OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE

Unit **4762:** Mechanics 2

Mark Scheme for June 2011

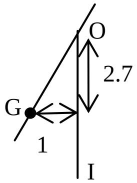
Oxford Cambridge and RSA Examinations

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
	$T = \dfrac{4.75 - (-1.75)}{1.3} = 5$	M1	Use of *suvat*
		A1	cao
		3	
(ii)	PCLM: $10 \times 4.75 - 15 \times 0.5 = 25 v_{P+Q}$	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: $10 \times 4.75 - 15 \times 0.5 = 10 \times 1 + 15 v_Q$	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: $\dfrac{v_Q - 1}{-0.5 - 4.75} = -e$	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 $v^2 = 7^2 + 2 \times 9.8 \times 3.125$ v = 10.5 Vert cpt after 2nd bounce 10.5 × 0.6^2 Horiz cpt is unchanged throughout $(14\cos 30)$ Angle is $\arctan\left(\frac{10.5 \times 0.6^2}{14\cos 30}\right) = 17.31586...$ so 17.3° (3 s. f.)	B1 M1 A1 M1 B1 B1 M1 A1 8	 Appropriate *suvat*. Allow ±9.8 etc Condone u =14 **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 use of × 0.6^2 or attempt at two bounces with 0.6 used each time Award even if value wrong or not given FT their horiz and vert components. oe. Fraction must be for correct angle. 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 $600 \times 0.8 - S \times 2 = 0$ S = 240 so 240 N vertically upwards	 M1 A1 A1 3	 Moments. All forces. No extras Need statement of direction or diagram
(ii)	cw moments about A Let tension be T $600 \times 0.8 - T \sin 50 \times 0.3 = 0$ $T = 2088.65\ldots$ ($\frac{1600}{\sin 50}$) so 2089 N (4 s. f.)	M1 M1 A1 A1 A1 5	Moments. All forces. No extras. Attempt at moment of T (need not be resolved) Note that mmts about B needs forces at hinge. Correct method for moment of T. Allow length errors and $s \leftrightarrow c$ Moment of T correct (allow sign error) All correct cao
(iii)	Resolve $\rightarrow$ $X - T\cos 50 = 0$ so X = 1342.55…. = 1343 (4 s. f.) Resolve $\downarrow$ $Y - T\sin 50 + 600 = 0$ so Y = 1000 Method for either R or α $R = \sqrt{1600^2 \cot^2 50 + 1000^2}$ = 1674.05.. so 1674 (4 s. f.) $\alpha = \arctan \dfrac{1000}{1600 \cot 50}$ α = 36.6804… so 36.68° (4 s. f.)	M1 F1 M1 F1 M1 F1 F1 7	Resolving horiz. Allow sign error. T must be resolved, allow $s \leftrightarrow c$ FT **their** T only. Allow 1600cot50 NB other methods possible FT **their** T only M dependent on attempts at X and Y using moments/resolution FT **their** X and Y Numerical value only FT **their** X and Y Numerical value only Accept 36.67
(iv)	Angle GAP is α above so 36.68° (4 s. f.) Weight, T and R are the only forces acting on the beam which is in equilibrium. Hence they are concurrent. Or geometrical calculation	B1 E1 2	 Must be clear
		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	Both
		4	
(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	Only FT if positive final answer
		5	
(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 B1	Dealing correctly with one folded part 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 5	All three components
(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 4	Do NOT isw
		18	

Q 4		mark	notes
(a)	$\frac{1}{2}\times 80\times(6^2 - V^2)$	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
	$= 80 \times 9.8 \times 1600 - 1300000$	B1	KE terms correct (accept $40 \times (V^2 - 6^2)$)
		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 $S - 1150 - 800 \times 9.8 \times 0.1 = 800 \times 0.25$	M1	N2L. Allow either resistance or weight cpt omitted. Allow weight not resolved and sign errors.
		B1	RHS correct
		M1	Attempt at weight cpt ($800g\sin\theta$ is sufficient) Allow missing ***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 $900 - F - 300 \times 9.8 \times 0.1 = 300 \times 0.25$	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 $300g\cos\theta$	B1	
	Use $\cos\theta = \sqrt{0.99}$ or cos5.7	B1	In context
	$\mu = \dfrac{531}{300\times 9.8\times\sqrt{0.99}}$	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	