Question	Answer	Marks	Guidance
1(i)	WD = 35 cos 20 × 12	M1	Uses WD = $Fd \cos\theta$
	395 J	A1	
	Total:	**2**	
1(ii)	*EITHER:* WD against resistance = 15 × 12	(B1	
	$35\cos 20 \times 12 = 15 \times 12 + ½ (25v^2)$	M1	Uses $WD_{man} = WD_{resistance}$ + KE gain
	$v = 4.14$ ms^{-1}	A1)	
	OR: 35 cos 20 – 15 = 25 *a* [*a* = 0.716]	(B1	Applies Newton's Second Law
	$v^2 = 2 \times 0.7155. \times 12$	M1	Uses $v^2 = u^2 + 2as$
	$v = 4.14$ ms^{-1}	A1)	
	Total:	**3**	

Question	Answer	Marks	Guidance
2	*EITHER:* $3P \sin 55 + P \sin \theta = 20 + P \sin \theta$ or $3P \sin 55 = 20$	(M1	Resolves forces vertically
	$P = 8.14$	A1	
	$3P \cos 55 = 2P \cos \theta$	M1	Resolves forces horizontally
	$\cos \theta = 1.5 \cos 55 \rightarrow \theta = \ldots$	M1	Attempt to solve for θ
	$\theta = 30.6$	A1)	
	OR: $\frac{3P}{\sin 90} = \frac{20}{\sin 125}$	(M1	Uses Lami's Theorem (forces $3P$ and 20)
	$P = 8.14$	A1	
	$\frac{3P}{\sin 90} = \frac{2P \cos \theta}{\sin 145}$	M1	Uses Lami's Theorem (forces $3P$ and $2P \cos \theta$)
	$\cos \theta = 1.5 \sin 145 \rightarrow \theta = \ldots$	M1	Attempt to solve for θ
	$\theta = 30.6$	A1)	
	Total:	**5**	

Question	Answer	Marks	Guidance
3(i)	Trapezium, right-hand steeper than left-hand slope	**B1**	
	Total:	**1**	
3(ii)	Deceleration 0.5 T	**B1**	May be implied
	Constant speed 180 – 1.5 T	**B1**	
	Total:	**2**	
3(iii)	$0.5[180 + (180 - 1.5T)] \times 25 = 3300$	**M1**	Uses area property
	$T = 64$	**A1**	
	Distance decelerating = $[0.5 \times 32 \times 25 =]$ 400 m	**B1**	
	Total:	**3**	
4(i)	$a = 3 \times 2 \times (2t - 5)^2$ [= 54]	***M1**	Uses a = dv/dt
	$6(2t - 5)^2 = 54 \rightarrow t = \ldots$	**DM1**	Solves for t
	$t = 1, 4$	**A1**	
	Total:	**3**	

Question	Answer	Marks	Guidance
4(ii)	$s = \frac{(2t-5)^4}{4\times 2}$ $(+ C)$	*M1	Uses $s = \int v\,dt$
	$C = -\frac{625}{8}$	DM1	Uses $s = 0$ at $t = 0$
	$s = \frac{(2t-5)^4}{8} - \frac{625}{8}$	A1	
	Total:	3	
	Alternative method for Question 4		
4(i)	$v = 8t^3 - 60t^2 + 150t - 125$ $\to a = 24t^2 - 120t + 150$	*M1	Uses $a = dv/dt$
	$24t^2 - 120t + 150 = 54 \to t = ...$	DM1	Solves for t
	$t = 1, 4$	A1	
	Total:	3	
4(ii)	$s = \int 8t^3 - 60t^2 + 150t - 125\,dt$ $\to s = \frac{8}{4}t^4 - \frac{60}{3}t^3 + \frac{150}{2}t^2 - 125t\ (+ C)$	*M1	Uses $s = \int v\,dt$
	$C = 0$	DM1	Uses $s = 0$ at $t = 0$ (may be implied)
	$s = 2t^4 - 20t^3 + 75t^2 - 125t$	A1	
	Total:	3	

Question	Answer	Marks	Guidance
5(i)	$s_2 = 20t - 0.5gt^2$	B1	Second particle
		M1	Uses $s = ut + ½ at^2$ for first particle
	$s_1 = 12(t + 2) - 0.5g(t + 2)^2$	*A1	
	$12(t + 2) - 0.5g(t + 2)^2 = 20t - 0.5gt^2$ $\rightarrow$ t=…	DM1	Solves $s_1 = s_2$
	$t = \frac{1}{7} = 0.143$	A1	
	Total:	**5**	
5(ii)	$[s = 20 \times \frac{1}{7} - 5 \times (\frac{1}{7})^2 = 2.755\ldots]$ Height is 2.76 m	B1	
	Total:	**1**	

Question	Answer	Marks	Guidance
6(i)(a)	$16\,000 = F \times 40$	**M1**	Using $P = Fv$
	Resistance is 400 N	**A1**	
	Total:	**2**	
6(i)(b)	$22\,500 = F \times 45$ $F = 500$	**B1**	
	$500 - 400 = 1200a$	**M1**	Applying Newton's Second Law
	$a = \frac{1}{12} = 0.0833$ (ms^{-2})	**A1**	
	Total:	**3**	
6(ii)	$16\,000 = (590 + 2v)v$	**M1**	Using $P = Fv$
	$[2v^2 + 590v - 16\,000 = 0] \rightarrow v = \ldots$	**M1**	Solving for v
	$v = 25$ (ms^{-1})	**A1**	
	Total:	**3**	

Question	Answer	Marks	Guidance
7(i)	$R = mg \cos 30$	**B1**	Resolves normally
	$F = 2m \cos 30$ [$= m\sqrt{3}$]	**M1**	Uses $F = \mu R$
	$T = 4g$ [$= 40$]	**B1**	Particle B
	$T = mg\sin 30 + F$	**M1**	Resolves parallel to plane for particle A
	$40 = 5m + m\sqrt{3}$	**A1**	Equation in m
	$m = \dfrac{40}{5+\sqrt{3}} = 5.94$	**A1**	**AG** All correct and no errors seen
	Total:	**6**	

Question	Answer	Marks	Guidance
7(ii)	*EITHER:* [$R = 3g \cos 30$] $F = 0.2 \times 3g \cos 30$ ($3\sqrt{3} = 5.196$)	(B1	
	$4g - T = 4a$ or $T - 3g\sin 30 - F = 3a$ or $4g - 3g\sin 30 - F = 7a$	M1	Applies Newton's Second Law to one of the particles or forms system equation in a ($m_B g - m_A g \sin 30 - F = (m_A + m_B)a$)
	$T - 3g\sin 30 - 3\sqrt{3} = 3a$ or $40 - T = 4a$ or $4g - 3g\sin 30 - 3\sqrt{3} = 7a \rightarrow a = \ldots$	M1	Applies Newton's Second Law to form second equation in T and a and solves for a or solves system equation for a
	$a = \dfrac{25 - 3\sqrt{3}}{7}$ $= 2.83.$	A1	
	$v^2 = 2 \times 2.83 \times 0.5$ $v = 1.68\ldots$	B1 FT	v as T becomes zero FT on a
	$-3g\sin 30 - 0.2(3g\cos 30) = 3a$ $-15 - 3\sqrt{3} = 3a$ $\rightarrow a = \ldots(-5 - \sqrt{3} = -6.73)$	M1	Applies Newton's Second Law and solves for a
	$0 = 1.68^2 - 2 \times 6.73s$ $s = \ldots(0.210)$	M1	Uses $v^2 = u^2 + 2as$ and solves for s
	Total distance = 0.710 m	A1)	
	OR: [$R = 3g \cos 30$] $F = 0.2 \times 3g \cos 30$ ($3\sqrt{3} = 5.196$)	(B1	

Question	Answer	Marks	Guidance
		M1	For 4kg mass, uses PE loss – WD_T = KE gain
		M1	For 3kg mass, uses WD_T = KE gain + PE gain + WD_{Fr}
	$4g(0.5) - 0.5T = ½ (4v^2)$ and $0.5T = ½ (3v^2) + 3g(0.5\sin30) + 3\sqrt{3}(0.5)$	A1	
	$v^2 = (25 - 3\sqrt{3})/7$ or $v = 1.68$	B1	
	$½ (3)(1.68)^2 = 3g(s \sin30) + 3\sqrt{3}s$	M1	For 3kg mass, uses KE loss = PE gain + WD_{Fr}
	$s = \ldots(0.210)$	M1	Solves for s
	Total distance = 0.710 m	A1)	
	Total:	**8**	