GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics and Statistics B
MBP7

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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

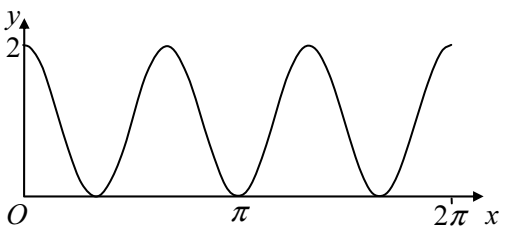
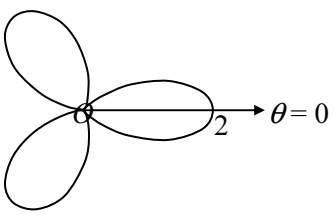
Abbreviations used in Marking

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**

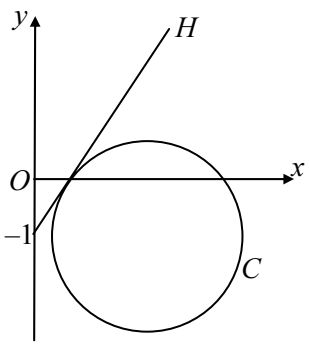
Mathematics and Statistics B Pure 7 MBP7 June 2004

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

MBP7 (cont)

Question Number and Part	Solution	Marks	Total	Comments
7				
(a) (i)	$2 - i$	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 Considering discriminant of their quadratic leading to $m = \sqrt{3}$	M1 A1 M1 A1	4	Creating quadratic in x $\Delta = 16 - 4(m^2+1)$ +ve root may be taken as given **Alternatively**: by geometric approach
(iii)	$\arg(z+i) = \frac{\pi}{3}$	B1 B1	2	α ; θ
(iv)	Δ with $m = \sqrt{3}$ used (or geometric approach) $x = \frac{1}{2}$, $y = \frac{1}{2}\sqrt{3} - 1$	M1 A1 A1	3	No need for complex no. here
	Total		**13**	
	TOTAL		**60**	