Question	Answer	Marks	Guidance
1	$[T - 2 = 0.2a \quad 8 - T = 0.8a]$ System is $0.8g - 0.2g = (0.2 + 0.8)a$ and $T = 2(0.2)(0.8)g/(0.8 + 0.2)$	**M1**	Attempt Newton's 2nd law for either particle or use a formula for the system for a and/or T
		A1	Two correct equations
	Attempt to solve for a or T	**M1**	
	$a = 6$ $T = 3.2$	**A1**	Both correct NB $a = 6$ **AG**
		4	

Question	Answer	Marks	Guidance
2	*EITHER:* $2P \sin\theta = P \sin 60$	**(M1**	Resolve vertically (2 terms)
	$\theta = 25.7$	**A1**	
	$2P \cos\theta + P \cos 60 = 10$	**M1**	Resolve horizontally (3 terms)
	$P = 4.34$	**A1)**	
	OR1: $\left[\frac{2P}{\sin 120} = \frac{P}{\sin(180-\theta)} = \frac{10}{\sin(60+\theta)}\right]$	**(M1**	Attempt Lami's theorem using one pair of terms
	$\theta = 25.7$	**A1**	Solve for θ
	Use a second Lami equation	**M1**	
	$P = 4.34$	**A1)**	
	OR2: Use sine or cosine rule with triangle of forces using forces P, $2P$ and 10 and with angles 60, θ and $120 - \theta$ between	**(M1**	
	$\theta = 25.7$	**A1**	
	Use a second relationship from the triangle of forces	**M1**	
	$P = 4.34$	**A1)**	
		4	

Question	Answer	Marks	Guidance
3(i)	$\frac{1}{2}\times 40\times v^2 = 40\times g\times 7.2$	**M1**	Use of KE gain = PE loss
	$v = 12$ m s^{-1}	**A1**	
		2	
3(ii)	Work done against friction(WDF) $\text{WDF} = 40\times g\times 7.2 - \frac{1}{2}\times 40\times 10^2\ [=880]$	**M1**	May be calculated as $\frac{1}{2}\times 40\times 12^2 - \frac{1}{2}\times 40\times 10^2$
	$\frac{1}{2}\times 40\times V^2 + 40\times g\times 7.2 = \frac{1}{2}\times 40\times 11^2 + 880$ **or** $\frac{1}{2}\times 40\times V^2 = \frac{1}{2}\times 40\times 11^2 - \frac{1}{2}\times 40\times 10^2$	**M1**	For 4-term work-energy equation with numerical attempt at work done or using the fact that WDF is the same in both cases, extra initial KE = difference in final KEs
	$V = \sqrt{21} = 4.58$	**A1**	
		3	

Question	Answer	Marks	Guidance
4	[$R = 12g\cos 25 + P\sin 25$ $P\cos 25 = F + 12g\sin 25$] or [$P = F\cos 25 + R\sin 25$ $R\cos 25 = F\sin 25 + 12g$]	**M1**	Attempt resolving of forces in any one direction, parallel to, perpendicular to plane or horizontally, vertically
		A1	Any one correct equation
		A1	Any second correct equation
	$F = 0.8R$	**M1**	Use of $F = \mu R$
	Complete method to find P from 2 equations(3 terms each)	**M1**	
	$P = 242$	**A1**	
		6	

Question	Answer	Marks	Guidance
5(i)	$200 = ½ \times (0 + v) \times 10$	**M1**	Use of *suvat*
	$v = 40$ m s^{-1}	**A1**	**AG**
	$200 = ½ \times a \times 10^2$	**M1**	Second use of *suvat*
	$a = 4$ m s^{-2}	**A1**	
		4	
5(ii)	$0 = 40^2 - 2 \times g \times s$	**M1**	Use of *suvat* with $a = g$
	$s = 80$ so height above ground = 280 m	**A1**	
		2	
5(iii)	*EITHER:* $0 = 40 - gt_1$	**(M1**	Use of *suvat* to find extra time to highest point
	$t_1 = 4$	**A1**	
	$280 = ½gt_2^2$	**M1**	Use of *suvat* to find time from highest point to ground
	$t_2 = \sqrt{56} = 7.48...$ so total time = 21.5 s	**A1)**	
	OR: $-200 = 40t_3 - ½gt_3^2$	**(M1**	Use of $s = ut + ½at^2$ with 200, 40 and g used
	$5t_3^2 - 40t_3 - 200 = 0$ o.e. $[t_3^2 - 8t_3 - 40 = 0]$	**A1**	Correct quadratic for time under gravity
	$[t_3 = 4 \pm \sqrt{56} = 4 \pm 7.48]$	**M1**	Solution of relevant 3-term quadratic
	$t_3 = 11.48$ so total time is 21.5 s	**A1)**	
		4	

Question	Answer	Marks	Guidance
6(i)	Driving force $= 35 \times 60$	**M1**	
	Power $= 35 \times 60^2 = 126000$ W	**A1**	
		2	

Question	Answer	Marks	Guidance
6(ii)	Driving force is $\text{DF} = \frac{126000}{30}$	**B1FT**	
	$\text{DF} - 35 \times 30 = 1200a$	**M1**	For 3-term Newton's 2nd law equation, dimensionally correct
	$a = \frac{3150}{1200} = \frac{21}{8} = 2.625 \text{ m s}^{-2}$	**A1**	**AG**
		3	
6(iii)	$\text{DF} = \frac{126000}{v}$	**M1**	For $F = \frac{P}{v}$
	$\frac{126000}{v} = 35v + 1200g \times \frac{7}{48}$	**M1**	For 3-term force equation, or equivalent
		A1	For correct (unsimplified) equation
	$35v^2 + 1750v - 126000 = 0$ or $v^2 + 50v - 3600 = 0$	**M1**	For simplifying and solving of a 3-term quadratic attempted
	$v = 40 \text{ ms}^{-1}$	**A1**	$v = -90$ rejected or ignored
		5	

Question	Answer	Marks	Guidance
7(i)	0.2 (m s^{-2})	**B1**	
		1	
7(ii)	$a = -1600t^{-3}$	**M1**	For attempted differentiation of $-2 + \frac{800}{t^2}$
	Acceleration at $t = 20$ is -0.2 (m s^{-2})	**A1**	
		2	
7(iii)	Straight line joining $t = 0$, $v = 4$ to $t = 10$, $v = 6$	**B1**	
	Curve with correct concavity joining end of line to $t = 20$, $v = 0$	**B1**	
	Correct labelling on axes provided the curves pass through (0,4), (10,6), (20,0)	**B1**	
		3	

Question	Answer	Marks	Guidance
7(iv)	Trapezium area = 50	**B1**	or from integration of $4 + 0.2t$
	$\int\left(-2+800t^{-2}\right)\mathrm{d}t = -2t-800t^{-1}$	**M1**	Integration attempted
		A1	Correct indefinite integral
	$\left[-2t-800t^{-1}\right]_{10}^{20}$ $= -40-40+20+80$	**M1**	Correct use of the limits $t = 10$ and $t = 20$
	Distance is 50 + 20 = 70 m	**A1**	Correct total
		5	