Deformation of Solids

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Deformation of Solids
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **57 minutes**

Score: **/47**

Percentage: **/100**

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

1 **(a** when the load is removed then the wire / body object does not return to its original shape / length B1 [1]

(b) (i) stress = force / area C1
$F = 220 \times 10^6 \times 1.54 \times 10^{-6} = 340\ (338.8)\,\text{N}$ A [2]

(ii) $E = (F \times l) / (A \times e)$ C
$e = (90 \times 10^6) \times 1.75 / (1.2 \times 10^{11}) = 1.31 \times 10^{-3}\,\text{m}$ A [2]

(c) the stress is no longer proportional to the extension B1 [1]

2 **(a** metal: regular / repeated / ordered arrangement / pattern / lattice or long range order (of atoms / molecules / ions) B1
polymer: tangled chains (of atoms / molecules) or long chains (of atoms / molecules / ions) B1
amorphous: disordered / irregular arrangement or short range order (of atoms / molecules / ions) B1 [3]

(b) metal: straight line or straight line then curving with less positive gradient B1
polymer: curve with decreasing gradient with steep increasing gradient at end B1 [2]

3 **(a)** extension is proportional to force / load B1 [1]

(b) $F = mg$ C1
$x = (mg / k) = 0.41 \times 9.81 / 25 = (4.02 / 25)$ M1
$x = 0.16\,\text{m}$ A0 [2]

(c) (i) weight and (reaction) force from spring (which is equal to tension in spring) B1 [1]

(ii) F – weight or $0.06 \times 25 = ma$ C1
$F = 0.2209 \times 25 = 5.52$ (N) or $0.22 \times 25 = 5.5$
$a = (5.52 - 0.41 \times 9.81) / 0.41$ or $1.5 / 0.41$ and $(5.5 - 4.02)$ C1
$a = 3.7\ (3.66)\,\text{m s}^{-2}$ gives $3.6\,\text{m s}^{-2}$ A1 [3]

(d) elastic potential energy / strain energy to kinetic energy and gravitational potential energy B1
stretching / extension reduces and velocity increases / height increases B1 [2]

4	(a)	Resultant force (and resultant torque) is zero Weight (down) = force from/due to spring (up)	B1 B1	[2]
	(b) (i)	0.2, 0.6, 1.0 s (*one of these*)	A1	[1]
	(ii)	0, 0.8 s (*one of these*)	A1	[1]
	(iii)	0.2, 0.6, 1.0 s (*one of these*)	A1	[1]
	(c) (	Hooke's law: extension is proportional to the force (*not mass*) Linear/straight line graph hence obeys Hooke's law	B1 B1	[2]
	(ii)	Use of the gradient (*not just* $F = kx$) K $= (0.4 \times 9.8) / 15 \times 10^{-2}$ $= 26(.1)\ \text{N m}^{-1}$	C1 M1 A0	[2]
	(iii)	*either* energy = area to left of line *or* energy = $\frac{1}{2} ke^2$ $= \frac{1}{2} \times [(0.4 \times 9.8) / 15 \times 10^{-2}] \times (15 \times 10^{-2})^2$ = 0.294 J (*allow 2 s.f.*)	C1 C1 A1	[3]
5	(a)	E = stress / strain	B1	[1]
	(b) (i)	1. diameter / cross sectional area / radius 2. original length	B1	[1]
	(ii)	measure original length with a metre ruler / tape measure the diameter with micrometer (screw gauge) *allow digital vernier calipers*	B1 B1	[2]
	(iii)	energy = $\frac{1}{2} Fe$ or area under graph or $\frac{1}{2} kx^2$ $= \frac{1}{2} \times 0.25 \times 10^{-3} \times 3 = 3.8 \times 10^{-4}$ J	C1 A1	[2]
	(c)	straight line through origin below original line line through (0.25, 1.5)	M1 A1	[2]

6	**(a)**		extension is proportional to force (for small extensions)	81	[1]
	(b)	(i)	point beyond which (the spring) does not return to its original length when the load is removed	81	[1]
		(ii)	gradient of graph = 80 $N m^{-1}$	A1	[1]
		(iii)	work done is area under graph / ½ *Fx* / ½ kx^2	C1	
			= 0.5 x 6.4 x 0.08 = 0.256 (allow 0.26) J	A1	[2]
	(c)	(i)	extension = 0.08 + 0.04 = 0.12 m	A1	[1]
		(ii)	spring constant = 6.4 / 0.12 = 53.3 $N m^{-1}$	A1	[1]