OCR
Recognising achievement

GCE

Mark Scheme for June 2011

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

(b)	Initial vert cpt is $14\sin30 = 7$	B1	
	1st hits ground at v given by		
	$v^2 = 7^2 + 2\times9.8\times3.125$	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 $(14\cos30)$	B1	Award even if value wrong or not given
	Angle is $\arctan\left(\dfrac{10.5\times0.6^2}{14\cos30}\right) = 17.31586...$	M1	FT their horiz and vert components. oe. Fraction must be for correct angle.
	so $17.3°$ (3 s. f.)	A1	cao SC answer of 11.7 will usually earn 5/8
		8	
		19	

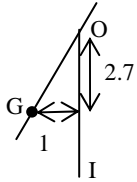| Q 2		mark	notes
			Penalise answers to fewer than 4sf only once
(i)	cw moments about A Let force be *S* $600 \times 0.8 - S \times 2 = 0$ $S = 240$ so 240 N vertically upwards	M1 A1 A1 3	Moments. All forces. No extras Need statement of direction or diagram
(ii)	cw moments about A Let tension be *T* $600 \times 0.8 - T \sin 50 \times 0.3 = 0$ $T = 2088.65\ldots$ $(\frac{1600}{\sin 50})$ 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 $X = 1342.55\ldots$ $= 1343$ (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.) $\alpha = \arctan \dfrac{1000}{1600 \cot 50}$ $\alpha = 36.6804\ldots$ 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)	$10\begin{pmatrix}\overline{x}\\\overline{y}\end{pmatrix}=4\begin{pmatrix}-\frac{1}{2}\\2\end{pmatrix}+2\begin{pmatrix}\frac{1}{2}\\3\end{pmatrix}+\begin{pmatrix}1\frac{1}{2}\\3\frac{1}{2}\end{pmatrix}+3\begin{pmatrix}2\frac{1}{2}\\2\frac{1}{2}\end{pmatrix}$	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 $\begin{pmatrix}\overline{x}\\\overline{y}\end{pmatrix}=\begin{pmatrix}0.8\\2.5\end{pmatrix}$ and c.m. is (0.8, 2.5)	E1	Both
		4	
(ii)	c.w. moments about J $3.2\times1.8-T_{H}\times4=0$	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 $\uparrow$	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)	$10\begin{pmatrix} \overline{x} \\ \overline{y} \\ \overline{z} \end{pmatrix} = 4\begin{pmatrix} 0 \\ 2 \\ \frac{1}{2} \end{pmatrix} + 2\begin{pmatrix} \frac{1}{2} \\ 3 \\ 0 \end{pmatrix} + 2\begin{pmatrix} 2 \\ 3\frac{1}{2} \\ 0 \end{pmatrix} + 2\begin{pmatrix} 2\frac{1}{2} \\ 3 \\ -1 \end{pmatrix}$	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 $\begin{pmatrix} \overline{x} \\ \overline{y} \\ \overline{z} \end{pmatrix} = \begin{pmatrix} 1 \\ 2.7 \\ 0 \end{pmatrix}$ 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)	$\frac{1}{2} \times 80 \times \left(6^2 - V^2\right)$ $= 80 \times 9.8 \times 1600 - 1300000$ so $V = 34.29285\ldots$ so 34.3 m s^{-1}, (3 s. f.)	M1 B1 B1 A1 A1 5	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 KE terms correct (accept $40 \times (V^2 - 6^2)$) GPE term. Allow sign error All terms present. Accept only sign errors, but not the 1300000 and 80x9.8x1600 terms with same sign Cao accept $14\sqrt{6}$
(b) (i)	N2L up the slope. Driving force is S N $S - 1150 - 800 \times 9.8 \times 0.1 = 800 \times 0.25$ $S = 2134$ Power is 2134×8 $= 17072$ so 17.1 kW (3 s. f.)	M1 B1 M1 A1 E1 M1 A1 7	N2L. Allow either resistance or weight cpt omitted. Allow weight not resolved and sign errors. RHS correct Attempt at weight cpt ($800g\sin\theta$ is sufficient) Allow missing **g** Weight cpt correct (numerical) May be implied Use of $P = Fv$
(ii)	Let resistance on sledge be F N N2L up slope for sledge $900 - F - 300 \times 9.8 \times 0.1 = 300 \times 0.25$ so $F = 531$ normal reaction is $300g\cos\theta$ Use $\cos\theta = \sqrt{0.99}$ or $\cos 5.7$ $\mu = \dfrac{531}{300 \times 9.8 \times \sqrt{0.99}}$ $= 0.181522\ldots$ so 0.182 (3 s. f.)	M1 A1 B1 B1 M1 A1 6	Need non-zero accn, correct mass and 900. Allow weight missing or unresolved and allow sign errors. Do not award if 2134 included In context Use of $F = \mu R$ for any F and R but not F=900 cao
		18	