Hooke's Law 2 MS

Q1.

7(i)	$0.4g = 24e/0.6$	**M1**	Uses $T = \lambda x/L$
	$e = 0.1$ m	**A1**	
	Total:	**2**	
7(ii)	Initial EE = $24 \times 0.1^2/(2 \times 0.6)$ (= 0.2 J)	**B1**	Uses EE = $\lambda x^2/2L$
	$0.4 \times 5^2/2 + 0.4gd = 24(0.1 + d)^2/(2 \times 0.6) - 24 \times 0.1^2/(2 \times 0.6)$	**M1 A1**	Set up a 4 term energy equation involving EE, PE and KE
	$d = 0.5$ m	**A1**	
	Total:	**4**	

7(iii)	$e = 0.2$	**B1**	
	$0.8v^2/2 = 24 \times 0.6^2/(2 \times 0.6) - 24 \times 0.2^2/(2 \times 0.6) - 0.8g \times 0.4$	**M1 A1**	Set up a 4 term energy equation in EE, PE and KE
	$v = 2\sqrt{2} = 2.83$ ms^{-1}	**A1**	
	Total:	**4**	

Q2.

5(i)	$0.3g = 6e / 0.8$	**M1**	Uses $T = \lambda x / L$
	$e = 0.4$ m	**A1**	
	EE = $6 \times 0.4^2/(2 \times 0.8)$	**B1 FT**	FT for their e
	$0.3v^2/2 - 0.3 \times 2^2/2 = 0.3\,g(0.8 + 0.4) - 6 \times 0.4^2/(2 \times 0.8)$	**M1**	Sets up a 4 term energy equation involving EE, KE and PE
	$v = 4.9(0)$ ms^{-1} or $2\sqrt{6}$	**A1**	
	Total:	**5**	
5(ii)	$0.3 \times 2^2/2 + 0.3gL = 6(L - 0.8)^2/(2 \times 0.8)$	**M1**	Sets up a 3 term energy equation involving EE, KE and PE
		A1	
	$L = 2.18$ m	**A1**	Ignore answers less than 0.8
	Total:	**3**	

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Q3.

5(i)	$0.3g = 24e$	**M1**	Use $T = \lambda x/L$
	$e = 0.1$	**A1**	
	$EE = 24 \times (1.2–0.8)^2/(2 \times 0.8)$ or $24 \times 0.1^2/(2 \times 0.8)$	**B1**	Use EE = $\lambda x^2/(2L)$.
	$0.3v^2/2 = 0.3 \times 4^2/2 + 24 \times (1.2 – 0.8)^2/(2 \times 0.8)$ $–24 \times 0.1^2/(2 \times 0.8) – 0.3g(1.2 – 0.8)$	**M1**	Sets up a 5 term energy equation involving *EE*, *KE* and *PE*.
	$v = 5$ m s^{-1}	**A1**	
		5	
5(ii)	$0.5 \times 5^2/2 + 24 \times 0.1^2/(2 \times 0.8) = 0.3(x + 0.9) \times 10$	**M1**	Sets up a 3 term energy equation where x is the distance above 0 when $v = 0$.
	$x = 0.4$	**A1**	
	Distance moved = 0.8 + 0.4 = 1.2 m	**A1**	AG
		3	

Q4.

3(i)	$mg = 12(0.7 – 0.4) / 0.4$	**M1**	Use $T = \lambda x / L$
	$m = 0.9$ kg **AG**	**A1**	
		2	

3(ii)	EPE = $12(0.7 – 0.4)^2 / (2 \times 0.4)$	**B1**	Correct EPE term
	$0.9v^2 / 2 = 0.9g(0.7 – 0.4) + 0.9 \times 1^2 / 2 – 12(0.7 – 0.4)^2 / (2 \times 0.4)$	**M1**	Attempts a 4 term energy equation
		A1	Correct equation
	$v = 2$ m s^{-1}	**A1**	
		4	

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Q5.

5(i)	$1.8 = \frac{20e^2}{(2\times 0.5)}$	**M1**	Use $T = \frac{\lambda x}{l}$
	$e = 0.3$, OA $= 0.8$	**A1**	
		2	
5(ii)	$0.7g\sin 30 = \frac{20x}{0.5}$	**M1**	Use Newton's Second Law up the plane
	$x = 0.0875$ m	**A1**	
	$\text{EPE} = \frac{20\times 0.0875^2}{(2\times 0.5)}$	**B1**	
	$\frac{0.7v^2}{2} = 1.8 + 1.8 - 0.7g(0.3 - 0.0875)\sin 30 - \frac{20\times 0.0875^2}{(2\times 0.5)}$	**M1**	Attempt to set up a 5 term energy equation
		A1	Correct equation
	$v = 2.78$ ms^{-1}	**A1**	
		6	

Q6.

4	Tcos60 = 0.3g	**M1**	Resolve vertically
	T = 6 N	**A1**	
	T = 16e/0.8 (= 6) leads to e = 0.3	**M1**	Use T =λx/L
	r = (0.8 + 0.3)sin60 (= 1.1sin60)	**A1**	
	Tsin60 = 0.3 v^2 /(1.1sin60)	**M1**	Use N2L horizontally
	v = 4.06 m s^{-1}	**A1**	
		6	

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Q7.

5(i)	$0.4g(0.5+x)=\frac{6x^2}{(2\times0.5)}$	**M1**	Set up an energy equation
	$6x^2-4x-2=0$ or $3x^2-2x-1=0$	**M1**	Attempt to solve a 3 term quadratic equation
	$x=1$ (ignore $-\frac{1}{3}$ if seen)	**A1**	
		3	
5(ii)	$0.4g=\frac{6e}{0.5}$	**M1**	Use $T=\frac{\lambda x}{l}$ to find the extension at the equilibrium position
	$e=\frac{1}{3}$	**A1**	
	PE change $=0.4g\left(0.5+\frac{1}{3}\right)$	**B1ft**	Ft for candidate's e
	$\frac{0.4V^2}{2}=0.4g\left(0.5+\frac{1}{3}\right)-\frac{6\left(\frac{1}{3}\right)^2}{(2\times0.5)}$	**M1**	Set up a three term energy equation
	$V=3.65\ \text{ms}^{-1}$	**A1**	
		5	

Q8.

6	$T+mg=m.\frac{7}{3}g$	**M1**	
	With $T=k\frac{\frac{3}{4}a}{a}$ giving $k=4mg$	**A1**	AG
	Let greatest height above Q be $\frac{4}{3}a+x$ Gain in GPE = mgx and Loss in KE = ½ $m.2ga$	**B1**	The length being found may be expressed as the total extension of the string or the greatest height above Q. GPE and KE
	Gain in EPE $=\frac{1}{2}.\frac{4mg}{a}\left(\left(x+\frac{a}{3}\right)^2-\left(\frac{a}{3}\right)^2\right)$	**B1**	EPE Note: initial EPE = $\frac{2mga}{9}$
	$\frac{4mg}{2a}\left(x^2+\frac{2ax}{3}+\frac{a^2}{9}-\frac{a^2}{9}\right)+mgx=mga$	**M1 A1**	Energy equation, correct number of terms
	$2x^2+\frac{7ax}{3}-a^2=0$	**M1**	Simplify to quadratic
	$x=\frac{1}{3}a$ so greatest height is $\frac{5}{3}a$	**A1**	

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Q9.

3(a)	Use Hooke's Law: $4mg = \frac{kmg(x-a)}{a}$ leading to $k = \frac{4a}{x-a}$	**B1**	AG. Shown convincingly.
		1	
3(b)	Gain in KE + gain in EPE = loss in GPE	**B1**	One correct EPE term seen.
	$\frac{1}{2}\times 6m\times\frac{ga}{9}+\frac{1}{2}\frac{kmg}{a}\left(\left(x+\frac{a}{3}-a\right)^2-(x-a)^2\right)=6mg\times\frac{a}{3}$	**M1** **A1**	All 3 types of energy included in energy equation. All terms correct.
	Simplify and substitute for k from part **(a)**	**M1**	
	Obtain linear equation in x and a	**M1**	
	$x=\frac{5}{3}a$	**A1**	$(k=6)$
		6	