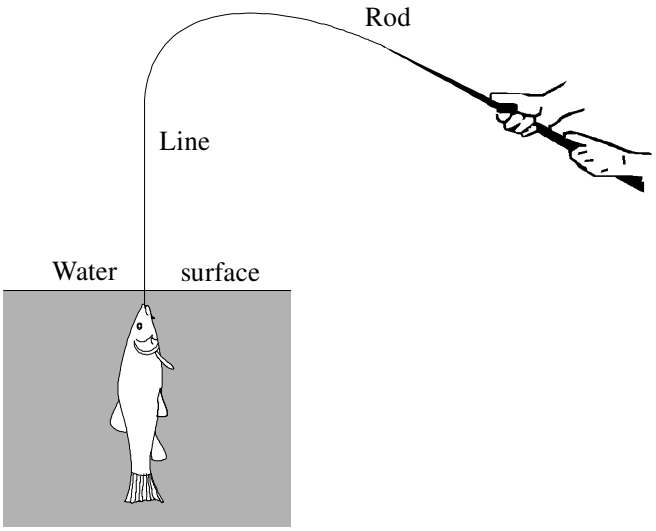
St Peter's RC High School

EAT HW Two

41 min
41 marks

1. Nomlas is a new material intended for fishing rods.



Complete the table below for the four other properties of materials listed.

Property	Desirable for rod	Not desirable for rod	Reason
Strong	✓		Needs a large force before it breaks
Elastic			
Brittle			
Hard			
Tough			

(Total 8 marks)

2. The body armour worn by modern police officers falls into two categories: hard and soft.

(a) Hard body armour gives more protection but is heavier to wear and does not give any flexibility of movement.

(i) Circle the word which describes the type of behaviour hard body armour is likely to demonstrate.

Ductile Elastic Plastic Tough

State what is meant by the word you have circled.

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(2)

(ii) Hard body armour is made of rigid ceramic plates. Ceramic materials are often described as being brittle. Why would this not be a desirable property for body armour?

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(1)

(iii) Many ceramics are not brittle, including alumina, the ceramic material used in body armour. Alumina is also a very strong material. What is meant by a **strong** material?

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(1)

(b) Soft body armour allows much greater flexibility of movement. Most soft body armour is made from Kevlar. A new fibre called Biosteel is now being developed, however, that is several times stronger than Kevlar.

The manufacturers claim that Biosteel can be up to 20 times stronger than an ordinary steel wire of the same thickness.

Material	Young Modulus	Breaking strain
Steel	2×10^{11} Pa	0.1%

(i) Calculate the maximum breaking stress that steel can withstand.

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Maximum stress = ...

(2)

(ii) Hence show that the force needed to break a steel wire of diameter 1 mm is about 160 N.

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(3)

(iii) If the manufacturers of Biosteel are correct, what maximum force would be needed to break a Biosteel fibre of the same dimensions as the steel wire?

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Maximum force = ...

(1)

(iv) State one assumption you have made in your previous calculations.

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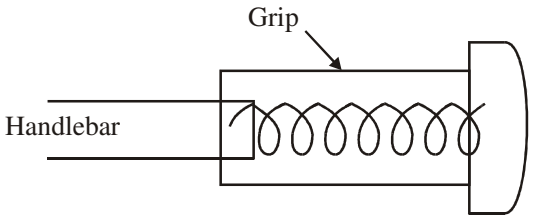
(1)

(Total 11 marks)

3. Children can seriously injure themselves when falling off bicycles if they land on upturned handlebars. A new design incorporates a spring inside the grip as shown below.



The grip needs to be tough.

(i) What does tough mean?

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(ii) Suggest a suitable tough material.

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(2)

The behaviour of the spring over the range of compression expected in a fall is elastic. What is meant by elastic?

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(1)

The maximum compression of the spring is 9.0 cm. Its stiffness is 1250 N m^{-1}. The spring obeys Hooke's law. For maximum compression calculate

(i) the force in the spring,

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Force = ...

(ii) the energy stored in the spring.

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Energy = ...

(4)

The mass of a child is 30 kg. Calculate the child's weight. Discuss how this new design could reduce the seriousness of an injury.

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(3)

The Young modulus of the material of a wire can be related to the stiffness of the wire. A student suggests that if the cross-sectional area of the spring and the initial length of the spring were known, then the Young modulus of the spring material could be calculated using the data given in this question. Explain why this is incorrect.

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(2)

(Total 12 marks)

4. The sap from a rubber tree may flow like thick treacle or thick oil. State **one** word which describes this flow behaviour.

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(1)

The sap is treated to produce a lump of rubber. Choose **two** words from the list below and explain the meaning of each as it applies to rubber.

Elastic, brittle, hard, durable, stiff

(i) .....

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(ii) .....

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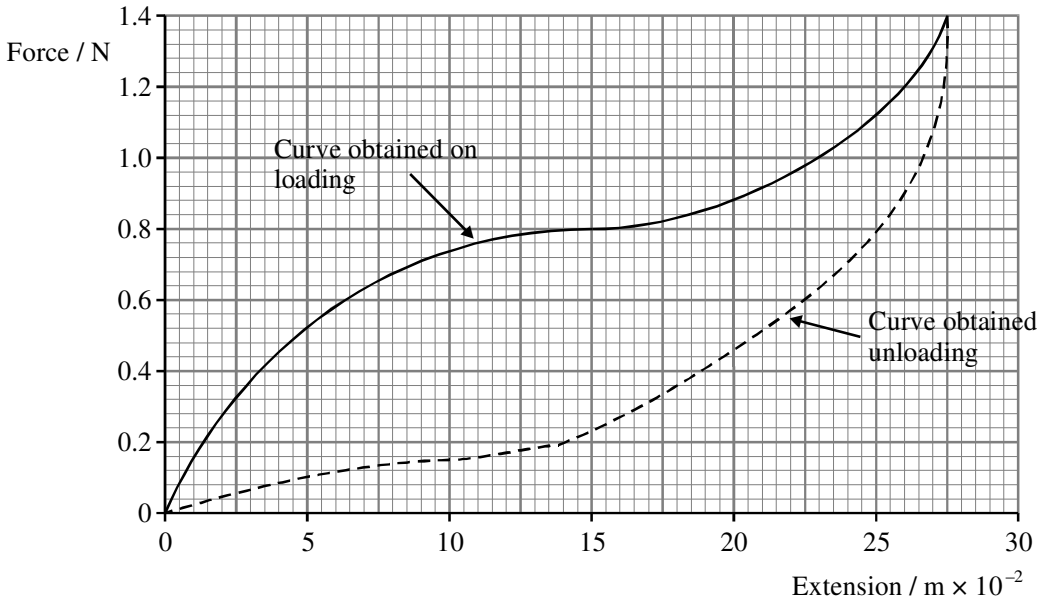
(2)

The solid line on the following force-extension graph is obtained when a rubber band is stretched.



Use the graph to estimate the work done in stretching the rubber band to a tension of 1.0 N.

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(4)

When the force is reduced gradually, the force-extension graph follows the dotted line.

What does the graph tell you about the work done by the rubber band when it returns to its original length?

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(1)

Rubber tyres are constantly being compressed and released as a car travels along a road. Explain why the tyres become quite hot.

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(1)

(Total 9 marks)