AQA, Edexcel, OCR

A Level

A Level Physics

MECHANICS: Solid Mechanics

Name:

M M E

Mathsmadeeasy.co.uk

Total Marks: /30

1. Figure 1 shows three plots of force, F, against extension, x. Measurements were taken during loading and unloading.

Total for Question 1: 15

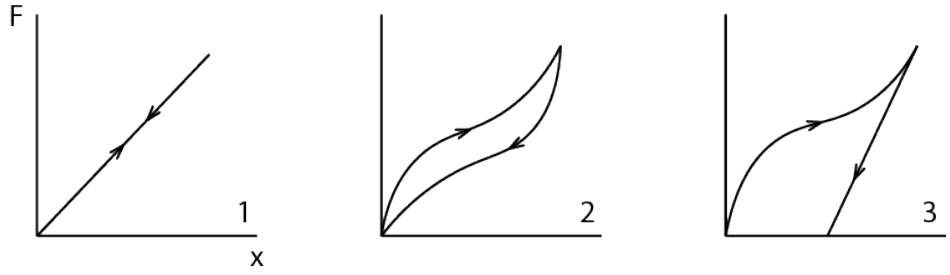

Figure 1: Plot of stress against strain for a typical metal. Elastic and plastic regions of deformation are indicated by the dashed line. Circles represent key points of the curve.

(a) These plots are associated with a shopping bag, a piece of wire and an elastic band. Assign a material to each graph. [3]

(b) What is represented by the area underneath a graph of force against extension? [1]

(c) The Hookean material deforms according to the equation $F = -kx$ (Hooke's Law). Show that the elastic strain energy stored when it is stretched is $\frac{1}{2}kx^2$. [2]

A cylindrical, Hookean wire has a diameter of 3 mm, a length of 1 m and a mass of 64 g when it is not being loaded. An applied force of 10 N is required to induce an extension of 2 cm.

(d) What is the density of the wire? [2]

(e) When extended by 10 cm what is the elastic strain energy stored in the wire? [3]

(f) If the wire were coiled to form a spring, and this was used to suspend a mass, describe how energy would be transferred between kinetic, gravitational potential and elastic strain forms when the mass moves up and down. [4]

2. Figure 2 is a typical stress strain graph for a metal.

Total for Question 2: 15

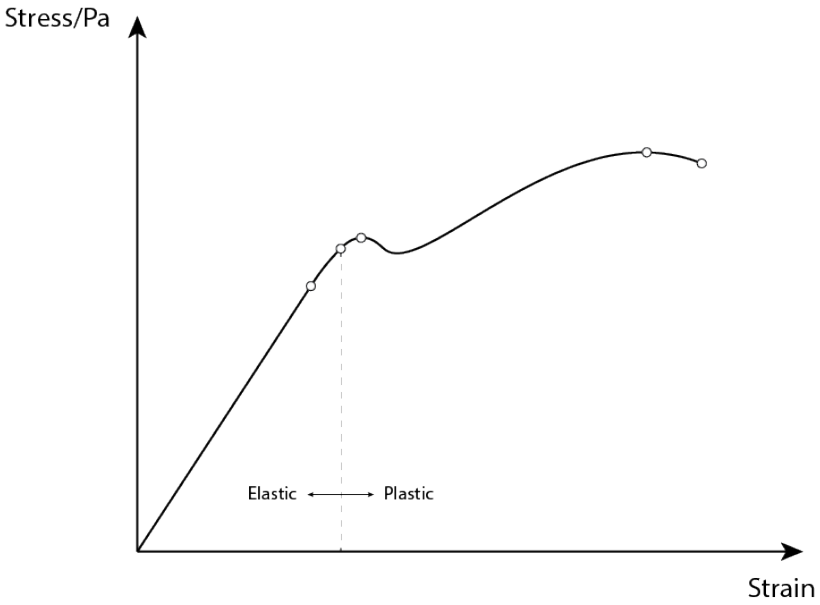

Figure 2: Plot of stress against strain for a typical metal. Elastic and plastic regions of deformation are indicated by the dashed line. Circles represent key points of the curve.

(a) Define tensile stress and tensile strain. [2]

(b) What are meant by the terms elastic and plastic deformation? [2]

(c) Label each circle on the plot above with **one** of the following terms: *ultimate tensile stress, elastic strain energy, limit of proportionality, breaking stress, Young's modulus, elastic limit, yield stress.* Note that not all terms need be used. [5]

Ahmed wants to know the Young's modulus ($E = \sigma/\epsilon$) of copper. He generates a graph like that above using a piece of copper wire whose original length and diameter were 1 m and 1 mm, respectively. The Young's modulus he calculates is 10×10^{10} Pa.

(d) Outline a simple method Ahmed could have used, detailing the apparatus used, the measurements taken and the the way in which the data is analysed. [3]

(e) The limit of proportionality was plotted when the extension measured 1 cm. Assuming that the line goes through (0,0) and is linear between there and this point, calculate the applied force when this measurement was taken. [3]