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General Certificate of Education (A-level)
June 2011

Mathematics MPC1

(Specification 6360)

Pure Core 1

Final

Mark Scheme

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Key to mark scheme abbreviations

M	mark is for method
m or dM	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
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
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)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

MPC1

Q	Solution	Marks	Total	Comments
1(a)	$y = \frac{13}{3} - \frac{7}{3}x$	M1		attempt at $y = a + bx$ or $\frac{\Delta y}{\Delta x}$ with 2 correct points
	(gradient =) $-\frac{7}{3}$	A1	2	condone slip in rearranging if gradient is correct
(b)(i)	$y - 3 =$ 'their grad'$(x - -1)$	M1		*or* $7x + 3y = k$ and attempt at k using $x = -1$ and $y = 3$ *or* $y =$ (their m)$x + c$ and attempt at c using $x = -1$ and $y = 3$
	$y - 3 = -\frac{7}{3}(x+1)$ or $7x + 3y = 2$ or $y = -\frac{7}{3}x + c,\quad c = \frac{2}{3}$	A1cso	2	correct equation in any form and replacing $- -$ with + sign
(ii)	$(4, -5)$	B1,B1	2	$x = 4$, $y = -5$ withhold if clearly from incorrect working
(c)	$7x + 3y = 13$ and $3x + 2y = 12$ $\Rightarrow$ equation in x or y only	M1		must use correct pair of equations and attempt to eliminate y (or x)
	$x = -2$	A1		
	$y = 9$	A1	3	
	Total		**9**	

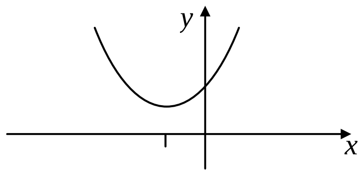
MPC1 (cont)

Q	Solution	Marks	Total	Comments
2(a)(i)	$\sqrt{48} = 4\sqrt{3}$	B1	1	condone $k = 4$ stated
(ii)	$\dfrac{4\sqrt{3}+6\sqrt{3}}{2\sqrt{3}}$	M1		attempt to write each term in form $k\sqrt{3}$ with at least 2 terms correctly obtained
		A1		correct unsimplified in terms of $\sqrt{3}$ only
	$= 5$	A1cso	3	must simplify fraction to 5
				Alternative 1 $\times\dfrac{\sqrt{12}}{\sqrt{12}}$ $\left(or\times\dfrac{\sqrt{3}}{\sqrt{3}}\right)$ M1
				correct with integer terms $=\dfrac{24+36}{12}$ A1
				$= 5$ A1cso
				Alternative 2 $\dfrac{\sqrt{48}+\sqrt{108}}{\sqrt{12}}$ M1
				$=\sqrt{4}+\sqrt{9}$ A1
				$= 5$ A1cso
				Alternative 3 $\sqrt{\dfrac{48}{12}}+2\sqrt{\dfrac{27}{12}}$ M1
				$=2+2\sqrt{\dfrac{9}{4}}$ A1
				$=5$ A1cso
				if hybrid of methods used, award M1 and most appropriate first A1
				NMS (answer =) 5 scores full marks
(b)	$\dfrac{1-5\sqrt{5}}{3+\sqrt{5}}\times\dfrac{3-\sqrt{5}}{3-\sqrt{5}}$	M1		
	(numerator =) $3-\sqrt{5}-15\sqrt{5}+25$	m1		correct unsimplified but must write $5\sqrt{5}\sqrt{5}=25$ PI by 28 seen later
	(denominator = 9 – 5 =) 4	B1		must be seen as denominator
	giving $\dfrac{28-16\sqrt{5}}{4}$			
	(answer =) $7-4\sqrt{5}$	A1	4	$m = 7$, $n = -4$
	Total		**8**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$\left(\frac{\mathrm{d}V}{\mathrm{d}t}=\right)\frac{3t^2}{4}-3$	M1 A1	2	one of these terms correct all correct (no + c etc)
(b)(i)	$t=1 \Rightarrow \frac{\mathrm{d}V}{\mathrm{d}t}=\frac{3}{4}-3$	M1		substituting $t = 1$ into their $\frac{\mathrm{d}V}{\mathrm{d}t}$
	$=-2\frac{1}{4}$	A1cso	2	(–2.25 OE) *BUT* must have $\frac{\mathrm{d}V}{\mathrm{d}t}$ correct
(ii)	Volume is decreasing when $t = 1$			must have used $\frac{\mathrm{d}V}{\mathrm{d}t}$ in (b)(i) or starts again
	because $\frac{\mathrm{d}V}{\mathrm{d}t}<0$	E1√	1	must state that $\frac{\mathrm{d}V}{\mathrm{d}t}<0$ (or $-2\frac{1}{4}<0$ etc) ft increasing plus explanation if their $\frac{\mathrm{d}V}{\mathrm{d}t}>0$
(c)(i)	$\left(\frac{\mathrm{d}V}{\mathrm{d}t}=0\Rightarrow\right)\frac{3t^2}{4}-3=0$	M1		PI by "correct" equation being solved
	$\Rightarrow t^2=4$	A1√		obtaining $t^n=k$ correctly from their $\frac{\mathrm{d}V}{\mathrm{d}t}$
	$t=2$	A1cso	3	withhold if answer left as $t = \pm 2$
(ii)	$\left(\frac{\mathrm{d}^2V}{\mathrm{d}t^2}=\right)\frac{3t}{2}$	B1√		(condone unsimplified) ft their $\frac{\mathrm{d}V}{\mathrm{d}t}$
	When $t=2$, $\frac{\mathrm{d}^2V}{\mathrm{d}t^2}=3$ or $\frac{\mathrm{d}^2V}{\mathrm{d}t^2}>0$	M1		ft their $\frac{\mathrm{d}^2V}{\mathrm{d}t^2}$ and value of t from (c)(i)
	$\Rightarrow$ minimum	A1cso	3	
	Total		**11**	

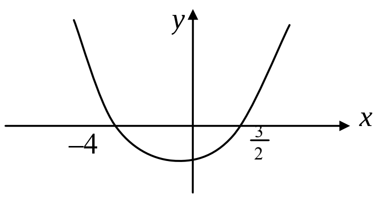
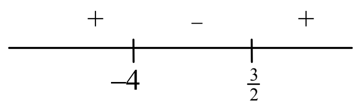
MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$(x+2.5)^2$	B1		$p = \frac{5}{2}$
	$q = 7 - \text{'their' } p^2$	M1		unsimplified attempt at $q = 7 - \text{'their' } p^2$ $q = 7 - \frac{25}{4} = \frac{3}{4}$
	$(x+2.5)^2 + 0.75$ ***mark their final line as their answer***	A1	3	
(b)(i)	$x = -$ 'their' p or $y =$ 'their' q	M1		or $x = -\frac{5}{2}$ cao found using calculus
	$\left(-\frac{5}{2}, \frac{3}{4}\right)$	A1cao	2	condone correct coordinates stated $x = -2.5$, $y = 0.75$
(ii)	$x = -\frac{5}{2}$	B1√	1	correct *or* ft "$x = -$ 'their' p"
(iii)		B1		y intercept = 7 stated or seen in table as $y = 7$ when $x = 0$ or 7 marked as intercept on y-axis (any graph)
		M1		$\cup$ shape
		A1	3	vertex above x-axis in correct quadrant and parabola extending beyond y-axis into first quadrant
(c)	Translation	E1		and no other transformation
	through $\begin{bmatrix} -\frac{5}{2} \\ \frac{3}{4} \end{bmatrix}$	M1		ft either 'their' $-p$ or 'their' q or one component correct for M1
		A1cao	3	both components correct for A1; may describe in words or use a vector
	Total		**12**	

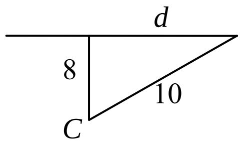
MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$\text{p}(3) = 3^3 - 2\times3^2 + 3 \,(= 27 - 18 + 3)$ $= 12$	M1 A1	 2	p(3) attempted; not long division
(b)	$\text{p}(-1) = (-1)^3 - 2(-1)^2 + 3$ $\text{p}(-1) = -1 - 2 + 3 = 0 \;\Rightarrow\; x+1$ is a factor	M1 A1cso	 2	p(–1) attempted; not long division correctly shown = 0 plus statement
(c)(i)	Quadratic factor $\left(x^2 - 3x + 3\right)$ $\left(\text{p}(x) =\right) \quad (x+1)\left(x^2 - 3x + 3\right)$	M1 A1	 2	b = –3 or c = 3 by inspection or full long division attempt or comparing coefficients must see correct product
(ii)	Discriminant of quadratic $b^2 - 4ac = (-3)^2 - 4\times3$ $\left.\begin{array}{l} b^2 - 4ac < 0 \Rightarrow \text{no real roots from quadratic} \\ \Rightarrow \text{only one real root} \end{array}\right\}$	M1 A1cso	 2	‘their’ discriminant considered possibly within quadratic equation formula
	Total		**8**	
6(a)	$\int_{-1}^{1}\left(x^3 - 2x^2 + 3\right)\text{d}x$ $= \left[\dfrac{x^4}{4} - \dfrac{2x^3}{3} + 3x\right]_{-1}^{1}$ $= \left(\dfrac{1}{4} - \dfrac{2}{3} + 3\right) - \left(\dfrac{1}{4} + \dfrac{2}{3} - 3\right)$ $= 4\dfrac{2}{3}$	 M1 A1 A1 B1√ A1cso	 5	 one term correct another term correct all correct (condone + c) ‘their’ F(1) – F(–1) with $(-1)^3$ etc evaluated correctly but must have earned M1 $\dfrac{14}{3}$, $\dfrac{56}{12}$ etc but combined as single fraction
(b)	Area of Δ $\left(= \dfrac{1}{2}\times2\times2\right)$ $= 2$ Shaded region has area $4\dfrac{2}{3} - 2$ $= 2\dfrac{2}{3}$	 B1 M1 A1cso	 3	 PI $\pm$ their (a) $\pm$ their Δ area $\dfrac{8}{3}$, $\dfrac{32}{12}$ etc but combined as single fraction
	Total		**8**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$8-6x > 5-4x-8$	M1		multiplying out correctly and $>$ sign used
	$11 > 2x$			
	$x < 5\frac{1}{2}$ $\left(or\ x < \frac{11}{2} \right)$	A1cso	2	accept $5.5 > x$ OE
(b)	$2x^2+5x-12 \geqslant 0$			
	$(x+4)(2x-3)$	M1		correct factors (or roots unsimplified) $\frac{-5\pm\sqrt{121}}{4}$
	Critical values are -4 and $\frac{3}{2}$	A1		both CVs correct; condone $\frac{6}{4}, -\frac{16}{4}$ etc here but must be single fractions
		M1		sketch or sign diagram including values 
	$x \leqslant -4$, $x \geqslant \frac{3}{2}$ ***take their final line as their answer***	A1	4	fractions must be simplified condone use of **OR** but not **AND**
	Total		**6**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
8(a)	$(x-3)^2+(y+8)^2$	B1		accept $(y--8)^2$
	$=100$	B1	2	condone RHS $=10^2$ or $k=10^2$
(b)	$y=0 \Rightarrow$ 'their'$(x-a)^2+b^2=k$	M1		**Alternative** 
	$(x-3)^2=36$ or $x^2-6x-27 \ (=0)$ (PI)	A1		
	$\Rightarrow x=-3,\ 9$	A1	3	$(d^2=)\ 10^2-8^2$ M1 $d^2=36$ A1 or $d=6$ $\Rightarrow x=-3,\ 9$ A1
(c)	Line *CA* has gradient $-\frac{2}{5}$	M1		
	CA has equation $(y+8)=-\frac{2}{5}(x-3)$	A1		any form of correct equation eg $y=-\frac{2}{5}x+c$, $c=-\frac{34}{5}$
	$2x+5y+34=0$	A1cso	3	integer coefficients - all terms on 1 side
(d)(i)	their $(x-3)^2+(2x+1+8)^2$ *or* $x^2+(2x+1)^2-6x+16(2x+1)\quad(+73)$	M1		substituting $y=2x+1$ correctly into LHS of "their" circle equation and attempt to expand in terms of x only
	$x^2-6x+9+4x^2+36x+81=100$ *or* $x^2+4x^2+4x+1-6x+32x+16+73=100$	A1		any correct equation (with brackets expanded)
	$\Rightarrow 5x^2+30x-10=0$			must see this line or equivalent
	$\Rightarrow x^2+6x-2=0$	A1cso	3	AG; all algebra must be correct
(ii)	$(x+3)^2=11$	M1		or correct use of formula must get as far as $x=\frac{-6\pm\sqrt{44}}{2}$
	$x=-3\pm\sqrt{11}$	A1cso	2	exactly this
	Total		**13**	
	TOTAL		**75**	