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RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE

Unit **4762:** Mechanics 2

Mark Scheme for June 2011

Oxford Cambridge and RSA Examinations

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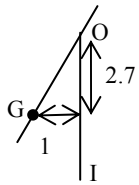
Q 1		mark	notes
(a) (i)	$13T = 10(4.75 - (-1.75))$	M1	Use of $I = Ft$. Allow sign errors
		A1	Signs correct on RHS
	so $T = 5$. So 5 s.	A1	cao
	OR: $13 = 10a$	B1	N2L
	$T = \frac{4.75 - (-1.75)}{1.3} = 5$	M1	Use of *suvat*
		A1	cao
		3	
(ii)	PCLM: $10 \times 4.75 - 15 \times 0.5 = 25v_{P+Q}$	M1	PCLM with combined mass. Allow sign errors
	$v_{P+Q} = 1.6$ so 1.6 m s^{-1} in +ve direction	A1	No need for reference to direction
		2	
(iii)	PCLM: $10 \times 4.75 - 15 \times 0.5 = 10 \times 1 + 15v_Q$	M1	PCLM with all correct terms. Allow sign errors
		A1	Any form
	Hence $v_Q = 2$ and Q has velocity 2 m s^{-1}	A1	Accept no direct reference to direction
	NEL: $\frac{v_Q - 1}{-0.5 - 4.75} = -e$	M1	NEL. Accept **their** v_Q and any sign errors. Fraction must be correct way up
		A1	Any form. FT **their** v_Q.
	so $e = 0.19047\ldots$ so 0.190 (3 s. f.)	A1	cao accept 0.19 , 4/21 accept 0.2 only if 0.19 seen earlier
		6	

(b)	Initial vert cpt is 14sin30 = 7 1st hits ground at *v* given by	B1	
	$v^2 = 7^2 + 2\times 9.8\times 3.125$	M1	Appropriate *suvat*. Allow ±9.8 etc Condone u =14
	$v = 10.5$	A1	
	Vert cpt after 2nd bounce		
	10.5×0.6^2	M1	**their** 10.5×0.6^n for n = 1, 2 or 3 Condone use of their initial vertical component. Do not award if horiz component is also multiplied by 0.6
		B1	use of $\times 0.6^2$ or attempt at two bounces with 0.6 used each time
	Horiz cpt is unchanged throughout $(14\cos 30)$	B1	Award even if value wrong or not given
	Angle is $\arctan\left(\frac{10.5\times 0.6^2}{14\cos 30}\right) = 17.31586...$	M1	FT their horiz and vert components. oe. Fraction must be for correct angle.
	so 17.3° (3 s. f.)	A1 8	cao SC answer of 11.7 will usually earn 5/8
		19	

Q 2		mark	notes
			Penalise answers to fewer than 4sf only once
(i)	cw moments about A Let force be S		
	$600\times0.8-S\times2=0$	M1	Moments. All forces. No extras
		A1	
	$S=240$ so 240 N vertically upwards	A1	Need statement of direction or diagram
		3	
(ii)	cw moments about A Let tension be T	M1	Moments. All forces. No extras. Attempt at moment of T (need not be resolved) Note that mmts about B needs forces at hinge.
	$600\times0.8-T\sin50\times0.3=0$		
		M1	Correct method for moment of T. Allow length errors and $s\leftrightarrow c$
		A1	Moment of T correct (allow sign error)
		A1	All correct
	$T=2088.65\ldots$ $(\frac{1600}{\sin 50})$		
	so 2089 N (4 s. f.)	A1	cao
		5	
(iii)	Resolve $\rightarrow$ $X-T\cos50=0$	M1	Resolving horiz. Allow sign error. T must be resolved, allow $s\leftrightarrow c$
	so $X=1342.55\ldots$.		
	= 1343 (4 s. f.)	F1	FT **their** T only. Allow 1600cot50
	Resolve $\downarrow$ $Y-T\sin50+600=0$	M1	NB other methods possible
	so $Y=1000$	F1	FT **their** T only
	Method for either R or α	M1	M dependent on attempts at X and Y using moments/resolution
	$R=\sqrt{1600^2\cot^2 50+1000^2}=1674.05..$		
	so 1674 (4 s. f.)	F1	FT **their** X and Y Numerical value only
	$\alpha=\arctan\dfrac{1000}{1600\cot 50}$		
	$\alpha=36.6804\ldots$ so 36.68° (4 s. f.)	F1	FT **their** X and Y Numerical value only Accept 36.67
		7	
(iv)	Angle GAP is α above so 36.68° (4 s. f.)	B1	
	Weight, T and R are the only forces acting on the beam which is in equilibrium. Hence they are concurrent. Or geometrical calculation	E1	Must be clear
		2	
		17	

Q 3		mark	notes
(i)	$10\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = 4\begin{pmatrix}-\frac{1}{2}\\ 2\end{pmatrix} + 2\begin{pmatrix}\frac{1}{2}\\ 3\end{pmatrix} + \begin{pmatrix}1\frac{1}{2}\\ 3\frac{1}{2}\end{pmatrix} + 3\begin{pmatrix}2\frac{1}{2}\\ 2\frac{1}{2}\end{pmatrix}$	M1	Correct method clearly indicated for x or y component.
		B1	If 2D method, at least 1 mass + cm correct for a region. If separate cpts, at least 2 mass + cm correct for one of the cpts
	$= \begin{pmatrix}-2+1+1\frac{1}{2}+7\frac{1}{2}\\ 8+6+3\frac{1}{2}+7\frac{1}{2}\end{pmatrix} = \begin{pmatrix}8\\ 25\end{pmatrix}$	E1	Working shown. Either expression shown oe
	so $\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}0.8\\ 2.5\end{pmatrix}$ and c.m. is (0.8, 2.5)	E1 4	Both
(ii)	c.w. moments about J $3.2\times1.8 - T_H \times 4 = 0$	B1	Use of 1.8 oe
		M1	A moments equation with all relevant forces. Allow use of 10 instead of 3.2
	so $T_H = 1.44$ and the force at H is 1.44 N	A1	
	Resolving ↑	M1	Or moments again
	force at J is 3.2 – 1.44 = 1.76 N	F1 5	Only FT if positive final answer
(iii)	below		

(iii)	$10\begin{pmatrix}\bar{x}\\ \bar{y}\\ \bar{z}\end{pmatrix} = 4\begin{pmatrix}0\\ 2\\ \frac{1}{2}\end{pmatrix} + 2\begin{pmatrix}\frac{1}{2}\\ 3\\ 0\end{pmatrix} + 2\begin{pmatrix}2\\ 3\frac{1}{2}\\ 0\end{pmatrix} + 2\begin{pmatrix}2\frac{1}{2}\\ 3\\ -1\end{pmatrix}$	M1	Dealing with 3D
		B1	Dealing correctly with one folded part
		B1	Dealing with the other folded part
	$= \begin{pmatrix}0+1+4+5\\ 8+6+7+6\\ 2+0+0-2\end{pmatrix} = \begin{pmatrix}10\\ 27\\ 0\end{pmatrix}$	E1	Working shown. Either expression shown oe
	so $\begin{pmatrix}\bar{x}\\ \bar{y}\\ \bar{z}\end{pmatrix} = \begin{pmatrix}1\\ 2.7\\ 0\end{pmatrix}$ and c.m. is (1, 2.7, 0)	E1	All three components
		5	
(iv)		B1	Recognising that cm is vertically below O (may be implied)
	Let angle IOG be θ	B1	Correctly identifying the angle
	$\tan\theta = \frac{1}{2.7}$	M1	Accept $\tan\theta = \frac{2.7}{1}$ oe
	so angle is 20.323... so 20.3° (3 s. f.)	A1	Do NOT isw
		4	
		18	

Q 4		mark	notes
(a)	$\frac{1}{2}\times 80\times\left(6^2-V^2\right)$	M1	WE equation. Allow GPE OR init KE term omitted or wrong. Allow sign errors. There must be 3 terms one of which is the WD term
	= 80 × 9.8 × 1600 – 1300000	B1	KE terms correct (accept 40 × (V^2 – 6^2))
		B1	GPE term. Allow sign error
		A1	All terms present. Accept only sign errors, but not the 1300000 and 80x9.8x1600 terms with same sign
	so V = 34.29285… so 34.3 m s^{-1}, (3 s. f.)	A1	Cao accept $14\sqrt{6}$
		5	
(b) (i)	N2L up the slope. Driving force is S N		
	S – 1150 – 800 × 9.8 × 0.1 = 800 × 0.25	M1	N2L. Allow either resistance or weight cpt omitted. Allow weight not resolved and sign errors.
		B1	RHS correct
		M1	Attempt at weight cpt (800$g$sinθ is sufficient) Allow missing $\boldsymbol{g}$
		A1	Weight cpt correct (numerical) May be implied
	S = 2134	E1	
	Power is 2134 × 8	M1	Use of $P = Fv$
	= 17072 so 17.1 kW (3 s. f.)	A1	
		7	
(ii)	Let resistance on sledge be F N		
	N2L up slope for sledge		
	900 – F – 300 × 9.8 × 0.1 = 300 × 0.25	M1	Need non-zero accn, correct mass and 900. Allow weight missing or unresolved and allow sign errors. Do not award if 2134 included
	so F = 531	A1	
	normal reaction is 300$g$cosθ	B1	
	Use cosθ = $\sqrt{0.99}$ or cos5.7	B1	In context
	$\mu = \frac{531}{300\times 9.8\times\sqrt{0.99}}$	M1	Use of $F = \mu R$ for any F and R but not F=900
	= 0.181522… so 0.182 (3 s. f.)	A1	cao
		6	
		18	

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