6. Deformation of Solids

6.2 Elastic and plastic behaviour

Paper 2

Marking Scheme

Q1.

(a)	$E = ½kx^2$ **or** $E = ½Fx$ **and** $F = kx$	**C1**
	$E = ½ \times 29 \times (8.0 \times 10^{-2})^2$ **or** $E = ½ \times 2.32 \times 8.0 \times 10^{-2}$ $E = 9.3 \times 10^{-2}$ J	**A1**

Q2.

(b)(iii)	elastic potential energy (stored in wire)	**B1**

Q3.

(c)(iii)	elastic limit is not reached **or** (new) stress is less than (stress at) elastic limit **or** (new) strain is less than (strain at) elastic limit	**M1**
	(so the wire behaves) elastically	**A1**

Q4.

(b)	$E = ½Fx$	**C1**
	$0.32 = ½ \times 8.2 \times x$ $x = 0.078$ m	**A1**

Q5.

(c)	$E = \frac{1}{2}Fx$ **or** $E = \frac{1}{2}kx^2$ **or** E = area under graph	**C1**
	$E = \frac{1}{2} \times 6.0 \times 0.080$ **or** $\frac{1}{2} \times 75 \times 0.08^2$ $= 0.24$ J	**A1**

Q6.

(c)(ii)	$E_{(P)} = ½Fx$ **or** $E_{(P)} = ½kx^2$ **and** $F = kx$	**C1**
	$E_{(P)} = ½ \times 4.00 \times 10^2 \times 6.0 \times 10^{-5}$ **or** $E_{(P)} = ½ \times 6.7 \times 10^6 \times (6.0 \times 10^{-5})^2$ $E_{(P)} = 0.012$ J	**A1**

Q7.

(a)	$E_{(P)} = ½kx^2$ **or** $E_{(P)} = ½Fx$ **and** $F = kx$	**C1**
	$0.048 = ½ \times k \times (2.1 \times 10^{-2})^2$ $k = 220$ N m^{-1}	**A1**
(d)	sketch: curved line from the origin	**M1**
	curved line has increasing gradient	**A1**

Q8.

(b)	$E = \frac{1}{2}F\Delta L$ **or** $\frac{1}{2}Fx$ **or** $\frac{1}{2}k(\Delta L)^2$ **or** $\frac{1}{2}kx^2$ **or** area under graph	**C1**
	$= \frac{1}{2} \times 15 \times 0.20$ **or** $\frac{1}{2} \times 75 \times 0.20^2$	**C1**
	= 1.5 J	**A1**

Q9.

(d)(ii)	$E = \frac{1}{2}kx^2$ **or** $E = \frac{1}{2}Fx$ **and** $F = kx$	**C1**
	$E = 0.65 \times 2^2$ = 2.6 J	**A1**
	or	
	$E = \frac{1}{2}Fx$ $0.65 = \frac{1}{2} \times 270 \times x$ and so $x = 4.8 \times 10^{-3}$ m $k = F / x = 270 / 4.8 \times 10^{-3}$ $= 5.6 \times 10^4$	**(C1)**
(d)(ii)	final $E = \frac{1}{2} \times 540 \times 9.6 \times 10^{-3}$ **or** $E = \frac{1}{2} \times (270 \times 2) \times (4.8 \times 10^{-3} \times 2)$ **or** $E = \frac{1}{2} \times 5.6 \times 10^4 \times (9.6 \times 10^{-3})^2$ = 2.6 J	**(A1)**

Q10.

(b)(iv)	$E = ½kx^2$ **or** $E = ½Fx$ **and** $F = kx$	**C1**
	$x_0 = [(2 \times 0.20) / 64]^{0.5}$ = 0.079 m or 0.080 m	**A1**

Q11.

(b)	$E = ½kx^2$ **or** $E = ½Fx$ **and**_ $F = kx$	**C1**
	$x = [(2 \times 0.66) / 420]^{0.5}$ = 0.056 m	**A1**
	or	
	$E = ½kx^2$	**(C1)**
	$½mv^2 = ½kx^2$ $x = (0.25 \times 2.3^2 / 420)^{0.5}$ = 0.056 m	**(A1)**
(d)	curved line from the origin with an increasing gradient	**B1**

Q12.

(c)(iv)	upthrust (on cylinder) increases (and weight constant)	**B1**
	tension/stress increases and (so) strain energy increases	**B1**

Q13.

(b)(ii)	strain energy = area under graph/line **or** $\frac{1}{2}Fx$ **or** $\frac{1}{2}kx^2$	**C1**
	$= \frac{1}{2} \times 120 \times 1.4 \times 10^{-3}$ **or** $\frac{1}{2} \times 8.6 \times 10^4 \times (1.4 \times 10^{-3})^2$	**C1**
	= 0.084 J	**A1**
(b)(iii)	(some of the) deformation of the wire is plastic/permanent/not elastic **or** wire goes past the elastic limit/enters plastic region	**B1**
	energy (that cannot be recovered) is dissipated as thermal energy/becomes internal energy	**B1**

Q14.

(d)	remove the force/F and wire returns to original length	**B1**

Q15.

(b)(i)	$E = FL / Ax$	**C1**
	$= GL / A$	**A1**
(b)(iii)	**1.** shaded area below the graph line and between the two vertical dashed lines	**B1**
	2. remove the force/F/F_2 and the wire goes back to original length/zero extension	**B1**

Q16.

(a)(ii)	(E =) $\frac{1}{2}kx^2$ **or** $\frac{1}{2}Fx$ **or** area under graph	**C1**
	$\frac{1}{2} \times 800 \times (0.045)^2$ **or** $\frac{1}{2} \times 36 \times 0.045 = 0.81$ (J)	**A1**

Q17.

(a)(i)	$E = \frac{1}{2}Fx$ **or** $E = \frac{1}{2}kx^2$ **or** E = area under graph	**C1**
	$E = \frac{1}{2} \times 4.0 \times 0.32 = 0.64$ J **or** $E = \frac{1}{2} \times 12.5 \times (0.32)^2 = 0.64$ J	**A1**

Q18.

(b)	$E = \frac{1}{2}Fx$ **or** $E = \frac{1}{2}kx^2$ **or** E = area under graph	**C1**
	$(\Delta)E = (\frac{1}{2} \times 3.2 \times 0.040) - (\frac{1}{2} \times 1.2 \times 0.015) = 0.055$ J **or** $(\Delta)E = (\frac{1}{2} \times 80 \times 0.040^2) - (\frac{1}{2} \times 80 \times 0.015^2) = 0.055$ J **or** $(\Delta)E = \frac{1}{2} \times (1.2 + 3.2) \times 0.025 = 0.055$ J	**A1**