

Mathematics (MEI)

Advanced GCE

Unit 4762: Mechanics 2

Mark Scheme for June 2011

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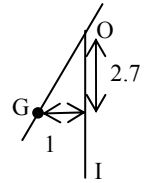
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Q 1	mark	notes
(a) (i) $13T = 10(4.75 - (-1.75))$ so $T = 5$. So 5 s. OR: $13 = 10a$ $T = \frac{4.75 - (-1.75)}{1.3} = 5$	M1 A1 A1 B1 M1 A1 3	Use of $I = Ft$. Allow sign errors Signs correct on RHS cao N2L Use of <i>suvat</i> cao
(ii) PCLM: $10 \times 4.75 - 15 \times 0.5 = 25v_{p+Q}$ $v_{p+Q} = 1.6$ 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: $10 \times 4.75 - 15 \times 0.5 = 10 \times 1 + 15v_Q$ Hence $v_Q = 2$ and Q has velocity 2 m s^{-1} NEL: $\frac{v_Q - 1}{-0.5 - 4.75} = -e$ so $e = 0.19047\dots$ 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)	<p>Initial vert cpt is $14\sin 30 = 7$ 1^{st} hits ground at v given by $v^2 = 7^2 + 2 \times 9.8 \times 3.125$ $v = 10.5$ Vert cpt after 2^{nd} bounce 10.5×0.6^2</p> <p>Horiz cpt is unchanged throughout $(14 \cos 30)$</p> <p>Angle is $\arctan\left(\frac{10.5 \times 0.6^2}{14 \cos 30}\right) = 17.31586\dots$ so 17.3° (3 s. f.)</p>	<p>B1 M1 A1 M1 B1 B1 M1 A1 8</p>	<p>Appropriate <i>suvat</i>. Allow ± 9.8 etc Condone $u = 14$</p> <p>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</p> <p>use of $\times 0.6^2$ or attempt at two bounces with 0.6 used each time</p> <p>Award even if value wrong or not given</p> <p>FT their horiz and vert components. oe. Fraction must be for correct angle.</p> <p>cao SC answer of 11.7 will usually earn $5/8$</p>
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Q2	mark	notes
(i)		Penalise answers to fewer than 4sf only once
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 $600 \times 0.8 - T \sin 50 \times 0.3 = 0$ $T = 2088.65\dots$ ($\frac{1600}{\sin 50}$) 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 $X = 1342.55\dots$ $= 1343$ (4 s. f.) Resolve $\downarrow Y - T \sin 50 + 600 = 0$ so $Y = 1000$ Method for either R or α $R = \sqrt{1600^2 \cot^2 50 + 1000^2} = 1674.05\dots$ so 1674 (4 s. f.) $\alpha = \arctan \frac{1000}{1600 \cot 50}$ $\alpha = 36.6804\dots$ 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 $1600 \cot 50$ 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
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Q 3		mark	notes
(i)	$10 \begin{pmatrix} \bar{x} \\ \bar{y} \end{pmatrix} = 4 \begin{pmatrix} -\frac{1}{2} \\ 2 \end{pmatrix} + 2 \begin{pmatrix} \frac{1}{2} \\ 3 \end{pmatrix} + \begin{pmatrix} 1\frac{1}{2} \\ 3\frac{1}{2} \end{pmatrix} + 3 \begin{pmatrix} 2\frac{1}{2} \\ 2\frac{1}{2} \end{pmatrix}$ $= \begin{pmatrix} -2+1+1\frac{1}{2}+7\frac{1}{2} \\ 8+6+3\frac{1}{2}+7\frac{1}{2} \end{pmatrix} = \begin{pmatrix} 8 \\ 25 \end{pmatrix}$ 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)	M1 B1 E1 E1 4	Correct method clearly indicated for x or y component. 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 Working shown. Either expression shown oe Both
(ii)	c.w. moments about J $3.2 \times 1.8 - T_H \times 4 = 0$ so $T_H = 1.44$ and the force at H is 1.44 N Resolving \uparrow force at J is $3.2 - 1.44 = 1.76$ N	B1 M1 A1 M1 F1 5	Use of 1.8 oe A moments equation with all relevant forces. Allow use of 10 instead of 3.2 Or moments again Only FT if positive final answer
(iii)	below		

(iii)	$10 \begin{pmatrix} \bar{x} \\ \bar{y} \\ \bar{z} \end{pmatrix} = 4 \begin{pmatrix} 0 \\ 2 \\ \frac{1}{2} \end{pmatrix} + 2 \begin{pmatrix} \frac{1}{2} \\ 3 \\ 0 \end{pmatrix} + 2 \begin{pmatrix} 2 \\ 3\frac{1}{2} \\ 0 \end{pmatrix} + 2 \begin{pmatrix} 2\frac{1}{2} \\ 3 \\ -1 \end{pmatrix}$ $= \begin{pmatrix} 0+1+4+5 \\ 8+6+7+6 \\ 2+0+0-2 \end{pmatrix} = \begin{pmatrix} 10 \\ 27 \\ 0 \end{pmatrix}$ <p>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)</p>	M1 B1 B1 E1 E1 5	Dealing with 3D Dealing correctly with one folded part Dealing with the other folded part Working shown. Either expression shown oe All three components
(iv)	 <p>Let angle IOG be θ $\tan \theta = \frac{1}{2.7}$ so angle is 20.323... so 20.3° (3 s. f.)</p>	B1 B1 M1 A1 4	Recognising that cm is vertically below O (may be implied) Correctly identifying the angle Accept $\tan \theta = \frac{2.7}{1}$ oe Do NOT isw
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Q 4	mark	notes
(a) $\frac{1}{2} \times 80 \times (6^2 - V^2)$ $= 80 \times 9.8 \times 1600 - 1300000$ so $V = 34.29285\dots$ 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 $80 \times 9.8 \times 1600$ terms with same sign Cao accept $14\sqrt{6}$
(b) (i) N2L up the slope. Driving force is $S \text{ N}$ $S - 1150 - 800 \times 9.8 \times 0.1 = 800 \times 0.25$ $S = 2134$ 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 $F \text{ N}$ 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 $\cos 5.7$ $\mu = \frac{531}{300 \times 9.8 \times \sqrt{0.99}}$ $= 0.181522\dots$ 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
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