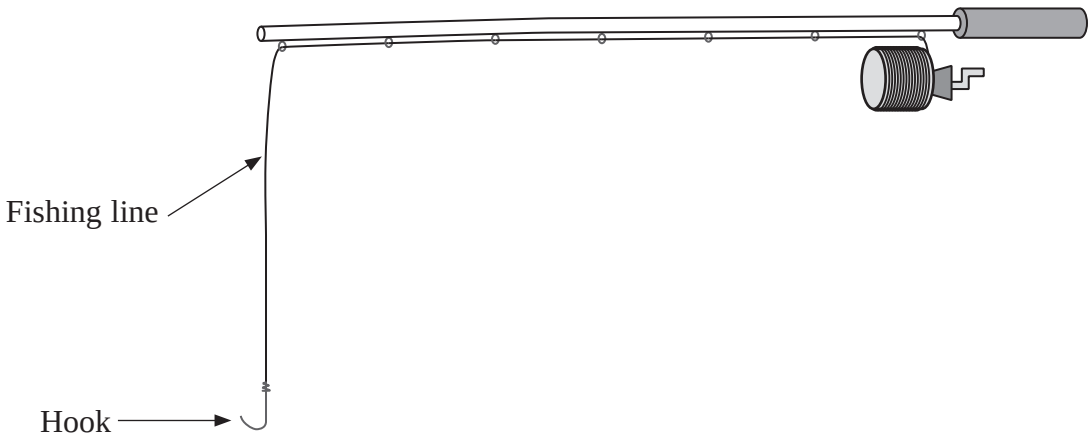
1 The following three properties can be used to describe copper.

Ductile Malleable Tough

(a) Select and explain the property that makes copper suitable for the production of wires.

(3)

(b) Both nylon and copper can be used to make fishing lines. Copper fishing lines sink faster than those made of nylon. This makes copper fishing lines more suitable for deep water fishing.



(i) By considering the forces acting on the submerged line, explain why nylon is less suitable than copper for deep water fishing. Include a suitable calculation in your answer.

Both lines have the same cross-sectional area.

ross-sectional area of lines = 1.30×10^{-7} m^2

ensity of saltwater = 1030 kg m^{-3}

eight of 20.0 m of copper line = 0.220 N

eight of 20.0 m of nylon line = 0.0280 N

(4)

(ii) A fish becomes caught on the hook and the copper line extends. Calculate the extension produced.

cross-sectional area of copper line = 1.30×10^{-7} m^2

load on line = 65.0 N

original length of line = 20.0 m

Young modulus of copper = 129 GPa

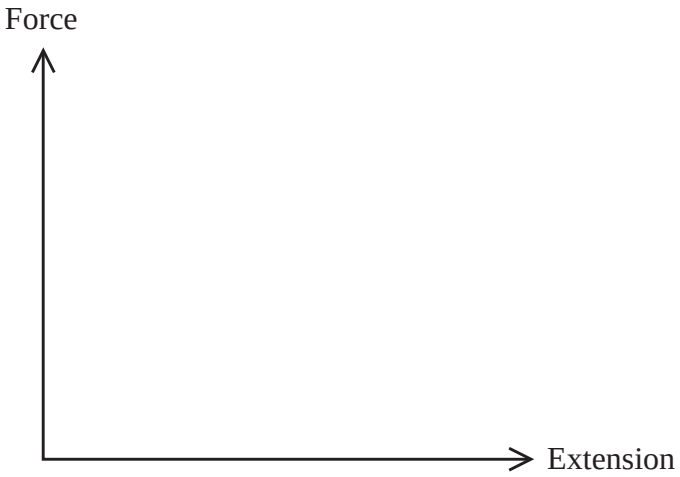
(3)

Extension =

(c) Some people use fishing lines that have been pre-stretched by loading and unloading.

(i) Sketch the force-extension graph for a copper line during the process of pre-stretching.

(3)



(ii) Suggest a reason why some people prefer to use this type of line.

(1)

(Total for Question = 14 marks)

2 When a note is played on a piano, a soft hammer is made to hit a wire. This causes the wire to vibrate creating a sound.

The wires used in pianos are hard, stiff and have a high tensile strength.

(a) Explain the meaning of the terms hard, stiff and high tensile strength.

(i) Hard

(1)

(ii) Stiff

(1)

(iii) High tensile strength

(1)

*(b) It is important that a piano wire has a high elastic limit.

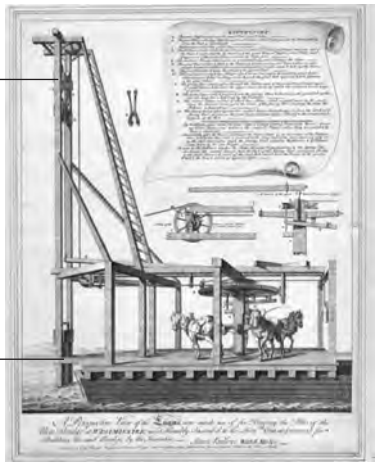
Explain why this is important.

(3)

(Total for Question = 6 marks)

3 Pile drivers have been used for centuries to push piles into the ground for use as foundations of buildings and other structures. A large mass (the driver) is raised and then dropped onto an object (the pile) which is pushed into the ground.

The picture shows the pile driver that was used to build a London bridge in the 17th century.



(a) (i) The driver on the pile driver above had a mass of 810 kg and could be dropped a maximum distance of 6.0 m onto the pile.

Show that the energy transferred from the driver is about 50 kJ.

(2)

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(ii) In one instance, 40% of this energy is used usefully to drive in the pile. The pile moves 0.20 m into the ground.

Determine the average resistive force acting on the pile as it moves through the ground.

(3)

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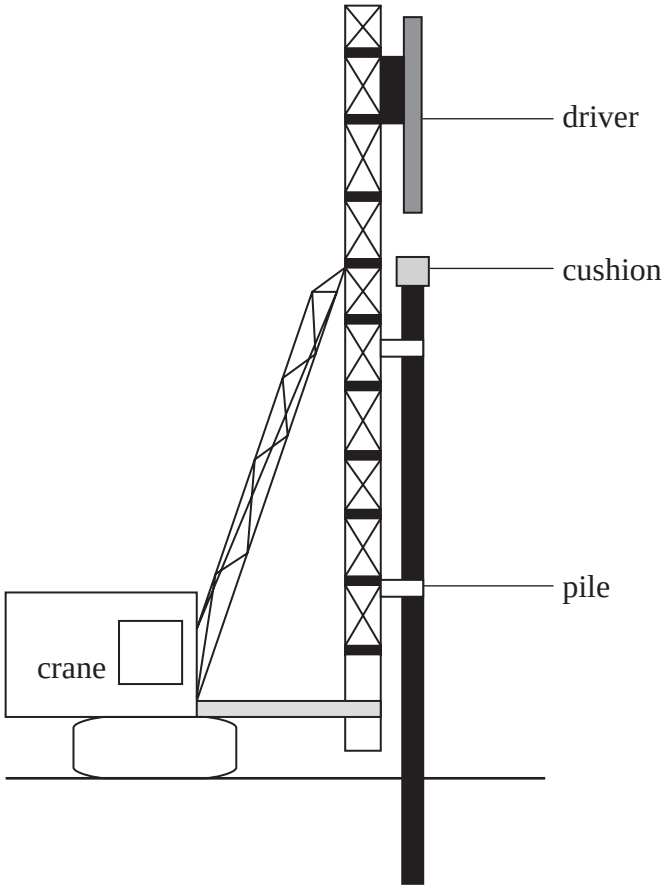
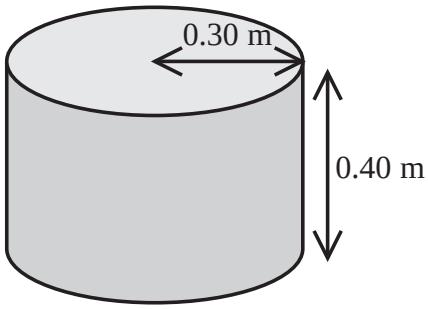
Average resistive force =

(b) In order to protect the driver on modern pile drivers, a cushion made of wood is placed on the pile.



The cushion is a cylindrical piece of wood of Young modulus = 120 MPa



The cushion is compressed when hit by the driver.

(i) The maximum compressive force applied to the wood during impact is 7.0×10^5 N. Show that the compression of the cushion is about 0.01 m.

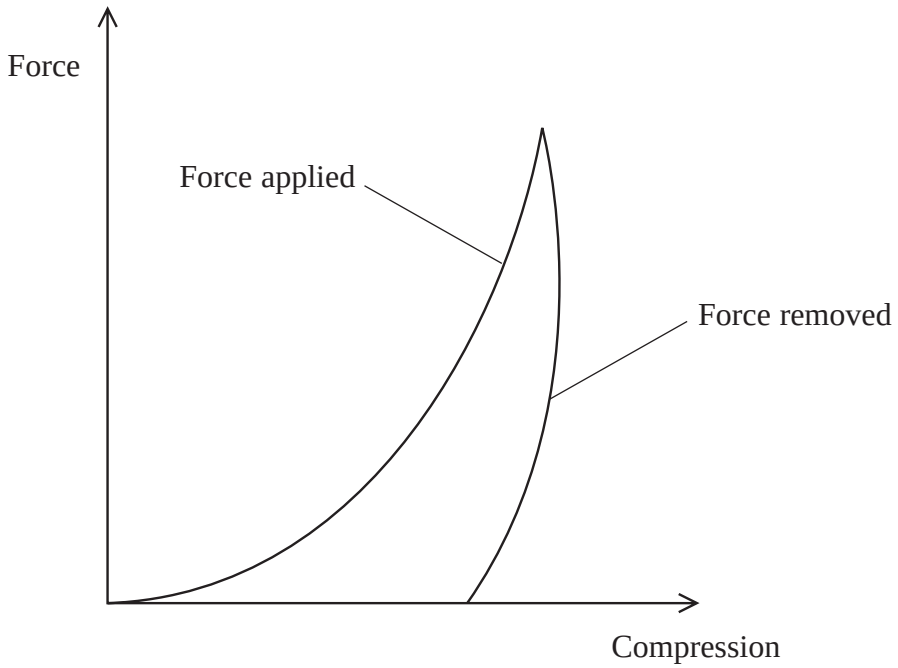
(3)

(ii) Calculate the energy stored in the cushion under compression.

(2)

Energy stored =

*(iii) The graph shows how the compression of the wooden cushion varies with force, as the force is applied and removed during an impact.



Use the graph to explain the following:

1. the wooden cushion has to be replaced after a few hundred impacts,

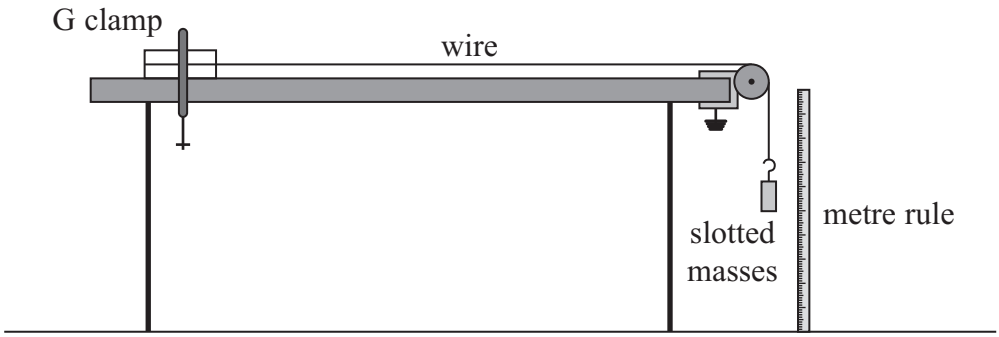
(2)

2. with each impact the temperature of the wooden cushion rises slightly.

(1)

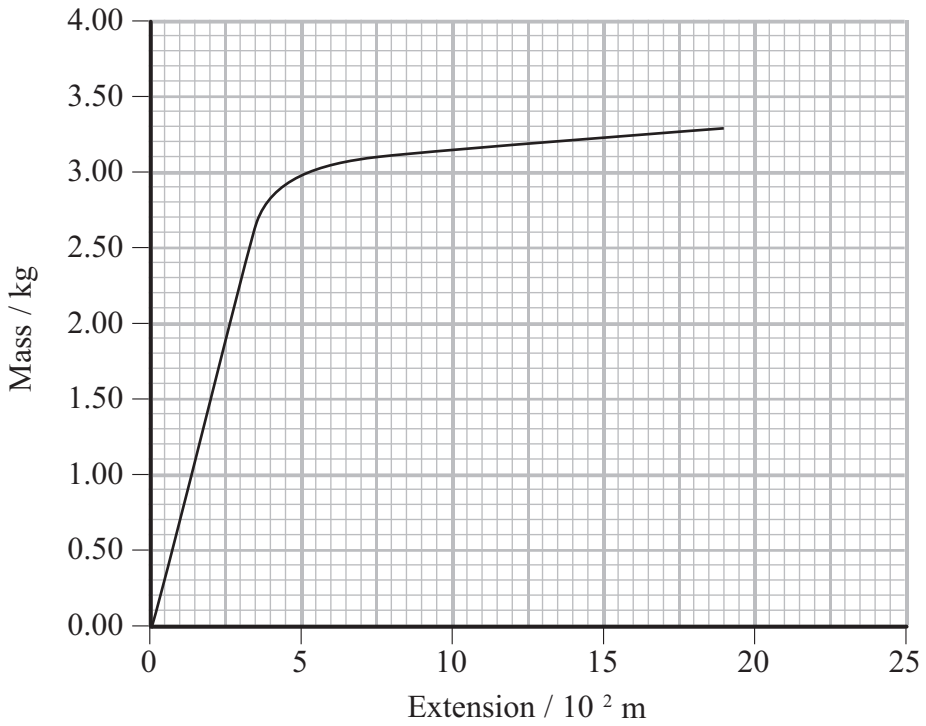
(Total for Question = 13 marks)

4 The diagram shows the equipment a student used to investigate the behaviour of a material in the form of a wire under an increasing tension.



Masses were added up to a maximum of 3.30 kg. Each time a mass was added the extension of the wire was calculated.

(a) The following mass-extension graph was obtained.



(i) Initially the extension increased linearly.

State what is meant by 'increased linearly' in relation to this graph and what can be concluded about the wire from this observation.

(2)

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.....

.....

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(ii) Use the graph to calculate the maximum energy that the wire could store while behaving linearly.

(3)

Maximum energy .....

(iii) Describe the behaviour of the wire when the added mass was greater than 2.9 kg.

(2)

(b) The student modifies the investigation.

(i) Suggest **one** modification that would produce a greater extension for a given mass.

(1)

(ii) Suggest **two** measuring techniques that could be used to ensure the accuracy of the measured extensions.

(2)

(Total for Question 10 marks)

5 (a) On a cold night ice forms over the surface of a small garden pond. The next day, the air temperature rises and the ice begins to melt slowly.

Melting can be speeded up by breaking the ice with a hammer.

(i) State the property of ice which means that it can be broken with a hammer.

(1)

(ii) Suggest why the broken ice melts more quickly.

(1)

(b) Ice is a hard material.

(i) Define the term hard.

(1)

(ii) The hardness of ice increases as its temperature decreases.

Explain why skaters often call colder ice ‘fast ice’ and warmer ice ‘slow ice’, due to this variation in hardness.

(2)

(Total for Question = 5 marks)

6 A copper wire and a steel wire of identical lengths l are soldered together. The compound wire is stretched by a force F and the total length increases by 0.010 m.

cross-sectional area of copper = 0.80×10^{-6} m^2

cross-sectional area of steel = 1.3×10^{-6} m^2

Young modulus of copper = 1.3×10^{11} Pa

Young modulus of steel = 1.8×10^{11} Pa

(a) (i) Show that the extension of the copper wire is about twice the extension of the steel wire.

(3)

(ii) Hence calculate the extension of the copper wire.

(2)

Extension =

(b) When the applied force is increased, it is found that the ratio of the extension of the copper wire to the extension of the steel wire becomes much greater.

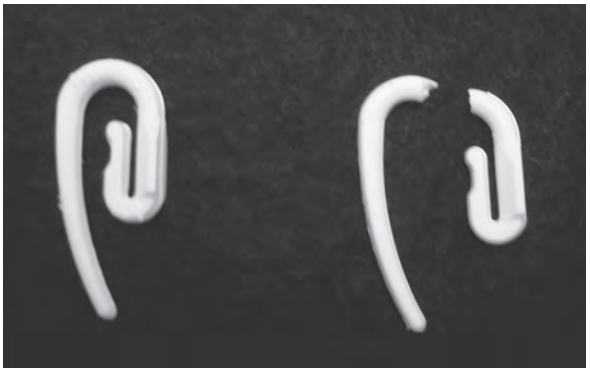
State the property of the copper that accounts for this high value of the ratio.

(1)

(Total for Question = 6 marks)

*7 A student is taking down some curtains and notices that several of the curtain hooks snap when they are bent.

The photograph shows an unsnapped hook and a snapped hook.



The student thinks that it is odd that the material the hooks are made from is referred to as plastic when the hooks don't show plastic behaviour.

The student finds the following list of terms used to describe materials.

Brittle Ductil Tough

Only one of these terms describes the behaviour of the hooks.

Explain what is meant by 'the hooks don't show plastic behaviour' and state and explain the term from the list that correctly describes the behaviour.

(4)

(Total for Question 4 marks)