1)

(a) (i) F/A **B1**

(ii) ΔL/L **B1**

(iii) FL/A.ΔL **B1 [3]**

(b) (i) ΔL = 0.012 x 0.62 x 350 **M2**

= 2.6 mm **A0 [2]**

(ii) $2.0 \times 10^{11} = (F \times 0.62)/(7.9 \times 10^{-7} \times 2.6 \times 10^{-3})$ **C1**

F = 660 N **A1 [2]**

(iii) *either* stress when cold = $660/(7.9 \times 10^{-7})$ = 840 MPa

or tension at uts = 198 N **M1**

either this is greater than the ultimate tensile stress

or tension at uts is less then tension in **(ii)** **A1**

the wire will snap **A1 [3]**

(Allow possibility for the two 'A' marks to be scored as long as some quantitative answer – even if incorrect – has been given for the 'M' mark)

2)

(a) **(i)** ductile B1

(ii)1 L shown at end of straight line B1

(ii)2 reciprocal of gradient of straight line region .... B1 [3]

(b) **(i)1** circumference = 3π cm or arc = $r\theta$ C1

extension = (6.5/360) x 3π = 1.5 sin (or tan) 6.5.......... M1

= 0.17 cm A0

(i)2 strain = extension/length.. C1

= 0.17/250

= 6.8×10^{-4} .... A1 [4]

(ii) stress = force/area C1

= $(6.0 \times 9.8)/(7.9 \times 10^{-7})$ C1

= 7.44×10^{7} Pa .... A1 [3]

(iii) Young modulus = stress/strain C1
= $(7.44 \times 10^7)/(6.8 \times 10^{-4})$
= 1.1×10^{11} Pa .... A1 [2]

(iv) remove extra load and see if pointer returns to original position or wire returns to original length .... B1 [1]

3)

(a)		copper and aluminium (-1 for each error or omission)	B2	**[2]**
(b)	**(i)**	A is brittle		
		B is ductile		
		C is polymeric (-1 each error or omission)	B2	**[2]**
		(named materials, all correct, allow $\frac{1}{2}$)		
	(ii)	work done is represented by area under graph	C1	
		$(\frac{1}{2} \times 2 \times 10^{-3} \times 3) + (2 \times 10^{-3} \times 3.1)$	C1	
		work done = 9.2×10^{-3} J (1 s.f. –1)	A1	**[3]**

4)

(a) (i) stress = F / A C1
= $25 / (1.7 \times 10^{-6})$
= 1.47×10^7 Pa ......(do not allow 1 sig fig) A1

(ii) stress = $E \times$ strain C1
$1.47 \times 10^7 = 7.1 \times 10^{10} \times (\Delta l / 1.8)$
Δl = 0.37 mm .... A1 [4]

5)

(a)	brittle	B1	**[1]**
(b) (i)	stress = force/area = $60/(7.9 \times 10^{-7})$ = 7.6×10^{7} Pa	C1 A1	 **[2]**
(ii)	Young modulus = stress/strain limiting strain = 0.03/24 (= 1.25×10^{-3}) Young modulus = $(7.6 \times 10^{7})/(1.25 \times 10^{-3}) = 6.1 \times 10^{10}$ Pa	C1 C1 A1	 **[3]**
(iii)	energy = $\frac{1}{2} \times 60 \times 3.0 \times 10^{-4}$ = 9.0×10^{-3} J	C1 A1	 **[2]**
(c)	If hard, ball does not deform (much) and <u>either</u> (all) kinetic energy converted to strain energy If soft, E_k becomes strain energy of ball and window (no mention of <u>strain</u> energy, max 2 marks) <u>or</u> impulse for hard ball takes place over shorter time (B1) larger force/greater stress (B1)	B1 B1 B1	 **[3]**

6)

(a)		metal: crystalline / lattice / atoms in regular pattern (atoms in regular) pattern that repeats itself (within crystal) polymer: long chains of atoms / molecules chain consists of 'units' that repeat themselves	B1 B1 B1 B1	 [2] [2]
(b)	**(i)**	e.g. latex is soft / not strong / flows / ductile elastic limit easily exceeded (*allow any two sensible comments, 1 each*)	B1 B1	 [2]
	(ii)	more solid / does not flow / stronger / higher ultimate tensile stress more brittle elastic limit much higher increased toughness (*any two, 1 each*)	 B2	 [2]

7)

(a)	**(i)**	$R = \rho L / A$	B1	
	(ii)	strain = $\Delta L / L$ *either* $\Delta R = \rho \Delta L / A$ *or* $R \propto L$ with ρ and A constant dividing, $\Delta R / R = \Delta L / L$	B1 B1 A0	 [3]
(b)		Young modulus = stress / strain strain = $72.0 / (1.20 \times 10^{-7} \times 2.10 \times 10^{11})$ = 2.86×10^{-3} (*allow 1/350* $\Delta R = 2.86 \times 10^{-3} \times 4.17 = 1.19 \times 10^{-2}\ \Omega$ answer given to 3 sig. fig	C1 C1 A1 A1 B1	 [5]

8)

(a)	brittle	B1	[1]
(b)	Young modulus = stress / strain	C1	
	= $(9.5 \times 10^8) / 0.013$		
	= 7.3×10^{10} Pa (*allow* $\pm 0.1 \times 10^{10}$ *Pa*)	A1	[2]
(c)	stress = force / area	C1	
	(minimum) area = $(1.9 \times 10^3) / (9.5 \times 10^8)$		
	= 2.0×10^{-6} m^2	C1	
	(max) area of cross-section = $(3.2 - 2.0) \times 10^{-6}$		
	= 1.2×10^{-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]

9)

(a) (i)	**1.** stress = force / (cross-sectional) area	B1	[1]
	2. strain = extension / original 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]