

Moments in 2 Dimensions (From OCR 4729)

Q1, (Jan 2006, Q1)

$\tan\theta = \frac{1}{3}$ ($\theta = 18.4^\circ$ at B)	B1		71.6° at C	
$3 \times T \sin\theta = 20 \times 1.5$ must have two distances and no g	M1		M(A) ($d=3/\sqrt{10}$)	
	A1			
$T = 31.6$ N	A1	4		4

Q2, (Jun 2009, Q3)

(i)	$\cos\theta = 5/13$ or $\sin\theta = 12/13$ or $\theta = 67.4^\circ$ $0.5 \times F \sin\theta = 70 \times 1.4 + 50 \times 2.8$ $F = 516$ N	B1 M1 A1 A1	any one of these moments about A (ok without 70) $0.5 \sin\theta = 0.4615$ SR 1 for 303 (omission of beam)	4
(ii)	$F \sin\theta = 120 + Y$ (resolving vertically) $Y = 356$ ✓ their $F \times 12/13 - 120$ $X = F \cos\theta$ (resolving horizontally) $X = 198$ ✓ their $F \times 5/13$ Force = $\sqrt{(356^2 + 198^2)}$ 407 or 408 N	M1 A1 ✓ M1 A1 ✓ M1 A1	M1/A1 for moments (B) $Y \times 2.8 + 1.4 \times 70 = 2.3 \times 516$ ✓ $\times 12/13$ (C) $0.5 \times Y = 0.9 \times 70 + 2.3 \times 50$ (D) $1.2X = 1.4 \times 70 + 2.8 \times 50$	6
				10

Q3, (Jan 2008, Q3)

direction of R perp. to wall R at 70° to rod $0.8 \times 25 \cos 60^\circ = 1.6 \times R \sin 70^\circ$ $0.8 \times 25 \cos 60^\circ$ $1.6 \times R \sin 70^\circ$ R = 6.65 N	B1 B1 M1 A1 A1 A1	10° to horiz. moments about A	6
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Q4, (Jun 2010, Q4)

(i)	$4T \cos 20^\circ = 5 \times g \times 2.5$ $T = 32.6$ N	M1 A1 A1	Using moments; allow sin/cos mix Allow with omission of g	3
(ii)	$X = T \sin 20^\circ$ $X = 11.1$ FT $Y + T \cos 20^\circ = 5 \times g$ or $2.5Y = 1.5 \times T \cos 20^\circ$ or $4Y = 1.5 \times 5g$ $Y = 18.4$ FT $R = \sqrt{(X^2 + Y^2)}$ or $\tan^{-1}(Y/X)$ or $\tan^{-1}(X/Y)$ $R = 21.5$ N $\theta = 58.8^\circ$ above the horizontal	M1 A1 M1 A1 M1 A1 A1	allow sin/cos mix FT their T FT their T, but not from omission of g $X \neq 0, Y \neq 0$ or 31.2° to left of vertical	7
				10

Q5, (Jan 2012, Q3)

(i)		$P \times 1.6 = 10g \cos 60 \times 1.2$ $P = 36.75 \text{ N}$	M1 A1 A1 [3]	Moments about A . Allow 36.8
(ii)		$R + 36.75 \sin 30 = 10g$ $F = 36.75 \cos 30$ $\mu = 31.8/79.6$ $\mu = 0.4(00)$	M1 A1 FT B1 FT M1 A1 [5]	Attempt at resolving vertically or taking moments. May be implied. $R = 79.6(25)$ Expect 31.8. Or second correct equation involving F or R or both. For use of (their) $F = \mu(\text{their})R$ R not = $10g$ or their P from (i). AWRT www. Allow inequality

Q6, (Jan 2013, Q5)

(i)		Use of moments $2.5R = 3g \cos 60 \times 2$ $R = 11.76 \text{ N}$	M1 A1 A1 [3]	Trig with $3g$, no trig with R unless using 2 components. Allow 11.8
(ii)		$R' + R \cos 60 = 3g$ $F = R \cos 30$ Use $F = \mu R'$ $\mu = 0.433$	M1 A1ft B1ft M1 A1 [5]	Resolve vertically, 3 terms, comp (R). Using cv(R) Using cv(R) Not $R' = 3g$ for method Allow 0.435 from use of $R = 11.8$

Q7, (Jun 2014, Q4)

(i)	$18(10) - T(20\sin\theta) + 3(6) = 0$ $T = 16.5 \text{ N}$	M1 A1 A1 [3]	Moments about P Need a value for $\sin\theta$ or θ Exact
(ii)	$X = T\cos\theta$ $Y + T\sin\theta - 18 - 3 = 0$ $R = \sqrt{(13.2^2 + 11.1^2)} = 17.2 \text{ N}$	B1ft M1 A1ft A1 [4]	ft candidates value of T . Resolve horizontally ($X = 13.2 \text{ N}$) or moments; Need a value for $\cos\theta$ or θ Resolve vertically or moments ft candidates value of T . $Y = 11.1 \text{ N}$; Need a value for $\sin\theta$ or θ $R = 17.2467\dots$
(iii)	$\mu = \text{cv}(Y)/\text{cv}(X) = 11.1/13.2$ $\mu = 0.841$	M1 A1 [2]	Use of $Fr = \mu R$ $\mu = 0.8409\dots$; allow $^{37}/_{44}$

Q8, (Jun 2015, Q7)

(i) OR	$2W(1\cos\theta) + W(2\cos\theta) = R_B(4\sin\theta)$ $R_A = 3W$ $\mu = 2/3$	<p>*M1</p> <p>A1</p> <p>A1</p> <p>B1</p> <p>dep*M1</p> <p>A1</p> <p>[6]</p>	<p>Moments about A, all terms needed and no extra; dimensionally correct; each term must include $\sin\theta$, or $\cos\theta$ or $\tan\theta$</p> <p>May have Fr for R_B</p> <p>Use of $Fr = \mu R_A$ to get an equation in W (or R_A) only</p> <p>AG; must come from exact θ</p>
	$W(2\cos\theta) + 2W(3\cos\theta) + Fr(4\sin\theta) = R_A(4\cos\theta)$ $R_A = 3W$ $\mu = 2/3$	<p>*M1</p> <p>A1</p> <p>A1</p> <p>B1</p> <p>dep*M1</p> <p>A1</p> <p>[6]</p>	<p>Moments about B, all terms needed and no extra; dimensionally correct; each term must include $\sin\theta$, or $\cos\theta$ or $\tan\theta$</p> <p>Use of $Fr = \mu R_A$ to get an equation in W (or R_A) only</p> <p>AG; must come from exact θ</p>
(ii) OR	$(W + aW)(2\cos\theta) = R_B(4\sin\theta)$ $R_A = 3W + aW$ $a \leq 3$	<p>*M1</p> <p>A1</p> <p>B1</p> <p>dep*M1</p> <p>A1</p> <p>[5]</p>	<p>Moments about A, all terms needed and no extra; dimensionally correct; each term must include $\sin\theta$, or $\cos\theta$ or $\tan\theta$</p> <p>May have Fr for R_B</p> <p>Resolve vertically</p> <p>$Fr \leq \mu R_A$ to get an inequality in W and a only; allow equality here</p> <p>Allow $a < 3$. If using equality, correct inequality need not be justified.</p>
	<p>For first 2 marks</p> $(W + aW)(2\cos\theta) + 2W(4\cos\theta) + Fr(4\sin\theta) = R_A(4\cos\theta)$	<p>*M1</p> <p>A1</p>	<p>Moments about B, all terms needed and no extra; dimensionally correct; each term must include $\sin\theta$, or $\cos\theta$ or $\tan\theta$</p>