GCE 2005
January Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics and Statistics B
(MBM4)

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Key to Mark Scheme

M ..... mark is for ..... method
m ..... mark is dependent on one or more M marks and is for ..... method
A ..... mark is dependent on M or m marks and is for ..... accuracy
B ..... mark is independent of M or m marks and is for ..... method and accuracy
E ..... mark is for ..... explanation
√ **or ft or F** ..... follow through from previous incorrect result
CAO ..... correct answer only
AWFW ..... anything which falls within
AWRT ..... anything which rounds to
AG ..... answer given
SC ..... special case
OE ..... or equivalent
A2,1 ..... 2 or 1 (or 0) accuracy marks
-*x* EE ..... deduct *x* marks for each error
NMS ..... no method shown
PI ..... possibly implied
SCA ..... substantially correct approach
c ..... candidate
SF ..... significant figure(s)
DP ..... decimal place(s)

Abbreviations used in Marking

MC – *x* ..... deducted *x* marks for mis-copy
MR – *x* ..... deducted *x* marks for mis-read
ISW ..... ignored subsequent working
BOD ..... given benefit of doubt
WR ..... work replaced by candidate
FB ..... formulae booklet

Application of Mark Scheme

No method shown:
Correct answer without working ..... mark as in scheme
Incorrect answer without working ..... zero marks unless specified otherwise

More than one method/choice of solution:

2 or more complete attempts, neither/none crossed out	mark both/all fully and award the mean mark rounded down
1 complete and 1 partial attempt, neither crossed out	award credit for the complete solution only

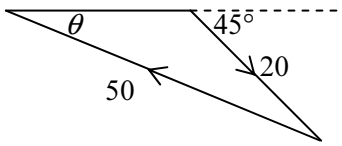
Crossed out work — do not mark unless it has not been replaced

Alternative solution using a correct or partially correct method — award method and accuracy marks as appropriate

Mathematics and Statistics B Mechanics 4 MBM4 January 2005

Question Number and Part	Solution	Marks	Total	Comments
1(a)	C of momentum			
	$m.63u = 81m.v$	M1 A1		
	$v = \frac{7}{9}u$	A1	3	
(b)	If x is the number of arrows required,			
	$x\,m.63u = (80m + xm)7u$	M1 A1		
	$9x = 80 + x$	M1		
	$x = 10$	A1	4	Needs unknown on both sides
	Total		**7**	
2(a)	Dimension of a force is $M\,L\,T^{-2}$	B1		
	Dimension of $\frac{mM}{r^2}$ is $M^2\,L^{-2}$			
	Dimension of G is $\frac{MLT^{-2}}{M^2L^{-2}}$	M1		
	$= M^{-1}L^3\,T^{-2}$	A1	3	
(b)	Inserting dimensions:			
	$L\,T^{-1} = (M^{-1}\,L^3\,T^{-2})^{\alpha}\,M^{\beta}\,L^{-\gamma}$	M1		
	$= M^{\beta-\alpha}\,L^{3\alpha-\gamma}\,T^{-2\alpha}$	A1√		
	Equating terms in T; $\alpha = ½$	M1		
	Equating terms in M; $\beta = ½$			
	Equating terms in L; $\gamma = ½$	A1	4	cao
	Total		**7**	

MBM4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
3(a)		B2		B1 if no θ
	$50 \sin \theta = 20 \sin 45$ $\sin \theta = \frac{20}{50} \sin 45$	M1		3 marks for any equation in one unknown
	$\theta = 16.4°$	A1		
	Bearing is 286°	A1	5	Accept 286.4° **OR** By vectors $v_{YrelB} = \begin{pmatrix} 50\cos\theta - 20\cos 45 \\ 50\sin\theta - 20\sin 45 \end{pmatrix}$ $\Rightarrow 50\sin\theta - 20\sin 45 = 0$ M2 A1 $r_{YrelB} = \begin{pmatrix} -40 + 50t\cos\theta - 20t\cos 45 \\ 50t\sin\theta - 20t\sin 45 \end{pmatrix}$ $\Rightarrow 50\sin\theta - 20\sin 45 = 0$ M2 A1
(b)	$V = 50\cos 16.4 - 20\sin 45$	M1		Or $V^2 = 20^2 + 50^2 - 2.20.50\cos 28.6$
	$= 33.8236..$	A1		
	Time $= \frac{40}{33.82..}$	M1	4	Not dep on above
	$= 1.18\ldots$ = 1 hour 11 minutes	A1	1	Accept 1.18 or 1hour 11 min
(c)	Distance travelled $= 50 \times 1.18..$ $= 59.1$ km	B1√		$50 \times$ their time
	Total		**10**	

MBM4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
4(a)	Resolve horizontally			
	$T_{ED}\cos30 + T_{EF}\cos60 = 0$	M1 A1		
	Resolve vertically;			
	$T_{ED}\cos60 + T_{EF}\cos30 + 500 = 0$	M1 A1		
	$T_{ED}\sqrt{3} + T_{EF} = 0$			
	$T_{ED} + T_{EF}\sqrt{3} = -1000$	M1		
	$2T_{EF} = -1000\sqrt{3}$	A1		
	$T_{EF} = -500\sqrt{3}$ or –866N			
	T_{ED} = 500N	A1		M3 A4 for *ED* and *EF*
	Resolve perpendicular to *CD*			
	$T_{DF}\cos30 + T_{ED}\cos60 = 0$	M1 A1		Need to use direction perp to *CD* or to use 2 equations
	$T_{DF}\sqrt{3} + 500 = 0$			
	$T_{DF} = -\frac{500}{\sqrt{3}}$ 0r – 289N	A1	10	Delete A1 for 500g etc
(b)	*ED* could be replaced by a rope since force is positive	B1√		
	EF and *DF* could not be replaced by a rope since force is negative	B1√	2	
(c)	No			
	Resolve horizontally at *C*	B1		Values could have been found in part (a)
	Force in $CF \neq 0$			
	∴Forces cannot be the same	B1	2	
	Total		**14**	

MBM4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
5	Velocity perp to line of centres: $u_2 = 3u\sin\theta$ $u_4 = u\sin\theta$ Along line of centres: m $2m$ Initial $\rightarrow 3u\cos\theta$ $\leftarrow u\cos\theta$ Final $\rightarrow u_A$ $\rightarrow u_B$ $3um\cos\theta - 2mu\cos\theta = mu_A + 2mu_B$ $u\cos\theta = u_A + 2u_B$ Restitution $4eu\cos\theta = u_B - u_A$ $u_B = \frac{1}{3}(1+4e)u\cos\theta$ $u_A = \frac{1}{3}(1-8e)u\cos\theta$	B1 B1 M1 A1 M1 A1 A1 A1	8	Must only consider velocities along line of centres
	Total		**8**	
6(a)	At point of sliding Vertically; $R = Mg - P\sin\theta$ Horizontally; $F = P\cos\theta$ $F = \frac{1}{5}R$ $\frac{1}{5}Mg - \frac{1}{5}P\sin\theta = P\cos\theta$ $P = \frac{Mg}{5\cos\theta + \sin\theta}$	M1 A1 M1 A1 B1 A1	6	
(b)	At point of toppling Taking moments about A $Mgl = P\cos\theta\, 7l$ $P = \frac{Mg}{7\cos\theta}$	M1 A1 A1	3	For moments about A and one side correct
(c)	If topples before it slides $\frac{Mg}{7\cos\theta} < \frac{Mg}{5\cos\theta + \sin\theta}$ $Mg(5 + \tan\theta) < 7Mg$ $5 + \tan\theta < 7$ $\tan\theta < 2$	M1 M1 A1√ M1 A1	5	Use of ≤ M3 A1 Use of > M2 A1
	Total		**14**	
	TOTAL		**60**	