OCR Maths M2

Topic Questions from Papers

Statics

Answers

1	(i)	60T = 15x30cosθ	M1		moments about A	
		"	A1			
		60T = 15x30 x 0.6	A1		cosθ = 0.6	
		T = 4.5 N	A1	4	**AG**	
	(ii)	X = Tsinθ	M1		res. horiz. (or moments)	
		X = 3.6 N	A1			
		Y + Tcosθ = 15	M1		res. vert.(3 terms) (or moments)	
		Y = 12.3 N	A1			
		R = 12.8 N	A1√		√(their $X^2 + Y^2$)	
		73.7° to horizontal	A1√	6	or 16.3° to vert.√$\tan^{-1}$their(Y/X)	**10**
		or triangle of forces: Triangle (M1) $R^2 = 15^2 + 4.5^2 - 2x4.5x15x0.6$(M1A1)				
		R= 12.8 (A1) sinθ/4.5=sinα/12.8 (M1) θ = 16.3° to vert. (A1)				

(Q5, June 2005)

2	(i)	50x9.8x2 = Rx3.75 +80x9.8x0.25	M1		moments about D.	
		"	A1		SR/no g/ R = 21.3 (M1A1A0)	
		R = 209 N	A1	3		
	(ii)	$130\bar{x} = 50 \times 2 + 80 \times 4.25$	M1 A1		moments about BC or FE….. $130\bar{x} = 80x0.25 + 50x2.5$	
		$\bar{x} = 3.385$	A1		$\bar{x} = 1.115$	
		$130\bar{y} = 50 \times 0.125 + 80 \times 0.25$	M1 A1		moments about EC	
		$\bar{y} = 0.202$	A1			
		tanθ = 0.615/0.202	M1			
		θ = 71.8° to the horizontal	A1	8	71.6° to 72.0°	**11**

(Q7, June 2005)

3		tanθ = ⅓ (θ = 18.4° at B)	B1		71.6° at C	
		3 x T sinθ = 20 x 1.5 must have two distances and no g	M1		M(A) (d=3/√10)	
			A1			
		T = 31.6 N	A1	4		**4**

(Q1, Jan 2006)

4	(i)	horiz comps in opp direct	B1		at E & F	
		Right at E + Left at F	B1	2		
	(ii)	1.6x9.8x30 = 20X or 0.5x30g + 0.7x30g + 0.2x60g = 20X	M1		or 10X + 1.6gx30 = 30X M(A)	
			A1		or 10X + (. . . = 470.4) = 30X M mark ok without g but 3 parts	
		X = 23.5 N	A1	3		

(Q4, Jan 2006)

5 (ii)	1.2 T	B1	
	0.8 F	B1	
	0.8F = 1.2T	M1	
	F = 3T/2	A1 **4**	aef
(iii)	F + Tcos30°	B1	**or** 45 x 0.8 sin30°
	45sin30° must be involved in res.	B1	T x (1.2 + 0.8cos30°)
	resolving parallel to the slope	M1	mom. about point of contact
	F + Tcos30° = 45sin30° aef	A1	45.0.8sin30°=T(1.2+0.8cos30°)
	T = 9.51	A1	
	F = 14.3	A1 **6**	**16**
or	T + Fcos30° = Rsin30°	B1	res. horizontally
(iii)	Rcos30° + Fsin30° = 45	B1	res. vertically
	tan30°=(T+Fcos30°)/(45-Fsin30°)	M1	eliminating R

(Q8, June 2007)

6	direction of R perp. to wall	B1	
	R at 70° to rod	B1	10° to horiz.
	0.8 x 25cos60° = 1.6 x R sin70°	M1	moments about A
	0.8 x 25 cos60°	A1	
	1.6 x R sin70°	A1	
	R = 6.65 N	A1 **6**	**6**

(Q3, Jan 2008)

7	20cos10° x T	B1	= or
	15cos10° x 9.63	B1	10.6 (A to com)
	15sin10° x 4.43	B1	34.7° ∠ comAH
	20cos10°.T=15cos10°x9.63–	M1	=15x10.6xcos34.7°
	15sin10°x4.43 (needs 3 parts)		
	T = 6.64 N	A1 **5**	**16**

(Q8, Jan 2008)

8 (i)	com of Δ 3 cm right of C	B1	
	(48+27) $\bar{x}$ = 48x4 + 27x11	M1	
		A1	
	$\bar{x}$ = 6.52	A1	
	com of Δ 2 cm above AD	B1	
	(48+27) $\bar{y}$ = 48x3 + 27x2	M1	
		A1	
	$\bar{y}$ = 2.64	A1 **8**	
(ii)	14F	B1	can be implied e.g. 7/sin30°. F
	3gcos30° x 6.52	B1	7.034 (AG) or (6.52-2.64tan30°)
	3gsin30° x 2.64	B1	52.0° (GAH) or (above)xcos30° (5.00)xcos30° (4.33)
	14F=3gcos30°x6.52- 3gsin30°x2.64	M1	14F = 3x9.8x7.034xcos52.0°
	F = 9.09 N	A1 **5**	**13**

(Q8, June 2008)

9	$\bar{x} = 8$	B1	
	T sin30° x 12 = 8 x 2 x 9.8	M1	ok if g omitted
		A1 ft	ft their $\bar{x}$
	T = 26.1	A1 **4**	**4**

(Q2, Jan 2009)

10 (i)	140 x X = 40 x 70	M1	
	X = 20 N	A1	
	at *F* 20 N to the right	B1	inspect diagram
	at *G* 20 N to the left	B1 **4**	**SR** B1 for correct directions only

(Q3, Jan 2009)

11(i)	$\cos\theta = 5/13$ or $\sin\theta = 12/13$ or $\theta = 67.4°$	B1	any one of these
		M1	moments about *A* (ok without 70)
	$0.5\times F\sin\theta = 70\times1.4 + 50 \times 2.8$	A1	$0.5\sin\theta = 0.4615$
	$F = 516$ N	A1 **4**	**SR** 1 for 303 (omission of beam)
(ii)	$F\sin\theta = 120 + Y$ (resolving vertically)	M1	M1/A1 for moments
	$Y = 356$ ✓ their F × 12/13 – 120	A1 ✓	(B) $Y\times2.8+1.4\times70=2.3\times516$✓$\times12/13$
	$X = F\cos\theta$ (resolving horizontally)	M1	(C) $0.5\times Y = 0.9\times70 + 2.3\times50$
	$X = 198$ ✓ their $F \times 5/13$	A1 ✓	(D) $1.2X = 1.4\times70 + 2.8\times50$
	Force = $\sqrt{(356^2 + 198^2)}$	M1	
	407 or 408 N	A1 **6**	**10**

(Q3, June 2009)

12 (ii)	s = 0.5	B1	slant height, may be implied
	Tsin80°× 0.5 = 0.47 × 0.5 × 9.8	M1	
		A1	
	T = 4.68 N	A1 **[4]**	**8**

(Q3, Jan 2010)

13 (i)	$4T\cos20° = 5 \times g \times 2.5$ $T = 32.6$ N	M1 A1 A1 **3**	Using moments; allow sin/cos mix Allow with omission of g
(ii)	$X = T\sin20°$ $X = 11.1$ FT $Y + T\cos20° = 5 \times g$ or $2.5Y = 1.5 \times T\cos20$ 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 $\theta = 58.8°$ above the horizontal	M1 A1 M1 A1 M1 A1 A1 **7**	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 **10**

(Q4, June 2010)

14	**(ii)**	**(a)**	$mg(0.09\cos45) =$ $2(0.6+0.6\cos45+0.6\sin45)$ $m = 4.65$kg	M1 A1 A1 A1 **[4]**	Attempt at moments (must resolve), allow without g $2(0.6+\sqrt{[0.6^2+0.6^2]})$ (4.6451...)
	(ii)	**(b)**	$2/4.6451g$ $\mu \geq 0.0439$	M1 A1 A1 **[3]**	Ratio force/weight cv(4.65) Correct inequality sign, accept 0.044

(Q5, Jan 2011)

15 i	$F \times 0.8 =$ $0.6\cos60 \times 550$ $F = 206.25$	M1 A1 A1 A1 [4]	Attempt at moments Accept 206, cao
ii	$T \times 2 \times 0.8/\tan30$ = $550 \times (0.8/\sin30 - 0.6\cos60)$ $T = 258$ $R = 550 - T\cos30$ $Fr = T\sin30$ $\mu = 129/326.6$ $\mu = 0.395$	M1* A1 M1* A1 A1 M1* A1 B1* M1dep* A1 [10]	Moment of T about P T x 2.77 Moment of weight about P 550 x (1.6 – 0.3) Accept to 2sf Resolving vertically, 3 terms needed Value for T not required Value for T not required; accept < or ≤ For correct use of $F = \mu R$, $R \neq 550$
OR	$T \times 0.8/\tan30 + 550 \times 0.6\cos60 = R \times 0.8/\cos60$ $R = 550 - T\cos30$ Solve for T or R $T = 258$ or $R = 326.5625$ $Fr = T\sin30$ $\mu = 129/326.6$ $\mu = 0.395$	M1* A2 M1* A1 M1 A1 B1* M1dep* A1 [10]	Moments about V, 3 terms needed A1 for two terms correct Resolving vertically, 3 terms needed Accept to 2sf Value for T not required; accept < or ≤ For correct use of $F = \mu R$, $R \neq 550$
OR	$Fr \times 1.6\cos30 + 550 \times (1.6\sin30 + 0.6\sin30) =$ $R \times (1.6 + 1.6\sin30)$ $R = 550 - T\cos30$ $Fr = T\sin30$ Solving for at least one of R, Fr, or T Either $R = 326.5625$, or $Fr = 129(.0017008)$, or $T = 258$ $\mu = 129/326.6$ $\mu = 0.395$	M1* A2 M1* A1 B1* M1 A1 M1dep* A1 [10]	Moments about Q, 3 terms needed A1 for two terms correct Resolving vertically, 3 terms needed accept < or ≤ Only one needed. Accept to 2sf. For correct use of $F = \mu R$, $R \neq 550$

(Q7, June 2011)

16	(i)		$P \times 1.6 = 10g\cos60 \times 1.2$ $P = 36.75$ N	M1 A1 A1 [3]	Moments about A. Allow 36.8
	(ii)		$R + 36.75\sin30 = 10g$ $F = 36.75\cos30$ $\mu = 31.8/79.6$ $\mu = 0.4(00)$	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)$F = \mu$(their)R R not = $10g$ or their P from **(i)**. AWRT www. Allow inequality

(Q3, Jan 2012)

17	(i)		$T\cos30 \times 1.5\sin30 = 15g \times 2$ $T = 453$	M1 A1 A1 **[3]**	Attempt at moments about A, g can be omitted at this stage
	(ii)		$X = T_c\sin30$ (=226) $Y + T_c\cos30 = 15g$ $R = \sqrt{(226^2 + 245^2)}$ or $\tan\theta = 245/226$ $R = 334$ $\theta = 47.3$ below horizontal (to the left)	B1ft M1 A1ft M1 A1 A1 **[6]**	Using their value T or taking moments about P Attempt to resolve vertically or taking appropriate moments Using their value T; expect $Y = -245$ or better Either or both of these equations can be replaced with moments about an appropriate point eg P, Q, B, c of m of beam. Any relevant angle Allow 333 Allow 47.2, 42.7 to the downward vertical SC: If *392* in (i) leading to $Y = \pm 245$ only in (ii) max M1A1

(Q3, June 2012)

18	(ii)		$\dfrac{a^2 + 15a + 75}{3(a+10)} = 5$ Solving for a $a = 8.66$ or $5\sqrt{3}$	*M1 dep*M1 A1 **[3]**	Substitute x_G as 5 $a \leq 8.66$
	(iii)		$(25 + 2.5a)y_G = 25 \times 2.5 + 2.5a \times (⅔ \times 5)$ $y_G = \dfrac{10a + 75}{3(a+10)}$ or 2.89 $\tan\theta = x_G / y_G$ $= 5 / y_G$ $\theta = 60$	*M1 A1ft A1ft dep*M1 A1ft A1 **[6]**	Method to find centre of mass from AB (or CD) with or without a substituted. ft their a from (ii), from CD $y_G = 2.11$ Using trig to find an appropriate angle, eg complement of θ. ft their a from (ii), but not an incorrect y_G $\theta \leq 60$ (anything that rounds to 60)

(Q7, June 2012)

19	**(i)**		Use of moments 2.5R = 3gcos60 x 2 R = 11.76 N	M1 A1 A1 **[3]**	Trig with 3g, no trig with R unless using 2 components. Allow 11.8	
	(ii)		R' + Rcos60 = 3g F = Rcos30 Use F = μR' μ = 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	

(Q5, Jan 2013)

20		**(i)**	$x_G = (2 \times 2)/\pi$ P(or X) $\times 4 = 0.3g \times x_G$ $Y = 0.3g$ Use $R^2 = X^2 + Y^2$ to find R $R = 3.09$ N	B1 *M1 A1ft B1 dep*M1 A1 **[6]**	$x_G = 1.2732\ldots$. May be seen in **(ii), mark only once.** Take moments about A or B $P = 0.9358\ldots$. ft their x_G for this mark.
		(ii)	$P \times 4 =$ $0.3g \times (2\sin 30 + x_G \sin 60)$ $P = 1.55$	M1 A1 A1 A1 **[4]**	Attempt at moments, force × distance = $0.3g$ × distance $0.3g \times 2.1026\ldots\ldots$ $1.545453\ldots\ldots$

(Q3, June 2013)

21		**(i)**	$4.4x_G = 4 \times \frac{1}{4} \times 8$ $\quad - 0.4 \times 1/3 \times 10$ $x_G = 1.52$ cm	M1 A1 A1 A1 **[4]**	Table of moments idea. Moments about other axes acceptable Allow $^{50}/_{33}$
		(ii)	$T_{shell} \times 18 = 4.4g \times (8 - 1.52)$ or $T_{cone} \times 18 = 4.4g \times (10 + 1.52)$ $T_{shell} + T_{cone} = 4.4g$ $T_{shell} = 15.5$ and $T_{cone} = 27.6$	M1 A1ft M1 A1 **[4]**	 Or any other correct moment equation. ft on x_G from **(i)** May use a second moments equation For both

(Q4, June 2013)