1. (a) State *Hooke's law* for a material in the form of a wire and state the conditions under which this law applies.

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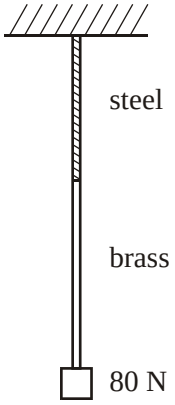
(2)

(b) A length of steel wire and a length of brass wire are joined together. This combination is suspended from a fixed support and a force of 80 N is applied at the bottom end, as shown in the figure below.



Each wire has a cross-sectional area of 2.4×10^{-6} m^2.

length of the steel wire = 0.80 m
length of the brass wire = 1.40 m
the Young modulus for steel = 2.0×10^{11} Pa
the Young modulus for brass = 1.0×10^{11} Pa

(i) Calculate the total extension produced when the force of 80 N is applied.

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(ii) Show that the mass of the combination wire = 4.4×10^{-2} kg.

density of steel = 7.9×10^{3} kg m^{-3}
density of brass = 8.5×10^{3} kg m^{-3}

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(7)

(c) A single brass wire has the same mass and the same cross-sectional area as the combination wire described in part (b). Calculate its length.

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(2)
(Total 11 marks)

2. As part of a quality check, a manufacturer of fishing line subjects a sample to a tensile test. The sample of line is 2.0 m long and is of constant circular cross-section of diameter 0.50mm. Hooke's law is obeyed up to the point when the line has been extended by 52mm at a tensile stress of 1.8×10^{8} Pa.
The maximum load the line can support before breaking is 45 N at an extension of 88 mm.

(a) Calculate

(i) the value of the Young modulus,

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(ii) the breaking stress (assuming the cross-sectional area remains constant),

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.....

(iii) the breaking strain.

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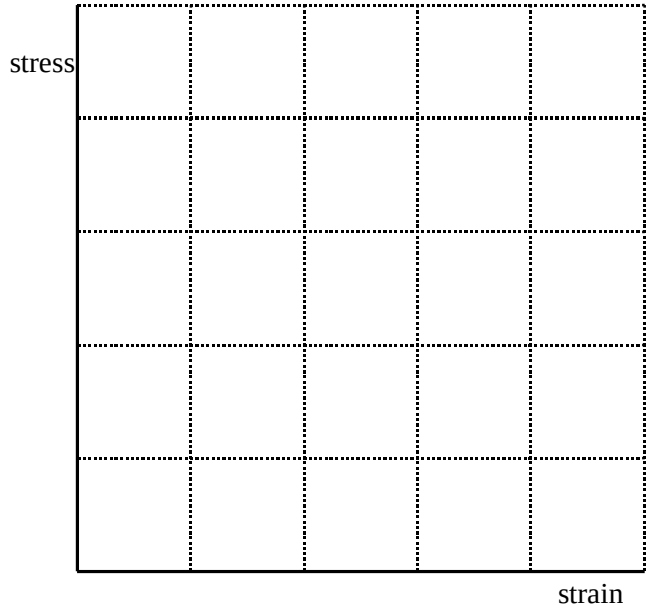
(5)

(b) Sketch a graph on the axes below to show how you expect the tensile stress to vary with strain. Mark the value of stress and corresponding strain at

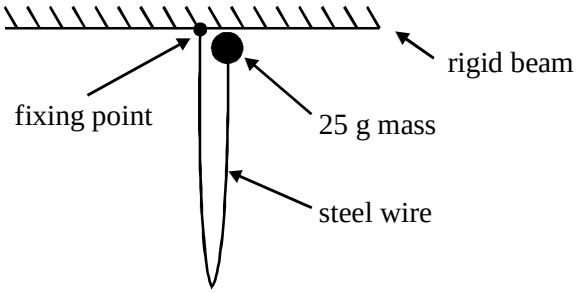
(i) the limit of Hooke's law,

(ii) the breaking point.



(4)
(Total 9 marks)

3. One end of a steel wire of length 1.2 m and 2.0 mm diameter is attached to a rigid beam. A 25 g mass is attached to the free end of the steel wire and placed against the underside of the beam as shown.



The 25 g mass is released and falls freely until the wire becomes taut. The kinetic energy of the falling mass is converted to elastic potential energy in the wire as the wire extends to a maximum of 1.0 mm. Energy converted to other forms is negligible.

For **maximum** extension of the wire, complete parts (i) to (v).

(i) Show that the elastic potential energy stored by the extended wire is 0.29 J.

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(ii) Calculate the tension in the wire.

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(iii) Calculate the stress in the wire.

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(iv) Calculate the strain of the wire.

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(v) Hence, calculate the Young modulus for the steel of the wire.

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(Total 9 marks)