Problem Solving with Moments in 1 and 2 Dimensions (From OCR 4762)

Q1, (Jan 2006, Q2)

(i)	Moments about C $240\times 2 = 3R_D$ $R_D = 160$ so 160 N Resolve vertically $R_C + R_D = 240$ $R_C = 80$ so 80 N	 M1 A1 M1 F1	 Moments about C or equivalent. Allow 1 force omitted Resolve vertically or moments about D or equivalent. All forces present. FT from **their** R_D only	4
(ii) (A)	Moments about D $240\times 1 = 4T\sin 40$ $T = 93.343\ldots$ so 93.3 N (3 s. f.)	 M1 M1 A1 A1	 Moments about D or equivalent Attempt at resolution for RHS RHS correct	4
(ii) (B)	In equilibrium so horizontal force needed to balance cpt of T. This must be friction and cannot be at C.		Need reference to horizontal force that must come from friction at D.	1
(iii) (A)	Moments about B $3\times 240\times\cos 30 = 6P$ $P = 60\sqrt{3}$ (103.92…..) P inclined at 30° to vertical Resolve horizontally. Friction force F $F = P\sin 30$ so $F = 30\sqrt{3}$ (51.961…)	 M1 E1 B1 M1 A1	 All terms present, no extras. Any resolution required attempted. Accept decimal equivalent Seen or equivalent or implied in (iii) (A) or (B). Resolve horizontally. Any resolution required attempted Any form	5

Q2, (Jun 2007, Q3)

(i)	Moments c.w. about B $200\times 0.6-0.8R_A=0$ $R_A=150$ so 150 N Resolve or moments $R_B=50$ so 50 N	 M1 A1 M1 F1	 Accept about any point. Allow sign errors.	4
(ii)	Moments c.w. about D $-0.8R_C+1.2\times 200=0$ $R_C=300\uparrow$ Resolve or moments $R_D=100\downarrow$	 M1 A1 M1 A1 E1	 Or equiv. Accept about any point. All terms present. No extra terms. Allow sign errors. Neglect direction Or equiv. All terms present. No extra terms. Allow sign errors. Neglect direction Both directions clearly shown (on diag)	5
(iii)	Moments c.w. about P $0.4\times 200\cos\alpha-0.8R_Q=0$ $R_Q=96$ so 96 N resolve perp to plank $R_P=200\cos\alpha+R_Q$ $R_P=288$ so 288 N	 M1 A1 A1 M1 A1 A1	 Or equiv. Must have some resolution. All terms present. No extra terms. Allow sign errors. Correct [No direction required but no sign errors in working] Or equiv. Must have some resolution. All terms present. No extra terms. Allow sign errors. Correct [No direction required but no sign errors in working]	6
(iv)	Need one with greatest normal reaction So at P Resolve parallel to the plank $F=200\sin\alpha$ so $F=56$ $\mu=\frac{F}{R}$ $=\frac{56}{288}=\frac{7}{36}$ (= 0.194 (3 s. f.))	 B1 B1 M1 A1	 FT their reactions Must use **their** F and R cao	4
		19		

Q3, (Jan 2013, Q4)

(a)	**(ii)**	EITHER: New c.m. has $\bar{x} = 1.2$ $(5.92 + m) \times 1.2 = 5.92 \times 1.5 + m \times 0$ $m = 1.48$	M1 M1 A1 **[3]**	Identifying and using a suitable condition. Complete method cao
		OR: Moment about any point is zero e.g. about S: $1.2mg = 0.3 \times 5.92g$ $m = 1.48$	M1 M1 A1 **[3]**	Identifying a suitable condition. Allow g omitted. Correct number of terms must be included cao
(b)	**(i)**	Consider the equilibrium at R Resolving horizontally gives $T_{QR} = 0$ Then resolving vertically gives $T_{OR} = 0$	 E1 E1 **[2]**	
(b)	**(ii)**	c.w. moments about O $120 \times 1 + 60 \times 2 = 3T$ so $T = 80$ Resolve to give $X = 80$ and $Y = 180$	 M1 A1 A1 **[3]**	 May also be argued by first considering internal forces FT $X = T$. Only Y =180 scores 0
(b)	**(iii)**		 B1 **[1]**	All correct. Accept T, X and Y labelled but not substituted. Accept mixes of T and C. Require pairs of arrows with label on OQ, OP and PQ.
(b)	**(iv)**	Take angle OPQ as α At P $\downarrow$ $60 + T_{OP} \sin\alpha = 0$ $\sin\alpha = \frac{3}{\sqrt{13}}$: $\alpha = 56.3^\circ$ $T_{OP} = -\frac{60}{\sin\alpha} = -20\sqrt{13}$ so $20\sqrt{13}$ N (C) At P $\leftarrow$ $T_{QP} + T_{OP} \cos\alpha = 0$ so $T_{QP} = 40$ so 40 N (T)	Forces internal to the rods have been taken to be tensions. M1 A1 A1 M1 A1 **[5]**	 Equilibrium at ANY pin-joint (not R) Correct equation(s) that leads directly to finding T_{OP} or T_{QP} o.e. Accept 72.1 N A second equilibrium equation leading to a second internal force cao T/C correct for both rods

Q4, (Jun 2015, Q1)

(i)		Suppose ↑ U N at J and V N at point of contact with cylinder Taking moments about point of contact with the cylinder or J $0.8U - 0.2 \times 30 = 0$ or $0.8V - 0.6 \times 30 = 0$ so $U = 7.5$ or $V = 22.5$ Resolve ↑ $U + V - 30 = 0$ so $V = 22.5$ or $U = 7.5$	 M1 A1 B1	 A correct moments equation FT use of 1st answer. (Or use moments again)	3
(ii)		Taking moments about point of contact with the cylinder $0.4W - 0.2 \times 30 = 0$ so $W = 15$	 M1 A1	 A correct moments equation and reaction at J = 0 Award SC2 for 15 seen WWW	2
(iii)		Taking moments about point of contact $S \times 0.9\cos\theta - 30 \times 0.3\cos\theta = 0$ so $S = 10$ cw moments about J $30 \times 0.6\cos\theta - R \times 0.9 = 0$ so $R = 20\cos\theta$ resolve up the rod $S\sin\theta + F - 30\sin\theta = 0$ so $F = 20\sin\theta$ **SC** Resolving vert and horiz leads to simultaneous eqns. $R = 20\cos\theta$ $F = 20\sin\theta$	 M1 A1 M1 A1 A1 M1 A1 M1 A1 M1 A1 M1 A1 A1 A1	 A moments equation about point of contact: allow sin instead of cos: Must be trig fn in both terms. Allow slip in distances if clearly taking moments about point of contact Award SC2 for 10 seen WWW Attempt at moments or resolution, involving F or R but not both, with all appropriate terms present and no extras. No need to substitute for S, if it is present. Or $R = (30 - S)\cos\theta$ o.e. FT their S Attempt at another moments or resolution, that will enable F or R to be found, with all appropriate terms present and no extras No need to substitute for S, if it is present. Or $F = (30 - S)\sin\theta$ o.e. FT their S One eqn in F and R Second eqn in F and R AND attempt to solve simult eqns for F or R Or $R = (30 - S)\cos\theta$ o.e. FT their S Or $F = (30 - S)\sin\theta$ o.e.FT their S	8

(iv)		Need $F \leq \mu R$ $20\sin\theta \leq \mu \times 20\cos\theta$ so $\mu \geq \tan\theta$	B1 M1 A1	Use of $F \leq \mu R$ or $F = \mu R$ or $F < \mu R$ Needs an inequality, using their F and R from **(iii)** FT incorrect S (Strict inequality gets 2/3)	3