OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE **4762**

Mechanics 2

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

Q 1		mark		sub
(i)	For P $200\times5+250=200v_P$ $v_P=6.25$ so $6.25\mathbf{i}$ m s^{-1} For Q $250\times5-250=250v_Q$ $v_Q=4$ so $4\mathbf{i}$ m s^{-1}	 M1 E1 M1 A1	 Award for I-M Accept no **i** and no units Must have impulse in opposite sense Must indicate direction. Accept no units.	4
(ii)	**i** direction positive PCLM: $2250=200\times4.5+250w_Q$ $w_Q=5.4$ so $5.4\mathbf{i}$ m s^{-1} NEL: $\frac{w_Q-4.5}{4-6.25}=-e$ $e=0.4$	 M1 F1 E1 M1 A1 A1	 PCLM used. Allow error in LHS FT from (i) Any form. FT only from (i) NEL . Allow sign errors Signs correct. FT only from (i) cao	6
(iii)	**i** direction positive Suppose absolute vel of object is $-V\mathbf{i}$ $200\times4.5=-20V+180\times5.5$ $V=4.5$ speed of separation is 5.5 + 4.5 = 10 m s^{-1}	 M1 B1 A1 A1 F1	 Applying PCLM. All terms present. Allow sign errors. Correct masses All correct (including signs) FT **their** V.	5
(iv)	$180\times5.5+250\times5.4=430W$ $W=5.4418\ldots$ so $5.44\mathbf{i}$ m s^{-1} (3 s. f.)	M1 A1	Using correct masses and velocities cao	2
				17

Q 2		mark		sub
(i)	$20\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix}=15\begin{pmatrix}20\\ 0\end{pmatrix}+3\begin{pmatrix}0\\ 100\end{pmatrix}+2\begin{pmatrix}25\\ 200\end{pmatrix}$ $\bar{x}=17.5$ $\bar{y}=35$	M1 B1 A1 A1 A1	Method to obtain at least 1 coordinate '100' or '25' correct Either one RHS term correct or one component of two RHS terms correct	5
(ii)	$25\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix}=\begin{pmatrix}350\\ 700\end{pmatrix}+5\begin{pmatrix}40\\ 200\end{pmatrix}$ so $\bar{x}=22$, $\bar{y}=68$	M1 E1	Using (i) or starting again Clearly shown.	2
(iii)	We need the edge that the $\bar{x}$ position is nearest $\bar{x}$ = 22; distances are 22 to PQ, 18 to SR 15 to QR so edge QR	M1 B1 B1 A1	This may be implied One distance correct All distances correct	4
(iv)	Moments about RS In sense xOy $T\sin 50\times 200 - T\cos 50\times 40$ $-20g\times(40-17.5)=0$ T = 34.5889… so 34.6 N (3 s. f.)	M1 B1 M1 A1 B1 A1 A1	Moments about RS attempted Use of weight not mass below. FT mass from here Attempt to find moment of T about RS, including attempt at resolution. May try to find perp dist from G to line of action of the force. 40 – 17.5 All correct allowing sign errors cao (except for use of mass)	7
				18

Q 3		mark		sub
(i)	a.c. moments about A $1 \times T - 2 \times 300 = 0$ so $T = 600$ Resolving $\rightarrow X = 0$ $\uparrow T - Y = 300$ so $Y = 300$	 E1 B1 M1 A1	 Justified 	4
(ii)	Diagram *The working below sets all internal forces as tensions; candidates need not do this.*	B1 B1	All external forces marked consistent with (i) All internal forces with arrows and labels	2
(iii)	Let angle DAB be θ. $\cos\theta = \frac{1}{2}$, $\sin\theta = \frac{\sqrt{3}}{2}$ A $\uparrow$ $-300 - T_{AB}\sin\theta = 0$ so $T_{AB} = -200\sqrt{3}$ so force is $200\sqrt{3}$ (C) A $\rightarrow$ $T_{AD} + T_{AB}\cos\theta = 0$ so $T_{AD} = 100\sqrt{3}$ so force is $100\sqrt{3}$ (T) C $\uparrow$ $T_{CD}\sin\theta - 300 = 0$ so $T_{CD} = 200\sqrt{3}$ so force is $200\sqrt{3}$ (T) C $\leftarrow$ $T_{BC} + T_{CD}\cos\theta = 0$ so $T_{BC} = -100\sqrt{3}$ so force is $100\sqrt{3}$ (C) B $\uparrow$ $T_{AB}\sin\theta + T_{BD} = 0$ so $T_{BD} = 300$ so force is 300 (T)	B1 M1 M1 A1 F1 F1 F1 F1 F1	Or equivalent seen Attempt at equilibrium at pin-joints 1 equilib correct, allowing sign errors All T/C consistent with their calculations and diagrams	9
(iv)	AD, AB, BC, CD 300 N, X and Y not changed. Equilibrium equations at A and C are not altered B $\uparrow$ $T_{AB}\sin\theta + T'_{BD} + 600 = 0$ so $T'_{BD} = -300$ so force is 300 (C)	B1 E1 M1 A1	 C not needed. [If 300 N (C) given WWW, award SC1 (NB it must be made clear that this is a compression)]	4
				19

Q 4		mark		sub
(i)	Let friction be F N and normal reaction R N			
	$F_{\max} = 58\cos 35$	B1	Need not be explicit	
	$R = 16g + 58\sin 35$	M1	Both terms required.	
		A1		
	$F_{\max} = \mu R$	M1		
	so μ = 0.249968… about 0.25	E1		5
(ii)	WD is $70\cos 35 \times 3 = 210\cos 35$	M1	Use of WD = Fd . Accept $\cos 35$ omitted.	
	so 172.0219… = 172 J (3 s. f.)	A1		
	Average power is WD/time	M1		
	so 34.4043…. = 34.4 W (3 s. f.)	A1	cao	4
(iii)	Using the constant acceleration result			
	$s = \frac{1}{2}(u+v)t$ with s = 3, u = 0, v = 1.5	M1	Attempt to substitute in *suvat* (sequence)	
	and t = 5 we see that			
	$3 \neq \frac{1}{2}(0+1.5)\times 5 = 3.75$	E1	Conclusion clear	2
(iv)				
	172.0219…	M1	Using W-E equn, allow 1 missing term	
	$= \frac{1}{2}\times 16 \times 1.5^2$	M1	KE term attempted	
		A1	correct	
	$+0.25\times(16g + 70\sin 35)\times 3$	M1	Attempt at using new F in $F_{\max} = \mu R$	
	+ WD	A1		
		A1	All correct	
	so WD by S is 6.30916…	A1	cao	
	so 6.31 J (3 s. f.)			7
				18