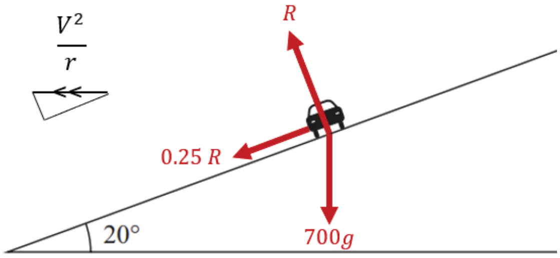
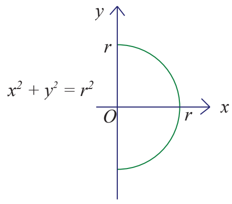
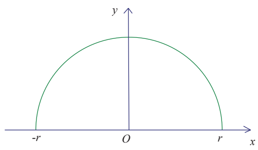
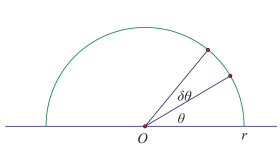
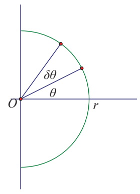
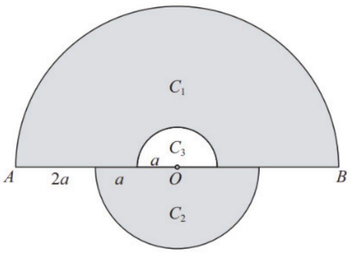
Question Number	Answer	Mark
1(a)		
	Form an equation in R only	M1
	$R\cos 20° = 700g + 0.25R\sin 20°$	A1 A1
	$(R =)\ 8030$ or $8000\ (N)$	A1
		(4)
1(b)	N2L horizontally	M1
	$\frac{700V^2}{60} = R\sin 20° + 0.25R\cos 20°$	A1 A1
	$(V =)\ 19.9$ or 20	A1
		(4)
		(8)
	Notes for Question 1	
	See note at end for marking parts (a) and (b) together. Penalise the use of $g = 9.81\ \text{ms}^{-2}$ once per question (first occurrence). Penalise over/under accuracy once per question (first occurrence).	
1(a)		
M1	Method to resolve vertically and form an equation in R only using $F = 0.25R$ All required terms present and no extras. Dimensionally correct. Condone sign errors and sin/cos confusion. Condone m if correctly replaced later. Alternative equations, must use $r = 60$: Perp to slope: $R - 700g\cos 20° = \frac{700V^2}{60}\sin 20°$ Parallel to slope: $0.25R + 700g\sin 20° = \frac{700V^2}{60}\cos 20°$	
A1	Unsimplified equation in R only with at most one error.	
A1	Correct unsimplified equation in R only.	
A1	3 sf or 2 sf only	
1(b)		
M1	Use equation for circular motion to form an equation in V and R only, using $r = 60$. All required terms present and no extras. Dimensionally correct. Only the relevant terms are resolved but condone sin/cos confusion. Condone sign errors.	
A1	Unsimplified equation in V and R with at most one error.	
A1	Correct unsimplified equation in V and R only.	
A1	3 sf or 2 sf	
	Note for marking (a) and (b) together.	

	M1A1A1: First relevant equation in V and R. Following rules as above for terms. (A1A0 for an equation with at most one error.) A1: correct R M1A1A1: Second relevant equation in V and R. Following rules as above for terms. (A1A0 for an equation with at most one error.) A1: correct V	

Question Number	Answer	Mark
	Use $v=\int a\,\mathrm{d}t$ $=\lambda t-\mu\, ln(2t+3) \quad (+C)$	M1
	$=3t-4\ln(2t+3) \quad (+C)$	A1
	Use $t=0, v=2\ln 3 \Rightarrow C=\cdots$	DM1
	$(v=)3t-4\ln(2t+3)+6\ln 3$ * $(p=3, q=-4, r=6)$	A1*
		(4)
2(b)	Use $x=\int v\,\mathrm{d}t$ to include integrated terms of the form $\frac{pt^2}{2}+(r\, ln\, 3)t$	M1
	Use integration by parts on the term $q\ln(2t+3)$ $\lambda t\ln(2t+3)+\mu\int\frac{t}{2t+3}\mathrm{d}t$	M1
	$(x=)$ $\frac{3}{2}t^2+(6\ln 3)t-4t\ln(2t+3)+4t-6\ln(2t+3)+6\ln 3$	A1
	12.3 (m)	A1
		(4)
		(8)
	Notes for Question 2	
2(a)		
M1	Correct method to obtain v from a by integrating with respect to t. Must reach a form that includes: $\lambda t-\mu\ln(2t+3)$ No need for the constant of integration. M0 for use of $v\frac{\mathrm{d}v}{\mathrm{d}x}$	
A1	Correct two terms	
DM1	Dependent on previous M. Use initial conditions to evaluate constant of integration.	
A1*	Obtain result in given form from correct algebraic integration. The values of p, q and r can be embedded in a correct solution – they do not need to be stated separately. Accept correct terms for v in any order.	
2(b)		
M1	Integrate their expression for v with respect to t. Must reach a form that includes: $\frac{pt^2}{2}+(r\, ln\, 3)t$ Ignore their integration of $q\ln(2t+3)$ for this method mark.	
M1	Independent. Use integration by parts to integrate $q\ln(2t+3)$ with respect to t at least as far as: $\lambda t\ln(2t+3)+\mu\int\frac{t}{2t+3}\mathrm{d}t$	
A1	Any equivalent form including the correct constant of integration (6ln3)	
A1	Must be 3sf. Correct answer must follow correct algebraic integration and the correct value for the constant of integration seen.	

	No need to see substitution of $t = 3$ into their correct expression.	

Question Number	Answer	Mark
3(a) **ALT 1**	 	
	Use $y=\sqrt{r^2-x^2}$ in an integral of the form $\lambda\int xy\,\mathrm{d}x$	M1
	Method to take moments about the y-axis $$\lambda\int x(r^2-x^2)^{\frac{1}{2}}\,\mathrm{d}x = \cdots(r^2-x^2)^{\frac{3}{2}}$$	DM1
	$$=\cdots\left(-\frac{1}{3}\right)(r^2-x^2)^{\frac{3}{2}}$$	A1
	Use limits 0 and r in a complete method $$\frac{2\int_0^r xy\,\mathrm{d}x}{\frac{1}{2}\pi r^2}$$ For a quadrant: $$\frac{\int_0^r xy\,\mathrm{d}x}{\frac{1}{4}\pi r^2}$$ N.B. Complete solution for a quadrant must include reference to symmetry.	DM1
	Obtain given answer from correct working $$\left(\frac{\frac{2}{3}r^2}{\frac{1}{2}\pi r^2}=\right)\ \frac{4r}{3\pi}\quad *$$	A1*
		(5)
3(a) **ALT2**	 	
	Use $y=\sqrt{r^2-x^2}$ in an integral of the form $\lambda\int y^2\,\mathrm{d}x$	M1
	Method to take moments about the x-axis $$\lambda\int (r^2-x^2)\,\mathrm{d}x = \cdots\left(xr^2-\frac{x^3}{3}\right)$$	DM1
	$$\frac{1}{2}\left(xr^2-\frac{x^3}{3}\right)$$	A1
	Use limits $-r$ and r in an expression of the form ar^2x+bx^3 in a complete method. $$\frac{\int_{-r}^{r}\frac{1}{2}y^2\,\mathrm{d}x}{\frac{1}{2}\pi r^2}\quad\text{or}\quad\frac{2\times\int_0^r\frac{1}{2}y^2\,\mathrm{d}x}{\frac{1}{2}\pi r^2}$$ For a quadrant:	DM1

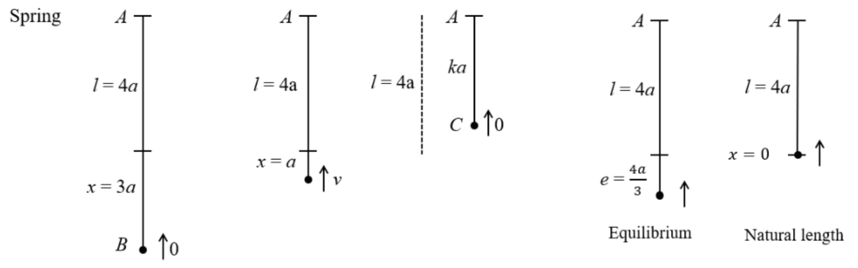
Question	Scheme	Marks
	$$\frac{\int_0^r \frac{1}{2}y^2\,\mathrm{d}x}{\frac{1}{4}\pi r^2}$$	
	$$\left(\frac{\frac{2}{3}r^2}{\frac{1}{2}\pi r^2}=\right)\ \frac{4\mathrm{r}}{3\pi}\quad *$$ N.B. Complete solution for a quadrant must include reference to symmetry.	A1*
		(5)
3(a) ALT3	 $\frac{2}{3}r\sin\theta$  $\frac{2}{3}r\cos\theta$	
	Use of $\frac{2}{3}r\sin\theta$ or $\frac{2}{3}r\cos\theta$ in the relevant integral	M1
	Method to take moments about the *x*-axis or *y*-axis $\int\frac{1}{2}r^2\times\frac{2}{3}r\sin\theta\ \mathrm{d}\theta$ or $\int\frac{1}{2}r^2\times\frac{2}{3}r\cos\theta\ \mathrm{d}\theta$	DM1
	$-\frac{1}{3}r^3\cos\theta$ or $\frac{1}{3}r^3\sin\theta$	A1
	Use limits 0 and π in an expression of the form $\mu r^3\cos\theta$ or limits $-\frac{\pi}{2}$ and $\frac{\pi}{2}$ in an expression of the form $\mu r^3\sin\theta$ in a complete method.	DM1
	$$\left(\frac{\frac{2}{3}r^2}{\frac{1}{2}\pi r^2}=\right)\ \frac{4\mathrm{r}}{3\pi}\quad *$$	A1*
		(5)
3(b)		

	area	C of M from O	Marks
large	$\frac{1}{2}\pi\times 16a^2$ [16]	$\frac{4\times 4a}{3\pi}$	B1 mass ratio
medium	$\frac{1}{2}\pi\times 4a^2$ [4]	$\frac{4\times 2a}{3\pi}$	
small	$\frac{1}{2}\pi\times a^2$ [1]	$\frac{4\times a}{3\pi}$	B1 distance
template	$\frac{1}{2}\pi\times 19a^2$ [16+4-1]	d	

	Moments about AB	M1
	$\frac{1}{2}\pi\times19a^2d=$ $\frac{1}{2}\pi\times16a^2\times\frac{16a}{3\pi}-\frac{1}{2}\pi\times4a^2\times\frac{8a}{3\pi}-\frac{1}{2}\pi\times a^2\times\frac{4a}{3\pi}$	A1
	$\left(19d=\frac{256a}{3\pi}-\frac{32a}{3\pi}-\frac{4a}{3\pi}\right)\quad d=\frac{220a}{57\pi}$	A1
	$\tan\theta\,^\circ=\frac{"\left(\frac{220a}{57\pi}\right)"}{4a}$	M1
	$\theta=17$	A1
		(7)
		(12)
	Notes for Question 3	
3(a) ALT1		
M1	Use $y=\sqrt{r^2-x^2}$ in an integral of the form $\lambda\int xy\,\mathrm{d}x$. No need to attempt integration.	
DM1	Dependent on the previous M. Method to take moments about the y-axis. Ignore constants. Integrate to the required form. $\lambda\int x(r^2-x^2)^{\frac{1}{2}}\,\mathrm{d}x=\cdots(r^2-x^2)^{\frac{3}{2}}$	
A1	Correct integration (constant may be processed later)	
DM1	Dependent on the two preceding M marks Use limits 0 and r in a complete method $\frac{2\int_0^r xy\,\mathrm{d}x}{\frac{1}{2}\pi r^2}$ e.g. $\frac{0+\frac{2}{3}r^3}{\frac{1}{2}\pi r^2}$ Quadrant method must use $\frac{1}{4}\pi r^2$	
A1*	Obtain given answer from complete and correct algebraic integration. N.B. Complete solution for a quadrant must include reference to symmetry.	
3(a) ALT2		
M1	Integrate $y=\sqrt{r^2-x^2}$ in an integral of the form $\lambda\int y^2\,\mathrm{d}x$. No need to attempt integration	
DM1	Dependent on the first M1. Method to take moments about the x-axis. Ignore constants. Integrate to the required form.	

	$$\lambda\int r^2 - x^2 \ \mathrm{d}x = \cdots xr^2 - \frac{x^3}{3}$$	
A1	Correct integration (constant may be processed later)	
DM1	Dependent on the two preceding M marks. Use limits $-r$ and r in a complete method $\dfrac{\int_{-r}^{r}\frac{1}{2}y^2\,\mathrm{d}x}{\frac{1}{2}\pi r^2}$ or $\dfrac{2\times\int_{0}^{r}\frac{1}{2}y^2\,\mathrm{d}x}{\frac{1}{2}\pi r^2}$ e.g. $\dfrac{\frac{1}{2}\left(r^3-\frac{1}{3}r^3-\left(-r^3+\frac{1}{3}r^3\right)\right)}{\frac{1}{2}\pi r^2}$ Quadrant method must use $\frac{1}{4}\pi r^2$	
A1*	Obtain given answer from complete and correct algebraic integration. N.B. Complete solution for a quadrant must include reference to symmetry.	
3(a) ALT3		
M1	Use of $\frac{2}{3}r\sin\theta$ or $\frac{2}{3}r\cos\theta$ in the relevant integral. No need to attempt integration.	
DM1	Dependent on the first M1. Ignore constants. Take moments and integrate to the required form. $\ldots r^3\cos\theta$ or $\ldots r^3\sin\theta$	
A1	$-\frac{1}{3}r^3\cos\theta$ or $\frac{1}{3}r^3\sin\theta$ (constant may be processed later)	
DM1	Dependent on the two preceding M marks. Use limits 0 and π in an expression of the form $\gamma r^3\cos\theta$ or use limits $-\frac{1}{2}\pi$ and $\frac{1}{2}\pi$ in an expression of the form $\gamma r^3\sin\theta$ in a complete method.	
A1*	Obtain given answer from complete and correct algebraic integration.	
(b)		
B1	Correct mass ratios	
B1	Correct distances (ignore signs)	
M1	Use their mass ratios and distances to take moments about AB or a parallel axis. Must form a dimensionally **consistent** equation. Condone sign errors. Accept mass ratio of 21 instead of 19.	
A1	Correct unsimplified equation.	
A1	Accept, $1.228\ldots a$	
M1	Use their d with trig to form a dimensionally correct equation in a relevant angle. Accept the reciprocal and consistent cancelled a's.	

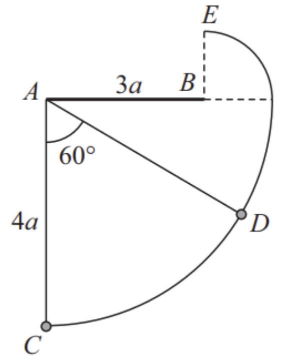
	$\tan\theta° = \dfrac{\frac{220a}{57\pi}}{4a} \left(= \dfrac{55}{57\pi} \right)$	
A1	Or better: 17.073… (only)	

Question Number	Answer	Mark
4(a)		
	Equation of motion at B ($x = 3a$)	M1
	$$\frac{3mg(3a)}{4a} - mg = \pm m\ddot{x}$$	A1
	$$(acc =) \pm \frac{5g}{4}$$	A1
		(3)
4(b)	Either $\dfrac{3mg(3a)^2}{8a}$ or $\dfrac{3mg(a)^2}{8a}$ seen	B1
	Conservation of energy to the point where $x = a$	M1
	$$\frac{3mg(3a)^2}{8a} = mg(2a) + \frac{3mg(a)^2}{8a} + \frac{1}{2}mv^2$$	A1 A1
	$$v = \sqrt{2ga}$$	A1
		(5)
4(c)	A second EPE term (**different** to the one awarded a mark in part (b))	B1
	Conservation of energy to C ($v = 0$)	M1
	Correct energy equation to C e.g. From B to C • if x is the compression in the spring at C $$\frac{3mg(3a)^2}{8a} = mg(x+3a) + \frac{3mg(x)^2}{8a}$$ • if x is the extension in the spring at C $$\frac{3mg(3a)^2}{8a} = mg(3a-x) + \frac{3mg(x)^2}{8a}$$ • if $x = \pm(4a - ka)$ is the extension $$\frac{3mg(3a)^2}{8a} = mg(7a - ka) + \frac{3mg(ka-4a)^2}{8a}$$	A1
	Solve to obtain $k =$	DM1
	$$k = \frac{11}{3} \text{ (only)}$$	A1
		(5)
		(13)
	Notes for Question 4	
4(a)		

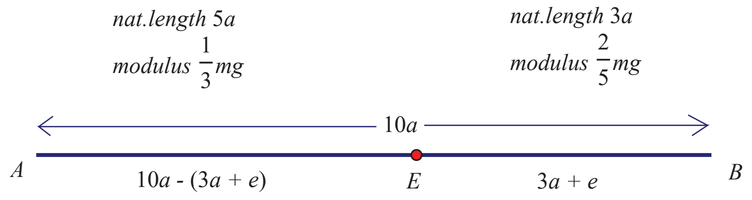
M1	Use Hooke's Law in an equation of motion at B. Tension must have an extension of $3a$. All required terms present and no extras. Dimensionally correct. Condone sign errors. Condone a for acceleration but M0 if it is treated as a length.	
A1	Correct unsimplified equation	
A1	Accept 12, 12.3 (ms^{-2})	
4(b)		
B1	One correct EPE term	
M1	Form an equation using conservation of energy from B to $x = a$. All required terms present and no extras. Dimensionally correct. Condone sign errors. EPE must have the form $\frac{\lambda x^2}{\mu a}$ where $x = a$ and μ is a constant (condone $\mu = 1$). GPE must have the form mgh where $h = 2a$	
A1	Unsimplified equation with at most one error	
A1	Correct unsimplified equation	
A1	Or equivalent in terms of a and g Accept a correctly rounded decimal instead of $\sqrt{2}$ but must have $\sqrt{ga}$. Calculator display for $\sqrt{2} = 1.414213562$	
4(c)		
B1	A correct relevant EPE term, it must be **different** to the one awarded in (b) and it must be used in (c).	
M1	Form a dimensionally correct conservation of energy equation Condone sign errors. EPE term must have the form $\frac{\lambda x^2}{\mu a}$ where x is their extension and μ is a constant (condone $\mu = 1$). GPE term must have the form mgh where h is a height in terms of a and/or x All required terms present and no extras. • ***B* to *C*:** 2 EPE terms and GPE • **Alternative point to *C*:** KE, GPE, 2 EPE (but 1EPE if using natural length position) **Equilibrium to *C***: $x = \frac{4a}{3}$, $v^2 = \frac{25}{12}ga$ leads to $\frac{3mg\left(\frac{4a}{3}\right)^2}{8a} + \frac{1}{2}m\left(\frac{25}{12}ag\right) = mg\left(\frac{16a}{3} - ka\right) + \frac{3mg(ka-4a)^2}{8a}$ **Natural length to *C***: $x = 0,\ v^2 = \frac{3}{4}ga$ leads to $\frac{1}{2}m\left(\frac{3}{4}ag\right) = mg(4a - ka) + \frac{3mg(ka-4a)^2}{8a}$ **Point in (b) to *C*:** $x = a\ ,\ v^2 = 2ga$ leads to $\frac{3mg(a)^2}{8a} + \frac{1}{2}m(2ga) = mg(5a - ka) + \frac{3mg(ka-4a)^2}{8a}$	
A1	Correct unsimplified equation (using their letter for length)	
DM1	Dependent on first M1. Solve to find a value for k.	
A1	3.7 or better	

Question Number	Answer	Mark
5(a)	**Take moments about the y-axis**, $(\pi)\int y\,x^2\,\mathrm{d}y$ with x^2 replaced in terms of y. **M0** for moments about the x-axis.	M1
	Integrate with respect to y to the form $(\pi)a^2(p\,y^2+q\,y^4)$	M1
	$=(\pi)a^2\left(\frac{9y^2}{2}-\frac{9y^4}{100a^2}\right)$	A1
	Use limits 0 and $5a$ $\pi\left(\frac{9a^2\times25a^2}{2}-\frac{9a^2\times625a^4}{100a^2}\right)$	DM1
	Complete the process to find the centre of mass	DM1
	$\left(d=\frac{9a}{30}\times\frac{25}{4}\right)\quad=\frac{15}{8}a\ *$	A1*
		(6)
5(b)	A complete method to obtain an equation in W and T_v only using the cone and dome.	M1
	For example, • cone and dome separately: $W\frac{5a}{2}=W\frac{15a}{8}+10aT_v$	A1
	• cone and dome combined: $2W\times\frac{5a}{16}=10aT_v$	A1
	$(T_v=)\frac{5W}{80}=\frac{W}{16}$	A1
		(4)
		(10)
	Notes for Question 5	
5(a)		
M1	Take moments about the y axis, using $(\pi)\int y\,x^2\,\mathrm{d}y$. Substitute their equation for x^2 into the correct formula. **M0 for moments taken about the x-axis so no further marks in (a).**	
M1	Integration with respect to y to reach the form (py^2+qy^4). Ignore constants. $\pi\int 9a^2y\left(1-\frac{y^2}{25a^2}\right)\mathrm{d}y\left(=9a^2\pi\int y-\frac{y^3}{25a^2}\mathrm{d}y\right)$	
A1	Correct integration.	
DM1	Dependent on the preceding M. Use the limits 0 and $5a$ in their integrated expression. Ignore constants. Allow if substitution of 0 is not seen.	
DM1	Dependent on both preceding M's. Divide by the given volume in a complete method. Condone consistent missing π and consistent ρ (both numerator and denominator or neither).	
A1*	Obtain given answer from correct working	
5(b)		

M1	Correct method involves an attempt to find the centre of mass of the cone or the combined solid in terms of a **and** a moments equation in W and T_v. The moments equation must be dimensionally correct with all required terms present and no extras. Accept consistent missing a's in the moments equation. Condone sign errors. If more than one equation is formed, T_p must be eliminated to earn the method mark. Alternative equations: Vert: $T_p + T_v = 2W$ M(V) combined $10aT_p = \left(10a - \frac{5}{16}a\right) \times 2W$ M(V) separate $10aT_p = \frac{30a}{4} \times W + \left(10a + \frac{15a}{8}\right)W$ M (plane face): $2W \times \frac{5a}{16} = 10aT_v$ **Note** the cone and the dome both have weight W. C of M for the model is $\dfrac{5a}{16}$ from the common plane face (towards the vertex of the cone).	
A1	Unsimplified equation in W and T_v with at most one error	
A1	Correct unsimplified equation	
A1	Correct answer, accept $0.0625W$	

Question Number	Answer	Mark
		
6(a)	Equation for circular motion	M1
	$T - mg\cos 60° = \frac{mv^2}{4a}$	A1
	Conservation of energy from C to D	M1
	$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg \times (4a - 4a\cos 60°)$	A1
	$T = \frac{mu^2}{4a} - \frac{mg}{2}$	A1
		(5)
6(b)	Conservation of energy from C to E $\frac{1}{2}mu^2 = \frac{1}{2}mw^2 + mg \times 5a$ **and** N2L for circular motion $T = \frac{mw^2}{a} - mg$	M1
	Use of condition for circular motion to form an inequality in a, g and u or w only $(T \geq 0\ \ldots)\quad w^2 \geq ag$	M1
	Complete solution must include sight of $T \geq 0$, correct inequality signs and correct working that leads to $u \geq \sqrt{11ga}$ *	A1*
		(3)
6(c)	Use $u^2 = 12ga$ to obtain $w^2 = 2ag$ **or** $w = \sqrt{2ga}$	B1ft
	Vertical motion to find the time taken $a = \frac{1}{2}gt^2,\quad t = \cdots\left(\sqrt{\frac{2a}{g}}\right)$	M1
	Horizontal motion to find the distance $\quad s = \sqrt{2ga} \times t$	M1
	$= 2a$	A1
		(4)
		(13)
	Notes for Question 6	
6(a)		
M1	N2L with circular form of acceleration and $r = 4a$. Accept $4a$ replaced later in working. Dimensionally correct. All required	

	terms present and no extra. Condone sign errors and sin/cos confusion.	
A1	Correct unsimplified equation	
M1	Conservation of energy from B to C. Dimensionally correct. All required terms present and no extra. Condone sign errors and sin/cos confusion. All energy terms with the correct structure. Accept vertical height as $2a$ without seeing $(4a - 4a\cos 60°)$.	
A1	Correct unsimplified equation	
A1	Accept equivalent but must have mg terms collected.	
6(b)		
M1	Equations for conservation of energy and circular motion at E. Dimensionally correct. All required terms present and no extra. Condone sign errors. Accept two energy equations where the journey from C to E is broken down into *C to level with B* then *level with B to E*. C to B: $\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg(4a) \Rightarrow v^2 = u^2 - 8ag$ and B to E: $\frac{1}{2}m(u^2 - 8ag) = \frac{1}{2}mw^2 + mg(a)$	
M1	Use correct condition for circular motion to form an inequality in a, g and w or u. For the method mark only, condone $T \geq 0$ not stated and condone strict inequality sign.	
A1*	Obtain given answer from complete and correct working. This must include sight of $T \geq 0$ and the correct inequality signs throughout.	
6(c)		
B1ft	Use $u^2 = 12ga$ to obtain $w^2 = 2ga$ **or** $w = \sqrt{2ga}$ Follow through is for their w following substitution of $u^2 = 12ga$ into their expression for v^2 in their energy equation in (b).	
M1	Vertical motion: correct use of *suvat* to find an expression for t in terms of a and g	
M1	Horizontal motion to find the distance BF	
A1	Correct only	

Question Number	Answer	Mark
7(a)		
	Equate the tensions	M1
	Correct equation with unknown extensions that sum to $2a$ e.g. $$\frac{\frac{2}{5}mge}{3a}=\frac{\frac{1}{3}mg(7a-e-5a)}{5a}$$	A1
	Solve their equation correctly with working that leads $$(EB=)\frac{11a}{3}\ *$$	A1*
		(3)
7(b)	N2L for general position using difference of tensions $$\pm(T_A-T_B)=-m\ddot{x}$$	M1
	Correct equation e.g. • $\frac{\frac{mg}{3}\left(\frac{19a}{3}+x-5a\right)}{5a}-\frac{\frac{2mg}{5}\left(\frac{11a}{3}-x-3a\right)}{3a}=-m\ddot{x}$	A1
	• $\frac{\frac{mg}{3}\left(\frac{4a}{3}+x\right)}{5a}-\frac{\frac{2mg}{5}\left(\frac{2a}{3}-x\right)}{3a}=-m\ddot{x}$	A1
	Reach given conclusion from complete and correct working. This must include all of: • at least one step between the initial N2L equation in x and the conclusion • reaching the correct form $\ddot{x}=-\frac{g}{5a}x$ • concluding SHM e.g. $\ddot{x}=-\frac{g}{5a}x$ Hence SHM *	A1*
		(4)
7(c)	Use of periodic time $=\frac{2\pi}{\omega}$	M1
	$$=2\pi\sqrt{\frac{5a}{g}}\ *$$	A1*
		(2)
7(d)	Correct method $$x=\frac{2}{3}a\sin\sqrt{\frac{g}{5a}}t=\frac{1}{3}a$$	M1

	$t=\frac{\pi}{6}\sqrt{\frac{5a}{g}}$	A1
	$(S=)4t=\frac{2\pi}{3}\sqrt{\frac{5a}{g}}$	A1
		(3)
7(d) ALT	Correct method $x=\frac{2}{3}a\cos\sqrt{\frac{g}{5a}}t=\frac{1}{3}a$	M1
	$t=\frac{\pi}{3}\sqrt{\frac{5a}{g}}$	A1
	$(S=)2\pi\sqrt{\frac{5a}{g}}-4t=\frac{2\pi}{3}\sqrt{\frac{5a}{g}}$	A1
		(3)
		(12)
	Notes for Question 7	
(a)		
M1	Equate the tensions in each string. Dimensionally correct. Tensions must have the form $\frac{\frac{1}{3}mg\ (x)}{5a}$ and $\frac{\frac{2}{5}mg\ (y)}{3a}$ M0 if extensions are assumed to be equal.	
A1	Correct unsimplified equation with extensions that are unknown and sum to $2a$.	
A1*	Solve their equation correctly and use to obtain given answer from complete and correct working.	
(b)		
M1	N2L at a general point. Dimensionally correct. Both tensions present. Condone sign errors but must be a difference in tensions. Accept acceleration as a for the method mark only. M0 if tensions are at a fixed point. M0 if extensions are assumed to be equal. M0 if resultant force is never used with $m\ddot{x}$	
A1	Unsimplified equation with at most one error. (if acceleration is not $\ddot{x}$, this is one error)	
A1	Correct unsimplified equation	
A1*	Reach given conclusion from complete and correct working. This must include all of: • at least one step between the initial N2L equation in x and the conclusion • reaching the correct form $\ddot{x}=-\frac{g}{5a}x$ • conclude: SHM	
(c)		
M1	Use of $\frac{2\pi}{\omega}$ with their ω or the correct ω substituted	
A1*	Given answer obtained using the correct ω	

(d)		
M1	Correct method using $x = \pm\, a\, sin\, \omega\, t$ to find a relevant time. Must use $x = \frac{1}{3}a$ and amplitude $\frac{2}{3}a$ but no need to substitute for ω e.g. $x = \frac{2}{3}a\, sin\, \omega\, t = \frac{1}{3}a$	
A1	Correct value for a relevant time.	
A1	Correct answer in exact form.	
(d) ALT		
M1	Correct method using $x = \pm\, a \cos \omega\, t$ to find a relevant time. Must use $x = \frac{1}{3}a$ and amplitude $\frac{2}{3}a$ but no need to substitute for ω e.g. $x = \frac{2}{3}a \cos \omega\, t = \frac{1}{3}a$	
A1	Correct value for a relevant time.	
A1	Correct answer in exact form.	