....

....

....

....

....

.... **[3]**

(b) Fig. 8.2 shows a metal strip pulled from its ends until it breaks.

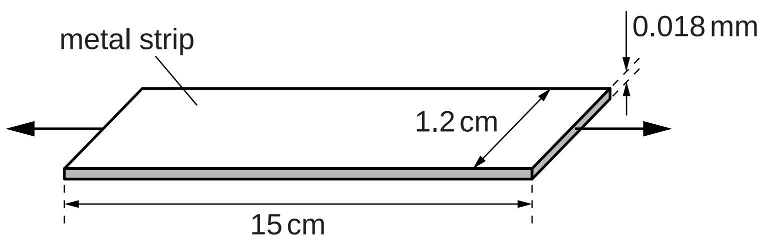


Fig. 8.2

The strip is 15 cm long, 1.2 cm wide and 0.018 mm thick. The breaking force for this strip is 16 N. The Young modulus of the metal is 7.1×10^{10} Pa.

(i) Calculate the extension of the metal strip when it breaks. State one assumption made in your calculation.

extension = ... m **[3]**

assumption: ....

.... **[1]**

(ii) Calculate the breaking force of a rod of radius 0.60 cm made from the same metal.

breaking force = ... N **[2]**

2 A light spring of unextended length 2.0 cm is hung from a fixed point. An object of weight 3.0 N is hung from the other end of the spring. Fig. 7.1 shows the length of the spring when the object is in equilibrium.

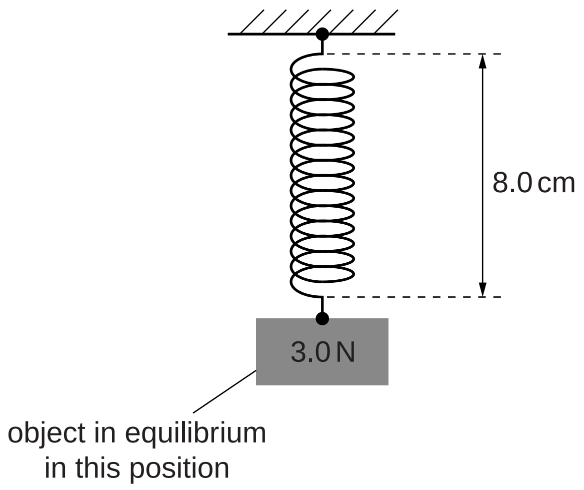


Fig. 7.1

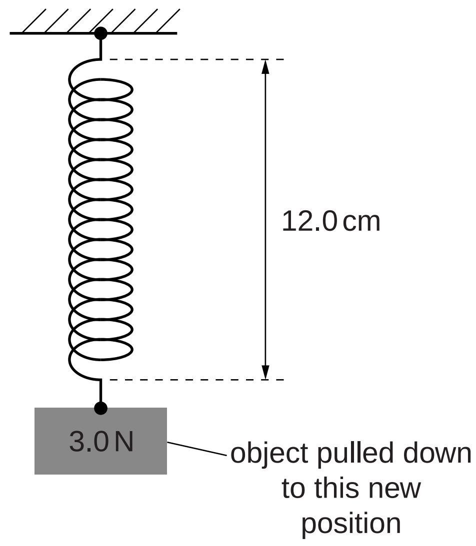


Fig. 7.2

(a) Show that the force constant of the spring is $50\,\text{N}\,\text{m}^{-1}$.

[1]

(b) The object is pulled vertically downwards. Fig. 7.2 shows the new length of the spring.

(i) Calculate the change in the elastic potential energy ΔE in the spring.

ΔE = ... J **[3]**

(ii) The object is released from its position shown in Fig. 7.2. Calculate the initial upward acceleration a of the object.

a = ... $m\,s^{-2}$ **[3]**

[Total: 7]

3 **(a)** Fig. 6.1 shows the stress against strain graphs of two materials **X** and **Y**.

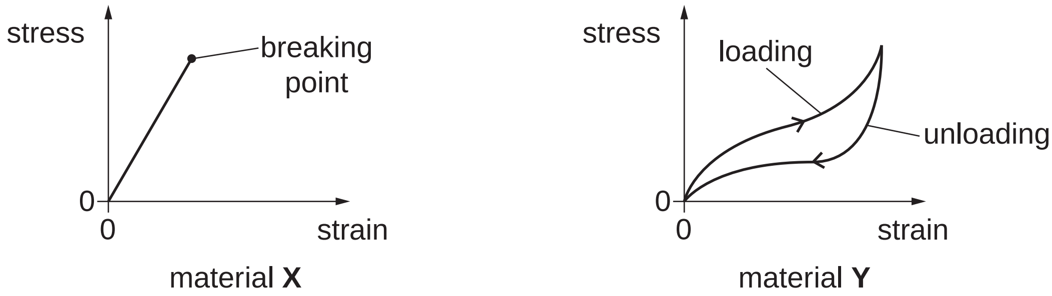


Fig. 6.1

Describe the properties of materials **X** and **Y**.

In your answer, you should use appropriate technical terms, spelled correctly.

material **X** ....

....

....

....

....

material **Y** ....

....

....

....

.... **[5]**

(b) You are given a spring, a metre rule and a 100 g mass. Describe how you would determine the force constant k of the spring.

....

....

....

....

.... **[3]**

(c) A glider of mass 0.180 kg is placed on a horizontal frictionless air track. One end of the glider is attached to a compressible spring of force constant $50\,N\,m^{-1}$. The glider is pushed against a fixed support so that the spring compresses by 0.070 m, see Fig. 6.2. The glider is then released.

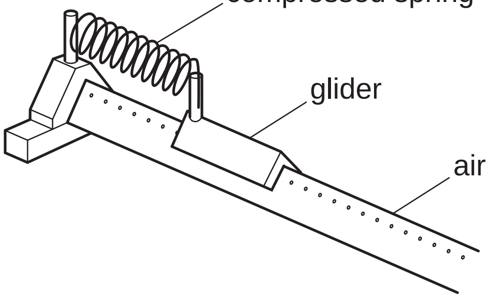


Fig. 6.2

(i) Calculate the horizontal acceleration of the glider **immediately** after release.

acceleration = ... $m\,s^{-2}$ **[3]**

(ii) After release, the spring exerts a force on the glider for a time of 0.094 s. Calculate the average rate of work done by the spring on the glider.

average rate of work done = ... $J\,s^{-1}$ **[2]**

[Total: 13]

4 **(a)** Atoms in a solid are held in position by electrical forces. These electrical forces can be represented by an imaginary 'interatomic spring' between neighbouring atoms, see Fig. 7.1.

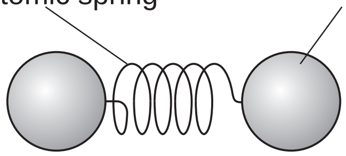
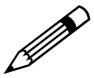


Fig. 7.1

The interatomic spring obeys *Hooke's law* and has a *force constant* just as a normal spring in the laboratory. Researchers in America have recently managed to determine the force experienced by an individual atom of cobalt when the atoms are squeezed together. The researchers found that a force of 210 pN changed the separation between a pair of atoms by a distance of 0.16 nm.

(i) State *Hooke's law*.



In your answer, you should use appropriate technical terms, spelled correctly.

....

....

.... **[1]**

(ii) Calculate the force constant of the interatomic spring for a pair of cobalt atoms.

force constant = ... $N\,m^{-1}$ **[3]**

(b) Fig. 7.2 shows a stress against strain graph for a metal wire up to its breaking point.

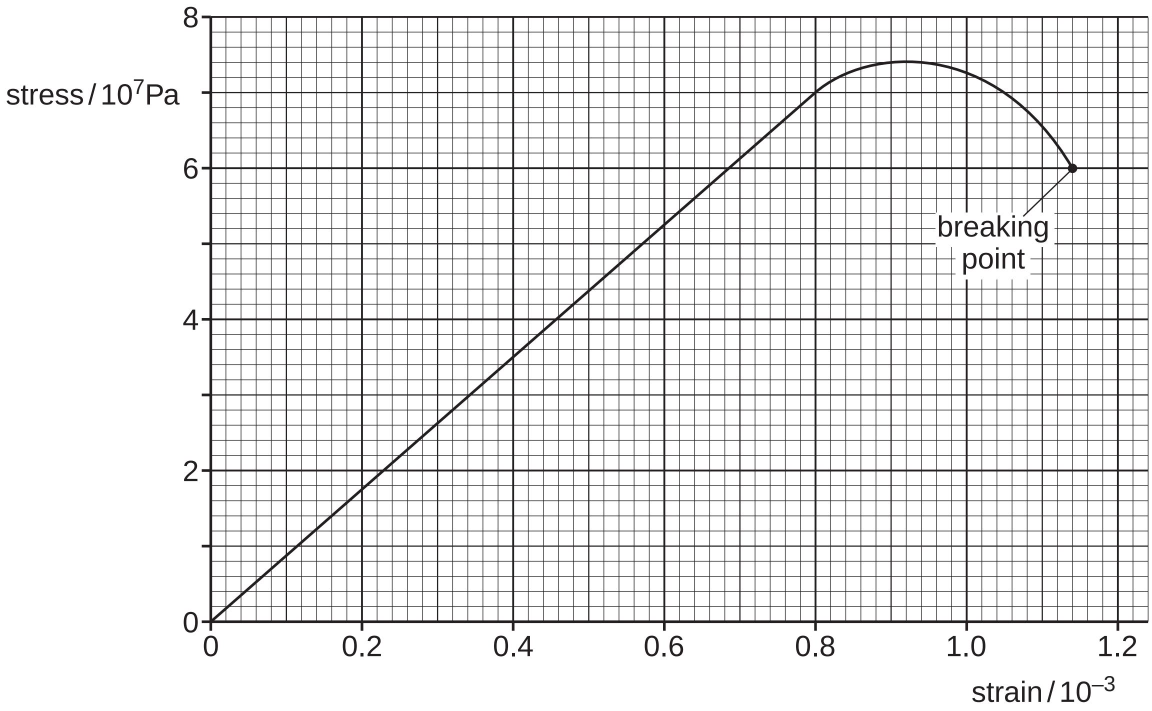


Fig. 7.2

(i) Use the graph to determine the Young modulus of the metal.

Young modulus = ... unit ....**[3]**

(ii) The wire breaks when a force of 19 N is applied. Use the graph to determine the cross-sectional area of the wire at the breaking point.

area = ... m^2 **[2]**

[Total: 9]

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

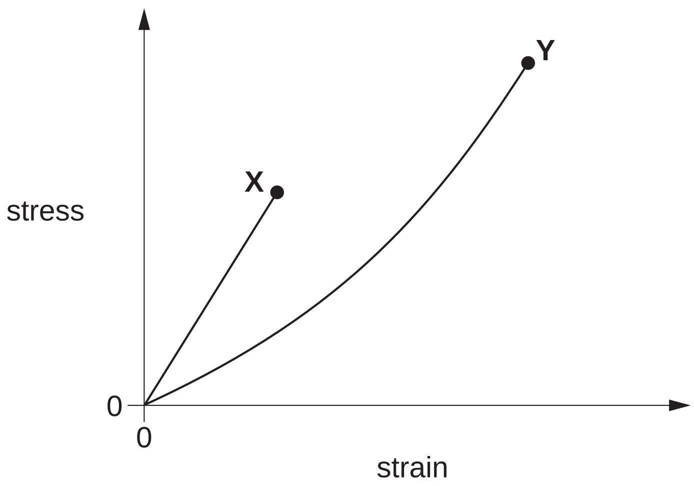


Fig. 7.1

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*.

....

....

.... **[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 1.02×10^{-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]