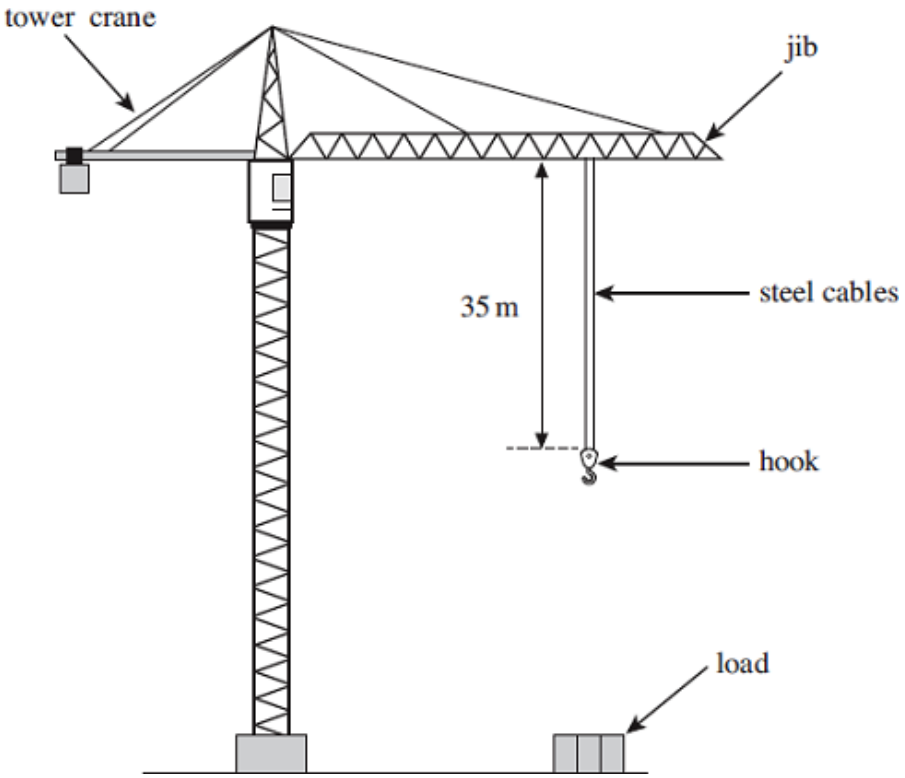
Q1. The diagram below shows a tower crane that has two identical steel cables. The length of each steel cable is 35 m from the jib to the hook.



(a) Each cable has a mass of 4.8 kg per metre. Calculate the weight of a 35 m length of one cable.

weight = ... N

(2)

(b) The cables would break if the crane attempted to lift a load of 1.5×10^{6} N or more. Calculate the breaking stress of **one** cable.

cross-sectional area of each cable = 6.2×10^{-4} m^2

breaking stress = ... Pa

(2)

(c) When the crane supports a load **each** cable experiences a stress of 400 MPa. Each cable obeys Hooke's law. Ignore the weight of the cables.

Young modulus of steel = 2.1×10^{11} Pa

(i) Calculate the weight of the load.

weight = ... N

(2)

(ii) The unstretched length of each cable is 35 m.

Calculate the extension of each cable when supporting the load.

extension = ... m

(3)

(iii) Calculate the combined stiffness constant, *k*, for the **two** cables.

stiffness constant = ... Nm^{-1}

(2)

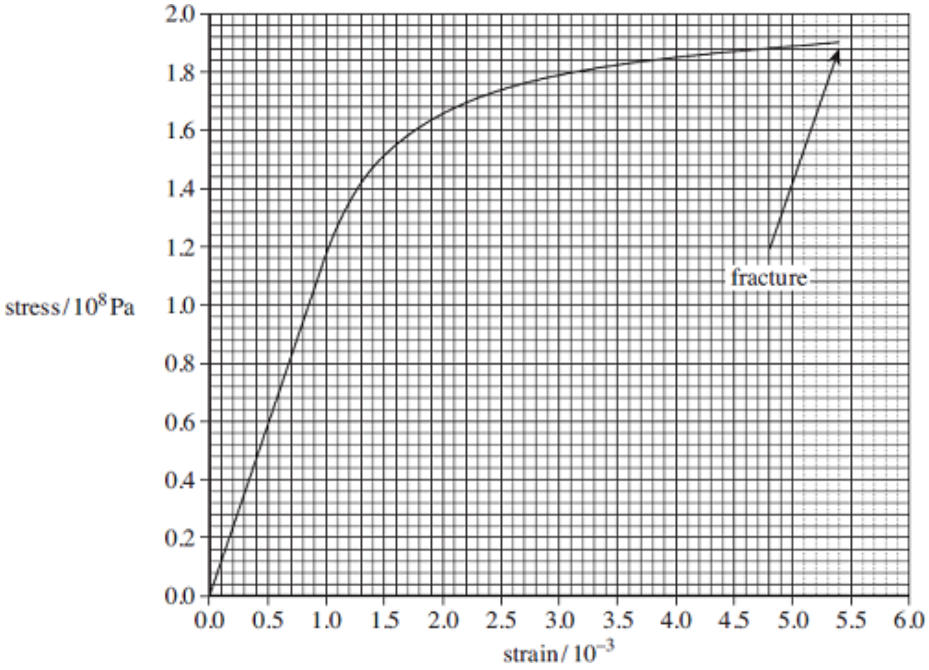
(iv) Calculate the total energy stored in both stretched cables.

energy stored = ... J

(2)

(Total 13 marks)

Q2. The figure below shows a stress-strain graph for a copper wire.



(a) Define tensile strain.

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(1)

(b) State the breaking stress of this copper wire.

answer = ... Pa

(1)

(c) Mark on the figure above a point on the line where you consider plastic deformation may start.
Label this point **A**.

(1)

(d) Use the graph to calculate the Young modulus of copper. State an appropriate unit for your answer.

answer = ...

(3)

(e) The area under the line in a stress-strain graph represents the work done per unit volume to stretch the wire.

(i) Use the graph to find the work done per unit volume in stretching the wire to a strain of 3.0×10^{-3}.

answer = ...J m^{-3}

(2)

(ii) Calculate the work done to stretch a 0.015 kg sample of this wire to a strain of 3.0×10^{-3}.

The density of copper = 8960 kg m^{-3}.

answer = ...J

(2)

(f) A certain material has a Young modulus greater than copper and undergoes brittle fracture at a stress of 176 MPa.

On the figure above draw a line showing the possible variation of stress with strain for this material.

(2)

(Total 12 marks)

Q3. (a) Describe how to obtain, accurately by experiment, the data to determine the Young modulus of a metal wire.

A space is provided for a labelled diagram.

The quality of your written answer will be assessed in this question.

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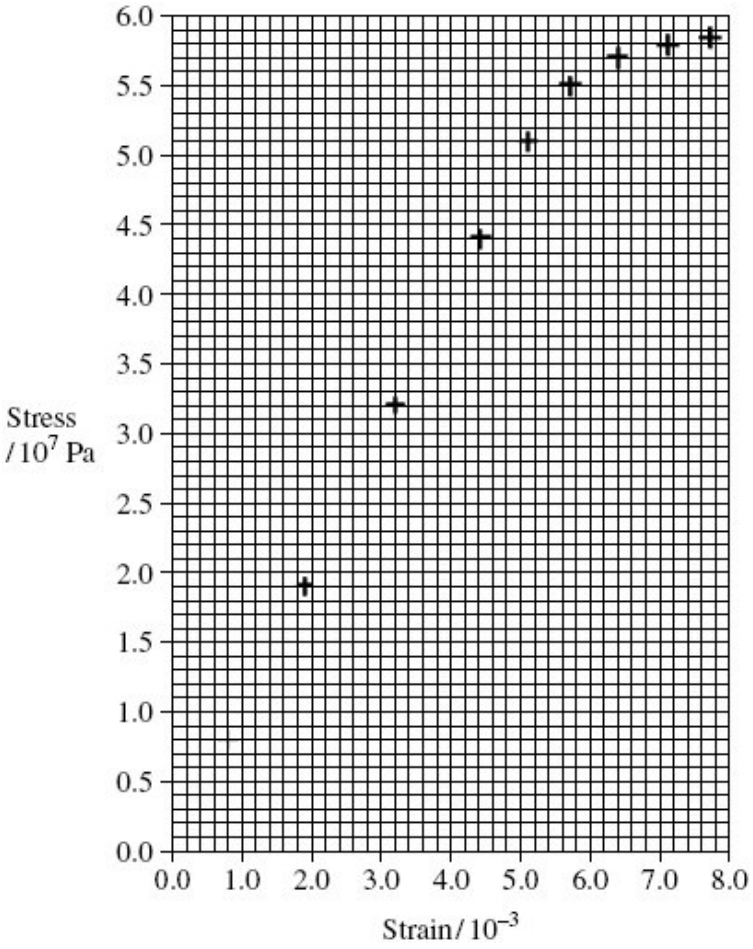
(6)

(b) The diagram below is a plot of some results from an experiment in which a metal wire was stretched.



(i) Draw a best-fit line using the data points.

(1)

(ii) Use your line to find the Young modulus of the metal, stating an appropriate unit.

answer = ...

(4)

(c) After reaching a strain of 7.7×10^{-3}, the wire is to be unloaded. On the diagram above, sketch the line you would expect to obtain for this.

(1)

(Total 12 marks)

Q4. (a) When a *tensile stress* is applied to a wire, a *tensile strain* is produced in the wire. State the meaning of

tensile stress, ...

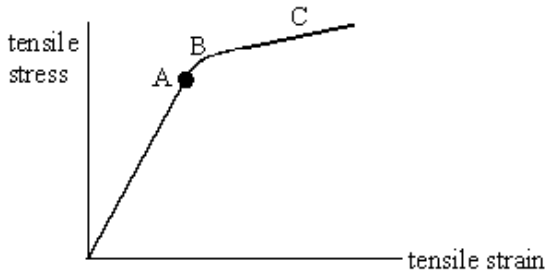
.....

tensile strain. .....

.....

(2)

(b) A long thin line metallic wire is suspended from a fixed support and hangs vertically. Weights are added to increase the load on the free end of the wire until the wire breaks. The graph below shows how the tensile strain in the wire increases as the tensile stress increases.



With reference to the graph, describe the behaviour of the wire as the load on the free end is increased. To assist with your answer refer to the point A, and regions B and C.

You may be awarded marks for the quality of written communication in your answer.

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(5)
(Total 7 marks)