Deformation of Solids

Mark Scheme 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Deformation of Solids
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 3

Time Allowed: **64 minutes**

Score: **/53**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** **(i)** stress = force / (cross-sectional) area B1 [1]

(ii) strain = extension / original length **or** change in length / original length B1 [1]

(b) point beyond which material does not return to the original length / shape / size when the load / force is removed B1 [1]

(c) UTS is the maximum force / original cross-sectional area M1
wire is able to support / before it breaks A1 [2]

allow one: maximum stress the wire is able to support / before it breaks

(d) **(i)** straight line from (0,0) M1
correct shape in plastic region A1 [2]

(ii) only a straight line from (0,0) B1 [1

(e) **(i)** ductile: initially force proportional to extension then a large extension for small change in force B1
brittle: force proportional to extension until it breaks B1 [2]

(ii) **1.** does not return to its original length / permanent extension (as entered plastic region) B1

2. returns to original length / no extension **(as no plastic region / still in elastic region)** B1 [2]

2 **(a (i)** power = work done per unit time / energy transferred per unit time / rate of work done **B1** [1

(ii) Young modulus = stress / strain B1 [1]

(b) (i) 1. $E = T / (A \times \text{strain})$ *(allow strain = ε)* C1
$T = E \times A \times \text{strain} = 2.4 \times 10^{11} \times 1.3 \times 10^{-4} \times 0.001$ M1
$= 3.12 \times 10^{4}\,\text{N}$ A0 [2]

2. $T - W = ma$ C1
$[3.12 \times 10^{4} - 1800 \times 9.81] = 1800a$ C1
$a = 7.52\ \text{m s}^{-2}$ A1 [3]

(ii) 1. $T = 1800 \times 9.81 = 1.8 \times 10^{4}\,\text{N}$ A1 [1]

2. potential energy gain $= mgh$ C1
$= 1800 \times 9.81 \times 15$
$= 2.7 \times 10^{5}\,\text{J}$ A1 [2]

(iii) $P = Fv$ C1
$= 1800 \times 9.81 \times 0.55$ C1
input power $= 9712 \times (100/30) = 32.4 \times 10^{3}\,\text{W}$ A1 [3]

3 **(a (i)** *stress* is force / area B1 [1]

(ii) *strain* is extension / <u>original</u> length B1 [1]

(b) (i) $E = [F / A] \div [e / l]$ C
$e = (25 \times 1.7) / (5.74 \times 10^{-8} \times 1.6 \times 10^{11})$ C
$e = 4.6 \times 10^{-3}$ m A1 [3]

(ii) A becomes $A/2$ or stress is doubled B1
$e \propto l / A$ or substitution into full formula B1
total extension increase is $4e$ A1 [3]

4 **(a** clamped horizontal wire over pulley or vertical wire attached to ceiling with mass attached B1
details: reference mark on wire with fixed scale alongside B1 [2]

(b) measure original length of wire to reference mark with metre ruler / tape (B1)
measure diameter with micrometer / digital calipers (B1)
measure initial and final reading (for extension) with metre ruler or other suitable scale (B1)
measure / record mass or weight used for the extension (B1)
good physics method:
measure diameter in several places / remove load and check wire returns to original length / take several readings with different loads (B1)

MAX of 4 points B4 [4]

(c) determine extension from final and initial readings (B1)
plot a graph of force against extension (B1)
determine gradient of graph for F / e (B1)
calculate area from πd^2 / 4 (B1)
calculate E from $E = F\,l / e\,A$ or gradient × l / A (B1)

MAX of 4 points B4 [4]

5 **(a** force is proportional to extension B1 [1]

(b) gradient of graph determined (e.g. 50 / 40 $\times 10^{-3}$) = 1250 N m^{-1} A1 [1]

(ii) $W = \frac{1}{2} k x^2$ or W = ½ final force × extension M1
= 0.5 × 1250 × (36 × 10^{-3})^2 or 0.5 × 45 × 36 × 10^{-3} M1
= 0.81 J A0 [2]

(c) $0.81 = \frac{1}{2} mv^2$ C1
v = 8.0 (8.0498) m s^{-1} A1 [2]

(ii) 4 × KE / 4 × WD or 3.24 J C1
hence twice the compression = 72 mm A1 [2]

(iii) Max height is when all KE or WD
or elastic PE is converted to GPE C1
ratio = 1/4 or 0.25 A1 [2]