GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics and Statistics B
MBP7

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from:

Publications Department, Aldon House, 39, Heald Grove, Rusholme, Manchester, M14 4NA
Tel: 0161 953 1170

or

download from the AQA website: www.aqa.org.uk

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales 3644723 and a registered charity number 1073334. Registered address AQA, Devas Street, Manchester. M15 6EX. *Dr Michael Cresswell Director General*

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

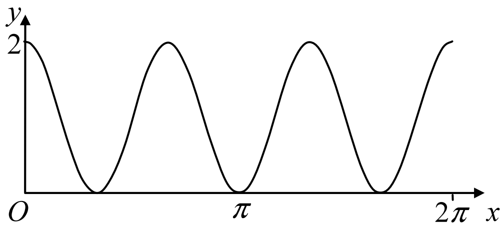
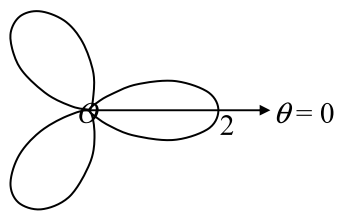
Abbreviations used in Marking

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**

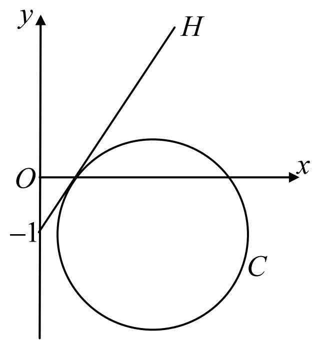
Mathematics and Statistics B Pure 7 MBP7 June 2004

Question Number and Part	Solution	Marks	Total	Comments
1 (a)		B1 B1	 2	For x – compression For y – translation
(b)		B1 B1 B1 B1	 4	Three segments Range 0 to 2 ok Approx. correct max's and min's All clearly shown to be correct
	Total		**6**	
2 (a)	E.g. $C_1' = C_1 - C_3$ $\Delta = \begin{vmatrix} 0 & -2 & 1 \\ a-c & b & c \\ c-a & c+a & a+b \end{vmatrix}$ Full method for expanding determinant Factor $(a+b+c)$ $\Delta = 3(a-c)(a+b+c)$	M1 A1 M1 A1 A1	 5	Row/column operation **Or** by *Factor theorem*, setting $c = a$ Gives $C_1 = C_3 \Rightarrow (a-c)$ a factor Good attempt
(b)	Identifying system as $\boldsymbol{M}\mathbf{x} = \mathbf{u}$ with det $\boldsymbol{M} = \Delta$, and $a = 5$, $b = 7$, $c = 5$ Using (a) with $c = a \Rightarrow \Delta = 0$ and system has no unique solution	M1 A1	 2	Allow start-from-scratch solutions that show $\Delta = 0$ or system inconsistent
	Total		**7**	
3 (a)	$e^x + \sin x = 1 + x + \frac{1}{2}x^2 + \frac{1}{6}x^3 + \frac{1}{24}x^4 \ldots$ $+ x - \frac{1}{6}x^3 \ldots$ $= 1 + 2x + \frac{1}{2}x^2 + 0x^3 + \frac{1}{24}x^4 \ldots$	M1 A1	 2	i.e. $p = 0$, $q = \frac{1}{24}$
(b) (i)	$(1+ax)^n = 1 + na.x + \frac{1}{2}n(n-1)a^2.x^2 \ldots$ Equating terms with answer to (a) to get $an = 2$ and $an(an - a) = 1$ $\Rightarrow a = \frac{3}{2}$ and $n = \frac{4}{3}$	B1 M1 A1 A1	 4	
(ii)	$k = -\frac{1}{6}$	B1√	1	ft their a, n in $\frac{1}{6}n(n-1)(n-2)a^3$ provided problem not trivialised
(iii)	Valid for $\lvert x \rvert <$ or $\leq \frac{2}{3}$	B1√	1	ft numerical $\lvert a \rvert$
	Total		**8**	

MBP7 (cont)

Question Number and Part	Solution	Marks	Total	Comments
4 (a)	$\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{2/t^2}{2}=\frac{1}{t^2}$	M1 A1		Use of Chain Rule
	Equation of normal is $y+\frac{2}{t}=-t^2(x-2t)$	M1		Must be correct ft gradient
	leading to $y+t^2x=\frac{2}{t}(t^4-1)$	A1	4	Given answer
(b)	$P=\left(\frac{2}{t^3}\left(t^4-1\right),0\right)$, $Q=\left(0,\frac{2}{t}\left(t^4-1\right)\right)$	B1 B1		
	giving $M=\left(\frac{1}{t^3}\left(t^4-1\right),\frac{1}{t}\left(t^4-1\right)\right)$	B1√		ft P , Q
	Eliminating t for cartesian eqn. by (e.g.) $y=t^2x$	M1		
	Locus of M: $y=\dfrac{\frac{y^2}{x^2}-1}{\sqrt{\frac{y}{x}}}$ etc.	A1	5	$x^3y^3=(y^2-x^2)^2$ when simplified, but any correct unsimplified form will suffice
	Total		**9**	
5 (a) (i)	$f^2(z)=\mathrm{i}\{\mathrm{i}z+\mathrm{i}\}+\mathrm{i}=-z-1+\mathrm{i}$ $f^3(z)=\mathrm{i}\{-z-1+\mathrm{i}\}+\mathrm{i}=-\mathrm{i}z-1$ and $f^4(z)=\mathrm{i}\{-\mathrm{i}z-1\}+\mathrm{i}=z$	M1 A1 M1 A1	4	Continuing to f^4 or by $f^4=f^2(f^2)=-\{-z-1+\mathrm{i}\}-1+\mathrm{i}$
(ii)	G is CYCLIC and of order 4	B1 B1	2	Clearly stated or implied here
(b)	*Lagrange*: o(subgroup) divides o(group) Subgroups of order 1 , 2 , 4 $\{f^4\}$ or "identity subgroup" of order 1; $\{f^2, f^4\}$ of order 2 G or "whole group" or $\{f, f^2, f^3, f^4\}$ of order 4	B1 B1 B1	3	**sc** give B1 if only two subgroups are listed (must include subgroup of order 2)
	Total		**9**	
6 (a) (i)	$\mathbf{a}$ = p.v. of any point on the line $\mathbf{d}$ = d.v. of line (or any vector ‖ to line)	B1	1	Both
(ii)	$(\mathbf{r}-\mathbf{a})=\lambda\mathbf{d}\Rightarrow(\mathbf{r}-\mathbf{a})\times\mathbf{d}=\lambda\,\mathbf{d}\times\mathbf{d}$ $=\lambda\,\mathbf{0}=\mathbf{0}$	M1 A1	2	or explanation that $(\mathbf{r}-\mathbf{a})\parallel\mathbf{d}$ $\Rightarrow$ vec. prod. = $\mathbf{0}$
(b) (i)	Method for vec. prod. of $2\mathbf{i}+4\mathbf{j}+7\mathbf{k}$ and $\mathbf{i}-3\mathbf{j}+\mathbf{k}$ $=25\mathbf{i}+5\mathbf{j}-10\mathbf{k}$	M1 A1	2	
(ii)	Good attempt at Sh. D. = $\lvert(\mathbf{b}-\mathbf{a})\bullet\hat{\mathbf{n}}\rvert$ Sc. prod. of their $2\mathbf{i}+\mathbf{j}+4\mathbf{k}$ and their $\mathbf{n}$	M1 B1√ A1	3	 ft(any multiple of $\mathbf{n}$) cao any correct exact surd form
	Total		**8**	

MBP7 (cont)

Question Number and Part	Solution	Marks	Total	Comments
7				
(a) (i)	$2 - \mathrm{i}$	B1	1	Must be a complex no.
(ii)	C on diagram above	B1√	1	ft centre; radius approx. correct
(iii)	$(x-2)^2 + (y+1)^2 = 3$	B1√	1	ft
(b) (i)	H on diagram above	B1	1	Ignore line extending to left of the imaginary axis
(ii)	$y = mx - 1$ tgt. to C $\Leftrightarrow (x-2)^2 + (mx)^2 = 3$ has double roots $\Leftrightarrow (m^2+1)x^2 - 4x + 1 = 0$ has double roots	M1 A1		Creating quadratic in x
	Considering discriminant of their quadratic	M1		$\Delta = 16 - 4(m^2+1)$
	leading to $m = \sqrt{3}$	A1	4	+ve root may be taken as given **Alternatively**: by geometric approach
(iii)	$\arg(z + \mathrm{i}) = \frac{\pi}{3}$	B1 B1	2	α; θ
(iv)	Δ with $m = \sqrt{3}$ used (or geometric approach)	M1		
	$x = \frac{1}{2}$, $y = \frac{1}{2}\sqrt{3} - 1$	A1 A1	3	No need for complex no. here
	Total		**13**	
	TOTAL		**60**	