Question	Answer	Mark	Guidance
1	PE loss = $0.6 \times 10 \times 8$ [= 48]	**B1**	
	KE gain = ½ (0.6) 10^2 [= 30]	**B1**	
	WD against Res = 48 – 30 = 18 J	**B1**	
	Total:	**3**	
2(i)	$R = 0.8g \cos 10$ [= 7.88]	**B1**	
	$F = 0.4 \times 8 \cos 10$ [= 3.15]	**M1**	Use $F = \mu R$
	$-8 \sin 10 - 3.2 \cos 10 = 0.8a$	**M1**	Newton 2 along the plane
	$a = -5.68$ ms^{-2}	**A1**	
	Total:	**4**	
2(ii)	$0 = 12^2 - 2 \times 5.68 \times s$	**M1**	Using $v^2 = u^2 + 2as$
	$s = 144/(2 \times 5.68) = 12.7$ m	**A1**	
	Total:	**2**	

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Question	Answer	Mark	Guidance
3	*EITHER*:	**(M1**	Resolve horizontally and/or vertically at the 25 N weight
	$A\cos 30 + B\cos 40 = 25$	**A1**	
	$A\sin 30 = B\sin 40$	**A1**	
		M1	Solve for A and/or B
	$A = 17.1$	**A1**	
	$B = 13.3$	**A1)**	
	OR:	**(M1**	Attempt Lami's theorem
	$\frac{25}{\sin 70} = \frac{A}{\sin 140} = \frac{B}{\sin 150}$	**A1**	One correct equation
		A1	A second correct equation
		M1	Solve for A and/or B
	$A = 17.1$	**A1**	
	$B = 13.3$	**A1)**	
	Total:	**6**	

Question	Answer	Mark	Guidance
4(i)		**M1**	Attempt KE and/or PE with correct dimensions
	KE gain = $\frac{1}{2} \times 800 \times (14^2 - 8^2) = 52800$ J	**A1**	
	PE gain = $800 \times 10 \times 120 \times 0.15 = 144000$ J	**A1**	
	Total:	**3**	
4(ii)	WD by engine = 32000×12	**B1**	
	$32000 \times 12 =$ $144000 + 52800 +$ WD against F	**M1**	Work/Energy equation 4 terms
	WD against $F = 187200$ J	**A1**	WD = 187000 to 3sf
	Total:	**3**	
5(i)	[$12^2 = 20^2 - 2a \times AB$ $6^2 = 12^2 - 2a \times BC$]	**M1**	Use $v^2 = u^2 + 2(-a)s$ for AB or BC where a is the deceleration
	$AB = 128/a$	**A1**	
	$BC = 54/a$	**A1**	
	$AB : BC = 64:27$	**A1**	Allow equivalent unsimplified ratio
	Total:	**4**	

Question	Answer	Mark	Guidance
5(ii)	$0 = 20^2 - 2a \times 80 \rightarrow a = 2.5$	**M1**	Use $v^2 = u^2 + 2(-a)AD$ to find a
	$BC = 54/2.5$	**M1**	Use a to find BC
	$BC = 21.6$ m	**A1**	
	Total:	**3**	
6(i)	$[q + r = 4$ and $2q + 4r = 4]$	**M1**	Use $v = 4$ at $t = 1$ and $t = 2$
	$q = 6$ and $r = -2$ so $v = 6t - 2t^2$	**A1**	
	$a = 6 - 4t$	**M1**	Differentiation used for a
	At $t = 0.5$, $a = 4$	**A1**	AG
	Total:	**4**	
6(ii)	$v = 6t - 2t^2 = 0$	**M1**	Set $v = 0$ and solve for t
	$t = 0$ and $t = 3$	**A1**	
	Total:	**2**	

Question	Answer	Mark	Guidance
6(iii)	*EITHER*: $s = \int(6t - 2t^2)\,\mathrm{d}t$	**(M1**	Attempt to integrate v to find s
	$s = 3t^2 - \frac{2}{3}t^3 + C$	**A1**	
	$0 = 3 \times 3^2 - \frac{2}{3} \times 3^3 + C$	**M1**	Use $s = 0$ when $t = 3$ to find C
	$C = -9$ so distance = 9 m	**A1)**	Valid argument
	OR: $s = \int_0^3 \left(6t - 2t^2\right)\mathrm{d}t$	**(M1**	Attempt integration with limits
	$\left[3t^2 - \frac{2}{3}t^3\right]_0^3$	**A1**	Correct integration and correct limits but no evaluation
	[27 – 18 = 9]	**M1**	Evaluation of integral between limits
	Distance from O at $t = 0$ is 9 m	**A1)**	With explanation
	Total:	**4**	

Question	Answer	Mark	Guidance
7(i)	[$T - 0.8g \sin 30 = 0.8a$ $1.2g \sin 60 - T = 1.2a$ $1.2g \sin 60 - 0.8g \sin 30 = 2a$]	**M1**	Resolve along the plane for either A or for B or for the system
	For A $\quad T - 4 = 0.8a$	**A1**	
	For B $6\sqrt{3} - T = 10.4 - T = 1.2a$	**A1**	System equation is $6\sqrt{3} - 4 = 6.4 = 2a$
		M1	Solve for a or T
	$a = 3\sqrt{3} - 2 = 3.20$ ms^{-2}	**A1**	
	$T = \frac{12}{5}\left(1 + \sqrt{3}\right) = 6.56$ N	**A1**	
	Total:	**6**	

Question	Answer	Mark	Guidance
7(ii)	$R_A = 0.8g\cos 30 = 4\sqrt{3}$ $R_B = 1.2g\cos 60 = 6$	**B1**	For either R_A or R_B
	$F_A = 4\sqrt{3}\ \mu$ and $F_B = 6\mu$	**M1**	Either F_A or F_B used
		M1	Resolve parallel to the plane for both particles A and B or system
	$12\sin 60 - 6\mu - T = 0$ or $T - 8\sin 30 - 4\sqrt{3}\ \mu = 0$	**A1**	System equation is $12\sin 60 - 8\sin 30 - 6\mu - 4\sqrt{3}\ \mu = 0$
		M1	Eliminate T and/or find μ
	$\mu = \left(6\sqrt{3} - 4\right)/\left(6 + 4\sqrt{3}\right)$ $= 0.494$	**A1**	
	Total:	**6**	