Question	Answer	Marks	Guidance
1	$F=\mu\times 500g$	**B1**	Use of $F=\mu R$
	$[2500=\mu\times 500g]$	**M1**	Resolving horizontally
	$\mu=0.5$	**A1**	
		3	

Question	Answer	Marks	Guidance
2	PE gain $=150000g\times 500\sin\alpha$ $(=75000000g\sin\alpha)$	**B1**	Correct expression for PE gain
	$\frac{1}{2}\times 150000\times 45^2-\frac{1}{2}\times 150000\times 42^2$ $(=19575000)$	**B1**	Correct expression for KE loss
		M1	For 5 term work energy equation (or 4 terms if using loss in KE as 1 term)
	$150000g\times 500\sin\alpha=19575000+16000\times 500-4\times 10^6$	**A1**	
	$\alpha=1.8$	**A1**	
		5	

Question	Answer	Marks	Guidance
3	Resolving horizontally or vertically	**M1**	
	50cos20 + 60 – 100sin30 (=56.984…)	**A1**	
	100cos30 – 50sin20 (= 69.501…)	**A1**	
	$R = \sqrt{(56.984...^2 + 69.501...^2)}$ or $\alpha = \tan^{-1}\left(\frac{56.984...}{69.501...}\right)$	**M1**	Method to find either R or α
	R=89.9 (89.876…)	**A1**	
	α=39.3 (39.348…)	**A1**	
		6	

Question	Answer	Marks	Guidance
4(i)	$s_{PQ} = 20\times10 - 0.5a\times10^2$ **or** $s_{QR} = 20\times10 + 0.5a\times10^2$	**M1**	For use of $s = vt - \frac{1}{2}at^2$ or $s = ut + \frac{1}{2}at^2$ OE suvat to find PQ or QR
	$s = 200–50a$ **and** $1.5s = 200 + 50a$	**A1**	OE
	$1.5(200 – 50a) = 200 + 50a \rightarrow 100 = 125a \rightarrow a = 0.8$ ms^{-2}	**B1**	AG
		3	
4(ii)	Distance $QS = 20\times20 + \frac{1}{2}\times0.8\times20^2$	**M1**	Using $s = ut + \frac{1}{2}at^2$
	Distance=560 m	**A1**	
	Average speed between Q and $S = \frac{560}{20} = 28\,\text{ms}^{-1}$	**B1**	
		3	

Question	Answer	Marks	Guidance
5(i)	Driving force $= \frac{240}{6}$ (= 40 N)	**B1**	Use of power = force × velocity
	[40 – R = 80 × 0.3]	**M1**	Use of Newton's Second Law (3 terms)
	Resistance is 16 N	**A1**	AG
		3	
5(ii)	$\left[\frac{240}{v} = 16\right]$	**M1**	Use of $P=Fv$ with DF=resistance
	Steady speed is 15 ms^{-1}	**A1**	
		2	
5(iii)	Use of Newton's Second Law	**M1**	(4 terms)
	$\frac{240}{4} - 16 - 80g\sin 3 = 80a$	**A1**	
	Acceleration is 0.0266 ms^{-2}	**A1**	
		3	

Question	Answer	Marks	Guidance
Q6(i)	$10 = 0.04\times5^3 + 5^2c + 5k$ $\quad (5c + k = 1)$	**B1**	Use of t=5, v=10
	$s = \frac{0.04}{4}t^4 + \frac{ct^3}{3} + \frac{kt^2}{2} + (C)$	***M1**	For use of $s = \int v\,dt$
	$25 = 0.01\times5^4 + \frac{5^3}{3}c + \frac{5^2}{2}k$	**DM1**	Use of $t = 0$, s = 0 and $t = 5$, $s = 25$
	$6.25 + \frac{125}{3}c + \frac{25}{2}k = 25$ $\quad \left(\frac{125}{3}c + \frac{25}{2}k = 18.75\right)$	**A1**	
	Solving for c or for k	**M1**	
	$c = -0.3$ and $k = 2.5$	**A1**	
		6	
Q6(ii)	$a = 0.12t^2 - 0.6t + 2.5$	**M1**	For use of $a = \frac{dv}{dt}$
	$a' = 0.24t - 0.6 = 0 \rightarrow t = ...$ **or** $a = 0.12(t^2 - 5t + ...) = 0.12\left[(t-2.5)^2 + ...\right]$	**M1**	Uses $\frac{da}{dt} = 0$ or completes the square for a
	Minimum when $t = 2.5$	**A1**	AG
		3	

Question	Answer	Marks	Guidance
7(i)	$\left[0.81 = 0 + \frac{1}{2} \times a \times 0.9^2\right]$	**M1**	For use of $s = ut + \frac{1}{2}at^2$
	$a = 2$	**A1**	
	$T - mg = ma$ **or** $kmg - T = kma$	**M1**	Use of Newton's Second Law for A or B or use of $a = \frac{(m_B - m_A)g}{(m_B + m_A)}$
	$T - mg = ma$ **and** $kmg - T = kma$ or $\left[a = \frac{(km - m)g}{(km + m)}\right]$	**A1**	
	$a = \frac{(kg - g)}{(k + 1)} = 2 \rightarrow k = ...$	**M1**	Solves to find k
	$k = 1.5$	**A1**	
	$T = 10m + 2m = 12m$ N	**B1**	AG
		7	
7(ii)	Velocity of A when string breaks = 2×0.9 (=1.8 ms^{-1} upwards)	**B1FT**	For use of $v=u+at$ ft a from **(i)**
	$v^2 = 1.8^2 + 2g \times 1.62 \rightarrow v = ...$	**M1**	For use of *suvat* to find v_A at ground
	Speed is 5.97 ms^{-1}	**A1**	AG
	Time taken $= \frac{(1.8 + 5.97)}{g} = 0.777s$ (0.7769...)	**B1**	
		4	

Question	Answer	Marks	Guidance
7(iii)	Straight line from (0, 0) to (0.9, 1.8)	**B1**	
	Straight line from (0.9, 1.8) to approx. (1.7, –6)	**B1FT**	FT 0.9 + t from **(ii)** for 1.7
		2	