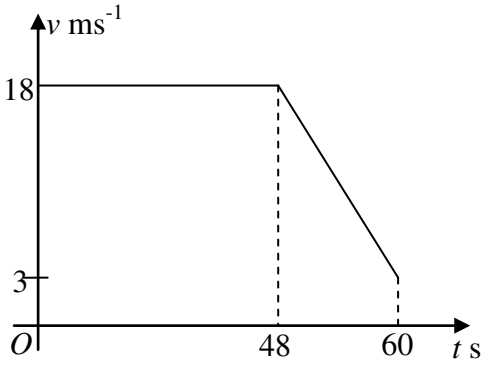
Mathematics M1 January 2014

Solutions and Mark Scheme

Final Version

Q	Solution	Mark	Notes
1(a)			
		B1	(0, 18) to (48, 18) Or (48, 18) to (60, 3)
		B1	graph all correct, with units, labels.
1(b)	magnitude of deceleration = $\frac{18-3}{12}$	M1	
	$= \underline{1.25\ (\text{ms}^{-2})}$	A1	A0 if negative
1(c)	Distance = area under graph	M1	attempt at total area.
	Distance = $48\times18 + 0.5(18 + 3)\times12$	B1	one correct area seen
	Distance = $\underline{990\ (\text{m})}$	A1	cao

Q	Solution	Mark	Notes
2(a)	Use of $v = u+at$, v=0, u=(±)7, a=(±)9.8 $0 = 7 - 9.8t$ $t = \frac{7}{9 \cdot 8} = \frac{5}{7}$ (s)	M1 A1 A1	oe correct equ solvable for t A1
2(b)	Use of $s= ut+0.5at^2$, u=(±)7, a=(±)9.8, t=4 $s = 7\times4 + 0.5(-9.8)\times4^2$ $s = 28 - 4.9\times16$ $s = -50.4$ Height of cliff is <u>50.4 (m)</u>	M1 A1 A1	 if staged method, one correct distance cao, allow –ve

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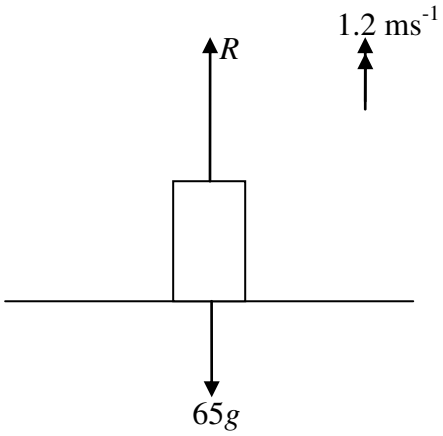
3			
	N2L applied to man	M1	dim correct and R and $65g$ opposing.
	$R - 65g = 65a$ $R = 65\times1.2 + 65\times9.8$	A1	
	$R = \underline{715\ (N)}$	A1	cao

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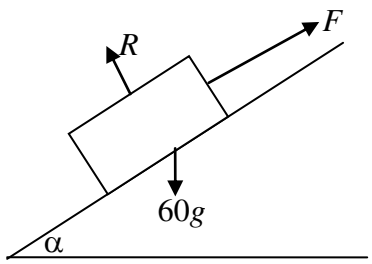
4(a)(i)			
	$R = 60g\cos\alpha$	B1	
	$F = \mu R$ $F = 60\times9.8\cos\alpha \times 0.3$		
	$F = \underline{159.87\ (N)}$	B1	
4(a)(ii)	N2L applied to object	M1	all forces, dim correct.
	$60g\sin\alpha - F = 60a$	A1	
	$60a = 60\times9.8\sin25^\circ - 159.87$		
	$a = \underline{1.48\ (ms^{-2})}$	A1	ft F
4(b)	If object remains stationary, component		
	Of weight down slope ≤ Friction	M1	si
	$60g\sin\alpha \leq \mu\times60g\cos\alpha$	A1	
	$\therefore$ least $\mu = \tan 25^\circ$		
	$= 0.4663$		
	$= \underline{0.47\ (\text{to 2 d.p.})}$	A1	

Q	Solution	Mark	Notes
5	Resolve in Q direction $Q = 9\sin 60^\circ$ $= 9 \times \frac{\sqrt{3}}{2} = \underline{7.794}$	M1 A1	equation required cao
	Resolve in P direction $P + 9\cos 60^\circ = 6$ $P = 6 - 9 \times 0.5$ $P = \underline{1.5}$	M1 A1 A1	equation required, all forces correct equation cao

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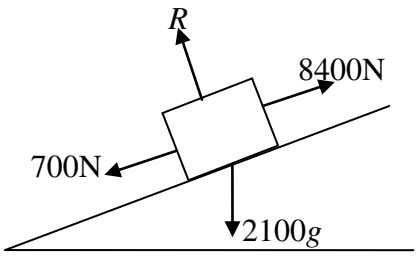
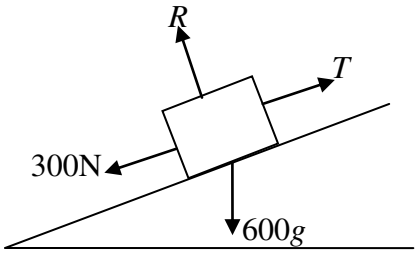
6(a)			
	N2L on whole system	M2	all forces in same dir, dim correct. 8400N and resistance opposing.
		(M1	one force missing but must have comp of wt. and resistance.)
	$8400 - 700 - 2100g\sin\alpha = 2100a$ $8400 - 700 - 5762.4 = 2100a$	A2	-1 each error
	$a = \underline{0.923\ (ms^{-2})}$	A1	cao 3 dp required.
6(b)			
	N2L applied to trailer	M1	all forces, no extra. Dim correct. Either resist. or comp wt opposing
	$T - 300 - 600g\sin\alpha = 600a$	A2	-1 each error
	$T - 300 - 600\times 9.8\times \frac{7}{25} = 600\times \frac{346}{375}$		
	$T = \underline{2500\ (N)}$	A1	ft a. answers rounding to 2500

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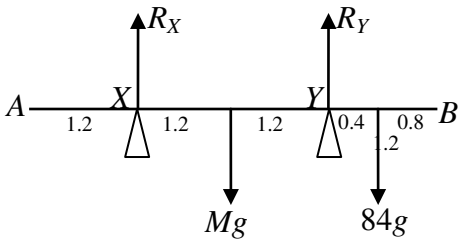
7(a)			
7(a)(i)	Moments about Y	M1	dim. Correct, all forces, equation, oe
		B1	any correct moment.
	$Mg\times1.2 = R_X\times2.4 + 84g\times0.4$ $(9.8\times1.2)M = 2.4\times156.8 + 84\times9.8\times0.4$		
	$M = \underline{60}$	A1	
7(a)(ii)	Resolve vertically	M1	all forces
	$R_X + R_Y = Mg + 84g$	A1	
	$R_Y = 144\times9.8 - 156.8$		
	$R_Y = \underline{1254.4\text{ (N)}}$	A1	ft M
7(b)(i)	When plank about to tilt about Y		
	$R_Y = 0$	M1	si
	Resolve vertically	M1	all forces
	$R_X = 60g + 84g$		
	$R_X = \underline{1411.2\text{ (N)}}$	A1	ft M
7(b)(ii)	Moments about X	M1	dim correct
	$84g \times x = 60g \times 1.2$		
	$x = \frac{6}{7} = \underline{0.86}$	A1	ft M
	Distance of the person from $X = 0.86$ (m)		

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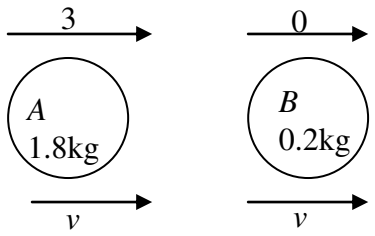
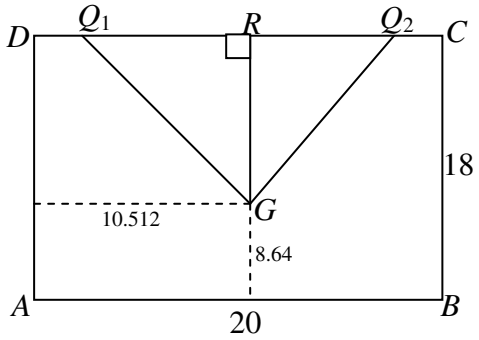
8(a)(i)			
	Conservation of momentum	M1	allow different v's
	$1.8\times3 + 0.2\times0 = 1.8v + 0.2v$	A1	
	$2v = 5.4$		
	$v = \underline{2.7\ (\text{ms}^{-1})}$	A1	convincing
8(a)(ii)	$e = \underline{0}$	B1	
8(b)(i)	N2L applied to combined object	M1	dim correct
	$-8 = 2a$		
	$a = -4\ \text{ms}^{-2}$		
	$\lvert a \rvert = \underline{4\ (\text{ms}^{-2})}$	A1	
8(b)(ii)	Use of $v = u+at$, u=2.7, a=(±)4, t=0.5	M1	oe
	$v = 2.7 - 4\times0.5$	A1	ft a if <0.
	$v = \underline{0.7\ (\text{ms}^{-1})}$	A1	ft a if <0.
8(b)(iii)	Use of $v^2=u^2+2as$, u=2.7, v=2, a=(±)4	M1	oe
	$2^2 = 2.7^2 - 2\times4s$	A1	ft a if <0.
	$s = \underline{0.41(125\ \text{m})}$	A1	ft a if <0.

Q	Solution				Mark	Notes
9(a)		Area	from *AD*	from *AB*		
	ABCD	360	10	9	B1	
	Circle	21	6	12	B1	
	XYZ	36	13	7	B1	
	Lamina	375	x	y	B1	all 4 correct areas
9(a)(i)	Moments about *AD*				M1	consistent use of signs for areas and moments.
	$360\times10 + 36\times13 = 375x + 21\times6$				A1	ft table if +*XYZ* and -circ
	$x = \underline{10.5(12\text{ cm})}$				A1	cao
9(a)(ii)	Moments about *AB*				M1	consistent use of signs for areas and moments.
	$360\times9 + 36\times7 = 375y + 21\times12$				A1	ft table if +*XYZ* and -circ
	$y = \underline{8.6(4\text{ cm})}$				A1	cao
9(b)						
	Consider triangle $RQ_{1/2}G$					
	Angle RGQ = angle RQG = 45°					
	$\therefore RQ = RG$					
	Let $DQ_1 = x$					
	$10.512 - x = 18 - 8.64$				M1	
	$x = 10.512 - 9.36$					
	$DQ_1 = \underline{1.1(52\text{ cm})}$				A1	ft *x*, *y*
	$DQ_2 = 10.512 + (18 - 8.64)$				M1	
	$DQ_2 = \underline{19.8(72\text{ cm})}$				A1	ft *x*, *y*