RECOGNISING ACHIEVEMENT

Oxford Cambridge and RSA Examinations

Advanced Subsidiary General Certificate of Education
Advanced General Certificate of Education

MEI STRUCTURED MATHEMATICS

MECHANICS 2, M2

4762

MARK SCHEME

Qu	Answer	Mark	Comment
1(i)	Before P → 2 ms^{-1} ← Q $^4/_3$ ms^{-1} After PQ → v ms^{-1} PCLM		
	$55\times 2-45\times\frac{4}{3}=100v$	M1 B1	PCLM applied Signs correct and consistent with the question
	$v = 0.5$ so 0.5 ms^{-1}	A1	
	in original direction of Percy	F1	Either explicit or implied by diagram
	→ $55(0.5-2)=-82.5$ Ns	M1 A1 **[6]**	Attempt at impulse Must have direction explicit (diagram will do)
1(ii)	Before PQ → 0.5 ms^{-1} R → v ms^{-1} After PQ → 0.1 ms^{-1} R → v' ms^{-1}		
	PCLM		
	$50+60v=10+60v'$	M1	PCLM
	$3v'-3v=2$	A1	Any Form
	NEL		
	$\frac{v'-0.1}{v-0.5}=-0.2$	M1	Including consistent use of signs
	$v'+0.2v=0.2$	A1	Any form
	Solving $v=\frac{7}{18},\ v'=\frac{5}{18}$	M1	
	So before, $-\frac{7}{18}$ ms^{-1} (opp direction to PQ)	A1	Award max A1 for final answers unless directions both specified or implied by diagram
	after, $\frac{5}{18}$ ms^{-1} (same direction as PQ)	A1 **[7]**	
1(iii)	Ball hits ice at vert speed $\sqrt{2\times 0.4\times 9.8}$ = 2.8 ms^{-1}	M1 A1	
	Linear momentum conserved horiz NEL on vert cpt gives 1.4 ms^{-1} up so after bounce 0.1 ms^{-1} horiz and 1.4 ms^{-1} up	M1 B1	May be implied e.g. in diagram
	Angle is $\arctan(\frac{1.4}{0.1})\approx 86°$	A1 **[5]**	

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2(i)	$(20g\sin 30 + 50)\times 4$ = 592 W	M1 B1 A1 **[3]**	Use of $P = Fv$ Weight term
2(ii)	$20\times 9.8\times 5\times \sin 35 - \frac{1}{2}\times 20\times (6^2 - 4^2)$ = 362.104.. so 362 J (3s.f.)	M1 B1 B1 A1 **[4]**	Difference in GPE and KE GPE term Either KE term Accept 2 s.f.
2(iii)	$5F = 362.104\ldots$ so $F = 72.4209\ldots$ $R = 20\times 9.8\times \cos 35$ $\mu = 0.4510\ldots$ so 0.45 (2s.f.)	B1 B1 M1 E1 **[4]**	 Use of $F = \mu R$
2(iv)	$\mu mg\cos 35 = mg\sin 35$ $\mu = 0.70$ (2s.f.)	M1 A1 **[2]**	 Accept WW
2(v)	$72.2492..\times x + 520 - 20gx\sin 35$ $= \frac{1}{2}\times 20\times 6^2$ $x = 3.982\ldots$ so 3.98m (2 s.f.)	M1 B1 A1 A1 A1 **[5]**	Use of work-energy Equation contains GPE term All terms present Signs correct (dependent on A1 above)
3(i)	$10\begin{pmatrix}\overline{x}\\ \overline{y}\end{pmatrix} = 2\begin{pmatrix}\frac{1}{2}\\ \frac{\sqrt{3}}{2}\end{pmatrix} + 2\begin{pmatrix}\frac{3}{2}\\ \frac{\sqrt{3}}{2}\end{pmatrix} + 3\begin{pmatrix}2.75\\ \frac{3\sqrt{3}}{4}\end{pmatrix} + 3\begin{pmatrix}5\\ \frac{3\sqrt{3}}{2}\end{pmatrix}$ (2.725, 1.516)	M1 B1 B1 B1 E1,A1 **[6]**	Appropriate method Correct masses At least two x cpts correct At least two y cpts correct
3(ii)	cm gives a clockwise moment about C Reaction at A cannot give an a.c. moment	E1 E1 **[2]**	Considering moments Complete argument
3(iii)	Moments about C $2w = 25g\times 0.725$ $w = 88.8125$ so about 88.81 N	M1 A1 B1 A1 **[4]**	 Use of weight

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Qu	Answer	Mark	Comment
3(iv)	Moments about C	M1	
	$3\frac{\sqrt{3}}{2}F = 25g \times 0.725$	A1	
	$F = 68.367\ldots$ so 68.3 N (3 s.f.)	A1 **[3]**	Any reasonable accuracy
3(v)	Moments about A	M1	
	$3\frac{\sqrt{3}}{2}F = 25g \times 2.725$	A1	
	F = 256.968.. so about 257 N	A1 **[3]**	Any reasonable accuracy
4(i)	$\rightarrow \quad U + X = 0 \Rightarrow x = -U$	E1	
	Â $\quad 2U + 3T = 1200$	M1	Moments about A or D
	so $-X = U = \frac{1200 - 3T}{2}$	E1 **[3]**	
4(ii)	$\uparrow \quad V = T_{CD}\cos 45$	M1	Resolving in each direction
	$\rightarrow \quad U = T_{CD}\cos 45$		
	so $U = V$	E1 **[2]**	Clearly shown

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Qu	Answer	Mark	Comment
4(iii)	↑ For the whole system $V + Y + T = 1200$	B1	
	so $Y = 1200 - T - \frac{(1200 - 3T)}{2} = \frac{1200 + T}{2}$	E1	Must be clearly derived
	Consider all the struts in tension and consider the equilibria at pin-joints	M1 M1	Considering equilibrium at a pin-joint At least two equilibrium equations attempted
	at D → $T_{CD}\cos 45 = U$ so $T_{CD} = \frac{1200 - 3T}{\sqrt{2}}$	A1	
	at A ↑ $Y + T_{AC}\cos 45 = 0$ so $T_{AC} = -\frac{(1200 + T)}{\sqrt{2}}$	A1	
	→ $X = T_{AC}\cos 45 + T_{AB}$ so = $T_{AB} = -\frac{(1200 - 3T)}{2} + \frac{(1200 + T)}{2} = 2T$	F1	
	at B ↑ $T_{CB} \times \frac{1}{\sqrt{5}} + T = 0$ so $T_{CB} = -\sqrt{5}T$	M1 A1	Attempt to find angle
		[9]	[For forces in struts, FT according to order they are determined]
4(iv)	When T increases Only CD can change sign for $T > 0$. There is zero force in CD when $T = 400$	E1 E1	Identifying CD $T = 400$
	When T decreases BC, CD remain in tension AB remains in thrust CA changes from thrust to tension when $T < -1200$	B1 B1	
		[4]	
			Total: 72

AO	Range	Total	Question Number			
			1	**2**	**3**	**4**
1	14-22	17	2	7	5	3
2	14-22	21	7	2	3	9
3	18-26	18	5	5	4	4
4	7-15	7	3	-	2	2
5	3-11	9	1	4	4	-
Totals		**72**	18	18	18	18

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