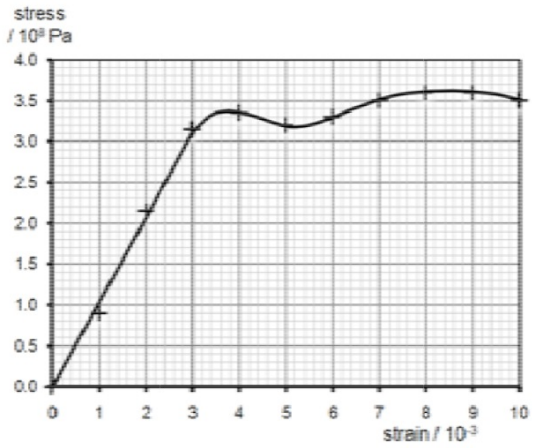
Question 6		
a	 suitable scale on both axes (eg not going up in 3s) **and** > ½ space used ✓ ≥ 8 points correct (within half a small square) ✓ line is straight up to at least stress = 2.5×10^8 **and** curve is smooth beyond straight section ✓	**3**
b	understanding that E = gradient (= $\Delta y/\Delta x$) ✓ allow y/x if line passes through origin = 1.05×10^{11} (Pa) (allow 0.90 to 1.1) **ecf** from their line in (a) if answer outside this range **and** uses a y value ≥ 2.0 ✓ when values used from table; ● two marks can be scored only if candidates line passes through them ● one mark only can be scored if these points are not on their line	**2**

Question			Expected Answers	Marks	Additional Guidance
7	(a)	(i)	It has maximum / large / increased stress at this point	B1	**Allow**: it has 'same force but thinner/smaller area' **Not**: Thin / small area
		(ii)	The tape has (permanent) extension / deformation when the force / stress is removed (AW)	B1	**Note**: Need reference to force or stress removed **Allow**: '.. does not return to original size / shape / length when force / stress is removed'
	(b)		**Measurement:** Diameter Any two from: • original / initial length (**Not**: final length) • extension / initial and final lengths • weight / mass **Equipment:** Micrometer / vernier (calliper) (for the diameter of the wire) Any two from: • Ruler / (metre) rule / tape measure (for measuring the original length / extension) • Travelling microscope (for measuring extension) • Scales / balance (for measuring the mass & *mg* equation is used or for measuring weight) / Newtonmeter (for the weight of hanging masses) / 'known' weights used **Determining Young modulus:** • stress = force/(cross-sectional) area and strain = extension/original length • Young modulus = stress/strain / Young modulus is equal to the gradient from stress-strain graph (in the linear region)	B1 B1 X 2 B1 B1 × 2 B1 B1	**The term *diameter* to be included and spelled correctly to gain the mark** **The term *micrometer* / *vernier* (*calliper*) to be included and spelled correctly to the gain mark. (ALLOW: Micrometer is used to measure area / radius / thickness – as BOD)** **Allow**: 'known masses & *mg* equation' but **not** 'known masses' **Allow:** stress = *F/A* and strain = *x/L* **Special case for determining Young modulus:** Gradient from force-extension graph is $\frac{EA}{L}$ B1 Young modulus = gradient × *L/A* B1
			Total	**10**	

Q7	Expected Answers	Marks	Additional Guidance
a(i)	**Y** (is brittle)	B1	
a(ii)	(Both) obey Hooke's law	B1	**Allow** (For both) stress ∝ strain / elastic (behaviour) / 'not plastic (behaviour)' / force ∝ extension **Not**: 'straight line(s)'
a(iii)	Gradient (of the linear section) is equal to Young Modulus / gradient is largest **X** (has largest Young modulus)	B1 B1	**Allow**: 'slope' for 'gradient'
b	(force increases by a factor of) 30^2 force = 240×30^2 force = 2.16×10^5 (N)	C1 A1	**Allow**: 1 mark for value of breaking stress of $1.2(2) \times 10^9$ (Pa)
	Total	**6**	

Question			Expected Answers	Marks	Additional Guidance
2	a		density = mass/volume or 'density is mass per (unit) volume'	B1	**Allow**: $\rho = \frac{M}{V}$, where M = mass and V = volume **Not**: mass per m^3
	b	i	Dramatic change(s) in density (at 3.0 Mm and 5.1 Mm) (AW)	B1	**Not**: There are three (distinct) layers / Each layer has different density
		ii	mass = $0.18 \times 6.0 \times 10^{24}$ ($=1.08 \times 10^{24}$ kg) or radius = 1.3×10^6 (m) volume = $\frac{4}{3}\pi \times (1.3 \times 10^6)^3$ density = $\frac{1.08 \times 10^{24}}{9.20 \times 10^{18}}$ density = 1.2×10^5 (kg m^{-3})	C1 C1 A1	**Note**: The first C1 mark is for determining the mass or the radius of core Possible 10^n errors **Bald** answer of 1.2×10^5 (kg m^{-3}) or 1.17×10^5 (kg m^{-3}) scores 3 marks **Allow**: 2 marks for $\frac{6.0 \times 10^{24}}{9.20 \times 10^{18}} = 6.5 \times 10^5$ (factor of 0.18 missed out) **Note**: The last two C1 and A1 marks cannot be scored if incorrect radius is used. Hence no further marks for $\frac{1.08 \times 10^{24}}{\frac{4}{3}\pi \times (6.4 \times 10^6)^3}$ or $\frac{1.08 \times 10^{24}}{\frac{4}{3}\pi \times (5.1 \times 10^6)^3}$, etc
			Total	**5**	

Question			Answer	Marks	Guidance
8	(a)		The graph is a straight line through the origin / F proportional to x / force is proportional to extension	B1	**Use ticks on Scoris to show where the marks are awarded** *origin / proportional* must be spelled correctly to gain the mark **Not**: $F \propto x$
	(b)		force constant	B1	**Allow**: spring constant
	(c)		stress = $\frac{100}{\pi \times (2.8 \times 10^{-4})^2}$ ($= 4.06 \times 10^8$ Pa) strain = $\frac{4.0 \times 10^{-3}}{1.60}$ ($= 2.5 \times 10^{-3}$) $E = \frac{4.06 \times 10^8}{2.5 \times 10^{-3}}$ Young modulus = 1.6×10^{11} (Pa)	C1 C1 A1	**Allow** use of any other point on the graph. **Alternative method:** $E = \frac{FL}{Ax}$ C1 (Any subject) $E = \frac{100 \times 1.60}{\pi \times (2.8 \times 10^{-4})^2 \times 4.0 \times 10^{-3}}$ C1 $E = 1.6 \times 10^{11}$ (Pa) A1 **Allow** 2 marks for 1.6×10^n, $n \neq 11$ (POT error)
	(d)		(Straight line) with quarter gradient Correct reasoning, for example: • gradient = EA/L and A decreases by a factor of 4 • A decreases by a factor of 4 and the same force gives 4 times the extension	B1 B1	**Note**: No need to define the labels
	(e)		½ kx^2 = ½ mv^2 Manipulation leading to $v \propto x$, for example: • taking square root of both sides (gives $v \propto x$) • $v^2 \propto x^2$ (hence $v \propto x$) • $v = (\sqrt{k/m})x$ (and therefore $v \propto x$)	M1 A1	**Note**: No need to define the labels
			Total	**9**	

Question			Answer	Marks	Guidance
8	(a)	(i)	Young modulus = gradient (in the linear region) $E = 1.5 \times 10^9/0.008$ $E = 1.9 \times 10^{11}$ (Pa)	C1 C1 A1	**Allow**: (E =) stress/strain for this C1 mark **Note**: Deduct 1 mark for incorrect value or omission of the prefix G. Also deduct another mark for incorrect conversion of 0.80% strain.
		(ii)	**1** Obeys Hooke's law/elastic (behaviour) (AW)	B1	**Allow**: stress $\propto$ strain
		(ii)	**2** Plastic (deformation) (AW)	B1	
		(iii)	No change (to the linear section)/gradient is the same because the Young modulus is the same (and independent of length)	M1 A1	
	(b)		Polymer or polymeric or rubber Any one from: • The material is elastic/there is no strain when the stress is removed/material returns to its original size or shape when forces are removed (AW) • The work done on the material > energy returned back by the material or area under loading graph > area under unloading graph (AW) The aeroplane/tyres do not bounce (too much on landing)	B1 B1 B1	***polymer/polymeric/rubber*** must be spelled correctly to gain the first B1 mark **Not**: 'Monomer' **Allow**: material/graph shows 'hysteresis' **Allow**: Material 'absorbs' energy/material gets hot (AW)
			Total	**10**	

Question			Answer	Marks	Guidance
8	a		The material is elastic / strain is zero when stress is removed / returns to its original shape when force is removed / there is no plastic deformation It does not obey Hooke's law The loading and unloading graphs are different (AW)	B1 B1 B1	The term **elastic / remove(d) / plastic** must be spelled correctly to gain this mark **Ignore** 'polymeric' **Not** 'it is ductile and elastic' **Allow**: Stress is not proportional to strain / force is not proportional to extension **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) strain = $\frac{7.41\times 10^7}{7.1\times 10^{10}}$ or 1.04×10^{-3} extension = $1.04 \times 10^{-3} \times 0.15$ extension = 1.6×10^{-4} (m) 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	C1 C1 A1 B1	**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
		ii	(breaking) stress = same $\frac{F}{\pi\times (0.60\times 10^{-2})^2} = 7.41\times 10^7$ force = 8.4×10^3 (N)	 C1 A1	**Allow** other correct methods Possible ecf from **(b)(i)**
			Total	**9**	