Question	Answer	Marks	Guidance
1(i)	KE = ½ × 0.4 × 12^2 = 28.8 J	B1	
	Total:	1	
1(ii)	PE gain = 0.4*gh* [= 4*d* sin 30]	B1	*h* = height gained *d* = distance travelled up the plane
	4*h* = 28.8	M1	Using KE loss = PE gain
	h = 7.2 *h* = *d* sin 30 *d* = 14.4 m	A1	
	Total:	3	

Question	Answer	Marks	Guidance
2		M1	Resolve forces horizontally and/or vertically
	T_A sin 20 + T_B sin 40 = 16	A1	Correct vertical equation
	T_A cos 20 = T_B cos 40	A1	Correct horizontal equation
		M1	Attempt to solve for T_A and/or T_B
	T_A = 14.2 N	A1	T_A = 14.1528...
	T_B = 17.4 N	A1	T_B = 17.3610...
	Total:	6	
	Alternative method for Question 2		
		M1	Attempt to use Lami's Theorem
	$\frac{16}{\sin 120} = \frac{T_A}{\sin 130}$	A1	
	$\frac{16}{\sin 120} = \frac{T_B}{\sin 110}$	A1	
		M1	Attempt to solve for T_A and/or T_B
	T_A = 14.2 N	A1	
	T_B = 17.4 N	A1	
	Total:	6	

Question	Answer	Marks	Guidance
3	$R = 0.6g\cos 21$ [= 5.60]	B1	
	$F = 0.3R = 1.8\cos 21$ [= 1.68]	M1	Using $F = \mu R$
	$P + F = 6\sin 21$[= 2.15]	M1	Slipping down
	$P = 2.15 - 1.68 = 0.470$ **AG**	A1	Least possible value
	$P - F = 6\sin 21$	M1	Slipping up
	$P = 2.15 + 1.68 = 3.83$	A1	Greatest possible value
	Total:	**6**	

Question	Answer	Marks	Guidance
4(i)	$36000 = 800v$	M1	Using $P = Fv$
	$v = 45\text{ m s}^{-1}$	A1	Speed of the car
	$AB = 45 \times 120 = 5400\text{ m}$	A1	
	Total:	**3**	
4(ii)	$-800 = 900a$ [$a = -8/9$]	M1	Using Newton's 2nd law
	$v^2 = 45^2 - \frac{16}{9} \times 450$	M1	Using $v^2 = u^2 + 2as$
	$v = 35\text{ m s}^{-1}$	A1	Speed of the car at C
	Total:	**3**	
	Alternative method for Question 4(ii)		
	$0.5 \times 900 \times (45 - v^2)$	M1	Attempt change in KE
	$0.5 \times 900 \times (45 - v^2) = 800 \times 450$	M1	KE loss = WD against Friction
	$v = 35\text{ m s}^{-1}$	A1	Speed of the car at C
	Total:	**3**	

Question	Answer	Marks	Guidance
4(iii)	$CD = 6637.5 - 5400 - 450 = 787.5$	B1	
	$0 = 35^2 - 2d \times 787.5$	M1	Using $v^2 = u^2 + 2as$, $a = -d$
	$d = 7/9 = 0.778 \text{ m s}^{-2}$	A1	d = deceleration
	$P = 900 \times (7/9) = 700$	A1	Using $F = ma$
	Total:	4	

Question	Answer	Marks	Guidance
5(i)	$0 = a + b \times 35^2$ $40 = a + b \times 15^2$	M1	For matching velocities at $t = 15$ and using $v = 0$ at $t = 35$
	$[1000b = -40 \rightarrow b = -0.04]$ $[a = 0.04 \times 352 = 49]$	M1	Solve for a and b
	$a = 49$ and $b = -0.04$ **AG**	A1	
	Total:	3	
5(ii)	$0 \leqslant t \leqslant 5$ correct	B1	Increasing quadratic, from (0,0) to (5,20), concave up
	$5 \leqslant t \leqslant 15$ correct	B1	Line from (5,20) to (15,40)
	$15 \leqslant t \leqslant 35$ correct	B1	Decreasing quadratic, from (15,40) to (35,0), concave down
	20 and 40 seen correct on v-axis	B1	
	Total:	4	
5(iii)	$A_1 = \int_0^5 0.8t^2 \text{d}t = \frac{100}{3}$	B1	
	$A_2 = \frac{1}{2}(20 + 40) \times 10 = 300$	M1	Using trapezium rule or integration for $t = 5$ to $t = 15$
	$A_3 = \int_{15}^{35} (a + bt^2) \text{d}t$ $= 49t - \frac{0.04}{3}t^3$	M1	Attempt to integrate the quadratic function from $t = 15$ to $t = 35$
	$A_3 = 453.3333 = 1360/3$	A1	
	Total Distance $= 2360/3 = 787 \text{ m}$	A1	
	Total:	5	

Question	Answer	Marks	Guidance
6(i)		M1	Apply Newton's law to either of the particles
	$12 - T = 1.2a$ and $T - 8 = 0.8a$	A1	Both equations correct
		M1	Solve for a and T
	$a = 2\,\text{m s}^{-2}$ and $T = 9.6\,\text{N}$	A1	
	Total:	**4**	
6(ii)	$[0.64 = ½ \times 2 \times t_1^2]$ $[v = 2t_1]$	M1	Attempt to find time t_1 taken for 1.2 kg particle to reach ground and/or its speed v at the ground
	$t_1 = 0.8$	A1	
	$v = 2 \times 0.8 = 1.6$	A1	
	$[0 = 1.6 - 10t_2]$ $[1.6^2 = 2 \times 10 \times s_2]$	M1	For attempting to find the time t_2 and/or distance travelled s_2 as 0.8 kg particle comes to rest
	$t_2 = 0.16$	A1	
	$s_2 = 0.128$	A1	
	$t_3 = 1 - 0.8 - 0.16 = 0.04$ $s_3 = ½ \times 10 \times 0.04^2$	B1	Finding the distance s_3 travelled downwards in t_3 seconds
	Total distance travelled = $0.64 + 0.128 + 0.008 = 0.776\,\text{m}$	B1	
	Total:	**8**	