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**General Certificate of Education**

**Mathematics 6360**

**MPC2      Pure Core 2**

**Mark Scheme**

*2009 examination - January series*

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## Key to mark scheme and abbreviations used in marking

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	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
-x EE	deduct x marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	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. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

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.**

**MPC2**

Q	Solution	Marks	Total	Comments
<b>1(a)</b>	{Area of sector =} $\frac{1}{2}r^2\theta$	M1	2	$\frac{1}{2}r^2\theta$ stated or used for area of sector. PI
	$=\frac{1}{2}\times 10^2\times 0.8=40\text{ cm}^2$	A1		
<b>(b)(i)</b>	{Arc =} $r\theta$ .... = 8	M1 A1	3	$r\theta$ stated or used for arc length. PI PI ft on $20+r\times\theta$
	Perimeter = $20+r\theta=28\text{ (cm)}$	A1ft		
<b>(ii)</b>	Area of square = $\left[\frac{\text{c's answer for (b)(i)}}{4}\right]^2$ $=49\text{ cm}^2$	M1 A1cao	2	PI
<b>Total</b>			<b>7</b>	
<b>2(a)</b>	$h=1.5$ $f(x)=x^2\sqrt{x^2-1}$ Integral = $h/2\{\dots\}$	B1	4	PI  For the M1 covered range must be 1.5 to 6 OE summing of areas of the three traps.  Check at least 3sf values, rounded or truncated, or award if a combined value WRT 444 is seen or final answer is 333 or rounds to 333 Condone one numerical slip  Must have 333  Treat using 4 strips as a MR and mark with max of B0M1A1A1cao as follows: $h=1.125$ B0 {...} $=f(1.5)+2[f(2.625)+f(3.75)+f(4.875)]+f(6)$ M1 $=2.51(5)+2[16.7(2)+50.8(2)+113(.3)]+212(.9)$ A1 or award if a combined value WRT 577 is seen or final answer is 325 or rounds to 325. Condone one numerical slip. Answer = 325 A1cao Must have 325
	{...} = $f(1.5)+2[f(3)+f(4.5)]+f(6)$	M1		
	{...} = $2.51(5..)+2[25.4(5..)+88.8(4..)]+212(.9..)$  Integral = $0.75\times 444.1=333$ to 3sf	A1 A1cao		
<b>(b)</b>	Increase the number of ordinates	E1	1	OE eg increase the number of strips
<b>Total</b>			<b>5</b>	

**MPC2 (cont)**

Q	Solution	Marks	Total	Comments
3(a)	{Area =} $\frac{1}{2} \times 7.4 \times 5.26 \times \sin 63^\circ$	M1	2	Accept any value from 17.3 to 17.341
	= 17.3(407...) {m <sup>2</sup> }	A1		
(b)	{BC <sup>2</sup> =} $5.26^2 + 7.4^2 - 2 \times 5.26 \times 7.4 \cos 63$	M1	3	RHS of cosine rule used
	..... = 27.66(76) + 54.76 - 35.34(22...)	m1		Correct order of evaluation
	$\Rightarrow BC = \sqrt{47.08(5...)} = 6.861(8..)$  $BC = 6.86 \text{ {m} to 3sf}$	A1		AG. Cand. must show a 4 <sup>th</sup> sf in either $\sqrt{47.08(5...)}$ or 6.861(8) before giving the printed answer 6.86
(c)	$\frac{\sin B}{5.26} = \frac{\sin 63}{BC}$	M1	2	Sine rule involving 'sin B' [If valid cosine rule used to find cos B, no marks awarded until stage of converting to sin B]
	sin B = 0.68 to 2sf	A1		If not 0.68, accept AWRT any value from 0.682 to 0.684 inclusive
	<u>ALTn</u> $\frac{1}{2} \times 7.4 \times (6.86..) \times \sin B = c's \text{ ans (a)}$	(M1)		(6.86..) could be c's ans (b)
	sin B = 0.68 to 2sf	(A1)		If not 0.68, accept AWRT any value from 0.682 to 0.684 inclusive
<b>Total</b>			<b>7</b>	

**MPC2 (cont)**

Q	Solution	Marks	Total	Comments
<b>4(a)(i)</b>	$\frac{dy}{dx} = 3x^{\frac{1}{2}}$	M1	2	$kx^{\frac{1}{2}}$ with or without + c
	$= 6$ {when $x = 4$ }	A1cao		Must be 6 and seen in (a)(i) $6 + c$ is A0
<b>(ii)</b>	y-coordinate of A = $2 \times 4^{\frac{3}{2}}$ (= 16)	M1	4	Substitute $x = 4$ in $y = 2x^{\frac{3}{2}}$
	$6 \times m' = -1$	M1		$m_1 \times m_2 = -1$ OE used with c's value of $\frac{dy}{dx}$ when $x = 4$ . PI
	$y - 16 = m(x - 4)$	m1		dep on 1 <sup>st</sup> M1 in (a)(ii) $m$ must be numerical
	$y - 16 = -\frac{1}{6}(x - 4)$	A1		ACF
<b>(b)(i)</b>	$\int 8x^{\frac{1}{2}} dx = \frac{8}{\frac{3}{2}} x^{\frac{1}{2}+1} \{+c\}$	M1	2	Index raised by 1
	$= \frac{16}{3} x^{\frac{3}{2}} \{+c\}$	A1		Condone missing '+ c' Coefficient must be simplified
<b>(ii)</b>	$\int 2x^{\frac{3}{2}} dx = \frac{2}{\frac{5}{2}} x^{\frac{3}{2}+1} \{+c\} \quad \{= \frac{4}{5} x^{\frac{5}{2}} \{+c\}\}$	B1	4	Can award for unsimplified form
	$\int_0^4 8x^{\frac{1}{2}} dx - \int_0^4 2x^{\frac{3}{2}} dx$	M1		Ignore limits here
	$= \frac{16}{3}(4)^{\frac{3}{2}} - 0 - \left[ \frac{4}{5}(4)^{\frac{5}{2}} - 0 \right]$	M1		F(4) – F(0) used in either; {F(0)=0 PI} Cand. must be using F(x) as a result of his/her integration in (b)(i) or in the (b)(ii) B1 line above
	$= \frac{256}{15}$	A1		Accept any value from 17.04 to 17.1 inclusive in place of 256/15
<b>(c)</b>	Translation	B1	2	Accept 'translat...' as equivalent [T or Tr is NOT sufficient]
	$\begin{bmatrix} -3 \\ 0 \end{bmatrix}$	B1		Accept equivalent in words provided linked to 'translation/move/shift' (BOB0 if >1 transformation)
<b>Total</b>			<b>14</b>	

**MPC2 (cont)**

<b>Q</b>	<b>Solution</b>	<b>Marks</b>	<b>Total</b>	<b>Comments</b>
<b>5(a)</b>	$(1+2x)^4 = 1+4(2x)+6(2x)^2+4(2x)^3+(2x)^4$	M1	4	(1), 4, 6, 4, (1) OE unsimplified with correct powers of $x$ Algebraic multiplication must be a full method
	$= 1 + 8x + 24x^2 + 32x^3 \{+ 16x^4\}$	A1 A1 A1		Accept $a = 8$ provided 1 <sup>st</sup> term is 1 $b = 24$ $c = 32$
	<b>(b)</b> $(1 - 2x)^4 = 1 - 8x + 24x^2 - 32x^3 \{+ 16x^4\}$	M1 A1ft		Replace $x$ by $-x$ even in M1 line of (a) PI ft c's non zero values for $a, b$ and $c$
<b>(c)</b>	$(1 + 2x)^4 + (1 - 2x)^4$ $= 1 + 8x + 24x^2 + 32x^3 + 16x^4$ $+ 1 - 8x + 24x^2 - 32x^3 + 16x^4$ $= 2 + 48x^2 + 32x^4$	A1cso	3	AG Be convinced
	$\frac{dy}{dx} = 96x + 128x^3$	M1		A correct power of $x$ OE
	For st. pt. $96x + 128x^3 = 0$  $32x(3 + 4x^2) = 0$ Since $3+4x^2 > 0$ there is only one stationary point	A1  E1		Any valid explanation of curve having just one stationary point
	The coordinates of the stationary point are (0, 2)	B1	4	(0, 2) as the <b>only</b> stationary point
	<b>Total</b>		<b>11</b>	

**MPC2 (cont)**

<b>Q</b>	<b>Solution</b>	<b>Marks</b>	<b>Total</b>	<b>Comments</b>	
<b>6(a)(i)</b>	$\log_a 40$	B1	1	Accept 'k = 40'	
<b>(ii)</b>	$\log_a 8$	B1	1	Accept 'k = 8'	
<b>(iii)</b>	$\log_a 125$	B1	1	Accept 'k = 125' but not 'k = 5 <sup>3</sup> '	
<b>(b)</b>	$\log_{10} [(1.5)^{3x}] = \log_{10} 7.5$	M1	3	Correct statement having taken logs of both sides of $(1.5)^{3x} = 7.5$ OE PI or $3x = \log_{1.5} 7.5$ seen	
	$3x \log_{10} 1.5 = \log_{10} 7.5$	m1			$\log 1.5^{3x} = 3x \log 1.5$ OE
	$x = \frac{\lg 7.5}{3 \lg 1.5} = 1.65645\dots = 1.656$ to 3dp	A1			Both method marks must have been awarded with clear use of logarithms seen
<b>(c)</b>	$\log_2 p = m \Rightarrow p = 2^m$ ; $\log_8 q = n \Rightarrow q = 8^n$	M1	3	Either $p = 2^m$ or $q = 8^n$ seen or used	
	$p = 2^m$ and $q = 2^{3n}$	m1			Writing $8^n = 2^{3n}$ and having $p = 2^m$
	$pq = 2^m \times (2^3)^n = 2^m \times 2^{3n}$ so $pq = 2^{m+3n}$	A1			Accept $y = m + 3n$
	<b>Total</b>		<b>9</b>		



**MPC2 (cont)**

Q	Solution	Marks	Total	Comments
7(a)	$\{x = \} \sin^{-1}(0.8) = 0.927(29\dots) \{ = \beta \}$	M1	3	Both Ignore values outside interval $0-2\pi$ but A0 if 'extra' values inside the given interval
	$\{x = \} \pi - \beta$	m1		
	$x = 0.927(29\dots), 2.21(42\dots)$	A1		
(b)(i)	$\left(\frac{3\pi}{2}, -1\right)$	B2,1	2	B1 if one coordinate correct or $\left(-1, \frac{3\pi}{2}\right)$
(ii)	$\pi - \alpha$	B1	1	
(iii)	$RS = (2\pi - \alpha) - (\pi + \alpha)$	M1	2	OE eg $RS = PQ = (\pi - \alpha) - \alpha$  Must be simplified
	$= \pi - 2\alpha$	A1		
(c)		B1	5	Sine curve with positive gradient at $O$ with at least 3 stationary points between $0$ and $2\pi$  Correct shaped curve with 2 max and 2 min between $0$ and $2\pi$  All 5 correct points of intersection with $x$ -axis with $\frac{\pi}{2}$ , $\pi$ and $\frac{3\pi}{2}$ clearly shown  B1 for either: 1 as the $y$ -coordinate of max pt(s) or: two max pts between $0$ and $2\pi$ with correct $x$ -coordinates
		B1		
		B1		
		B2,1		
<b>Total</b>			<b>13</b>	

**MPC2 (cont)**

Q	Solution	Marks	Total	Comments
<b>8(a)</b>	$\{S_{40} = \frac{40}{2}[2a + (40-1)d]\}$	M1	6	Dep on both previous two Ms. Solving two equations in $a$ and $d$ simultaneously  AG Be convinced SC Using the given answer for $d$ : mark out of a maximum of 4/6 as M1A1M1A1 {conclusion also needed in last A mark} (m0A0)
	$20(2a + 39d) = 1250$	A1		
	$\{25^{\text{th}} \text{ term} = \} a + (25 - 1)d$	M1		
	$a + 24d = 38$	A1		
		m1		
	$18d = 27 \Rightarrow d = 1.5$	A1cso		
<b>(b)</b>	$a = 38 - 24 \times 1.5$	M1	3	PI if using $a = 2$ in <b>(b)</b>  If using eg $a = 38$ award this M mark at stage: no. of terms $\frac{100-38}{1.5} + 1 + 24$
	$= 2$			
	$a + (n - 1)1.5 < 100$	M1		
	$n < \frac{100 - a}{1.5} + 1$			
	$n < 66.333\dots$ $\Rightarrow$ number of terms $< 100$ is 66	A1		
	<b>Total</b>		<b>9</b>	
	<b>TOTAL</b>		<b>75</b>	