Question	Answer	Marks	Guidance
1	Trapezium	**B1**	Includes (0,0) and (...,0)
	(t = 0), t = 5, t = 29, t = 35	**B1**	Correct trapezium with key time values
	$v_{max} = 2.1 \times 5 = 10.5$ ms^{-1}	**B1**	
	[½ × (24 + 35) × 10.5] or [½ × 5 × 10.5 + 24 × 10.5 + ½ × 6 × 10.5]	**M1**	Use of area property to find distance
	309.75 m or 310 m	**A1**	
		5	

Question	Answer	Marks	Guidance
2(i)	[24cos25° – 12cos65°]	**M1**	Resolving in x-direction
	16.7 N	**A1**	(16.679...)
	[30 – 24sin25° – 12sin65°]	**M1**	Resolving in y-direction
	8.98 N	**A1**	(8.981...)
		4	
2(ii)	[$\tan^{-1} \dfrac{8.98....}{16.67....}$]	**M1**	Uses trigonometry to find the angle
	28.3° (anticlockwise) from x-direction	**A1**	(28.300...) or equivalent
		6	

Question	Answer	Marks	Guidance
3(i)		**M1**	Use of Newton's Second Law (4 terms)
	$DF - 1550 - 1400g\sin4° = 1400 \times 0.4$	**A1**	$(DF = 3086.59...)$
	$[30000 = (1400 \times 0.4 + 1550 + 1400g\sin4°)v]$	**M1**	Use of $P = Fv$
	$v = 9.72 \text{ ms}^{-1}$	**A1**	
		4	
3(ii)	$[DF - 1550 - 1400g\sin4° = 0]$	**M1**	$(DF = 2526.59...)$ Resolving up the hill
	$[P_{max} = (1550 + 1400g\sin4°) \times 40]$	**M1**	Use of $P = Fv$
	$P = 101000$ W or 101 kW	**A1**	$(P = 101063.6...)$
		3	

Question	Answer	Marks	Guidance
4(i)	Particle A: $[1.3g - T = 1.3a]$ or Particle B: $[T - 0.7g = 0.7a]$	M1	Use of Newton's Second law for A or B or use of $a = (m_A - m_B)g/(m_A + m_B)$
	$1.3g - T = 1.3a$ and $T - 0.7g = 0.7a$ OR $a = \dfrac{(1.3-0.7)g}{(1.3+0.7)}$ and $1.3g - T = 1.3a$ or $T - 0.7g = 0.7a$	A1	Two correct equations
	$[6 = 2a, a=3]$ or $[\dfrac{1.3g-T}{1.3} = \dfrac{T-0.7g}{0.7}, T = 9.1]$	M1	Solves for a or for T
	$a = 3 \text{ ms}^{-2}$ and $T = 9.1$ N	A1	($a = 3$)
		4	
4(ii)	Distance while connected = 0.375 m	B1	
	$[v^2 = 0^2 + 2 \times 3 \times 0.375 \rightarrow v = ...]$	M1	Use of *suvat* to find v at 'break' ($v^2 = 2as$)
	$v = 1.5 \text{ ms}^{-1}$	A1	Correct value or expression for v
	$[A\text{: } 1.375 = 1.5t + \frac{1}{2}gt^2 \rightarrow t = 0.395...]$	M1	Finds one time 'from break to floor'
	$[B\text{: } 1.375 = -1.5t + \frac{1}{2}gt^2$ or $-1.375 = 1.5t - \frac{1}{2}gt^2 \rightarrow t = 0.695...]$	M1	Finds second time 'from break to floor'
	Difference in times = 0.3 s	A1	
	Alternative Method 1 for 4(ii) (last 3 marks)		
	$[u_B = 1.5, v_B = 0, a = -g, 0 = 1.5 - gt \rightarrow t = 0.15]$	M1	Finds t_B from 'break' to maximum height
	Difference in times = 2×0.15	M1	
	Difference in times = 0.3 s	A1	

Question	Answer	Marks	Guidance
4(ii)	**Alternative Method 2 for 4(ii) (last 3 marks)**		
	[A: $0.375 = ½ \times 3t^2 \rightarrow t = 0.5$ $1.375 = 1.5t + ½ gt^2 \rightarrow t =$ 0.395... t_A total = 0.5 + 0.395... = 0.895... s]	**M1**	Use of *suvat* to find total time for A
	[B: $0.375 = ½ \times 3t^2 \rightarrow t = 0.5$; $0 = 1.5 - gt \rightarrow t = 0.15$, $s = 1.5t - 1/2gt^2 = 0.1125$ $1.4875 = ½ \times gt^2 \rightarrow t = 0.545...$ t_B total = 1.195 s]	**M1**	Use of *suvat* to find total time for B
	Difference in times = 0.3 s	**A1**	
		6	

Question	Answer	Marks	Guidance
5(i)	(PE gain =) $18gd\sin30°$ **or** (KE loss =) $½ \times 18 \times 20^2$	**B1**	
	(PE gain =) $18gd\sin30°$ **and** (KE loss =) $½ \times 18 \times 20^2$	**B1**	
	[$18gd\sin30° = ½ \times 18 \times 20^2$] **or** [$18gh = ½ \times 18 \times 20^2$]	**M1**	Energy equation (PE gain = KE loss)
	Distance up plane = 40 m	**A1**	
		4	
5(ii)	$R = 18g\cos30°$ ($90\sqrt{3}$ or 155.884...)	**B1**	
	[$F = 0.25(18g\cos30°)$] ($45\sqrt{3}/2$ or 38.971...)	**M1**	Use of $F = \mu R$
	[$18g\sin30° + 0.25(18g\cos30°) = -18a \rightarrow a = ...$] ($a = -7.165..$)	**M1**	Newton's Second Law (3 term equation)
	[$0^2 = 20^2 + 2 \times -7.165.. \times s$ $\rightarrow s = ...$]	**M1**	Use of *suvat* to find s
	$s = 27.913...$	**A1**	

Question	Answer	Marks	Guidance
5(ii)	[$18g\sin30° - 0.25(18g\cos30°) = 18a \quad \rightarrow \quad a = ...$]	M1	($a = 2.835..$) – Newton's Second Law (3 term equation)
	[$v^2 = 0^2 + 2 \times 2.835.. \times 27.913.. \quad \rightarrow \quad v = ...$]	M1	Use of *suvat* to find s
	$v = 12.6\ \text{ms}^{-1}$	A1	(12.580...)
	Alternative Method 1 for 5(ii)		
	$R = 18g\cos30°$ ($90\sqrt{3}$ or 155.884...)	B1	
	[$F = 0.25(18g\cos30°)$] ($45\sqrt{3}/2$ or 38.971...)	M1	Use of $F = \mu R$
	[KE gain = $\frac{1}{2} \times 18 \times 20^2$ and PE loss = $18gh$ or $18gs(\sin30°)$]	M1	Use of KE = $1/2\ mv^2$ and PE = mgh
	[$\frac{1}{2} \times 18 \times 20^2 = 18gs(\sin30°) + 45\cos30° \times s$]	M1	Work / Energy equation (up plane)
	$s = 27.913...$	A1	
	[WD = $45\cos30° \times 27.91...$]	M1	Work done against friction
	[$\frac{1}{2} \times 18v^2 = (18g\sin30°) \times 27.91.. - 45\cos30° \times 27.91...$]	M1	Work / Energy equation (down plane)
	$v = 12.6\ \text{ms}^{-1}$	A1	(12.580...)
	Alternative Method 2 for 5(ii) (last 3 marks)		
	[WD = $2 \times 45\cos30° \times 27.91...$]	M1	WD against friction (up and down)
	[$\frac{1}{2} \times 18 \times 20^2 - \frac{1}{2} \times 18v^2 = 2 \times 45\cos30° \times 27.91...$]	M1	Uses KE loss = total WD against friction
	$v = 12.6\ \text{ms}^{-1}$	A1	(12.580...)
		8	

Question	Answer	Marks	Guidance
6(i)	[$v = 6t^2/2 - 12t + C$] $v = 3t^2 - 12t + C$	*M1	Use of $v = \int a\,dt$
	[$s = 3t^3/3 - 12t^2/2 + Ct + D$] $s = t^3 - 6t^2 + Ct + D$	*M1	Use of $s = \int v\,dt$
	[$5 = 1 - 6 + C + D$ $C + D = 10$ $1 = 27 - 54 + 3C + D$ $3C + D = 28$ $\rightarrow$ $C = ...,\ D = ...$]	DM1	Substitutes for s and t and solves equations. Dependent on both Ms.
	$s = t^3 - 6t^2 + 9t + 1$ or $p = 9,\ q = 1$	A1	
		4	
6(ii)	[$v = 0,\ 3t^2 - 12t + 9 = 0\,(t-1)(t-3) = 0$ $\rightarrow$ $t = ...$]	M1	Solves $v = 0$ to find t values
	$t = 1$ or $t = 3$	A1	
		2	
6(iii)	[$\int_0^1 v\,dt + \int_1^3 v\,dt + \int_3^4 v\,dt$]	M1	Attempts to use at least three t intervals
	[For $0 \leqslant t \leqslant 1$, $s = (1 - 6 + 9 + 1) - 1 = 4$]	M1	Evaluates s for one time interval
	[$0 \leqslant t \leqslant 1$, $s = (1 - 6 + 9 + 1) - 1 = \mathbf{4}$; $1 \leqslant t \leqslant 3$, $s = (27 - 54 + 27 + 1) - 5 = {}^{-}\mathbf{4}$ $3 \leqslant t \leqslant 4$, $s = (64 - 96 + 36 + 1) - 1 = \mathbf{4}$]	A1	Correctly finds all at least two distances (ignoring signs)
	Total distance is 12 m	A1	
		4	