Deformation of Solids

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Deformation of Solids
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **59 minutes**

Score: **/49**

Percentage: **/100**

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

1	**(a**	**(i)**	two sets of co-ordinates taken to determine a constant value (F/x)	M1	
			F/x constant hence obeys Hooke's law	A1	[2]
			or gradient calculated and one point on line used to show no intercept hence obeys Hooke's law	 (M1) (A1)	
		(ii)	gradient or one point on line used e.g. $4.5/1.8 \times 10^{-2}$	C1	
			(k =) 250 N m^{-1}	A1	[2]
		(iii)	work done or E_P = area under graph or ½Fx or ½kx^2	C1	
			= $0.5 \times 4.5 \times 1.8 \times 10^{-2}$ or $0.5 \times 250 \times (1.8 \times 10^{-2})^2$	C1	
			= 0.041 (0.0405) J	A1	[3]
	(b)		KE = ½mv^2		
			½mv^2 = 0.0405 or KE = 0.0405 (J)	C1	
			(v = $[2 \times 0.0405/1.7]^{1/2}$ =) 0.22 (0.218) m s^{-1}	A1	[2]
2	**(a**	**(i)**	diameter and extension: micrometer (screw gauge) or digital calipers	B1	
			length: tape measure or metre rule	B1	
			load: spring balance or Newton meter	B1	[3]
		(ii)	to reduce the effect of random errors **or** to plot a graph to check for zero error in measurement of extension **or** to see if limit of proportionality is exceeded	B1	1]
	(b)		plot a graph of F against e and determine the gradient	B1	
			E = (gradient $\times$ l)/[$\pi d^2/4$]		[2]

3	**(a**	**(i)** solid: (molecules) vibrate	B1	
		no translational motion / fixed position, liquid: translational motion	B1	[2]
		(ii) gas: molecules have random (and translational) motion	B1	[1]
	(b)	**(i)** ductile: straight line through origin then curving towards *x*-axis	B1	[1]
		(ii) brittle: straight line through origin with no or negligible curved region	B1	[1]
	(c)	similarity: obey Hooke's law / $F \propto x$ or have elastic regions	B1	
		difference: brittle no or (very) little plastic region ductile has (large(r)) plastic region	B1	[2]
4	**(a**	(Young modulus / E =) stress / strain		[1]
	(b)	**(i)** stress $= F/A$ *or* $= F/(\pi d^2/4)$ *or* $= F/(\pi d^2)$	M1	
		ratio = 4 (or 4:1)	A1	[2]
		(ii) E is the same for both wires (as same material) [e.g. $E_P = E_Q$] strain = stress / E	M1	
		ratio = 4 (or 4:1) [*must be same as* ***(i)***]	A	[2]
5	**(a**	<u>add small mass</u> to cause extension then remove mass to see if spring returns to original length	M1	
		repeat for larger masses and note maximum mass for which, when load is removed, the spring does return to original length	A1	[2]
	(b)	Hooke's law requires force proportional to extension	B1	
		graph shows a straight line, hence obeys Hooke's law	M1	[2]
	(c)	k = force / extension $= (0.42 \times 9.81) / [(30 - 21.2) \times 10^{-2}]$ $= 47\ (46.8)\ \mathrm{N\,m^{-1}}$	C A1	[3]

(a	the wire returns to its original length (*not 'shape'*)	M	
	when the load is removed	A1	[2]
(b)	energy: N m / kg m^2 s^{-2} and volume m^3	C1	
	energy / volume: kg $m^2 s^{-2}$ / m^3	M1	
	energy / volume: kg m^{-1} s^{-2}	A0	[2]
(c)	ε has no units	B1	
	E: kg m s^{-2} m^{-2}	M1	
	units of RHS: kg m^{-1} s^{-2} = LHS units / satisfactory conclusion to show *C* has no units	A1	[3
(a (i)	stress = force / cross-sectional area	B1	[1]
(ii)	strain = extension / <u>original</u> length	B1	[1]
(b) (i)	*E* = stress / strain	C1	
	E = 0.17 × 10^{12}	C1	
	stress = 0.17 × 10^{12} × 0.095 / 100	C1	
	= 1.6(2) × 10^8 Pa	A1	[4]
(ii)	force = (stress × area) = 1.615 × 10^8 × 0.18 × 10^{-6}	C1	
	= 29(.1) N	A	[2]