Qu	Answer	Part Marks	Mark	Notes
1	[$X = 7 - 8\cos\alpha - 6\sin\alpha = -3$]	M1		For resolving forces horizontally
	$X = 7 - 8 \times (4/5) - 6 \times (3/5) = -3$	A1		Allow $\alpha = 36.9$ used
	[$Y = 8\sin\alpha - 6\cos\alpha = 0$]	M1		For resolving forces vertically
	$Y = 8 \times (3/5) - 6 \times (4/5) = 0$	A1		Allow $\alpha = 36.9$ used
	Resultant force is 3N to the left	B1	5	
2 (i)	$4t^2 - 8t + 3 = 0$ $(2t-3)(2t-1)$	M1		Set $v = 0$ and attempt to factorise or use the quadratic formula or completing the square.
	$t = 0.5$ and $t = 1.5$	A1	2	
(ii)	$s = -\int(4t^2 - 8t + 3)\,dt$	M1		Integrating v to find s. Allow minus sign omitted.
	$-\left[\frac{4}{3}t^3 - 4t^2 + 3t\right]_{0.5}^{1.5}$	M1		Attempted integration with limits substituted and then subtracted but not necessarily fully evaluated. [$= -(0 - 2/3)$] Allow first minus sign omitted
	Distance travelled =2/3 m	A1	3	Must justify sign of answer
3 (i)	[$80x\sin 22.6$ or $80x(5/13)$]	M1		For using PE change = mgh PE change = $8 \times g \times x\sin\alpha$
	$= \frac{400}{13}x = 30.8x$	A1	2	Allow $\alpha = 22.6$ used
(ii)	WD against friction = $15 \times x$	B1		
	$\frac{1}{2} \times 8 \times 5^2$	B1		
	$\frac{1}{2} \times 8 \times 5^2 = \frac{400}{13}x + 15x$	M1		For using KE loss = PE gain + WD against friction
	$x = \frac{260}{119} = 2.18$	A1	4	

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Qu	Answer	Part Marks	Mark	Notes
4 (i)	½ × 6 × 8.2 + 36 × 8.2 Or ½ × 8.2 × (36 + 42)	M1		For using distance = total area under graph
	Distance = 319.8 m	A1	2	
(ii)	$s = 80.2$	B1√		Distance from $t = 42$ to $t = 52$
	$80.2 = \frac{8.2 + V}{2} \times 10$	M1		For equating remaining distance to total area under graph between $t = 42$ and $t = 52$
	$V = 7.84$	A1	3	**AG**
(iii)		M1		Use gradient property for deceleration
	$d = \frac{8.2 - 7.84}{10} = 0.036$	A1	2	
	Alternative for 4(iii)			
(iii)	$80.2 = 8.2 \times 10 + ½\, a \times 10^2$	M1		For using $s = ut + ½at^2$ between $t = 42$ and $t = 52$
	$a = -0.036\ \text{ms}^{-2}$ or $d = 0.036\ \text{ms}^{-2}$	A1	2	
5		M1		For resolving forces perpendicular to the plane (3 term equation)
	$R + T \sin 20 = 2.5g \cos 30$	A1		
	$F = 0.25 \times R$	B1		May be implied
		M1		For resolving forces parallel to the plane (3 term equation)
	$T \cos 20 = F + 2.5g \sin 30$	A1		
		M1		For solving and obtaining T
	$T = 17.5$	A1	7	

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Qu	Answer	Part Marks	Mark	Notes
Alternative scheme				
5	$F = 0.25 \times R$	B1		May be implied
		M1		For resolving forces horizontally (3 term equation)
	$T \cos 50 = F \cos 30 + R \sin 30$	A1		
		M1		For resolving forces vertically (4 term equation)
	$R \cos 30 + T \sin 50 = F \sin 30 + 2.5g$	A1		
		M1		For solving and obtaining T
	$T = 17.5$	A1	7	
6 (i) (a)	Power = 1550 × 40 W	M1		Using Power = Fv where F = Resistance force
	Power = 62000 W = 62 kW	A1	2	Answer must be in kW
(b)	(62000 – 22000) = DF × 40 [DF = 1000]	B1ft		For stating $P - 22000 = \text{DF} \times 40$ to find the new driving force. ft on Power found in **(i)(a)**
	DF – 1550 = 1100a	M1		For applying Newton's second law to the car (3 terms)
	$a = -0.5$ ms^{-2} or $d = 0.5$ ms^{-2}	A1	3	
(ii)	DF = 1100g sin 8 + 1550 [= 3081]	M1		For stating the equilibrium of the three forces
	80000 = 3081v	M1		For using $P = Fv$ with F involving a weight and a resistance term
	$v = 26(.0)$ ms^{-1}	A1	3	

Qu	Answer	Part Marks	Mark	Notes
7 (i)	[$2.4g - T = 2.4a$ $T = 1.6a$ or the system equation $2.4g = (1.6 + 2.4)a$]	M1		For applying Newton's second law to one of the particles or to the combined system
		M1		For applying Newton's second law to a second particle if needed and/or solving for a
	$a = 6\ \text{ms}^{-2}$	A1		
	$0.5 = ½ \times 6 \times t^2$	M1		For using $s = ut + ½at^2$
	$t = 0.408\text{s}$	A1	5	Accept $t = \sqrt{6}/6$
Alternative for 7(i)				
(i)	[PE loss $= 2.4 \times g \times 0.5 = 12$ KE gain $= ½(1.6 + 2.4)v^2 = 2v^2$]	M1		For attempting to find PE and KE as B reaches the ground
	[$12 = 2v^2$]	M1		Using PE loss = KE gain
	$v^2 = 6 \rightarrow v = 2.45\ \text{ms}^{-1}$	A1		
	[$0.5 = ½ \times (0 + 2.45) \times t$]	M1		Using $s = ½(u + v)t$
	$t = 0.408\text{s}$	A1	5	Accept $t = \sqrt{6}/6$
(ii)	$R = 1.6g = 16$ and $F = 3/8\ R = 6$	B1		
	System is [$2.4g - 6 = (1.6 + 2.4)a$]	M1		For using Newton's second law for both particles or the system
	$2.4g - T = 2.4a$ and $T - 6 = 1.6a$	A1		Both or system equation
	[$a = 4.5$]	M1		For finding a and using $v^2 = u^2 + 2as$ to find v as B reaches the ground
	$v = \sqrt{2 \times 4.5 \times 0.5} = \sqrt{4.5} = 2.12\ \text{ms}^{-1}$	A1		
	$-6 = 1.6a \rightarrow a = -3.75\ \text{ms}^{-2}$ $0 = 4.5 + 2 \times (-3.75) \times (s - 0.5)$	M1		For finding the deceleration of A and using $v^2 = u^2 + 2as$ to find s the total distance travelled by A
	$s = 1.1\ \text{m}$	A1	7	

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Qu	Answer	Part Marks	Mark	Notes
First Alternative for 7(ii)				
(ii)	$R = 1.6g = 16$ and $F = 3/8\ R = 6$	B1		
		M1		For attempting PE loss **and** KE gain as B reaches the ground
	PE loss = $2.4 \times g \times 0.5$ [= 12] KE gain = $½ \times (1.6 + 2.4) \times v^2$ [= $2v^2$]	A1		For both PE and KE correct
		M1		For using PE loss = KE gain + WD against F
	$12 = 2v^2 + 6 \times 0.5 \rightarrow v^2 = 4.5 \rightarrow v = 2.12$	A1		
	Loss of KE = WD against F [$½ \times 1.6 \times 4.5 = 6 \times (s - 0.5)$]	M1		For considering the motion of A after B reaches the ground to find s the total distance travelled
	$s = 1.1$ m	A1	7	

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