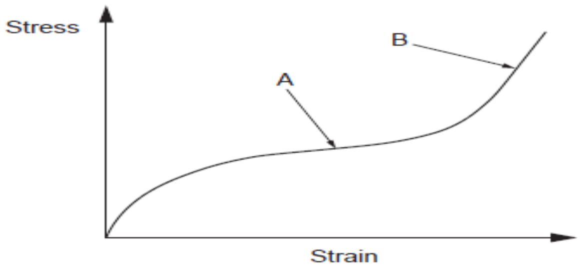
Physics

Question	Maximum Mark	Mark Awarded
#1	9	
#2	11	
#3	11	
#4	11	
#5	12	
#6	12	
#7	13	
#8	13	
#9	14	
#10	15	
#11	19	
#12	20	
Total	160	

#1

(a) Materials can be classified as being *crystalline*, *amorphous* or *polymeric*. Making reference to their microscopic structures explain what is meant by each of these terms. Give **one** example of each type of material. [3]

(b) Experiments are carried out on a specimen of rubber. The diagram shows a stress-strain curve for the specimen when it is gradually loaded.



(i) By referring to the molecular structure of rubber, explain why the gradient at A is less than the gradient at B. [3]

(ii) When the specimen is gradually unloaded, it is noted that the curve for unloading is different from the curve for loading.

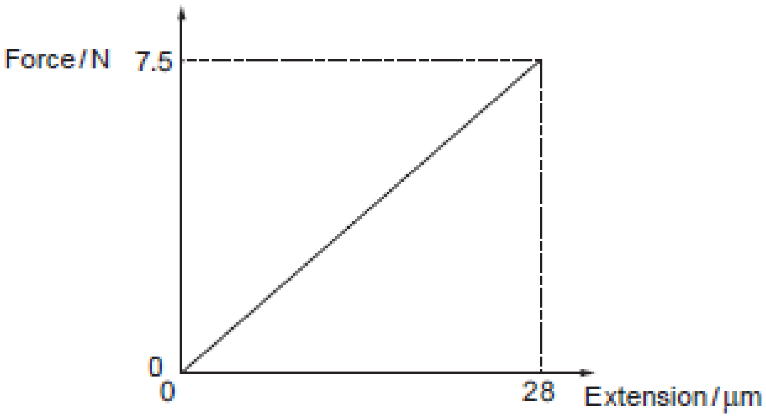
I. Name this phenomenon and account for it in terms of energy. [2]

II. **Sketch the curve** for unloading on the graph opposite. [1]

Question taken from Eduqas examination paper 842102, November 2020

#2

1. Emily carries out an experiment to obtain a force-extension graph for a thin glass fibre. She loads the thin glass fibre until it breaks. The force-extension graph obtained is shown below.



(a) (i) Emily measures the length and diameter of the glass fibre and finds them to be 19.8 cm and 1.01 mm respectively. Suggest what measuring instruments she uses. [1]

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(ii) Determine the Young modulus of glass. [3]

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(iii) Write a risk assessment for Emily's experiment. [2]

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(iv) Determine the energy stored in the glass just before breaking point is reached. [2]

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(b) Glass is a brittle material. Describe the process by which glass fractures. [3]

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Question taken from Eduqas examination paper 842001, June 2018

#3

3. A child's jumping toy uses the compression of a spring to fire it up into the air. The spring used requires a force of 0.50 N to compress it by 1.0 cm.

(a) State Hooke's law. [1]

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(b) The toy has a mass of 20 g and the spring is compressed by 6.0 cm and then released.

(i) Calculate the velocity with which it leaves the ground. [3]

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(ii) Determine the initial acceleration of the toy as the spring extends. State any assumption you make. [2]

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(c) (i) Ignoring air resistance, determine the maximum height gained by the toy. [3]

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(ii) Determine the total time of flight. [2]

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Question taken from Eduqas examination paper 842001, June 2019

#4

1. *(a)* (i) Define the Young modulus of a material. [1]

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(ii) Express the unit of the Young modulus in terms of S.I. base units. [3]

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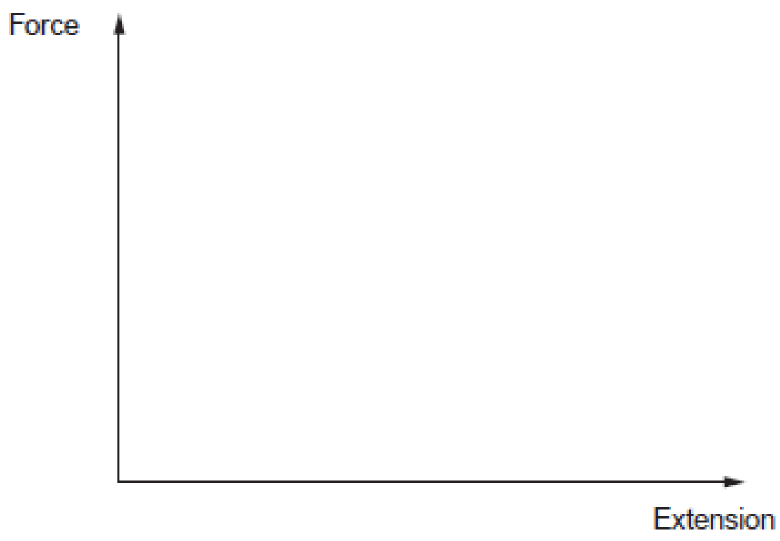
(b) (i) When a rubber band is gradually loaded and then unloaded it shows *hysteresis* and *permanent set*. Sketch, and **clearly label** a force-extension graph for rubber to illustrate these two effects. [3]



(ii) Considering the molecular structure of rubber explain why it has a much lower value of Young modulus than that of a metal. [2]

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(iii) What is the effect on the Young modulus of rubber when its temperature rises? Explain your answer. [2]

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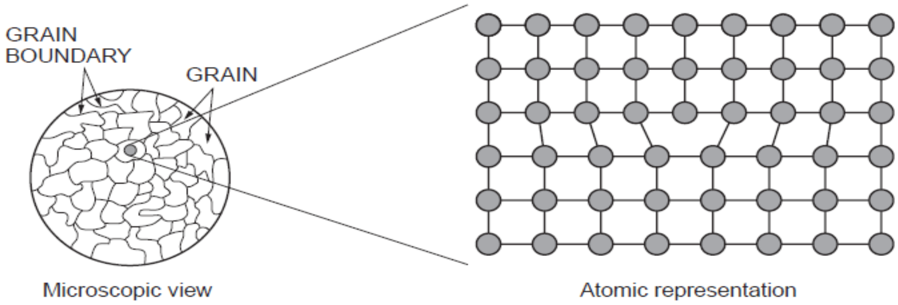
Question taken from Eduqas examination paper 842001, June 2019

#5

(a) The diagrams show a microscopic view and an atomic representation of the crystalline structure of a typical metal.



Describe how plastic deformation takes place in ductile metals and explain methods for increasing the strength of ductile metals. [6 QER]

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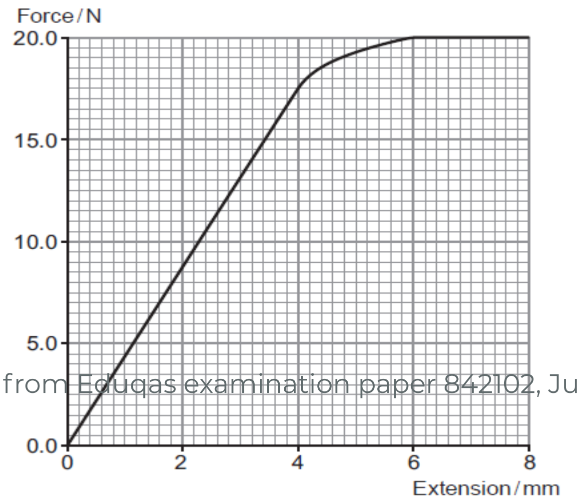
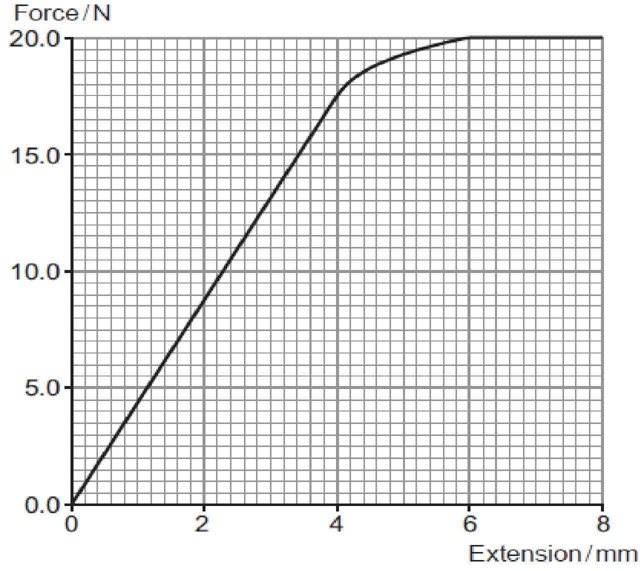
(b) A student investigates the force-extension properties of copper wire. He measures the diameter of the wire to be 0.32 mm and the original length to be 2.2 m. He measures the extension of the wire for various loads applied to it, up to a maximum load of 20.0 N. He draws a graph of force against extension from his results.



#5 con

(b) A student investigates the force-extension properties of copper wire. He measures the diameter of the wire to be 0.32 mm and the original length to be 2.2 m. He measures the extension of the wire for various loads applied to it, up to a maximum load of 20.0 N. He draws a graph of force against extension from his results.



(i) Determine whether or not these measurements are consistent with copper having a Young Modulus of 120 GPa. [3]

(ii) Estimate the work needed to produce a strain of 0.2% in the wire. [2]

(iii) **Sketch a line on the graph** to show the possible behaviour of the wire when the 20 N force is removed. [Assume the wire has been stretched beyond its elastic limit.] [1]

Question taken from Eduqas examinatiopaper 842102, June 2017

#6

6. *(a)* Define the *capacitance* of a capacitor. [1]

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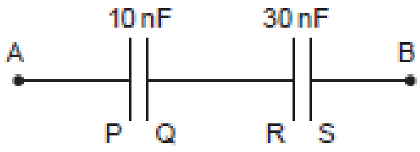
(b) Two capacitors, initially uncharged, are arranged in series as shown. When a battery is connected across A and B, the charge on plate P is found to be +75 nC.



(i) Write down the charges on each of the plates Q, R and S. Give a reason for your answer to the charge on plate S. [3]

Charge on Q: ....

Charge on R: ....

Charge on S: ....

Reason:

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(ii) Calculate the pd across A and B. [2]

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(iii) A Physics student makes the following comment:

For capacitors in series, a capacitor of higher capacitance stores more energy than a capacitor of smaller capacitance.

By considering this combination of capacitors, investigate whether or not the student is correct. [2]

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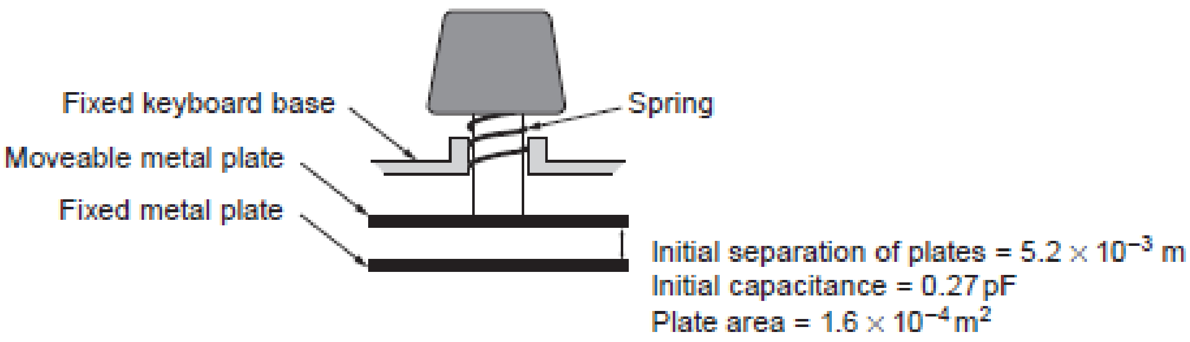
(c) Some computer keyboards work on the principle of varying capacitance. When a key is pressed, a spring is compressed and the separation of two parallel metal plates is decreased. The computer responds if the increase in capacitance of the plates is 0.20 pF or more.
The diagram shows how a single key is constructed.



The designers of a keyboard require that the increase in capacitance of 0.20 pF occurs when a force of 0.20 N is exerted on a key. Different springs are available, of spring constant 90 N m^{-1}, 120 N m^{-1} and 150 N m^{-1}. Determine which (if any) of these springs would be suitable in meeting the designer's requirements. The capacitor is filled with air. [4]

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Question taken from Eduqas examination paper 842102, June 2018

#7

1. (a) Explain what is meant by a progressive wave. [2]

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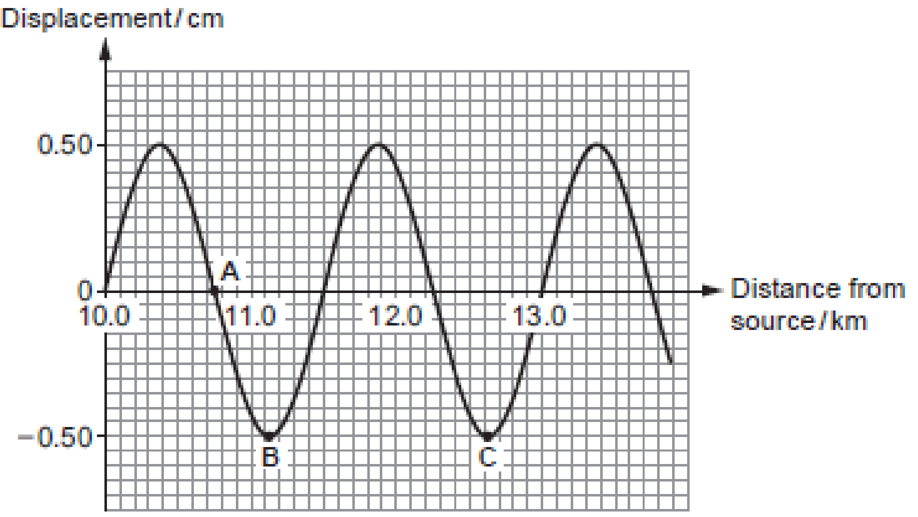
(b) Earthquakes produce seismic waves that travel through rock. The following graph shows the displacement at a given instant for a seismic wave.



(i) Determine the phase difference between: [2]

A and B ....

B and C ....

(ii) A geologist at a monitoring station notes that there are 50 complete cycles of the wave in a time interval of 20 s. Calculate the speed of the wave. [4]

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(c) A section of rock undergoes a tensile stress of 900 MPa during an earthquake. Calculate the tensile strain if the Young modulus is 70 GPa for rock. [3]

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(d) Explain how data obtained by geologists about earthquakes from various monitoring stations can benefit society. [2]

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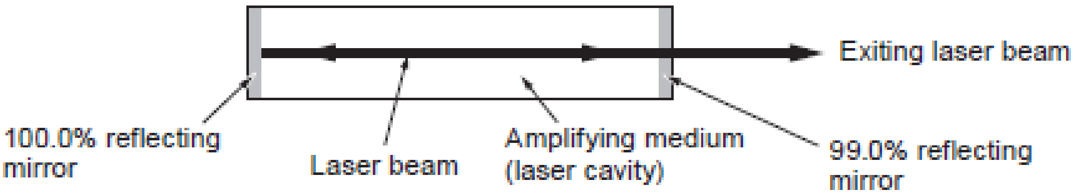
Question taken from Eduqas examination paper 842002, June 2018

#8

4. A laser has two mirrors either side of the amplifying medium as shown.



(a) Explain the purpose of the 99.0% reflecting mirror and the 100.0% reflecting mirror. [2]

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(b) Explain the purpose of a population inversion in the laser cavity. [3]

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(c) (i) The light intensity inside a powerful laser is 2.0×10^{15} W and its wavelength is 1.05 μm. Show that this corresponds to approximately 1×10^{34} photons per second. [2]

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(ii) Show that the momentum of a 1.05 µm photon is approximately 6×10^{-28} kg m s^{-1}. [1]

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(iii) Show that the force exerted on a 100.0% reflecting mirror by a beam of power 2.0×10^{15} W is approximately 1×10^{7} N. [2]

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(iv) Calculate the strain produced in a laser structure if the power of the beam between the mirrors is 2.0×10^{15} W. You may assume that the structure of the laser cavity has a cross-sectional area of 43 cm^2 and is made of a material with Young modulus 2.8×10^{11} Pa. [3]

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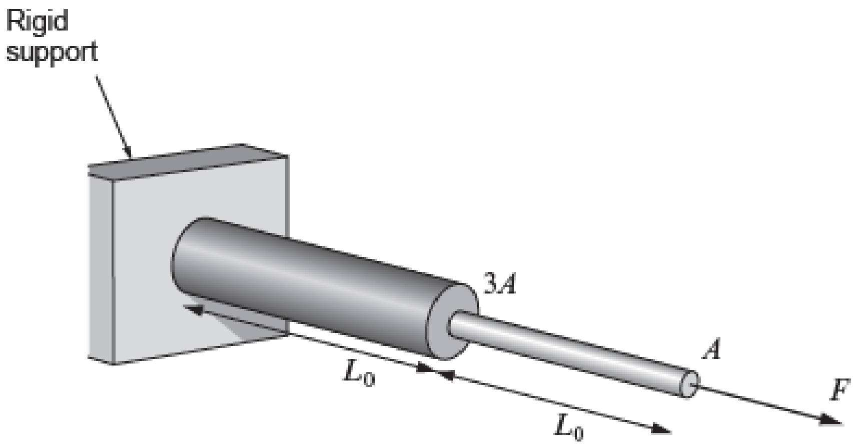
Question taken from Eduqas examination paper 842103, June 2018

#9

5. *(a)* The bar in the figure below is made from a **single piece of metal**. It consists of two parts of equal length L_0 and cross-sectional area A and $3A$. The diagram is not drawn to scale.



(i) Show that the total extension, Δx_{total}, of the bar under the action of an applied force, F, as shown in the diagram, can be given by:

$$\Delta x_{\text{total}} = \frac{4FL_0}{3AE}$$

where E represents the Young modulus of the metal in the bar. [3]

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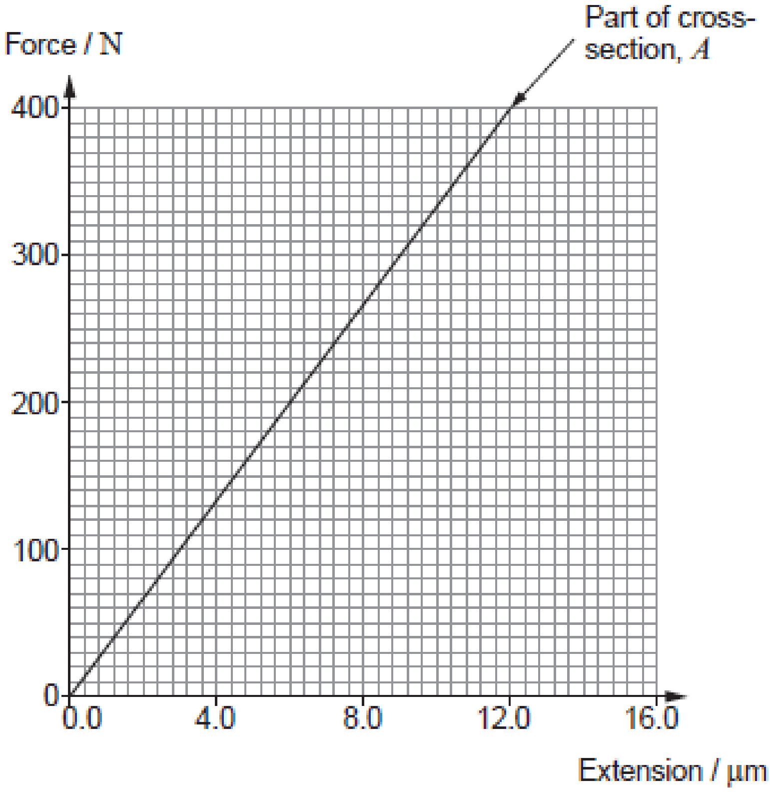
(ii) The graph shows the variation of extension with applied force for the part of cross-section, A. Draw (on the same grid) the expected force-extension graph for the segment of cross-section $3A$. [1]



(iii) Determine the Young modulus of the metal in the bar given that L_0 = 1.2 m and $A = 2.0 \times 10^{-4}\,m^2$. [3]

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(iv) Calculate the elastic potential energy stored in the whole bar when F = 400 N. [2]

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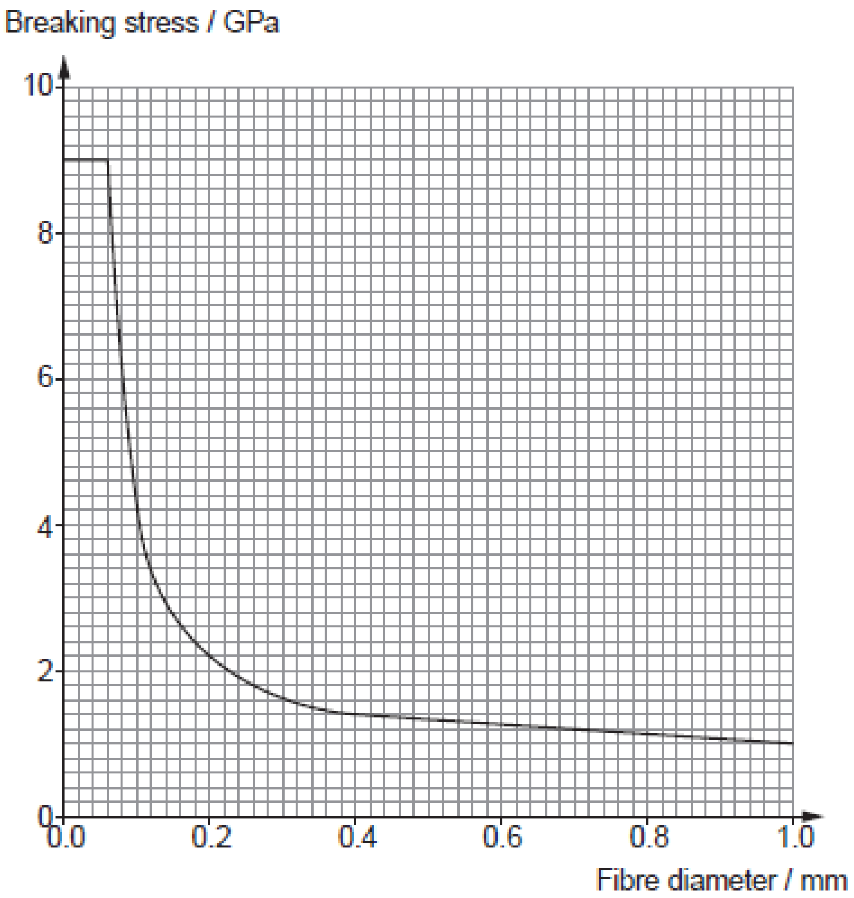
(b) Glass is a brittle material. The graph shows how the breaking stress of glass, in the form of thin fibres and rods, varies with the diameter of the fibre.



(i) Use the graph to estimate the greatest mass which can be hung from a glass fibre of diameter 0.2 mm. [3]

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(ii) Explain the term *brittle fracture* as it applies to glass and give a reason why very thin fibres have a greater breaking stress than thicker ones. [2]

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Question taken from Eduqas examination paper 842102, June 2019

Question taken from Eduqas examination paper 842001, June 2017

#11

Two students, Simon and Natalie are investigating the mechanical properties of a steel wire of length 2.5 m and cross-sectional area 1.0 mm^2.

(a) They are given the following information.
[Young modulus, $E_{steel} = 2.0 \times 10^{11}\,N\,m^{-2}$, Stress, σ_{steel} (at elastic limit) = $1.0 \times 10^8\,N\,m^{-2}$].

(i) Show that the maximum extension possible for the wire without the elastic limit being exceeded is 1.25 mm. [2]

(ii) Simon believes that this maximum extension (1.25 mm) of the steel wire depends on the radius of the wire. Natalie disagrees. Discuss who is correct, explaining carefully how you arrive at your answer. [3]

(b) Natalie suspends a mass, m, from the wire vertically. The wire can be considered to be weightless.

(i) Show that the force per unit extension, k, of the wire is 80 kN m^{-1}. [3]

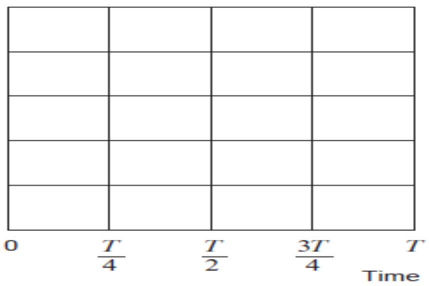
(ii) Determine the mass, m, that causes an equilibrium extension of 1.0 mm. [2]

(c) This mass is given a small downward displacement and released from rest. The mass oscillates with simple harmonic motion (SHM) **provided that the maximum extension of the wire never exceeds the elastic limit**.

(i) Calculate the period of this oscillation. [2]

(ii) Calculate the maximum possible velocity of the mass, m. [3]

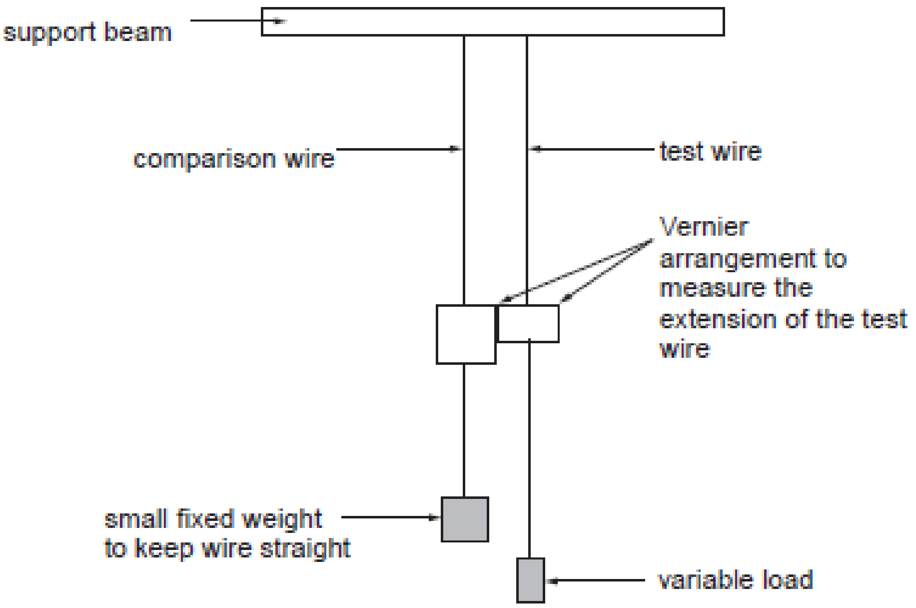
(iii) Assuming the mass is released when the wire is at maximum extension without exceeding the elastic limit, sketch a graph showing how the stress in the wire varies with time **for one complete oscillation** from the moment of release of the mass. Indicate appropriate numerical values on the stress axis of your graph.
Space for calculations. [4]



Question taken from Eduqas examination paper 842102, November 2020

#12

3. Kiera uses the following apparatus to find the Young modulus of a metal alloy in the form of a wire.



(a) Explain how the choice of a suitable comparison wire minimises the effect of a change in temperature. [2]

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(b) Kiera uses a micrometer of resolution 0.01 mm to measure the mean diameter of the wire. She determines the mean diameter to be 0.16 mm. Calculate the cross-sectional area of the wire in m^2, along with its percentage uncertainty. [3]

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(c) Kiera then uses a metre ruler with a resolution of 1 mm to measure the initial length of the wire. She determines the length to be 1.680 m. Show, with an appropriate calculation, that the percentage uncertainty in this reading can be considered negligible. [2]

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(d) Kiera adds various masses to the test wire and measures the extension. The table shows the extension of the wire for increasing load.

Load (negligible absolute uncertainty) / N	Mean extension / mm	Absolute uncertainty in extension / mm
1.96	1.4	± 0.2
3.92	2.7	± 0.2
5.89	4.1	± 0.2
7.85	5.5	± 0.2
9.81	6.8	± 0.2

Kiera plots a graph (shown opposite) of load against extension from her data, but does not include error bars.

(i) I. **Add error bars** for the extension on the plotted points. [1]

II. Draw lines of maximum gradient and minimum gradient and determine the gradients of both lines. [3]

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(ii) Hence, calculate the mean gradient and the **percentage** uncertainty in its value. [2]

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(e) Determine the Young modulus of the metal alloy, along with its **absolute** uncertainty. Give your answer to an appropriate number of significant figures. [5]

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(f) State which of the measurements contributes most to the overall uncertainty in your answer and suggest one change Kiera could make to her experiment which would reduce the size of this uncertainty. [2]

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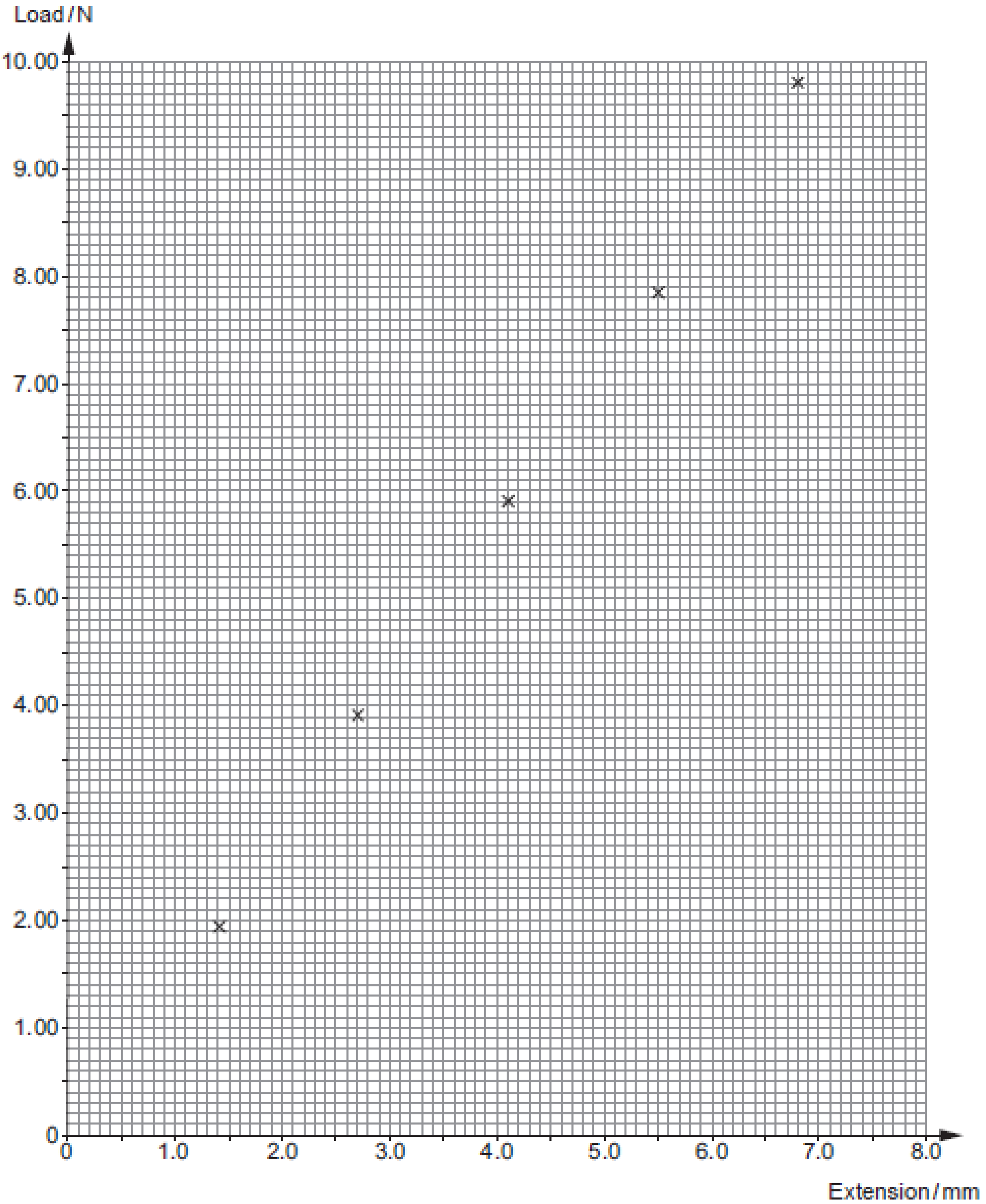

Question taken from Eduqas examination paper 842102, June 2018