



Question		Answer	Marks	Guidance	
1	a	The material is <u>elastic</u> / strain is zero when stress is <u>removed</u> / returns to its original shape when force is <u>removed</u> / there is no <u>plastic</u> deformation	B1	 The term elastic / remove(d) / plastic must be spelled correctly to gain this mark Ignore 'polymeric' Not 'it is ductile <u>and</u> elastic'	
		It does not obey Hooke's law	B1	Allow: Stress is not proportional to strain / force is not proportional to extension	
		The loading and unloading graphs are different (AW)	B1	Allow: It shows hysteresis / heat produced (when loaded and unloaded)	
	b	i	(breaking) stress = $\frac{16}{0.012 \times 0.018 \times 10^{-3}}$ or 7.41×10^7 (Pa)	C1	Alternative: $x = \frac{FL}{EA}$ (Any subject) C1 extension = $\frac{16 \times 0.15}{7.1 \times 10^{10} \times (0.012 \times 0.018 \times 10^{-3})}$ C1 extension = 1.6×10^{-4} (m) A1
			strain = $\frac{7.41 \times 10^7}{7.1 \times 10^{10}}$ or 1.04×10^{-3}	C1	
			extension = $1.04 \times 10^{-3} \times 0.15$		
			extension = 1.6×10^{-4} (m)	A1	
			assumption: Hooke's law obeyed / elastic limit is not exceeded / not plastically deformed / (cross-sectional) area is the same / thickness is the same / width is the same / no 'necking' / material is brittle	B1	
		ii	(breaking) stress = same $\frac{F}{\pi \times (0.60 \times 10^{-2})^2} = 7.41 \times 10^7$	C1	Allow other correct methods Possible ecf from (b)(i)
		force = 8.4×10^3 (N)	A1		
Total			9		

Question		Answers	Marks	Guidance
2	(a)	force constant = $\frac{3.0}{0.06}$ (Any subject) force constant = 50 (N m ⁻¹)	M1 A0	Not 3.0/6.0 = 50 (N m ⁻¹) Note: There is no mark for the answer because it is given on the paper; the mark is for the working.
	(b) (i)	$(E_i =) \frac{1}{2} \times 50 \times 0.06^2$ or $\frac{1}{2} \times 3.0 \times 0.06$ or 0.09 (J) $(E_f =) \frac{1}{2} \times 50 \times 0.10^2$ or $\frac{1}{2} \times 5.0 \times 0.10$ or 0.25 (J) $\Delta E = 0.25 - 0.09$ $\Delta E = 0.16$ (J)	C1 C1 A1	Special case ' $\frac{1}{2} \times 50 \times (0.10 - 0.06)^2 = 0.04$ (J)' mark or ' $\frac{1}{2} \times 50 \times (0.12 - 0.08)^2 = 0.04$ (J)' scores 1
	(ii)	tension in spring = 50×0.10 or tension in spring = 5.0 (N) net force = 5.0 – 3.0 and mass of object = 3.0/9.81 $a = 2.0/(0.3058..)$ $a = 6.5$ (m s ⁻²)	C1 C1 A1	Special case: $5.0/(3.0/9.81) = 16.35$ (m s ⁻²) scores 1 mark because of the first C1 mark Note: $a = 16.35 - 9.81 = 6.5$ (4 m s ⁻²) scores full marks
Total			7	

Question		Answer	Marks	Guidance	
3	(a)	<p>Material X It is a brittle material No plastic deformation / It is elastic / It returns to same length when stress / force is removed</p> <p>Material Y It is a polymeric / polymer (material) It is elastic / It returns to same length when stress / force is removed</p> <p>X obeys Hooke's law / Y does not obey Hooke's law</p>	<p>B1 B1</p> <p>B1 B1</p> <p>B1</p>	<p>Use ticks on Scoris to show where the marks are awarded ✍ Brittle must be spelled correctly to gain the mark.</p> <p>Allow: rubber / 'elastic band' Allow: energy 'lost' (when unloaded)</p>	
	(b)	<p>Place the 100 g mass on the spring / hang the 100 g mass from the spring Determine the extension / compression of the spring (using a ruler) force constant = 0.98(1)/extension</p>	<p>B1 B1 B1</p>	<p>Allow: $k = (0.1 \times 9.8)/\text{extension}$ Allow: $k = 1.0 \text{ (N)}/\text{extension}$</p>	
	(c)	(i)	<p>$F = kx$</p> <p>$F = 50 \times 0.070$ / $F = 3.5 \text{ (N)}$ $a = 3.5/0.180$ acceleration = 19 (m s⁻²)</p>	<p>C1 C1 A1</p>	<p>Answer to 3 sf is 19.4 (m s⁻²)</p>
		(ii)	<p>average work done = <u>average</u> force × displacement = 1.75 × 0.070 (= 0.1225) av rate of work done = 0.1225/0.094 av rate of work done = 1.3 (J s⁻¹)</p>	<p>C1 A1</p>	<p>Alternative (allow full credit for other correct methods) $E = \frac{1}{2} \times 50 \times 0.070^2 (= 0.1225)$ C1 power = 0.1225/ 0.094 power = 1.3 (J s⁻¹) A1</p>
Total			13		

Question		Expected Answers	Marks	Additional Guidance
4	a	i		Must use tick or cross on Scoris to show if the mark is awarded
			B1	 This B1 can only be scored when ' <i>extension</i> ' is spelled correctly Note: If ' <i>change in length</i> ' or ' Δ length' used instead of ' <i>extension</i> ', then <i>length</i> must be spelled correctly Allow: stress \propto strain as BOD (stress or strain must be spelled correctly)
		ii	C1 C1 A1	Possible ecf Allow: 1 mark for '210/0.16 =1312.5'
	b	i	C1 A1 B1	Allow: An answer in the range $(8.3 \text{ to } 9.1) \times 10^{10}$ (Pa) Allow: 1 mark for an answer 8.75×10^n , $n \neq 10$ Note: This is an independent mark
		ii	C1 A1	Allow: 1 mark 3.17×10^n (m^2), $n \neq -7$ Note: No marks if breaking stress of 6.0×10^n is not used
		Total	9	

5	Expected Answers	Marks	Additional Guidance								
a	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">X</td> <td style="text-align: center;">Y</td> </tr> <tr> <td style="text-align: center;">✓</td> <td></td> </tr> <tr> <td></td> <td style="text-align: center;">✓</td> </tr> <tr> <td style="text-align: center;">✓</td> <td></td> </tr> </table>	X	Y	✓			✓	✓		B1	All 3 ticks correctly placed for 1 mark
X	Y										
✓											
	✓										
✓											
b(i)	Material is permanently deformed / longer when stress / force is removed (wtte)	B1	Note: The answer must make reference to stress or forces <u>removed</u>								
b(ii)1	(stress = force/area) $force = 3.00 \times 10^9 \times 1.02 \times 10^{-7}$ $force = 306 \text{ (N) or } 310 \text{ (N)}$	C1 A1	Allow: Any subject Allow: 2 marks for a bald 306 (N) or 310 (N)								
b(ii)2	$(E = \text{stress/strain})$ $strain = \frac{1.20 \times 10^9}{1.30 \times 10^{11}} \quad / \quad strain = 9.23 \times 10^{-3}$ $extension = 9.23 \times 10^{-3} \times 0.500$ $extension = 4.6(15) \times 10^{-3} \text{ (m)}$	C1 A1	Allow: 4.6×10^{-3} , 4.61×10^{-3} , 4.62×10^{-3} Allow: 2 marks for a bald $4.6(15) \times 10^{-3} \text{ (m)}$ Allow: 1 mark for using breaking stress of $3.0 \times 10^9 \text{ Pa}$; this gives an extension of 0.0115 (m) Alternative answer: $x = (1.20 \times 10^9 \times 0.500) / 1.30 \times 10^{11}$ C1 (Any subject) $extension = 4.6(15) \times 10^{-3} \text{ (m)}$ A1								
	Total	6									