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General Certificate of Education (A-level)
January 2012

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**.

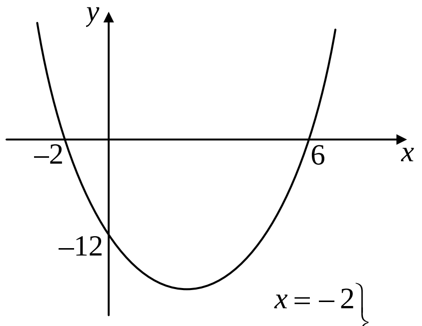
Otherwise we require evidence of a correct method for any marks to be awarded.

MPC1

Q	Solution	Marks	Total	Comments
1(a)	$(OA^2 =)\ 6^2 + (-4)^2$; $(OB^2 =)\ (-2)^2 + 7^2$	M1		either correct PI by 52 or 53 seen
	$(OA^2 =)\ 52$ **and** $(OB^2 =) 53$ or $(OA =)\sqrt{52}$ **and** $(OB =)\sqrt{53}$	A1		both correct values 52 or $\sqrt{52}$ **and** 53 or $\sqrt{53}$ seen
	$OA = \sqrt{52}$ and $OB = \sqrt{53}$ $\Rightarrow\ OA < OB$	A1	3	or $OA^2 = 52$ *and* $OB^2 = 53$ correct working + concluding statement involving *OA* and/or *OB*
(b)(i)	grad $AB = \dfrac{7+4}{-2-6}$	M1		condone one sign error
	$= -\dfrac{11}{8}$	A1	2	
(ii)	$y - -4 =$ 'their grad AB'$(x - 6)$ or $y - 7 =$ 'their grad AB'$(x - -2)$	M1		or $y =$ 'their grad AB' $x + c$ and attempt to find c using $x = 6$, $y = -4$ or $x = -2$, $y = 7$
	$y + 4 = -\dfrac{11}{8}(x - 6)$ OE	A1		any correct form *eg* $y = -\dfrac{11}{8}x + \dfrac{34}{8}$ but must simplify $--$ to +
	$\Rightarrow 11x + 8y = 34$	A1	3	condone $8y + 11x = 34$ or any multiple of these equations
(c)	(grad AC =) $\dfrac{8}{11}$	B1√		FT −1 / 'their grad AB'
	$\dfrac{4}{k-6}$ = 'their $\dfrac{8}{11}$' OE $\Rightarrow\ 2k - 12 = 11$	M1		equating gradients; LHS must be correct and RHS is "attempt" at perp grad to *AB*
	$\Rightarrow\ k = \dfrac{23}{2}$	A1cso	3	$k = 11.5$ OE
	Total		**11**	

(c) ***Alternative:*** Eqn AC : $(y + 4) =$ '*their* $\dfrac{8}{11}$' $(x - 6)$ B1√ $(11y = 8x - 92)$ **AND** must sub $y = 0$ for M1

or $(y - 0) =$ '*their* $\dfrac{8}{11}$' $(x - k)$ B1√ **AND** must sub $x = 6$, $y = -4$ for M1

Q	Solution	Marks	Total	Comments
2(a)	$(x-6)(x+2)$	B1	1	ISW for $x=6,\ x=-2$ etc
(b)				
	$\left.\begin{array}{l} x=-2 \\ x=6 \end{array}\right\}$	B1√		correct x values *or* FT 'their' factors (x-intercepts stated ***or*** marked on sketch) may be seen in (a)
	$y=-12$	B1		(stated ***or*** –12 marked on sketch)
	∪ – shaped curve	M1		approximately
	"correct" shape in all 4 quadrants with minimum to right of y-axis	A1	4	
(c)(i)	$(x-2)^2$	M1		$p=2$
	$(x-2)^2-16$	A1	2	$p=2$ and $q=16$
(ii)	(Minimum value is) –16	B1√	1	FT ' their $-q$ '
(d)	Replacing each x by $x+3$ **OR** adding 2 to their quadratic	M1		in original equation or 'their' completed square or factorised form or replacing y by $y-2$
	$y=\left[(x+3)^2-4(x+3)-12\right]+2$ or $y=(x+1)^2-14$ or $y=x^2+2x-13$ or $y-2=(x-3)(x+5)$	A1	2	OE any correct equation in x and y **unsimplified**
	Total		**10**	

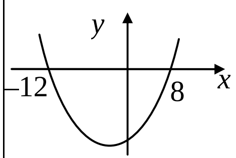
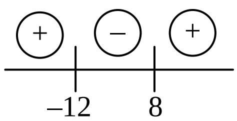
MPC1 (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	$\left(3\sqrt{2}\right)^2 = 18$	B1	1	
(ii)	$\left(3\sqrt{2}-1\right)^2 = \text{'}\textit{their}\ 18\text{'} - 3\sqrt{2} - 3\sqrt{2} + 1$	M1		FT their $\left(3\sqrt{2}\right)^2$
	$= 18 - 3\sqrt{2} - 3\sqrt{2} + 1$	A1		$\left(=19-6\sqrt{2}\right)$
	$\left(3+\sqrt{2}\right)^2 = 9 + 3\sqrt{2} + 3\sqrt{2} + 2$	B1		$\left(=11+6\sqrt{2}\right)$
	$\Rightarrow$ Sum = 30	A1cso	4	
(b)	$\dfrac{4\sqrt{5}-7\sqrt{2}}{2\sqrt{5}+\sqrt{2}} \times \dfrac{2\sqrt{5}-\sqrt{2}}{2\sqrt{5}-\sqrt{2}}$	M1		
	Numerator = $8\left(\sqrt{5}\right)^2 - 4\sqrt{5}\sqrt{2} - 14\sqrt{5}\sqrt{2} + 7\left(\sqrt{2}\right)^2$	m1		correct unsimplified $\left(=54-18\sqrt{10}\right)$
	Denominator = $\left(2\sqrt{5}\right)^2 - \left(\sqrt{2}\right)^2$ = 18	B1		must be seen as denominator
	$\Rightarrow$ Answer = $3 - \sqrt{10}$	A1cso	4	
	Total		**9**	

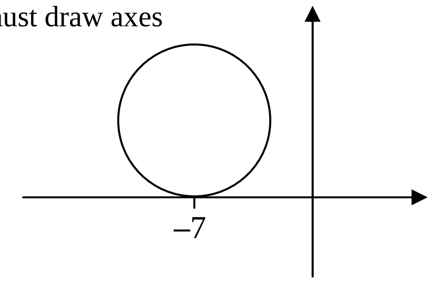
MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$\left(\frac{dy}{dx}=\right)\ 5x^4-6x+1$	M1 A1 A1	3	one term correct another term correct all correct (no + c etc)
(ii)	$\left(\frac{d^2y}{dx^2}=\right)\ 20x^3-6$	B1√	1	FT 'their' $\frac{dy}{dx}$
(b)	$x=-1 \Rightarrow \frac{dy}{dx}=5(-1)^4-6(-1)+1\ \ (=12)$	M1		must sub $x=-1$ into 'their' $\frac{dy}{dx}$
	$\Rightarrow\ y=12(x+1)$	A1cso	2	any correct form with $(x--1)$ simplified condone $y=12x+c,\quad c=12$
(c)	$x=1\Rightarrow\frac{dy}{dx}=5-6+1$	M1		sub $x=1$ into their $\frac{dy}{dx}$
	$\frac{dy}{dx}=0\ \Rightarrow$ stationary point	A1cso		shown $=0$ plus correct statement
	when $x=1,\ \frac{d^2y}{dx^2}=14$			or $\frac{d^2y}{dx^2}=20-6>0$
	$\Rightarrow$ (B is a) minimum (point)	E1	3	$\Rightarrow$ (B is a) minimum (point) must have correct $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ for E1
(d)(i)	$\frac{x^6}{6}-\frac{3x^3}{3}+\frac{x^2}{2}+5x$	M1 A1 A1		one term correct another term correct all correct (may have $+c$)
	$\left[\frac{1}{6}-1+\frac{1}{2}+5\right]-\left[\frac{1}{6}+1+\frac{1}{2}-5\right]$	m1		'their' F(1) – F(–1) with powers of 1 and –1 evaluated correctly
	$=\ 8$	A1cso	5	
(ii)	'their answer to part (i)' -2	M1		
	$\Rightarrow$ Area = 6	A1cso	2	
	Total		**16**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$p(-2) = (-2)^3 + (-2)^2 c + (-2)d - 12$	M1		p(–2) attempted *or* long division by x+2 as far as remainder
	‘their’ $-8 + 4c - 2d\ \ -12 = -150$	m1		putting expression for remainder = –150
	$\Rightarrow\ 2c - d + 65 = 0$	A1cso	3	**AG** terms all on one side in any order (check that there are no errors in working)
(b)	$p(3) = 3^3 + 3^2 c + 3d - 12$	M1		p(3) attempted *or* long division by x–3 as far as remainder
	$9c + 3d + 15 = 0$	A1	2	any correct equation with terms collected eg $3c + d = -5$
(c)	$\left.\begin{array}{l}2c - d + 65 = 0\\ 3c + d + \ \ 5 = 0\end{array}\right\} \Rightarrow 5c = -70$	M1		Elimination of c or d
	$\Rightarrow\ c = -14\ ,\ d = 37$ OE	A1 A1	 3	value of c ***or*** d correct unsimplified both c and d correct unsimplified
	Total		**8**	
6(a)	Sides are x and $x + 4$ $\Rightarrow\ x + x + x + 4 + x + 4 > 30$ *or* $2x + 2x + 8 > 30$ *or* $2(2x + 4) > 30$ *or* $4x + 8 > 30$			must see this line OE
	$(\Rightarrow 4x > 22)$ $\Rightarrow 2x > 11$	B1	1	**AG** (be convinced) condone 11 < 2x
(b)	$x(x + 4) < 96$			must see this line OE
	$\Rightarrow x^2 + 4x - 96 < 0$	B1	1	**AG**
(c)	$(x + 12)(x - 8)$	M1		correct factors or correct quadratic equation formula
	Critical values 8, –12	A1		
	 or 	M1		sketch or sign diagram
	$\Rightarrow\ -12 < x < 8$	A1cso	4	accept $x < 8$ **AND** $x > -12$ but **not** $x < 8$ **OR** $x > -12$ **nor** $x < 8$ **,** $x > -12$
(d)	$5\frac{1}{2} < x < 8$	B1	1	
	Total		**7**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$\left(x+7\right)^2+\left(y-5\right)^2$	M1		one term correct ; condone $(x--7)^2$
		A1		both terms correct with squares and plus sign between terms
	$\left(x+7\right)^2+\left(y-5\right)^2 \quad = 5^2$	A1cao	3	condone 25 for 5^2
(b)(i)	$C\left(-7, 5\right)$	B1$\surd$		correct or FT 'their' circle equation
(ii)	$r = 5$	B1$\surd$	2	correct or FT 'their' $r^2 > 0$ condone $\sqrt{25}$ etc but not $\pm\sqrt{25}$
(c)	must draw axes 	M1		freehand circle with C correct or FT 'their C' for quadrant of centre
		A1	2	circle touching x-axis at -7 with -7 marked (need not show 5 on y-axis) but circle must not touch y-axis
(d)(i)	$x^2+(kx+6)^2+14x-10(kx+6)+49=0$			clear attempt to sub $y = kx+6$ into original or 'their' circle equation …
	$x^2+k^2x^2+12kx+36+14x$ $-10kx-60+49=0$	M1		…***and*** attempt to multiply out
	$(1+k^2)x^2+2kx+14x+25=0$ $\Rightarrow (k^2+1)x^2+2(k+7)x+25=0$	A1cso	2	**AG** condone $x^2(1+k^2)+2x(7+k)+...$ etc
(ii)	Equal roots '$b^2-4ac=0$'	B1		allow statement alone if discriminant in terms of k attempted
	$\left[2\left(k+7\right)\right]^2-4\times 25\left(k^2+1\right)$	M1		discriminant (condone one slip)
	$4\left\{k^2+14k+49-25k^2-25\right\}=0$ $-24k^2+14k+24=0$			
	$\Rightarrow 12k^2-7k-12=0$	A1	3	**AG** all working correct but = 0 must appear before last line
(iii)	$\left(4k+3\right)\left(3k-4\right)$	M1		correct factors or correct use of formula as far as $k=\dfrac{7\pm\sqrt{49+576}}{24}$
	$\Rightarrow k=-\dfrac{3}{4},\ k=\dfrac{4}{3}$ OE are values of k for which line is a tangent	A1	2	
	Total		**14**	
	TOTAL		**75**	