Hooke's Law 1 MS

Q1.

5	**(i)**	$0.3g = \frac{18e}{0.9}$	M1		Uses T = $\frac{\lambda x}{l}$
		$e = 0.15$ m	A1	**[2]**	
	(ii) (a)	$12 = \frac{18ext}{0.9}$ and $ht = 3 - 0.9 - ext$	M1		Both ideas needed, ext = 0.6
		$ht = 1.5$ m	A1	**[2]**	
	(ii) (b)	$\frac{0.3\times6^2}{2} - \frac{0.3u^2}{2} + 0.3g(0.6 - 0.15)$ $= \frac{18\times0.6^2}{2\times0.9} - \frac{18\times0.15^2}{2\times0.9}$	M1 A1		KE/PE/EE balance up to string breaking
		$\left(\frac{0.3u^2}{2} = 3.375\right)$			$u^2 = 22.5$
		$0.3v^2 = 0.3u^2 + 0.3g(3 - 0.6 - 0.9)$ OR $v^2 = u^2 + 2g(3 - 0.6 - 0.9)$	M1		KE/PE balance after string breaks or $v^2 = u^2 + 2g$(ht) using ht from **(ii)(a)**
		$v = 7.25$ ms^{-1}	A1	4	7.2456

Q2.

2	**(i)**	$mg = 30(0.8 - 0.5)/0.5$	M1		
		$m = 1.8$ kg AG	A1	2	
	(ii)	EE = $30(1.2 - 0.5)^2/(2 \times 0.5)$	B1		
		$1.8v^2/2 = 30(1.2–0.5)^2/(2 \times 0.5)$ $– 1.8 \times (1.2 - 0.5)g$	M1		KE/EE/PE equation, 3 terms RHS = 2.1
		$v = 1.53$ ms^{-1}	A1	3	

Hooke's Law 1 MS

Q3.

3	**(i)**	$20x/0.4 = 0.5g\sin 30$	M1		λext/nat length = comp weight
		$x = 0.05$ m	A1	2	
	(ii)	$20(0.05)^2/(2 \times 0.4)+0.5 \times 5^2/2 =$ $20e^2/(2 \times 0.4)+0.5 \times 2^2/2$ $-0.5(e-0.05)g\sin 30$	M1 A1		KE/PE/EE balance with 2 KE and 2 EE terms All terms without e correct
		$2.5e^2 - 2.5e - 5.1875 = 0$	M1		Creates /attempts to solve a 3 term quadratic equation
		$e = 0.508$	A1	4	

Q4.

5	**(i)**	C of M is 0.1 m from AB	B1		
		$0.05T = 20(0.25 - 0.1)$	M1		Moments about D
		$T = 60$ N AG	A1	3	
	(ii)	$60 = 48e/0.6$	M1		Toppling $T = \lambda$ext/nat length
		$e = 0.75$ m	A1		
		$2.5v^2/2 + 48(0.75)^2/(2 \times 0.6) =$ $2.5g(0.75 + 0.6)$	M1 A1		KE/EE/PE balance
		$v = 3$ ms^{-1}	A1	5	

Hooke's Law 1 MS

Q5.

5	(i)	$0.2g = R + 21\times\frac{0.05}{0.75}$	M1		
		$R = 0.6\,\text{N}$	A1	2	
	(ii)	$21\left(\frac{0.8}{\cos\theta - 0.75}\right)/(0.75\cos\theta) = 0.2g$	M1 A1		θ = angle of string with vertical Comp of tension = weight $\theta = 13.7(291\ldots)$
		$e = 0.0735$	A1	3	$e = 0.8/\cos\theta - 0.75 = 0.073529\ldots$
		OR			
		$\frac{21e}{0.75}\times\frac{0.8}{(e+0.75)} = 0.2g$	M1 A1		e = extension Comp of tension = weight
		$e = 0.073529\ldots$	A1		
	(iii)	$\frac{0.2(3)^2}{2} + \frac{21(0.05)^2}{(2\times0.75)} = \frac{0.2v^2}{2} + \frac{21\times0.0735^2}{1.5}$	M1 A1		Uses EE/KE balance
		$v = 2.93\,\text{ms}^{-1}$	A1	3	

Q6.

7	(i)	$Mg = \frac{12.5e}{0.8}$	M1		Uses $T = \lambda e/l$
		$e = 0.64M$ AG	A1	2	
	(ii)	$Mg(0.8 + e) =$ $\frac{M\times44^2}{2} + \frac{12.5e^2}{(2\times0.8)}$	M1 A1		PE/KE/EE conservation
		$10M(0.8 + 0.64M) =$	M1		
		$9.68M + \frac{12.5(0.64M)^2}{1.6}$	A1		$8M+6.4M^2 = 9.68M+3.2M^2$
		$8+6.4M = 9.68 + 3.2M$	M1		Attempt to solve equation in M
		$M = 0.525$	A1	6	
	(iii)	$0.525gd = \frac{12.5(d-0.8)^2}{(2\times0.8)}$	M1		PE/EE balance
		$0.672d = d^2 - 1.6d + 0.64$	M1		
		$d = 1.94$	A1	3	

Hooke's Law 1 MS

Q7.

5 (i)	$24e/0.8 = 0.2g$ $e = 0.2$	**M1** **A1**	 2	
(ii)	$24 \times 0.2^2 / (2 \times 0.8)$ $(= 0.6)$ $0.6 \times 4.5^2/2 + 0.6gd + 24 \times 0.2^2/(2 \times 0.8)$ $= 0.6 \times 3.5^2/2 + 24 \times (0.2 + d)^2/(2 \times 0.8)$ $d = 0.4$ so AP $(= 0.8 + 0.2 + 0.4) = 1.4$m	**B1**✓ **M1** **A1** **A1**	 4	ft(cv0.2) Initial EE PE/EE/KE balance attempt d = distance particle falls
(iii)	$24 \times 0.2^2/(2 \times 0.8) + 0.6 \times 4.5^2/2 =$ $0.6v^2/2 + 0.6g \times 0.5$ $v = 3.5\ \text{m}\,s^{-1}$	**M1** **A1** **A1**	 3	PE/EE/KE balance, 4 terms. Award B1ft for initial KE if not already seen in part ii

Q8.

7 (i)	$12(1.6–1.2)/1.2 = mg\sin30$ m = 0.8 kg	**M1** **A1**	 2	Uses $T = \lambda ext/l$
(ii)	PE change = 1.6 IKE + $12 \times 0.4^2/2.4 =$ $1.6 \times 0.2g\sin30 + 12 \times 0.2^2/2.4$ IKE = 1 J **AG**	**B1**✓ **B1** **M1** **A1**	 4	2 × ans(i) Both EE terms correct KE/PE/EE balance Both EE terms correct
(iii)	$12e/1.2 = 1.6g\sin30$ e = 0.8 $1.6v^2/2 + 12 \times 0.8^2/2.4 =$ $1.6g \times 0.6\sin30 + 12 \times 0.2^2/2.4$ $v = 1.5\ \text{m}\,s^{-1}$	**M1** **A1** **M1** **A1** **A1**	 5	$\lambda e \times t/l$ = new weight component May be stated without explanation Must use new equilibrium position

Hooke's Law 1 MS

Q9.

2 (i)	$5 = 0.2\lambda/0.4$	**M1**		Tension = λext/l
	$\lambda = 10\,\text{N}$	**A1**	2	
(ii)		**B1**		Correct EE term
	$10(0.2^2/(2 \times 0.4) + (5/g)v^2)/2 = 0.3 \times 5$	**M1**		PE/KE/EE 3 terms
	$v = 2\,\text{m}\,s^{-1}$	**A1**	3	
(iii)		**B1**		Correct EE term
	$10e^2/(2 \times 0.4) = 5(e + 0.1)$	**M1**		Energy equation
	$e = 0.483$	**A1**	3	

Q10.

6 (i)	$EE = 8(0.9\pi - 1.2)^2/(2 \times 1.2)$	**B1**		Initial EE = 8.83 J
	$8.83 = 0.2g \times 0.9 + 0.2v^2/2 + 8(0.9\pi/2 - 1.2)^2/(2 \times 1.2)$	**M1** **A1**		
	$v = 8.29\ \text{m}s^{-1}$	**A1**	4	
(ii)	$\theta = 1.2/0.9 = 4/3$ rad (=76.4°)	**B1**		
	$8.83 = 0.2g \times 0.9 + 0.2g \times 0.9\cos\theta + 0.2v^2/2$	**M1**		$0.2 \times 8.29^2/2 = 0.2g \times 0.9\cos\theta + 0.2v^2/2$
	$v = 8.13\ \text{m}s^{-1}$	**A1**	3	