CAMBRIDGE INTERNATIONAL AS & A LEVEL • PHYSICS 9702

Topical Questions

Unit 6: Elasticity, Stress and Strain

Past Papers 2021 – 2025

MARK SCHEME 24 Questions

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Question 1 — Mark Scheme

Question	Answer	Mark
3(a)	Hooke's (law)	**B1**
3(b)(i)	$k = F / x$ or k = gradient e.g. $k = 7.0 / 5.0 \times 10^{-2}$	**C1**
	$= 140\ \text{N m}^{-1}$	**A1**
3(b)(ii)	$E = ½ F x$ or $E = ½ k x^2$ or E = area under graph $= ½ \times 5.6 \times 4.0 \times 10^{-2}$ or $½ \times 140 \times (4.0 \times 10^{-2})^2$	**C1**
	$= 0.11$ J	**A1**
3(c)(i)	(upthrust =) 6.20 – 5.60 = 0.60 (N)	**A1**
3(c)(ii)	$\Delta p = \Delta F / A$ $= 0.60 / 1.2 \times 10^{-3}$	**C1**
	$= 500$ Pa	**A1**
3(c)(iii)	$(\Delta)p = \rho g(\Delta)h$ $\rho = 500 / (9.81 \times 5.8 \times 10^{-2})$	**C1**
	$= 880\ \text{kg m}^{-3}$	**A1**
3(d)(i)	(upthrust) increases	**B1**
3(d)(ii)	(extension) decreases	**B1**

Question 2 — Mark Scheme

Question	Answer	Marks
3(a)(i)	$\sigma = F / xy$	**B1**
3(a)(ii)	$\varepsilon = (z - w) / w$	**B1**
3(a)(iii)	$E = \sigma / \varepsilon$	**C1**
	$= Fw / xy(z - w)$	**A1**
3(b)(i)	extension = 2.2 mm (*allow* 2.0–2.4 mm)	**A1**
3(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**
3(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**

Question 3 — Mark Scheme

Question	Answer	Marks
1(a)	$m = \rho V$ **or** ρAL	**C1**
	$W = mg$	**C1**
	$(A =)\ 24 / (9.81 \times 850 \times 0.18) = 0.016\ (m^2)$	**A1**
	or	
	$P = F / A$	**(C1)**
	$P = \rho gh$	**(C1)**
	$(A =)\ 24 / (9.81 \times 850 \times 0.18) = 0.016\ (m^2)$	**(A1)**
1(b)(i)	(upthrust =) 24 + 8(.0) = 32 (N)	**A1**
1(b)(ii)	$(\Delta)p = 32 / 0.016\ (= 2000)$	**C1**
	$(\Delta)p = \rho g(\Delta)h$ $\rho = 2000 / (9.81 \times 0.17)$	**C1**
	$= 1200\ kg\ m^{-3}$	**A1**
1(c)(i)	$E = ½Fx$ **or** $E = ½kx^2$ **or** E = area under graph	**C1**
	$(\Delta)E = (½ \times 8.0 \times 0.40) – (½ \times 4.0 \times 0.20)$ **or** $(½ \times 20 \times 0.40^2) – (½ \times 20 \times 0.20^2)$ **or** $½ \times (4.0 + 8.0) \times 0.20$	**C1**
	$= 1.2\ J$	**A1**
1(c)(ii)	length = 30 cm	**A1**

Question 4 — Mark Scheme

Question	Answer	Marks
4(a)	ratio = 300 / 3200 = 0.094	A1
4(b)	$E = \frac{1}{2}mv^2$ or $E \propto v^2$	C1
	ratio = $(0.094)^{0.5}$ = 0.31	A1
4(c)	work (done against frictional force) = 3200 – 300 (=2900)	C1
	length = 2900 / 76 = 38 m	A1
4(d)(i)	$E = \frac{1}{2}kx^2$ or $E = \frac{1}{2}Fx$ and $F = kx$ $140 = \frac{1}{2} \times 63 \times x^2$ or $140 = \frac{1}{2}Fx$ and $F = 63x$	C1
	x = 2.1 m	A1
4(d)(ii)	percentage efficiency = (140 / 300) × 100 = 47%	A1
4(d)(iii)	curved line from the origin	M1
	gradient of line increases	A1

Question 5 — Mark Scheme

Question	Answer	Marks
4(a)	$k = F / \Delta L$ **or** F / x **or** gradient	**C1**
	= e.g. 30 / (0.60 – 0.20)	**A1**
	= 75 N m^{-1}	
4(b)	$E = \frac{1}{2} F \Delta L$ **or** $\frac{1}{2} F x$ **or** $\frac{1}{2} k (\Delta L)^2$ **or** $\frac{1}{2} k x^2$ **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**

Question 6 — Mark Scheme

Question	Answer	Marks
4(a)(i)	oscillations are in a single direction, which is perpendicular to the direction of propagation (of the wave) **or** oscillations are in a single plane, which contains the direction of propagation (of the wave)	**B1**
4(a)(ii)	light waves are transverse **and** sound waves are longitudinal	**B1**
4(b)	$I = I_0 \cos^2\theta$	**C1**
	$\cos^2\theta = 1/4$ so $\cos\theta = 1/2$ $\theta = 60°$ or $120°$ or $240°$ or $300°$	**C1**
	angle of rotation $= (120° - 90°)$ or $(240° - 90°)$ or $(300° - 90°)$ $= 30°$ or $150°$ or $210°$ or $330°$	**A1**
4(c)(i)	the waves have different amplitudes	**B1**
	cannot have resultant displacement that is always zero **or** cannot have (complete) destructive interference (at nodes) **or** (at nodes resultant) amplitude is the difference of the amplitudes	**B1**
4(c)(ii)	$I \propto A^2$	**C1**
	$A^2 / A_0^2 = (I_0/4)/I_0$ $A = 0.5\,A_0$	**C1**
	maximum amplitude $= A_0 + 0.5\,A_0$ $= 1.5\,A_0$	**A1**

Question 7 — Mark Scheme

2(b)(i)	$\rho = m / V$	**C1**
	$V = \frac{4}{3}\pi r^3$	**C1**
	$\rho = 0.017 / [\frac{4}{3}\pi \times (0.016 / 2)^3]$ $= 7900\ \text{kg m}^{-3}$	**A1**
2(b)(ii)	$(E =)\ ½mv^2$	**C1**
	$(E =)\ ½ \times 0.017 \times 4.9^2 = 0.20\ (\text{J})$	**A1**

Question	Answer	Marks
2(b)(iii)	$k = F / x$ **or** k = gradient	**C1**
	e.g. $k = 6.4 / 10 \times 10^{-2}$ $= 64\ \text{N m}^{-1}$ (*allow 63–65 N m*$^{-1}$)	**A1**
2(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**
2(c)(i)	same elastic potential energy / same (initial) kinetic energy and (polystyrene ball has) smaller mass (so greater speed) **or** same (average) force and (polystyrene ball has) smaller mass, (so greater average acceleration so greater speed)	**B1**
2(c)(ii)	(for the polystyrene ball there is) less (average vertical) acceleration / smaller (average vertical component of) resultant force (so takes longer time to reach ground)	**B1**

Question 8 — Mark Scheme

Question	Answer	Marks
4(a)	$E = \frac{1}{2}mv^2$	C1
	$= \frac{1}{2} \times 0.25 \times 2.3^2$ $= 0.66$ J	A1
4(b)	$E = \frac{1}{2}kx^2$ **or** $E = \frac{1}{2}Fx$ **and** $F = kx$	C1
	$x = [(2 \times 0.66) / 420]^{0.5}$ $= 0.056$ m	A1
	or	
	$E = \frac{1}{2}kx^2$	(C1)
	$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$ $x = (0.25 \times 2.3^2 / 420)^{0.5}$ $= 0.056$ m	(A1)
4(c)(i)	(p =) 0.25×2.3 **or** 0.25×1.5	C1
	change in momentum = $0.25\ (2.3 + 1.5)$ $= 0.95$ N s	A1
4(c)(ii)	resultant force = $0.95 / 0.086$ or $0.25 \times (2.3 + 1.5) / 0.086$ $= 11$ N	A1
4(d)	curved line from the origin with an increasing gradient	B1

Question 9 — Mark Scheme

Question	Answer	Marks
3(a)	sum of CW moments = sum of ACW moments	M1
	about the same point for (an object in rotational) equilibrium	A1
3(b)	moment = 0.3(0) × 0.29 cos 40° **or** 0.3(0) × 0.222	C1
	= 0.067 N m	A1
3(c)(i)	$k = F / x$ **or** k = gradient	C1
	e.g. $k = 21 / 10 \times 10^{-3}$ $k = 2100\ \text{N m}^{-1}$	A1
3(c)(ii)	$V_{(\text{sphere})} = \frac{4}{3} \times \pi \times (0.0480)^3$	C1
	$F = \rho g V$ (upthrust =) $1000 \times 9.81 \times (\frac{4}{3} \times \pi \times (0.048)^3) \times 0.26(0) = 1.18$ (N)	A1
3(c)(iii)	1.18 × 0.29 **or** 0.30 × 0.29 **or** F × 0.017	C1
	(1.18 × 0.29) = (0.30 × 0.29) + (F × 0.017) F = 15 N	A1

Question	Answer	Marks
3(c)(iv)	$E_{(P)} = ½kx^2$ **or** $E_{(P)} = ½Fx$	**C1**
	$x = F / k = 15 / 2100$ **or** x determined from graph for $F = 15.0$ N $E_P = ½ \times 2100 \times (15 / 2100)^2$ **or** $E_P = ½ \times 15 \times (15 / 2100)$ $E_P = 0.054$ J	**A1**
3(d)	the sphere has gained gravitational potential energy	**B1**

Question 10 — Mark Scheme

Question	Answer	Marks
2(c)(i)	$((\Delta)E) = mg(\Delta)h$ **or** $W(\Delta)h$	**C1**
	$= 0.30 \times 0.090$ $= 0.027$ J	**A1**
2(c)(ii)	$E = \frac{1}{2}mv^2$	**C1**
	$E = 0.044 - 0.027$ (= 0.017)	**C1**
	$v^2 = (2 \times 0.017) / (0.30 / 9.81)$ (where v = speed at A) $v = 1.1$ m s^{-1}	**A1**
	or	
	$E = \frac{1}{2}mv^2$	**(C1)**
	$0.044 = \frac{1}{2} \times (0.30 / 9.81) \times v^2$ (where v = speed at B) $(v^2 = 2.88)$ $v^2 = u^2 + 2as$ (where u = speed at A) $2.88 = u^2 + 2 \times 9.81 \times 0.090$	**(C1)**
	$u = 1.1$ m s^{-1}	**(A1)**
2(c)(iii)	(gravitational / resultant) force / weight is vertical	**B1**
2(c)(iv)	straight line with positive gradient starting from non-zero value of v_Y at time t_A to a time t_B	**B1**

Question 11 — Mark Scheme

Question	Answer	Marks
4(a)	Hooke's (law)	**B1**
4(b)	$k = F / x$ **or** k = gradient	**C1**
	= e.g. 12.0 / (0.240 – 0.08) = 75 N m^{-1}	**A1**
4(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**

Question 12 — Mark Scheme

Question	Answer	Marks
3(a)	$E_{(P)} = ½kx^2$ **or** $E_{(P)} = ½Fx$ **and** $F = kx$	**C1**
	$0.048 = ½ \times k \times (2.1 \times 10^{-2})^2$ $k = 220\ \text{N m}^{-1}$	**A1**
3(b)	$E_{(K)} = ½mv^2$	**C1**
	$0.048 = ½ \times 7.5 \times 10^{-3} \times v^2$ $v = 3.6\ \text{m s}^{-1}$	**A1**
3(c)(i)	$(\Delta)E = mg(\Delta)h$	**C1**
	$0.039 = 7.5 \times 10^{-3} \times 9.81 \times (\Delta)h$ $\Delta h = 0.53\ \text{m}$	**A1**
3(c)(ii)	$F \times 0.53 = 0.048 - 0.039$	**C1**
	$F = 0.02\ \text{N}$	**A1**
3(d)	sketch: curved line from the origin	**M1**
	curved line has increasing gradient	**A1**

Question 13 — Mark Scheme

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Question	Answer	Marks
4(a)(i)	spring constant	**B1**
4(a)(ii)	area represents the work done (to extend the wire)	**B1**
	work done (to extend the wire) is equal to elastic potential energy	**B1**
4(b)(i)	x_G = 0.39 mm **and** x_H = 0.29 mm	**A1**
4(b)(ii)	$E = ½Fx$ **or** $E = ½kx^2$ **and** $F = kx$ **or** E = area under graph	**C1**
	for G: $E = ½ \times 2.0 \times (0.39 \times 10^{-3})$ **or** $½ \times 5.1 \times 10^3 \times (0.39 \times 10^{-3})^2$ for H: $E = ½ \times 2.0 \times (0.29 \times 10^{-3})$ **or** $½ \times 6.9 \times 10^3 \times (0.29 \times 10^{-3})^2$ $E_P = 3.9 \times 10^{-4} + 2.9 \times 10^{-4}$ $= 6.8 \times 10^{-4}$ J	**A1**
4(b)(iii)	$E = FL / Ax$ **or** stress / strain = FL / Ax	**C1**
	$A_G / A_H = 1 \times (0.29 \times 10^{-3}) / [1.5 \times (0.39 \times 10^{-3})]$	**C1**
	ratio = 0.50	**A1**

Question 14 — Mark Scheme

Question	Answer	Marks
3(a)(i)	$\sigma = 0.72 \times 10^9$	C1
	force $= \sigma \times A$ $= 0.72 \times 10^9 \times \pi \times (1.2 \times 10^{-3} / 2)^2$	C1
	$= 810$ N	A1
	or Young modulus = gradient of graph e.g. $= 0.80 \times 10^9 / 6.0 \times 10^{-3}$ $= 1.33 \times 10^{11}$	(C1)
	force = Young modulus × strain × A $= 1.33 \times 10^{11} \times 5.4 \times 10^{-3} \times \pi \times (1.2 \times 10^{-3} / 2)^2$	(C1)
	$= 810$ N	(A1)

Question	Answer	Marks
3(a)(ii)	$E_{(P)} = ½ Fx$ or $E_{(P)} = ½ kx^2$ **and** $F = kx$	**C1**
	$x = 2E_P / F$ $x = 2 \times 0.31 / 810$ $x = 7.7 \times 10^{-4}$	**C1**
	$L = x / \varepsilon$ $L = 7.7 \times 10^{-4} / 5.4 \times 10^{-3}$ $L = 0.14$ m	**A1**
	or $E_{(P)} = ½ Fx$+ or $E_{(P)} = ½ kx^2$ **and** $k = EA/L$	**(C1)**
	$x = 2E_P / EA\ \varepsilon$ $x = 2 \times 0.31 / (1.33 \times 10^{11} \times \pi \times (1.2 \times 10^{-3} / 2)^2 \times 5.4 \times 10^{-3})$ $x = 7.6 \times 10^{-4}$	**(C1)**
	$L = x / \varepsilon$ $L = 7.6 \times 10^{-4} / 5.4 \times 10^{-3}$ $L = 0.14$ m	**(A1)**
3(b)	A straight line, passing through the origin with a larger gradient than wire X.	**M1**
	Gradient of the line is twice the gradient of wire X.	**A1**

Question 15 — Mark Scheme

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>extension / original length</td><td>B1</td></tr>
<tr><td rowspan="3">4(b)(i)</td><td>Young modulus = stress / strain</td><td>C1</td></tr>
<tr><td>= $(18 / 4.5 \times 10^{-7}) / (1.4 \times 10^{-3} / 4.0)$</td><td>C1</td></tr>
<tr><td>= $(4.0 \times 10^{7}) / (3.5 \times 10^{-4})$
= 1.1×10^{11} Pa</td><td>A1</td></tr>
<tr><td rowspan="2">4(b)(ii)</td><td>straight line through the origin</td><td>B1</td></tr>
<tr><td>ending at the point (3.5, 4.0)</td><td>B1</td></tr>
<tr><td>4(c)</td><td><table>
<tr><th></th><th>greater in second wire</th><th>less in second wire</th><th>the same in both wires</th></tr>
<tr><td>stress</td><td></td><td>✓</td><td></td></tr>
<tr><td>strain</td><td></td><td>✓</td><td></td></tr>
</table></td><td>B2</td></tr>
</table>

Question 16 — Mark Scheme

Question	Answer	Marks
4(a)	$E = \frac{1}{2}kx^2$ **or** $E = \frac{1}{2}Fx$ **and** $F = kx$	C1
	$E = \frac{1}{2} \times 29 \times (8.0 \times 10^{-2})^2$ **or** $E = \frac{1}{2} \times 2.32 \times 8.0 \times 10^{-2}$ $E = 9.3 \times 10^{-2}$ J	A1
4(b)(i)	$(\Delta)E_{(P)} = mg(\Delta)h$	C1
	$= 4.5 \times 10^{-2} \times 9.81 \times 8.0 \times 10^{-2} \sin 15°$	C1
	$= 9.1 \times 10^{-3}$ J	A1
4(b)(ii)	$E_{(K)} = \frac{1}{2}mv^2$	C1
	$(9.3 \times 10^{-2} - 9.1 \times 10^{-3}) = \frac{1}{2} \times 4.5 \times 10^{-2} \times v^2$	C1
	$v = (2 \times 8.4 \times 10^{-2} / 4.5 \times 10^{-2})^{0.5}$ $= 1.9\,\text{m s}^{-1}$	A1

Question 17 — Mark Scheme

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Question	Answer	Marks
3(a)	extension is proportional to (applied) force	**B1**
3(b)(i)	P at (60, 5.4)	**A1**
3(b)(ii)	E at (80, 5.9)	**A1**
3(c)(i)	$k = F / x$ **or** k = gradient of (straight line section of) graph	**C1**
	e.g. gradient = 5.4 / 0.060 $k = 90\ \text{N m}^{-1}$	**A1**
3(c)(ii)	Young modulus or $E = \sigma / \varepsilon$ **or** FL / Ax **or** kL / A	**C1**
	$E = (5.4 \times 3.2) / (4.0 \times 10^{-7} \times 0.06)$ **or** $90 \times 3.2 / (4.0 \times 10^{-7})$	**C1**
	$E = 7.2 \times 10^{8}$ Pa	**A1**
3(d)	work done = area under graph	**B1**
	$= (1.0 \pm 0.2)$ J	**A1**
3(e)	the extension will be smaller (for the same force on the thicker sample) **or** a greater force is required (to extend the thicker sample by the same amount) **or** spring constant is proportional to area	**M1**
	the spring constant (of the second sample) will be greater	**A1**

Question 18 — Mark Scheme

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Question	Answer	Marks
4(a)	stress per unit strain	**B1**
4(b)(i)	straight line with positive gradient passing through origin	**B1**
4(b)(ii)	spring constant	**B1**
4(b)(iii)	elastic potential energy (stored in wire)	**B1**
4(c)	length (of Q) is half (the length of P)	**B1**
	extension is proportional to length, and inversely proportional to area and Young modulus	**B1**
	extension of Q is = ½ / (2 × 2) = ⅛ times the extension of P	**B1**

Question 19 — Mark Scheme

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Question	Answer	Marks
3(a)(i)	$E = \sigma / \varepsilon$ **or** E = gradient	**C1**
	E = e.g. $12 \times 10^7 / 0.0050$ $= 2.4 \times 10^{10}$ Pa	**A1**
3(a)(ii)	cross drawn at (1.0%, 24×10^7 Pa), labelled Q	**B1**

Question 20 — Mark Scheme

Question	Answer	Marks
4(a)(i)	(normal) force per unit cross-sectional area	**B1**
4(a)(ii)	extension per unit unstretched length	**B1**
4(b)(i)	$E = FL / Ax$	**C1**
	$A = (9.0 \times 0.84) / (1.9 \times 10^{9} \times 0.47 \times 10^{-3})$	**C1**
	$= 8.5 \times 10^{-6}$ m^2	**A1**
4(b)(ii)	F, L and x are all the same (for both wires / as in X) **or** F and strain are the same	**B1**
	A is greater (for Y), so the Young modulus (for Y) is less than 1.9×10^{9} Pa **or** less than that of wire X	**B1**

Question 21 — Mark Scheme

Question	Answer	Marks
5(a)	the ratio of stress to strain	B1
5(b)(i)	$A = FL / Ex$	C1
	A = e.g. $(500 \times 0.81) / (95 \times 10^9 \times 4.0 \times 10^{-3})$	C1
	$A = 1.1 \times 10^{-6}\ m^2$	A1
	OR $A = kL / E$ **or** A = gradient $\times L / E$ k = e.g. $500 / 4.0 \times 10^{-3}$ $k = 1.25 \times 10^5$	(C1)
	$A = 1.25 \times 10^5 \times 0.81 / 95 \times 10^9$	(C1)
	$A = 1.1 \times 10^{-6}\ m^2$	(A1)

Question	Answer	Marks
5(b)(ii)	$E = ½\ kx^2$ **or** $E = ½\ Fx$ **or** E = area (under graph)	C1
	$(\Delta)E = ½ \times 1.25 \times 10^5 \times ((3.0 \times 10^{-3})^2 - (2.0 \times 10^{-3})^2)$ **or** $(\Delta)E = (½ \times 375 \times 3.0 \times 10^{-3}) - (½ \times 250 \times 2.0 \times 10^{-3})$ **or** $(\Delta)E = ½ \times (375 + 250) \times 1.0 \times 10^{-3}$	C1
	work done = 0.31 J	A1

Question 22 — Mark Scheme

Question	Answer	Marks
3(a)	ratio of stress to strain	**B1**
3(b)(i)	$R_0 = \rho L / A$	**A1**
3(b)(ii)	$k = F / x$	**C1**
	$E = FL / Ax = ((F / x) \times (L / A)) = kL / A$ leading to $k_0 = EA / L$	**A1**
3(c)(i)	straight line with positive gradient starting at (0, R_0)	**B1**
3(c)(ii)	straight horizontal line starting at (0, k_0)	**B1**
3(d)(i)	$L = [0.034 \times \pi \times (0.80 \times 10^{-3})^2] / 1.8 \times 10^{-8} = 3.8$ (m)	**A1**
3(d)(ii)	$k = [1.3 \times 10^{11} \times \pi \times (0.80 \times 10^{-3})^2] / 3.8$ **or** $k = EA / [RA / \rho] = E\rho / R$ $= [1.3 \times 10^{11} \times 1.8 \times 10^{-8}] / 0.034$	**C1**
	$k = 6.9 \times 10^4$ N m^{-1}	**A1**

Question 23 — Mark Scheme

Question	Answer	Marks
3(a)	an arrow horizontally on the page to the left labelled F	**B1**
	two arrows horizontally on the page to the right each labelled T	**B1**
3(b)(i)	$T = 110 / 2$ $= 55$ N	**A1**
3(b)(ii)	$x = F / k$	**C1**
	$= 110 / 250$ $= 0.44$ m	**A1**
3(c)(i)	extension $= 55 / 250$ **or** $110 / (2 \times 250)$	**C1**
	extension $= 0.22$ m	**A1**
3(c)(ii)	$E = \frac{1}{2} Fx$ **or** $E = \frac{1}{2} kx^2$ **or** $E = \frac{1}{2} F^2 / k$	**C1**
	$E_1 / E_2 = (\frac{1}{2} \times 110 \times 0.44) / (2 \times (\frac{1}{2} \times 55 \times 10.22))$ **or** $E_1 / E_2 = (\frac{1}{2} k \times 0.44^2) / (2 \times (\frac{1}{2} k \times 0.22^2))$ **or** $E_1 / E_2 = (\frac{1}{2} \times 110^2 / k) / (2 \times (\frac{1}{2} \times 55^2 / k))$ $E_1 / E_2 = 2.0$ (no ECF from **3(b)(ii)** and **3(c)(i)**)	**A1**

Question 24 — Mark Scheme

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Question	Answer	Marks
3(a)	force is proportional to extension	B1
3(b)(i)	length = 37 m	A1
3(b)(ii)	spring constant = F / x	C1
	= e.g. 1800 / (120 – 37) = 22 N m^{-1}	A1
3(c)(i)	$((\Delta)E) = mg(\Delta)h$	C1
	= 64 × 9.81 × 120 = 75 000 J **or** 75 kJ	A1
3(c)(ii)	$(E=)\ \frac{1}{2}Fx$ **or** $(E=)\ \frac{1}{2}kx^2$ **or** $(E=)\ \frac{1}{2}F^2/k$ **or** $(E=)$ area under graph	C1
	$(E=)\ \frac{1}{2} \times 1800 \times (120 - 37) = 75\,000$ J **or** 75 kJ **or** $(E=)\ \frac{1}{2} \times 21.7 \times (120 - 37)^2 = 75\,000$ J **or** 75 kJ	A1
3(d)	(all) gravitational potential energy has been converted / equal to elastic potential energy (so no kinetic energy)	B1
	kinetic energy is zero so speed is zero	B1

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