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General Certificate of Education (A-level)
January 2011

Mathematics MPC1

(Specification 6360)

Pure Core 1

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)	$\frac{dy}{dx} = 18 + 6x - 12x^2$	M1 A1 A1	 3	one of these terms correct another term correct all correct (no + *c* etc) (penalise + *c* once only in question)
(b)	$18 + 6x - 12x^2 = 0$	M1		putting their $\frac{dy}{dx} = 0$, PI by attempt to solve or factorise
	$6\ (3-2x)(x+1) \quad (=0)$	m1		attempt at factors of **their quadratic** or use of quadratic equation formula
	$x = -1,\ x = \frac{3}{2}$ OE	A1	3	must see both values unless $x = -1$ is verified separately If M1 not scored, award SC B1 for verifying that $x = -1$ leads to $\frac{dy}{dx} = 0$ and a further SC B2 for finding $x = \frac{3}{2}$ as other value
(c)(i)	$\frac{d^2y}{dx^2} = 6 - 24x$	B1√		FT their $\frac{dy}{dx}$ but $\frac{d^2y}{dx^2}$ must be correct if 3 marks earned in part (a)
	When $x = -1,\ \frac{d^2y}{dx^2} = 6 - (24 \times -1)$	M1		Sub $x = -1$ into 'their' $\frac{d^2y}{dx^2}$
	$\frac{d^2y}{dx^2} = 30$	A1cso	3	
(ii)	Minimum point	E1√	1	must have a value in (c)(i) FT "maximum" if their value of $\frac{d^2y}{dx^2} < 0$
	Total		**10**	

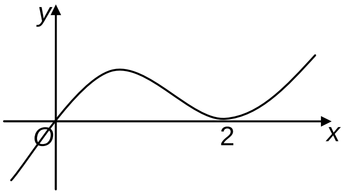
MPC1 (cont)

Q	Solution	Marks	Total	Comments
2(a)	27	B1	1	
(b)	$\dfrac{4\sqrt{3}+3\sqrt{7}}{3\sqrt{3}+\sqrt{7}} \times \dfrac{3\sqrt{3}-\sqrt{7}}{3\sqrt{3}-\sqrt{7}}$	M1		
	(Numerator =) $36 + 9\sqrt{21} - 4\sqrt{21} - 21$	m1		expanding numerator condone one slip or omission
	(Denominator =) 20	B1		must be seen as denominator
	$\dfrac{15+5\sqrt{21}}{20}$ $= \dfrac{3+\sqrt{21}}{4}$	A1cso	4	$m = 3$, $n = 4$ condone $\dfrac{3}{4}+\dfrac{\sqrt{21}}{4}$
	Total		**5**	
3(a)(i)	$y = \dfrac{1}{2}(7-3x)$	M1		attempt at $y = \ldots$ or use of 2 correct points using $\dfrac{\Delta y}{\Delta x}$
	$\Rightarrow$ gradient $= -\dfrac{3}{2}$	A1	2	condone slip in rearranging if gradient is correct
(ii)	$y =$ 'their grad' $x + c$ and substitution of $x = 2$, $y = –7$	M1		or using $3x + 2y = k$ with $x = 2$, $y = –7$ and attempt to find k or $y - -7 =$ 'their grad'$(x-2)$
	$y = -\dfrac{3}{2}x + c, \quad c = -4$	A1		correct equation in any form $y+7 = -\dfrac{3}{2}(x-2)$, $3x + 2y + 8 = 0$, etc
	$(x = 0 \Rightarrow)\ y = -4$	A1cso	3	or y-intercept = –4 or $D(0, –4)$
(b)	$3x+2(1-4x)=7$, $y = 1-\dfrac{4}{3}(7-2y)$	M1		elimination of y (or x) (condone one slip)
	$x = -1$	A1		one coordinate correct
	$y = 5$	A1	3	other coordinate correct coordinates of $A(–1, 5)$
(c)	$(5-2)^2 + (k+7)^2 = 5^2$ (or $k + 7 = 4$ or $k + 7 = –4$)	M1		condone one sign slip within one bracket
	$k = -3$	A1		one correct value of k
	or $k = -11$	A1	3	both correct (and no other values)
	Total		**11**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$\frac{dy}{dx} = -1 - 4x^3$	M1 A1		one of these terms correct all correct (no + c)
	(When $x = 1$, grad =) -5	A1cso	3	(Check that $\frac{dy}{dx}$ is actually correct!)
(ii)	$y - 12 = \text{'their grad'}(x - 1)$	M1		any form of equation through (1, 12) and attempt at c if using $y = mx + c$
	$y = -5x + 17$ (or $y = 17 - 5x$)	A1√	2	FT their gradient Condone $y = -5x + c$, $c = 17$ etc
(b)(i)	$14x - \frac{x^2}{2} - \frac{x^5}{5}$	M1 A1 A1		one of these terms correct another term correct all correct (may have + c)
	$[\ ]_{-2}^{1} =$			
	$\left(14 - \frac{1}{2} - \frac{1}{5}\right) - \left(-28 - 2 + \frac{32}{5}\right)$	m1		F(1) and F(–2) attempted
	= 36.9 OE	A1	5	Condone recovery to this value
(ii)	Area $\Delta = \frac{1}{2} \times 3 \times 12$ = 18	M1		Correct area of triangle unsimplified
	$\Rightarrow$ shaded area = 18.9	A1cso	2	
	Total		**12**	

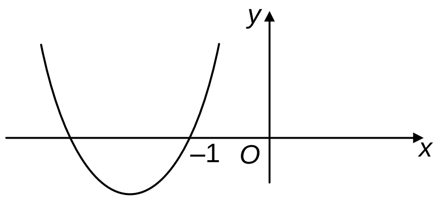
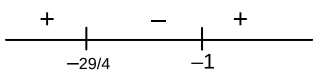
MPC1 (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)		M1		cubic curve with one max and one min (either way up)
		A1		curve touching positive x-axis (either way up)
		A1	3	correct graph passing through O and touching x-axis at 2
(ii)	$x\left(x^2-4x+4\right)=3$			
	$\Rightarrow x^3-4x^2+4x-3=0$	B1	1	AG (must have = 0)
(b)(i)	$\text{p}(-1)=(-1)^3-4(-1)^2+4(-1)-3$ $(=-1-4-4-3)$	M1		p(–1) attempted (condone one slip) or full long division to remainder
	$= -12$	A1	2	must indicate remainder = –12 if long division used
(ii)	$\text{p}(3)=3^3-4\times3^2+4\times3-3$	M1		p(3) attempted (condone one slip) NOT long division
	$\text{p}(3)=27-36+12-3$ $\text{p}(3)=0\Rightarrow x-3$ is factor	A1	2	shown = 0 **plus statement**
(iii)	Either $b=-1$ (coefficient of x correct) or $c=1$ (constant term correct)	M1		allow M1 for full attempt at long division or comparing coefficients if neither b nor c is correct
	$\text{p}(x)=(x-3)\left(x^2-x+1\right)$	A1	2	
(c)	Discriminant of ‘their quadratic’ $=(-1)^2-4$	M1		numerical expression must be seen
	Discriminant = –3 (or < 0) $\Rightarrow$ no real roots	A1cso		must have correct quadratic and statement and all working correct
	(Only real root is x =) 3	B1	3	
	Total		**13**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$(x+3)^2+(y-1)^2$	B1		condone $(x--3)^2$
	$= 13$	B1	2	condone $\left(\sqrt{13}\right)^2$
(ii)	$x^2+6x+9+y^2-2y+1$	M1		attempt to multiply out both of 'their' brackets; must have x and y terms
	$x^2+y^2+6x-2y$	A1		both $m = 6$ and $n = -2$
	$-3=0$	A1	3	All correct, $p = -3$ and ... = 0
(b)	$x=0 \Rightarrow y^2-2y-3=0$			putting $x = 0$ PI
	$\Rightarrow (y-3)(y+1)=0$	M1		and attempt to solve or factorise
	$y=3,\ y=-1$	A1		
	$\Rightarrow$ Distance $AB=3+1=4$	A1cso	3	**OR** Pythagoras $d^2=13-3^2$ M1 $d = 2$ A1 distance $= 2\times 2 = 4$ A1
(c)(i)	$(-5+3)^2+(-2-1)^2=4+9$			Substitution $x=-5$, $y=-2$ into any correct circle equation
	$=13$			
	$\Rightarrow$ D lies on circle	B1	1	convincing verification **plus statement**
(ii)	grad CD $=\dfrac{1+2}{-3+5}$	M1		condone one sign slip
	$=\dfrac{3}{2}$ (or 1.5)	A1	2	not $\dfrac{-3}{-2}$
(iii)	Perpendicular gradient $=-\dfrac{2}{3}$	M1		ft their grad CD or $m_1m_2=-1$ stated
	Tangent has equation $y+2=-\dfrac{2}{3}(x+5)$	A1	2	any form of correct equation eg $2x + 3y + 16 = 0$ $y=-\dfrac{2}{3}x+c,\ c=-\dfrac{16}{3}$
	Total		**13**	

MPC1 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	(–) $(x+5)^2$	M1		$q = 5$; condone $(-x-5)^2$
	$29 - (x+5)^2$	A1	2	$p = 29$ and $q = 5$
(ii)	$x = -5$ is line of symmetry	B1√	1	FT $x = -$ 'their q' or correct
(b)(i)	$4 - 10x - x^2 = k(4x - 13)$			
	$\Rightarrow x^2 + 4kx + 10x - 13k - 4 = 0$			Must see both these lines OE
	$\Rightarrow x^2 + 2(2k+5)x - (13k+4) = 0$	B1	1	AG all correct working and = 0
(ii)	2 distinct roots $\Rightarrow b^2 - 4ac > 0$	B1		stated or used (must be > 0)
	Discriminant = $4(2k+5)^2 + 4(13k+4)$	M1		condone one slip (may be within formula)
	$4(4k^2 + 20k + 25 + 13k + 4) > 0$			or $16k^2 + 132k + 116 > 0$
	$\Rightarrow 4k^2 + 33k + 29 > 0$	A1	3	AG > 0 must appear before final line
(iii)	$(4k+29)(k+1)$	M1		correct factors or correct unsimplified quadratic equation formula $\dfrac{-33 \pm \sqrt{33^2 - 4\times 4\times 29}}{8}$
	$k = -\dfrac{29}{4}$, $k = -1$	A1		condone $k = -\dfrac{58}{8}$ **,** –7.25 etc but not left with square roots etc as above
$-\dfrac{29}{4}$		M1		sketch or sign diagram including values 
	$k < -\dfrac{29}{4}$, $k > -1$ ***Take their final line as their answer***	A1	4	condone use of **OR** but not **AND**
	Total		**11**	
	TOTAL		**75**	