1	Tension is 30 N	**B1**		
	$[R = (4g - 30) \times 0.8]$	**M1**		For resolving forces acting on B, perpendicular to the plane.
	Normal component is 8 N	**A1**	3	
2	$F = T\cos\alpha = 0.96T$	**B1**		
	$R = 0.2g - T\sin\alpha = 2 - 0.28T$	**B1**		
	$[0.96T = 0.25(2 - 0.28T)]$	**M1**		For using $F = \mu R$
	$[(0.96 + 0.07)T = 0.5 \rightarrow T = ...]$	**M1**		For solving resultant equation for T
	$T = 0.485$	**A1**	5	
3		**M1**		For resolving forces in the x or $-x$ direction
	$120\cos75° = 150 - 100 - P\cos\theta°$	**A1**		
		M1		For resolving forces in the y direction
	$120\sin75° = P\sin\theta°$	**A1**		
	$[P^2 = 14400 - 12000\cos75° + 2500]$ or $\tan\theta = [120\sin75°/(50 - 120\cos75°)]$	**M1**		For using $P^2 = (P\cos\theta)^2 + (P\sin\theta)^2$ or for using $P\sin\theta / P\cos\theta = \tan\theta$
	$P = 117$ or $\theta = 80.7$	**A1**		
	$\theta = 80.7$ or P = 117	**B1**	7	
4 (i)		**M1**		For applying Newton's second law to A or to B or for using $m_A g - m_B g = (m_A + m_B)a$
	$0.35g - T = 0.35a$ $T - 0.15g = 0.15a$ $(0.35 - 0.15)g = (0.35 + 0.15)a$	**A1**		Two of the three equations
	Acceleration is 4 ms^{-2}	**B1**		
	Tension is 2.1 N	**B1**	4	
(ii)	$[v_1^2 = 0 + 8 \times 1.6\ (= 12.8)]$	**M1**		For using $v_1^2 = 0 + 2a \times 1.6$
	$[H = 1.6 + (-12.8) \div (-20)]$	**M1**		For using $H = 1.6 + (0 - v_1^2)/(-2g)$ or for using $h = (0 - v_1^2)/(-2g)$
	Greatest height is 2.24 m	**A1**	3	

5 (i)	$a =$ $(5^2 - 3^2)\div(2 \times 500) = 0.016$	B1		
		M1		For using Newton's 2nd law
	$DF + 90g \times 0.05 - R = 90 \times 0.016$	A1		
	$[R = \frac{420}{v} - 90(0.016 - 0.5)]$	M1		For using $DF = P/v$
	$R = \frac{420}{v} + 43.56$	A1	5	AG **SR** for assuming constant R and DF (max 2/5) PE loss = 90g(500)(0.05) and KE gain = $\frac{1}{2}(90)(5^2 - 3^2)$ B1 WD_{DF}+PE loss = KEgain+WD_R $\rightarrow R = 420/v + 43.56$ B1
(ii)	$v_M^2 = 3^2 + 2\times0.016 \times 250 \rightarrow$ speed at mid-point is 4.12ms^{-1}	B1		
	[Decrease in R from top to mid-way $=420[(1\div3) - (1\div\sqrt{17})]$ or [Decrease in R from midway to b'm = $420[(1\div\sqrt{17}) - (1\div5)]$	M1		For finding the difference in R for either top to midway or midway to bottom
	38.1 and 17.9	A1	3	
6 (i)	Time taken $= \frac{0.08}{0.0002} = 400$ s	B1		
	$v = \frac{dx}{dt} = 0.16t - 0.0006t^2$	B1		
	[speed $= -0.16 \times 400 + 0.0006 \times 400^2$]	M1		For evaluating $\pm v(400)$
	Speed at O is 32 ms^{-1}	A1	4	
(ii) (a)	Time to furthest point is 0.16/0.0006 s	B1√		√ $v = 0.16t - kt^2$ or $v = kt - 0.0006t^2$ from part (i)
	$[0.08(800/3)^2 - 0.0002(800/3)^3]$ (×2)	M1*		For evaluating $x(t_{\text{furthest point}})$ (×2)
	Distance moved is 3790 m	A1	3	
(b)	[speed = $3790/400\text{ ms}^{-1}$]	dM1*		For using 'average speed = total distance moved/time taken'
	Average speed is 9.48 ms^{-1}	A1	2	

7 (i)	Gain in KE $= \frac{1}{2}\, 1250(8^2 - 5^2)$	**B1**		
	Loss in PE = $1250g \times 400\sin 4^{\circ}$	**B1**		
		M1		For using WD by *DF* = Gain in KE – Loss in PE + WD by resistance
	$400(DF) = \frac{1}{2}\, 1250\,(8^2 - 5^2) - 1250g \times 400\sin 4^{\circ} + 2000 \times 400$	**A1**		
	Driving force is 1189 N or 1190 N	**A1**	5	
				SR for using Newton's second law (max 2/5) $DF + 1250g\sin 4^{\circ} - 2000 = 1250a$ B1 $a = (8^2 - 5^2)/2 \times 400 \rightarrow DF = 1190$ N B1
(ii)		**M1**		For using Newton's second law to find acceleration or for finding v_C and using $v^2 = u^2 + 2as$ to find acceleration
	$1189 \times 2 - 2000 = 1250a$ or $22.75^2 = 8^2 + 2a \times 750$	**A1**√		√ *DF* from part (i)
	Acceleration is 0.302 ms^{-2}	**A1**	3	
(iii)	$v_c^2 = 64 + 2 \times 0.302 \times 750$	**B1**√		√ acceleration from part (ii)
	[$P/\ 22.75 - 2000 = 1250 \times 0.302$]	**M1**		
	Power is 54.1 kW or 54100 W	**A1**	3	