Deformation of Solids

Mark Scheme 5

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Deformation of Solids
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 5

Time Allowed: **62 minutes**

Score: **/51**

Percentage: **/100**

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

1 **(a)** **(i)** returns to original shape / size / length etc. B1
when load / distorting forces / weight / strain is removed ..... B1 [2]

(ii) $R = \rho L / A$ ..... B1 [1
2 $E = WL / Ae$ ..... B1 [1]

(b) $E = WR / e\rho$ C1
$= (34 \times 0.44) / (7.7 \times 10^{-4} \times 9.2 \times 10^{-8})$ C1
$= 2.1 \times 10^{11}$ Pa ..... A1 [3]

[Total: 7]

2 **(a)** ability to do work B1
as a result of a change of shape of an object/stretched etc ..... B1 [2]

(b) work = average force ×distance moved (in direction of the force) B1
either work = $\frac{1}{2} \times F \times x$
or work is area under F/x graph which is $\frac{1}{2}Fx$ B1
$F = kx$ B1
so work / energy = $\frac{1}{2}kx^2$ ..... A0 [3]

(c) **(i)** spring constant = $\frac{3.8}{2.1}$ M1
= 1.8 N cm^{-1} ..... A0 [1]

(ii) **1** $\Delta E_P = mg\Delta h$ *or* $W\Delta h$ C1
$= 3.8 \times 1.5 \times 10^{-2}$
= 0.057 J ..... A1 [2]
2 $\Delta E_S = \frac{1}{2} \times 1.8 \times 10^{-2} (0.036^2 - 0.021^2)$ M1
= 0.077 J ..... A0 [1]
3 work done = 0.077 – 0.057
= 0.020 J ..... A1 [1]
(*allow e.c.f. if* $\Delta E_S > \Delta E_P$)

[Total: 10]

3	**(a)**	**(i)**	change of shape / size / length / dimension	C1	
			when (deforming) <u>force is removed</u>, returns to original shape / size	A1	[2]
		(ii)	$L = ke$	B1	[1]
	(b)		$2e$	B1	
			$\frac{1}{2}k$ …(*allow e.c.f. from extension*)	B1	
			$\frac{1}{2}e$ and $2k$	B1	
			$\frac{3}{2}e$ …(*allow e.c.f. from extension in part 2*)	B1	
			$\frac{2}{3}k$ …(*allow e.c.f. from extension*)	B1	[5]

4	**(a**	**(i)**	k is the reciprocal of the gradient of the graph	C1	
			$k = \{32 / (4 \times 10^{-2}) = \}\ 800\ \text{N m}^{-1}$	A1	[2]
		(ii)	*either* energy = average force × extension *or* $\frac{1}{2}kx^2$		
			or area under graph line	C1	
			energy $= \frac{1}{2} \times 800 \times (3.5 \times 10^{-2})^2$ *or* $\frac{1}{2} \times 28 \times 3.5 \times 10^{-2}$	M1	
			energy = 0.49 J	A0	[2]
	(b)	**(i)**	momentum before cutting thread = momentum after	C1	
			$0 = 2400 \times V - 800 \times v$	M1	
			$v / V = 3.0$	A0	[2]
		(ii)	energy stored in spring = kinetic energy of trolleys	C1	
			$0.49 = \frac{1}{2} \times 2.4 \times (\frac{1}{3}v)^2 + \frac{1}{2} \times 0.8 \times v^2$	C1	
			$v = 0.96\ \text{m s}^{-1}$	A1	[3]
			(if only one trolley considered, or masses combined, allow max 1 mark)		

5	**(a**	**(i)** **1.** stress = force / (cross-sectional) area	B1	[1]
		2. strain = extension / <u>original</u> length	B1	[1]
		3. Young modulus = stress / strain	B1	[1]
		(ratios must be clear in each answer)		
		(ii) *either* fluids cannot be deformed in one direction / cannot be stretched		
		or fluids can only have volume change		
		or no fixed shape	B1	[1]
	(b)	*either* unless Δp is very large *or* 2.2×10^9 is a large number	M1	
		ΔV is very small *or* $\Delta V/V$ is very small, (so 'incompressible')	A1	[2]
	(c)	$\Delta p = h\rho g$		
		$1.01 \times 10^5 = h \times 1.08 \times 10^3 \times 9.81$	C1	
		$h = 9.53$ m	C1	
		$\Delta h / h = 0.47 / 10$ *or* $0.47 / 9.53$		
		error = 4.7% *or* 4.9% *or* 5%	A1	[3]

6	**(a**	brittle	B1	[1
	(b)	Young modulus = stress / strain	C1	
		$= (9.5 \times 10^8) / 0.013$		
		$= 7.3 \times 10^{10}$ Pa (*allow* $\pm 0.1 \times 10^{10}$ *Pa*)	A	[2]
	(c)	stress = force / area	C1	
		(minimum) area $= (1.9 \times 10^3) / (9.5 \times 10^8)$		
		$= 2.0 \times 10^{-6}$ m^2	C1	
		(max) area of cross-section $= (3.2 - 2.0) \times 10^{-6}$		
		$= 1.2 \times 10^{-6}$ m^2	A1	[3]
	(d)	when bent, 'top' and 'bottom' edges have different extensions	M1	
		with thick rod, difference is greater (than with a thin rod)	A1	
		so breaks with less bending	A0	[2]