1 A brochure states that a particular type of wood is “extremely tough and does not become brittle over time”.

(a) Describe what is meant by the following terms

(2)

tough

brittle

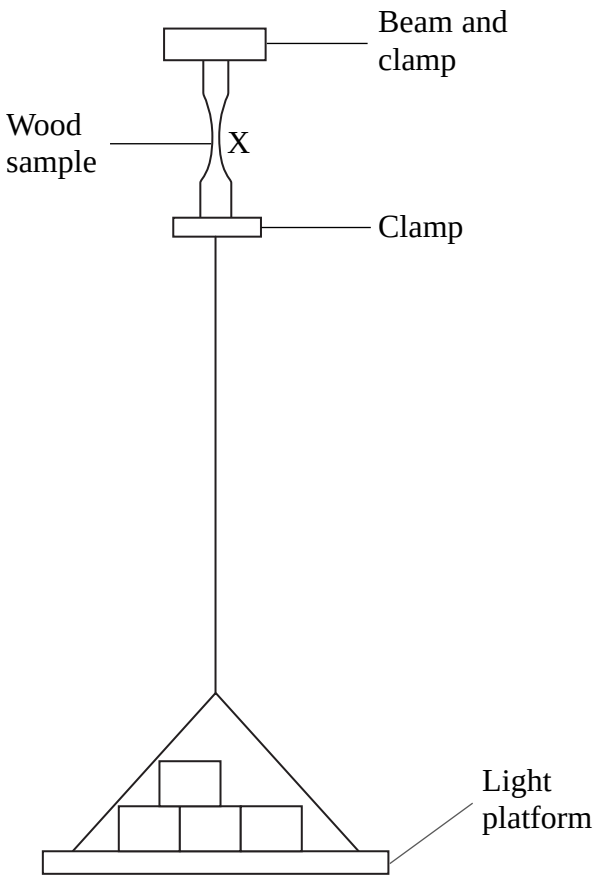
(b) A cricket bat made of wood is found to have a dent after striking a cricket ball.

State the type of behaviour shown by the material of the cricket bat.

(1)

(Total for Question = 3 marks)

2 A sample of wood is tested using the following arrangement.



The wood sample is clamped securely to a supporting beam. A light platform is suspended from the wood sample using another clamp.

The dimensions of the wood sample at X are known. Masses of 2 kg are added to the platform during the testing process.

(a) The wood sample breaks at X when the total suspended mass is 84 kg. The cross-sectional area at X is 1.3×10^{-5} m^2.

Show that the ultimate tensile strength is about 6×10^7 Pa.

(3)

(b) Explain why this method of testing may produce a larger value than the true ultimate tensile strength.

(2)

(c) Explain why the wood sample used for this test has the shape shown.

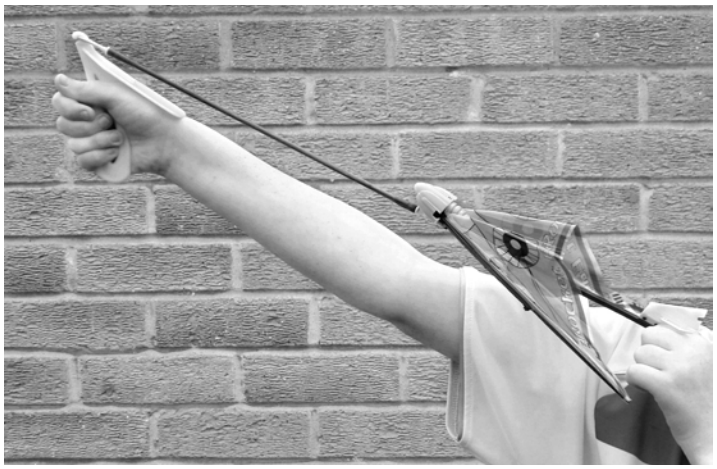
(2)

(d) Samples of wood of the same type are not entirely uniform. What should be done to ensure reliable results are obtained when carrying out this test?

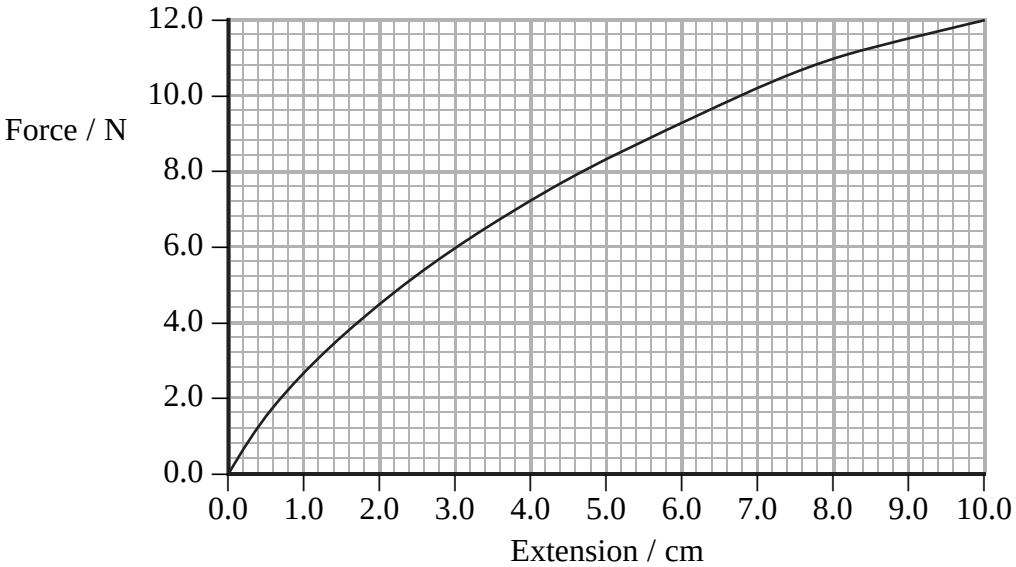
(1)

(Total for Question = 8 marks)

***3** The photograph shows a long rubber band being used to launch a model aeroplane.



The following graph shows force against extension for the rubber band.



(a) Explain whether the rubber band obeys Hooke's law.

(2)

(b) Use the graph to show that the elastic strain energy stored in the rubber band when it has an extension of 10.0 cm is less than 0.8 J.

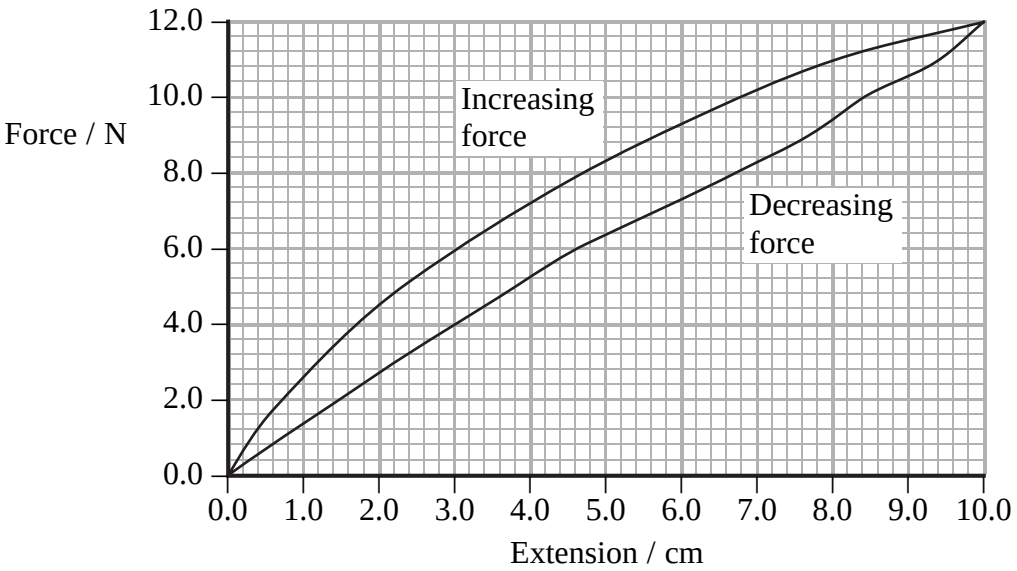
(c) The rubber band is extended by 10.0 cm before being released to launch the aeroplane. Calculate the maximum possible initial speed of the aeroplane.

Mass of aeroplane = 0.027 kg

(3)

Speed =

(d) The following graph shows two lines. Measurements were obtained by increasing the force on the band to 12 N and then decreasing the force.



(i) Describe the energy transfers taking place when the force on the band is increased and then decreased.

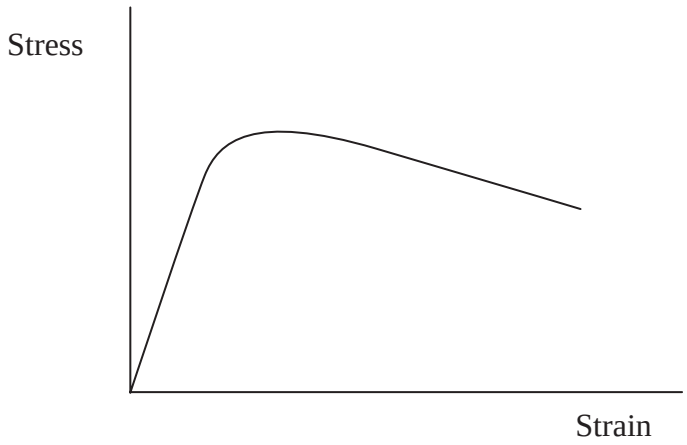
(2)

(ii) The maximum speed of the aeroplane will be less than that calculated in (c). Without further calculation use the graph to explain this.

(3)

(Total for Question = 13 marks)

4 The graph shows how stress varies with strain for a given material.



(a) Explain what is meant by each of the following terms

(3)

limit of proportionality (L)

.....

.....

tensile strength

.....

.....

yield point (Y)

.....

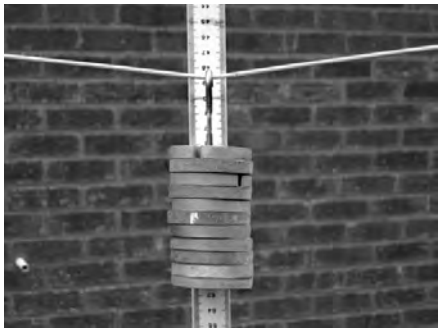
.....

(b) Using crosses and the letters shown above, mark the 'limit of proportionality' (L) and the 'yield point' (Y) on the graph.

(2)

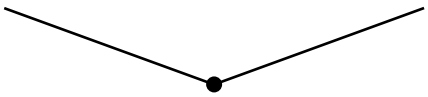
(Total for Question = 5 marks)

5 A washing line has a negligible mass and is initially horizontal. A student investigates the effect of hanging masses from the midpoint of the washing line.



(a) Add to the diagram to show the forces acting at the midpoint of the line when a mass is hung from its midpoint.

(2)



(b) A mass of 1.10 kg is hung from the midpoint of the line.

(i) Show that the downward vertical force on the line is about 11 N.

(1)

(ii) This force pulls the midpoint down a distance of 48.5 cm.

Show that the line is at an angle of about 84° to the vertical.

length of washing line when horizontal = 9.600 m

(2)

(iii) Show that the tension in the line is less than 60 N.

(2)

(iv) The washing line stretches so that the total length of the line is now 9.847 m.

Calculate the strain for the line.

(2)

Strain =

(c) Calculate the value of the Young modulus for the line material.

cross-sectional area of the line = $6.6 \times 10^{-6}\,m^2$

(3)

Young modulus =

(Total for Question = 12 marks)

6 (a) A manufacturer of spring balances needs to select a spring that produces an extension of 0.80 cm for each 100 g mass added.

Show that the manufacturer will need to select a spring with a spring constant of about 120 N m^{-1}.

(3)

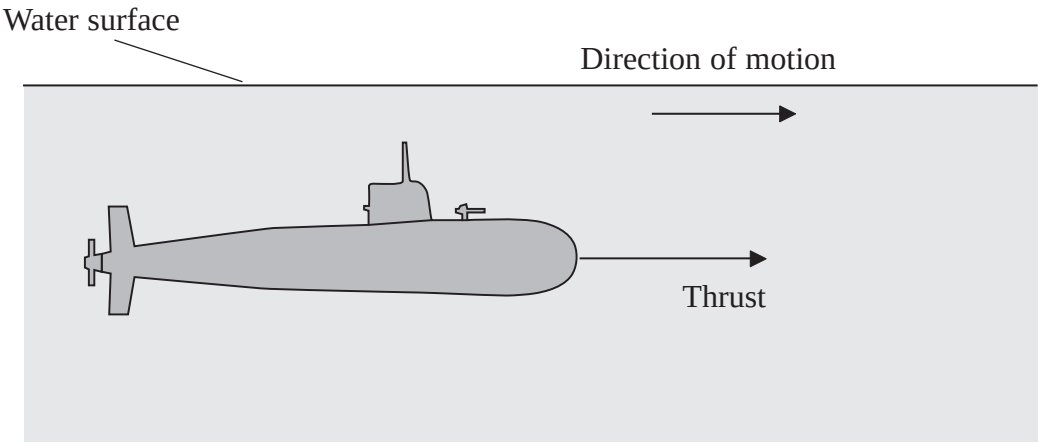
(b) The manufacturer states that the maximum mass that can be hung on the spring balance is 1.2 kg.

Explain why it is necessary to state the maximum mass.

(3)

(Total for Question = 6 marks)

7 The diagram shows a submarine and one of the forces acting on it. The submarine moves at a constant depth and speed in the direction shown.



(a) Add labelled arrows to show the other **three** forces on the submarine.

(2)

(b) State **two** equations that show the relationship between the forces acting on the submarine.

(2)

.....

.....

.....

.....

(c) The submarine has a volume of 7100 m^3.
Show that the weight of the submarine is about 7×10^7 N.

Density of sea water = 1030 kg m^{-3}

(2)

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(d) The submarine can control its depth by changing its weight. This is done by adjusting the amount of water held in ballast tanks.

As the submarine dives to greater depths the increased pressure of the surrounding water produces a compressive strain.

(i) Explain what is meant by compressive strain.

(1)

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.....

(ii) This decreases the volume of the submarine. Explain the action that should be taken to maintain a constant depth as the volume of the submarine is decreased.

(2)

.....

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.....

(iii) The submarine is made from steel. Suggest why a material, such as fibreglass, which has a much smaller Young modulus than steel would be unsuitable at greater depths.

(2)

.....

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(Total for Question = 11 marks)