1	**(i)**	[24 = μ30]	M1		For using R = W, F = T and F = μR
		Coefficient is 0.8	A1	[2]	
	(ii)		M1		For resolving forces vertically and using F = μR
		F = 0.8(30 – 25sin30°) (=14)	A1		
		[25 cos 30° – F = (30 ÷ g)a]	M1		For using of Newton's 2nd law
		Acceleration is 2.55 ms^{-2}	A1	[4]	
2	**(i)**		M1		For using work done by pulling force = increase in KE – decrease in PE + WD by resistance
		$1150 = ½\ 16 \times 10^2 - 16g(50 \times 0.05)$ + WD by resistance	A1		
		WD by resistance = 750 J	A1	[3]	
	(ii)	1150 = increase in KE + 16 g(50 × 0.05) + 750	M1		For WD by pulling force = KE gain + PE gain + WD by resistance
		KE gain = 0 → speed at top = speed at bottom	A1	[2]	AG
3			M1		For resolving forces acting on P horizontally or vertically
		$T_A \times (40/50) + T_B \times (40/104) = 21$ or $T_A \times (30/50) = T_B \times (96/104)$	A1		
		$T_A \times (30/50) = T_B \times (96/104)$ or $T_A \times (40/50) + T_B \times (40/104) = 21$	B1		
		Solve for T_A and T_B	M1		Solving for both
		Tension in AP is 20 N and tension in BP is 13 N	A1	[5]	Both $T_A = 20$ and $T_B = 13$
		First Alternative Marking Scheme			
3			M1		For using the sine rule in the triangle of forces
		21/sin 75.75 (or 75.7 or 75.8) = T_A/sin 67.4 (or T_B/sin 36.9)	A1		
		21/sin 75.75 (or 75.7 or 75.8) = T_B/sin 36.9 (or T_A/sin 67.4) or T_B/sin 36.9 = 20/sin 67.4	B1		
		Solve for T_A and T_B	M1		Solving for both

		Tension in AP is 20N and tension in BP is 13N	A1	[5]	Both $T_A = 20$ and $T_B = 13$
Second Alternative Marking Scheme					
3			M1		For using Lami's Rule
		21/sin 104.3 = T_A/sin 112.6 (or T_B/sin 143.1)	A1		
		21/sin 104.3 = T_B/sin 143.1 (or T_A/sin 112.6) or T_B/sin 143.1 = 20/sin 112.6 or T_A/sin 112.6 = 13/sin 143.1	B1		
		Solve for T_A and T_B	M1		For using the equations to find T_A and T_B
		Tension in AP is 20 N and tension in BP is 13 N	A1	[5]	Both $T_A = 20$ and $T_B = 13$
4	**(i)**	$a = (16 \div 65)g$	B1		
		$[8^2 = 2(16 \div 65)gS]$	M1		For using $v^2 = 2as$ to find S
		S = 13	A1		
		$[v^2 = 2(16 \div 65)g \times 6.5$ or $v^2 \div 8^2 = ½]$	M1		For using $v^2 = 2a(½S)$ or $v^2 \propto s$
		Speed is 5.66 ms^{-1}	A1	[5]	
	(ii)	$[s = ½ a \times (64 \div 4a^2)$ or $s \div 13 = (½)^2]$	M1		For using $8 = 0 + aT$ and $s = ½a(T/2)^2$ or $s \propto t^2$
		Distance is 3.25 m	A1	[2]	
Alternative Marking Scheme					
4	**(i)**	$[½ m v^2 = mgh$ and $S = h \div \sin \alpha$	M1		For using KE gain = PE loss
		$S = (8^2 \div 20) \div (16 \div 65)$	A1		Or AEF
		S = 13	A1		
		$½ m v^2 = mg(½ 13 \times (16/65))$	M1		Or AEF
		Speed is 5.66 ms^{-1}	A1	[5]	
	(ii)		M1		For eliminating at^2 from $s = ½at^2$ and $13 = ½a(2t)^2$
		Distance is 3.25 m	A1	[2]	
5	**(i)**	Driving force = 1000P/25	B1		

			M1		For using Newton's 2nd law
		$1000P/25 - 600 = 1000 \times 0.2$	A1		
		$P = 20$	A1	[4]	
	(ii)		M1		For using Newton's 2nd law with $a = 0$
		$20000/v_{max} - 600 = 0$	A1ft		ft for their P in (i)
		Steady speed is 33.3 ms^{-1}	A1	[3]	
6	**(i)**	For sketch of single valued, continuous graph consisting of 3 straight line segments with $+^{ve}$, then $-^{ve}$, then $+^{ve}$ slope	B1		
		Sketch appears to show $v(0) = 0$ and $v(8) > v(26) > v(20)$	B1	[2]	
	(ii)	For shading the triangle from $t = 0$ to $t = 8$, the trapezium from $t = 8$ to $t = 20$ and the trapezium from $t = 20$ to a value of t seen to be between 20 and 26	B1	[1]	
	(iii)		M1		For using area property to find s(20)
		$s(20) = ½(8 \times 8) + ½(8 + 2) \times 12 \quad (= 92)$	A1		
			M1		For using the gradient property to find acceleration in 3rd phase
		$a = (6.5 - 2)/6 \quad (= 0.75)$	A1		
		$[s(t) = 92 + 2(t - 20) + 0.375(t - 20)^2$	M1		
		Displacement is $0.375t^2 - 13t + 202$ metres	A1	[6]	
Alternative Marking Scheme for final 2 marks of Q6					
		$[v(t) = 2 + 0.75(t - 20)$ $s(t) = 0.375t^2 - 13t + A$ where $92 = 0.375 \times 400 - 13 \times 20 + A]$	M1		For finding v(t), integrating and using s(20) = 92
		Displacement is $0.375t^2 - 13t + 202$ metres	A1		
6	**(iii)**	**First Alternative Marking Scheme for part (iii) of Q6**			
		$a = (6.5 - 2) / (26 - 20) = 0.75$	B1		
		$v = 0.75t$ (+ C1)	M1		Integrating
		$v = 0.75t - 13$	A1		Using $v(20) = 2$ or $v(26) = 6.5$

		s(20) = 92 or s(26) = 117.5	B1		Using area in diagram
		$s = 0.375t^2 – 13t (+ C_2)$	M1		Integrating
		$s = 0.375t^2 – 13t + 202$	A1	[6]	Using s(20) or s(26) to find $C_2 = 202$
6	**(iii)**	**Second Alternative Marking Scheme for part (iii) of Q6**			
		s = 0.375t2 – 13t + 202			Given
		v = 0.75t – 13	M1		Differentiating
		a = 0.75	M1		Differentiating
		a = (6.5–2)/(26–20) = 0.75	B1		Check agreement from graph
		v(20) = 0.75(20) – 13 = 2 or v(26) = 0.75(26) – 13 = 6.5	B1		Check v agrees at a point between t = 20 and t = 26
		Show s(20) = 92 or s(26) = 117.5	B1		Using area under graph
		$s(20) = 0.375(20)^2 – 13(20) + 202 = 92$ or $s(26) = 0.375(26)^2 – 13(26) + 202 = 117.5$	B1		Check s agrees at a point between t = 20 and t = 26
7	**(i)**		M1		For applying Newton's 2nd law to A or B
		T – 0.26g(16÷65) = 0.26a or 0.52g – T = 0.52a	A1		
		For {0.52g – T = 0.52a or T – 0.26g(16 ÷ 65) = 0.26a} or 0.52g – 0.26g(16 ÷ 65) = (0.52 + 0.26)a	B1		
		Acceleration is 5.85 ms^{-2}	B1		
		Tension is 2.16 N	A1	[5]	
	(ii)	$[v^2 = 2 \times (76/13) \times 0.6]$	M1		For using $v^2 = 2as$
		Speed is 2.65 ms^{-1}	A1		
		$0 = 91.2/13 – 2(160/65)s$	M1		For using $0 = v_B^2 – 2(g \sin\alpha)s$
		S = 57/40 (= 1.425)	A1		
		[AP = 2.5 – 0.6 – 1.425]	M1		For using AP = 2.5 – 0.6 – s
		Distance AP is 0.475 m	A1	[6]	