GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics and Statistics B
MBM1

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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	accuracy
E	mark is for	explanation
√or ft or F		follow through from previous incorrect result
cao		correct answer only
cso		correct solution only
awfw		anything which falls within
awrt		anything which rounds to
acf		any correct form
ag		answer given
sc		special case
oe		or equivalent
sf		significant figure(s)
dp		decimal place(s)
A2,1		2 or 1 (or 0) accuracy marks
–*x* ee		deduct *x* marks for each error
pi		possibly implied
sca		substantially correct approach

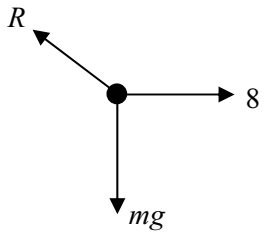
Abbreviations used in Marking

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 book

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 1 MBM1 June 2004

Question Number and Part	Solution	Marks	Total marks	Comments
1(a)	$24.5 = 9.8t$	M1		Use of $v = u + at$ with $u = 0$
	$t = \frac{24.5}{9.8} = 2.5$ seconds	A1	2	Correct time
(b)	$24.5^2 = 0^2 + 2 \times 9.8s$	M1		Use of constant acceleration equation to find s, with $u = 0$ or $v = 24.5$
		A1		Correct equation
	$s = \frac{24.5^2}{2 \times 9.8} = 30.625$ m	A1	3	**ag** Correct distance from correct working
(c)	$30.625 - 5 = 4.9t^2$	M1		Use of $s = ut + \frac{1}{2}at^2$ with $u = 0$
		A1		Correct equation
	$t = \sqrt{\frac{25.625}{4.9}} = 2.29$	m1		Solving for t having subtracted 5
		A1	4	Correct t
	Total		**9**	
2(a)		B1	1	Correct force diagram with labels
(b)	$R\cos 30° = 8$	M1		Resolving horizontally to get two terms
		A1		Correct equation
	$R = \frac{8}{\cos 30°} = 9.24$	A1	3	**ag** Correct answer from correct working (Other methods: M1 A1 if correct)
(c)	$R\cos 60 = 9.8m$	M1		Resolving horizontally to get two terms, with 8 not included
		A1		Correct equation
	$m = \frac{8\cos 60°}{9.8\cos 30°} = 0.47$	A1	3	Correct m to 2 sf (Resolving perpendicular to the plane: M1 A1 for equation and A1 for final answer)
	Total		**7**	

MBM1 (cont)

Question Number and Part	Solution	Marks	Total marks	Comments
3(a)	$R = 20 \times 9.8 = 196$	B1	1	cao
(b)	$F \leq 0.3 \times 196 = 58.8$	M1		Using 0.3×196
	If $P = 80,\ F = 58.8$	A1		58.8 as answer
	If $P = 40,\ F = 40$	A1	3	40 as answer
(c)	$P - 58.8 = 20 \times 0.8$	M1		Three term equation of motion including 58.8
		A1		Correct equation
	$P = 74.8$	A1	3	Correct P
(d)	$a = \frac{-58.8}{20} = -2.94$	M1		Use of $F = ma$ with ± 58.8
		A1		Correct acceleration with a negative sign
	$0^2 = 6^2 + 2 \times (-2.94)s$	m1		Use of $v^2 = u^2 + 2as$ with $v = 0$
		A1		
	$s = \frac{36}{5.88} = 6.12$	A1	5	Correct distance
	Total		**12**	
4(a)	$2 \times 4 = 2 \times 1 + 4v$	M1		Three term equation for conservation of momentum, with $u_B = 0$
		A1		Correct equation
	$v = \frac{8-2}{4} = 1.5$	A1	3	Correct velocity (use of mg deduct 1 mark)
(b)	$4 \times 1.5 = 4v + m \times 2$	M1		Three term equation for conservation of momentum, with $u_C = 0$
		A1√		Correct equation
	$v = \frac{6-2m}{4}$	A1√	3	Correct velocity
(c)	$1 > \frac{6-2m}{4}$	M1		Equation or inequality with v from previous answer and 1
		A1√		Correct inequality
	$4 > 6 - 2m$	m1		Solving for m
	$2m > 2$			
	$m > 1$	A1	4	**ag** Correct result from correct working
	Total		**10**	

MBM1 (cont)

Question Number and Part	Solution	Marks	Total marks	Comments
5(a)	$0.5 = \frac{1}{2} \times a \times 4$	M1		Use of $s = ut + \frac{1}{2}at^2$ with $u = 0$
	$a = 0.25$	A1	2	Correct acceleration
(b)	$6 \times 9.8 - T = 6 \times 0.25$	M1		Three term equation of motion for particle, with correct use of g
		A1√		Correct equation
	$T = 57.3$	A1√	3	**ag** Correct T from correct working
(c)	$57.3 - F = 10 \times 0.25$	M1		Three term equation of motion for the block
		A1√		Correct equation
	$F = 54.8$	A1√		Correct F
	$R = 10 \times 9.8 = 98$	B1		$R = 98$ seen in working
	$54.8 = 98\mu$	m1		Use of $F = \mu R$
	$\mu = \frac{54.8}{98} = 0.559$	A1√	6	correct μ
	Total		**11**	
6(a)	$8\bar{x} = 1 \times 6 + 2.4 \times 2$	M1		Three term moment equation
		A1		Correct equation
	$\bar{x} = \frac{10.8}{8} = 1.35$	A1	3	**ag** Correct value form correct working
(b)	$\tan\alpha = \frac{0.4}{1.05}$	M1		Use of tan or sin/cos plus finding hypotenuse
		A1		Use of 0.4
		A1		Correct trig expression
	$\alpha = 20.9°$	A1	4	Correct angle
	Total		**7**	

MBM1 (cont)

Question Number and Part	Solution	Marks	Total marks	Comments
7(a)(i)	$\mathbf{a} = \frac{1}{4}(8\mathbf{i} - 12\mathbf{j}) = 2\mathbf{i} - 3\mathbf{j}$	M1 A1	2	Use of $\mathbf{F} = m\mathbf{a}$, must be applied to both components Correct acceleration
(ii)	$\mathbf{v} = 20(2\mathbf{i} - 3\mathbf{j}) = 40\mathbf{i} - 60\mathbf{j}$	M1 A1	2	Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ with $\mathbf{u} = 0\mathbf{i} + 0\mathbf{j}$ Correct **v**
(iii)	$\mathbf{r} = \frac{1}{2}(2\mathbf{i} - 3\mathbf{j}) \times 20^2$ $= 400\mathbf{i} - 600\mathbf{j}$	M1 A1 A1	3	Use of constant acceleration equation to find **r** with $\mathbf{u} = 0\mathbf{i} + 0\mathbf{j}$ Correct expression Correct **r** in simplified form
(b)	$\mathbf{r} = 400\mathbf{i} - 600\mathbf{j} + 25(40\mathbf{i} - 60\mathbf{j})$ $= 1400\mathbf{i} - 2100\mathbf{j}$ $r = \sqrt{1400^2 + 2100^2} = 2520\,\text{m}$ (to 3 sf)	M1 A1√ A1√ m1 A1√	5	Use of $\mathbf{r} + 25\mathbf{v}$ Correct expression Correct position vector Finding magnitude Correct distance from correct working **Alternative:** Straight line method M1 two distances *r* and 25*v* A1 for each distance m1 adding A1 correct final answer
	Total		**12**	
8(a)	$5 = 32\sin 60^\circ t - 4.9t^2$ $4.9t^2 - 32\sin 60^\circ t + 5 = 0$ $t = 0.1866$ or 5.4691 5.47 seconds	M1 A1 A1 m1 A1	5	Equation for vertical motion with ± 5 LHS correct RHS correct Solving quadratic Selecting larger answer from two solutions or obtaining one answer with a reason
(b)	$32\cos 60° \times 5.469 = 87.5\,\text{m}$	M1 A1	2	Equation for horizontal motion Correct range
(c)	$v_H = 32\cos 60^\circ$ $v_V = 32\sin 60^\circ - 9.8 \times 5.469 = -25.88$ $v = \sqrt{16^2 + 25.88^2} = 30.4\,\text{ms}^{-1}$	B1 M1 A1 m1 A1	5	Horiz. component of velocity seen or used Finding vertical component of velocity Correct vertical component Finding magnitude Correct speed (Note Max Height = 39.2 m from $t = 2.83$)
	Total		**12**	
	TOTAL		**80**	