AQA Maths Pure Core 2

Mark Scheme Pack

2006-2015

Version 1.0: 0106

General Certificate of Education

Mathematics 6360

MPC2 Pure Core 2

Mark Scheme

2006 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.

Q	Solution	Marks	Total	Comments
1	$y'(x) = 16 - x^{-2}$	M1 A1		One term correct Both correct
	$y'(x) = 16 - \frac{1}{x^2}$	B1		$x^{-2} = \frac{1}{x^2}$ OE PI
	$y'(x) = 0 \Rightarrow 16x^2 = 1$;	M1		c's $y'(x)$=0 and one relevant further step
	$\Rightarrow x = \pm\frac{1}{4}$	A1	5	Both answers required.
	Total		**5**	
2(a)	$h = 1$	B1		PI
	Integral $= \frac{h}{2}\{\ldots\}$ $\{\ldots\} = f(0) + f(4) + 2[f(1) + f(2) + f(3)]$	M1		OE summing of areas of the four trapezia. [0.75+0.35+0.15+0.079…]
	$= \left[1 + \frac{1}{17} + 2\left(\frac{1}{2} + \frac{1}{5} + \frac{1}{10}\right)\right]$	A1		Exact or to 3dp values Condone one numerical slip
	Integral = 1.329	A1	4	**CSO**. Must be 1.329
(b)	Increase the number of ordinates	E1	1	OE
	Total		**5**	
3(a)	$\log 0.8^x = \log 0.05$ | $x = \log_{0.8} 0.05$ (**M1**)	M1		**NMS**: **SC** B2 for 13.425 or better (B1 for 13.4 or 13.43; 13.42)
	$x\log_{10} 0.8 = \log_{10} 0.05$ oe	A1		
	$x = 13.425$ to 3dp | 13.425 (**A2**) (**else A1** for 1 or 2dp)	A1	3	Condone greater accuracy
(b)(i)	$\frac{a}{1-r}$	M1		$S_\infty = \frac{a}{1-r}$ **<u>used</u>**
	$\frac{a}{1-r} = 5a \Rightarrow a = 5a(1-r)$	A1		Or better
	$\Rightarrow 1 = 5(1-r) \Rightarrow r = \frac{4}{5} = 0.8$	A1	3	AG (be convinced)
(ii)	n^{th} term = $20 \times (0.8)^{n-1}$	M1		Condone $20 \times (0.8)^n$.
	n^{th} term < 1 $\Rightarrow 0.8^{n-1} < \frac{1}{20}$ oe	A1		$0.8^{n-1} < 0.05$ or $0.8^{n-1} = k$, where k =0.05 or k rounds **up** to 0.050
	Least n is 15	A1F	3	If not 15, ft on integer part of [answer (a)+2] provided n>2 **SC** 3/3 for 15 if no error **SC** n^{th} term=16^{n-1}M1A0A0
	Total		**9**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
	[**Note: Calc. set in wrong mode, penalise only once on the paper**.] **Condone missing units throughout the question.**			
4(a)	Area of triangle $=\frac{1}{2}(12)(8)\sin\theta$	M1		Use of $\frac{1}{2}ab\sin C$ or full equivalent
	$\sin\theta=\frac{20}{48}$ [=0.41(666…)]	A1		OE (giving 0.412 to 0.42)
	$\Rightarrow\theta$ = 0.4297(7…) = 0.430 to 3sf	A1	3	AG(need to see >3sf value)
(b)	$\{AB^2=\}8^2+12^2-2\times8\times12\times\cos\theta$	M1		
	= 64 + 144 – 174.5….	m1		Accept 33 to 34 inclusive if three values not separate
	$\Rightarrow AB$ = 5.78… = 5.8 cm to 2sf	A1	3	If not 2sf condone 5.78 to 5.79 inclusive. Condone ±
(c)(i)	Arc $AD=8\theta$;	M1;		
	= 3.44.. = 3.4 cm to 2sf	A1	2	If not 2sf condone 3.438 to 3.44 inclusive
(ii)	Area of sector = $\frac{1}{2}r^2\theta$	M1		Stated or used [or 13.7(6..) seen]
	Shaded area = Area of triangle – sector area	M1		Difference of areas
	Shaded area $=20-0.5\times8^2\times\theta$			
	= 6.2 cm^2 to 2sf	A1	3	Condone 6.24 to 6.2472
	Total		**11**	
5(a)	$150=200p+q$	M1		Either equation
	$120=150p+q$	A1		Both (condone embedded values for the M1A1)
		m1		Valid method to solve two simultaneous eqns in p <u>and</u> q to find either p or q
	p = 0.6	A1		AG (condone if left as a fraction)
	q = 30	B1	5	
(b)	$u_4=102$	B1F√	1	Ft on (72 + q)
(c)	$L=pL+q$; $L=0.6L+30$	M1		
	$L=\frac{q}{1-p}$	m1		
	L = 75	A1F√	3	Ft on 2.5q
	Total		**9**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	Stretch **(I)** in y-direction **(II)** Scale factor 2 **(III)**	M1A1	2	>1 transformation is M0. M1 for **(I)** and either **(II)** or **(III)** or **(III)**
(ii)	Reflection; in x-axis	M1 A1	2	'Reflection'/ 'reflect(ed)' (or in y-axis or $y = 0$ or $x = 0$)
(iii)	Translation; $\begin{bmatrix} 30^\circ \\ 0 \end{bmatrix}$	B1 B1	2	'Translation'/'translate(d)' Accept **full** equivalent in words provided linked to 'translation/move/shift' and **positive** x-direction (Note: B0 B1 is possible)
(b)	$\{\theta - 30^\circ =\}\sin^{-1}(0.7) = 44.4\ldots^\circ$ ……… $= 180° – 44.4°$ $\theta = 74.4°,\ 165.6°$	M1 m1 A1	3	Inverse sine of 0.7 PI eg by sight of 44, 74 or better Valid method for 2nd angle Condone >1dp accuracy
(c)	$\ldots = \cos^2 x + 2\cos x \sin x + \sin^2 x +$ $\cos^2 x - 2\cos x \sin x + \sin^2 x$ $\ldots. = 2\cos^2 x + 2\sin^2 x$ $= 2(\cos^2 x + \sin^2 x) = 2\ (1)$ $= 2$	M1 A1 M1 A1	4	Award for either bracket expanded correctly OE $\cos^2 x + \sin^2 x = 1$ stated or used. AG (be convinced)
	Total		**13**	
7(a)	$2\log_a n - \log_a(5n-24) = \log_a 4$ $\Rightarrow \log_a n^2 - \log_a(5n-24) = \log_a 4$ $\Rightarrow \log_a\left[\dfrac{n^2}{5n-24}\right] = \log_a 4$ $\Rightarrow \dfrac{n^2}{5n-24} = 4$ $\Rightarrow n^2 - 20n + 96 = 0$	M1 M1 A1	3	A law of logs used A second law of logs used leading to both sides being single log terms or single log term on LHS with RHS=0 **CSO.** AG
(b)	$\Rightarrow (n-8)(n-12) = 0$ $\Rightarrow n = 8,\ 12$	M1 A1	2	Accept alternatives eg formula, completing of sq..
	Total		**5**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
8(a)	$\frac{dy}{dx} = \frac{3}{2}x^{\frac{1}{2}} - 3$	M1 A1	 2	One term correct Both correct
(b)(i)	When $x = 0$, $\frac{dy}{dx} = -3$ Eqn of tangent at O is $y = -3x$	B1F√ B1F√	 2	Ft provided answer < 0. OE Ft on $y'(0)$
(ii)	At (9,0) $\frac{dy}{dx} = \frac{3}{2}(9)^{\frac{1}{2}} - 3$ Eqn tangent at A is $y - 0 = y'(9)[x - 9]$ $\Rightarrow y = \frac{3}{2}(x-9) \Rightarrow 2y = 3x - 27$	M1 m1 A1	 3	Attempt to find $y'(9)$ OE **CSO**. AG
(iii)	Eliminating $y \Rightarrow -6x = 3x - 27$ $9x = 27 \Rightarrow x = 3$ When $x = 3$, $y = -9$. $\{P(3, -9)\}$	M1 A1F A1F	 3	OE method to one variable (eg $2y = -y - 27$) [A1F for each coordinate; only ft on $y = kx$ tangent in (b)(i) for $k < 0$]
(c)	$\int \left(x^{\frac{3}{2}} - 3x\right) dx = \frac{2}{5}x^{\frac{5}{2}} - \frac{3x^2}{2}$ $(+c)$	M1 A2,1,0	 3	One power correct Condone absence of "+c" and unsimplified forms
(d)	$\int_0^9 \left(x^{\frac{3}{2}} - 3x\right) dx =$ $= \frac{2}{5} \times 9^{\frac{5}{2}} - \frac{3}{2} \times 9^2 - 0$ $= -24.3$ Area of triangle $OPA = \frac{1}{2} \times 9 \times \lvert y_P \rvert$ Sh.Area $= \frac{1}{2} \times 9 \times \lvert y_P \rvert - \left\lvert \int_0^9 \left(x^{\frac{3}{2}} - 3x\right) dx \right\rvert$ $= 40.5 - 24.3 = 16.2$	B1 M1 M1 M1 A1	 5	PI Correct use of limits following integration OE
	Total		**18**	
	TOTAL		**75**	

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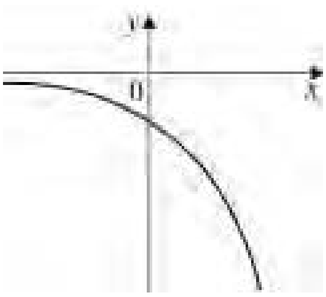
MPC2

Question	Solution	Marks	Total	Comments
1(a)	Area of sector = $\frac{1}{2}r^2\theta = \frac{1}{2}\times 5^2 \times \theta$	M1		$\frac{1}{2}r^2\theta$ seen or used
	$12.5\theta = 8.1 \Rightarrow \theta = 0.648$	A1	2	AG Condone θ = 0.648 used to show that area = 8.1
(b)	Arc = 5θ;	M1		5θ
	….. = 3.24 cm	A1		PI by a correct perimeter
	$\Rightarrow$ Perimeter = 10 + arc = 13.24 cm	A1√	3	CSO Condone missing/wrong units; condone 3sf i.e. 13.2 if no obvious error NMS 3/3
	Total		**5**	
2(a)	$\frac{\sin B}{4.8} = \frac{\sin 100}{12}$	M1		Use of the sine rule
	$\sin B = \frac{4.8 \sin 100}{12}$ [= 0.39(392…)]	m1		Rearrangement
	(angle *ABC*) = 23.19(8…) {= 23.2°.}	A1	3	AG Need >1dp eg 23.19 or 23.20
(b)	Angle *C* = 80° – 23.2° = 56.8°	M1		Valid method to find a relevant angle eg *C* (PI eg by correct sin *C*) or 23.2°+10°
	Area of triangle = 0.5×12×4.8×sin *C*	M1		OE eg 0.5×4.8×12×cos (*B*+10)
	….. = 24.09…. = 24.1 cm^2. (to 3sf)	A1	3	Condone missing/wrong units
	Total		**6**	
3(a)	(Tenth term) = $a + (10-1)\,d$	M1		
	…………… = 1 + 9(6) = 55	A1	2	NMS or rep. addn. B2 CAO SC if M0 award B1 for $6n-5$ OE
(b)(i)	$S_n = \frac{n}{2}[2+(n-1)6]$	M1		Formula for $\{S_n\}$ with either a = 1 or d = 6 substituted
	$\frac{n}{2}[2+6n-6]$ = 7400	A1		Eqn formed with some expansion of brackets
	$3n^2 - 2n = 7400 \Rightarrow 3n^2 - 2n - 7400 = 0$	A1	3	CSO AG
(ii)	$(3n+148)(n-50) = 0$	M1		Formula/factorisation OE
	$\Rightarrow n = 50$	A1	2	NMS single ans. 50.. B2 CAO NMS 50 and –49.3(3…) B1 CAO
	Total		**7**	

MPC2 (cont)

Question	Solution	Marks	Total	Comments
4(a)	$(1-2x)^4 = (1)^4 + 4(1)^3(-2x) + 6(1^2)(-2x)^2 + [4(1)(-2x)^3 + (-2x)^4]$	M1		Any valid method as far as term(s) in x and term(s) in x^2.
	$= [1] - 8x + 24x^2 + [-32x^3 + 16x^4]$	A1		$p = -8$ Accept $-8x$ even within a series.
		A1	3	$q = 24$ Accept $24x^2$ even within a series.
(b)	x term is $\binom{9}{1} 2^8 x$	M1		OE
	Coefficient of x term is $= 9 \times 2^8 = 2304$ $(=k)$	A1	2	Condone $2304x$
(c)	$(1-2x)^4(2+x)^9 = (1+px+..)(2^9+kx...)$	M1		Uses (**a**) and (**b**) oe (PI)
	$= ...$			
	$= .....+ kx + px(2^9) + ...$	M1		Multiply the two expansions to get x terms
	Coefficient of x is $k + 512p$			
	$= 2304 - 4096 = -1792$	A1ft	3	ft on candidate's values of k and p. Condone $-1792x$ SC If 0/3 award B1ft for $p+k$ evaluated
	Total		**8**	
5(a)	$\log_a x = \log_a 6^2 - \log_a 3$	M1		One law of logs used correctly
	$\log_a x = \log_a \left(\frac{6^2}{3}\right)$	M1		A second law of logs used correctly
	$\log_a x = \log_a \frac{36}{3} \Rightarrow x = 12$	A1	3	CSO AG
(b)	$\log_a y + \log_a 5 = 7 \Rightarrow \log_a 5y = 7$	M1		
	$\Rightarrow 5y = a^7$ or $y = \frac{1}{5}a^7$ or $a = (5y)^{1/7}$	m1 A1	3	Eliminates logs Accept these forms
	Total		**6**	

MPC2 (cont)

Question	Solution	Marks	Total	Comments
6(a)(i)	y-coordinate of A is $27-3^0$; = 26	M1A1	2	
(ii)	When $x = 3$, $y = 27 - 3^3 = 0 \Rightarrow B(3,0)$	B1	1	AG**;** be convinced
(b)	$h = 1$	B1		PI
	Area $\approx h/2\{\ldots\}$ $\{\ldots\}=$ f(0)+f(3)+2[f(1)+f(2)]	M1		OE summing of areas of the 'trapezia'..
	$\{\ldots\}=$ "26" + 0 + 2(24 + 18)	A1√		on (a)(i) (∑trap= "25"+21+9)
	(Area $\approx$) 55	A1√	4	on [42 + 0.5× "(a)(i)"]
(c)(i)	$\log_{10} 3^x = \log_{10} 13$	M1		Takes ln or $\log_{10}$ on both or $x = \log_3 13$
	$x \log_{10} 3 = \log_{10} 13$	m1		Use of $\log 3^x = x \log 3$ or $\log_3 13 = \frac{\lg 13}{\lg 3}$ OE (PI by $\log_3 13 = 2.335$ or better)
	$x = \frac{\lg 13}{\lg 3} = 2.334717\ldots$ = 2.3347 to 4dp	A1	3	Must show that logarithms have been used
(ii)	$\{k =\}$ 14	B1	1	Condone $y = 14$; Accept final answer 14 with only zeros after decimal point eg 14.000
(d)(i)	Translation;	B1;		'Translation'/'translate(d)' B0 if more than one transformation
	$\begin{bmatrix} 0 \\ -27 \end{bmatrix}$	B1	2	Accept full equivalent in words provided linked to 'translation/move/shift' and negative y-direction (Note: B0 B1 is possible)
(ii)		B1		Correct shape (translation of given curve vertically downwards)
		B1	2	Only point of intersection with coord axes is on negative y-axis and curve is asymptotic to the negative x-axis
	Total		**15**	

MPC2 (cont)

Question	Solution	Marks	Total	Comments
7(a)(i)	When $x = 4$, $\frac{dy}{dx} = 3(2) + \frac{16}{16} - 7 = 0$	B1	1	AG Be convinced
(ii)	$\frac{16}{x^2} = 16x^{-2}$	B1	1	Accept $k = -2$
(iii)	$\frac{d^2y}{dx^2} = 3 \times \frac{1}{2}x^{-\frac{1}{2}} + 16 \times (-2)x^{-3} - 0$	M1		A power decreased by 1
	$\frac{d^2y}{dx^2} = \frac{3}{2}x^{-\frac{1}{2}}$; $\quad -32x^{-3}$	A1; A1√	3	candidate's negative integer k [−1 for >2 term(s)]
(iv)	When $x = 4$, $\frac{d^2y}{dx^2} = \frac{3}{4} - \frac{32}{64} = \frac{1}{4}$	M1		Attempt to find $y''(4)$ reaching as far as two simplified terms
	Minimum since $y''(4) > 0$	E1√	2	candidate's sign of $y''(4)$
	[Alternative: Finds the sign of $y'(x)$ either side of the point where x=4, need evidence rather than just a statement: (M1) Correct ft conclusion with valid reason E1√**]** [In both, condone absent statement $y'(4)=0$]			
(b)(i)	At $P(1,8)$, $\frac{dy}{dx} = 3(1)^{\frac{1}{2}} + \frac{16}{1^2} - 7 = 12$	B1	1	AG Be convinced
(ii)	Gradient of normal = $-\frac{1}{12}$	M1		Use of or stating $m \times m' = -1$
	Equation of normal is $y - 8 = m[x - 1]$	M1		Can be awarded even if m=12
	$y - 8 = -\frac{1}{12}(x - 1) \Rightarrow 12y - 96 = -x + 1$ $\Rightarrow 12y + x = 97$	A1	3	Any correct form of the equation
(c)(i)	$\int 3x^{\frac{1}{2}} + \frac{16}{x^2} - 7\, dx =$			
	…….. $= 3\frac{x^{\frac{3}{2}}}{\frac{3}{2}} + 16\frac{x^{-1}}{-1} - 7x + c$	M1 A2,1,0 √	3	One power correct. A1 if 2 of 3 terms correct candidate's negative integer k Condone absence of "+ c"
(ii)	$y = 2x^{\frac{3}{2}} - 16x^{-1} - 7x + c \qquad (*)$	B1√		y = candidate's answer to (c)(i) with tidied coefficients and with '+c'. ('y =' PI by next line)
	When $x = 1$, $y = 8$ $\Rightarrow 8 = 2–16–7+c$	M1		Substitute. (1,8) in attempt to find constant of integration
	$y = 2x^{\frac{3}{2}} - 16x^{-1} - 7x + 29$	A1	3	Accept $c = 29$ after (*), including y =, stated
	Total		**17**	

MPC2 (cont)

Question	Solution	Marks	Total	Comments
8(a)	Stretch **(I)** in x-direction **(II)** scale factor 2 **(III)**	M1 A1	2	Need**(I)** and one of **(II),(III)** M0 if more than one transformation
(b)	$\tan^{-1} 3 = 1.2(49\ldots.)\ (=\alpha)$	M1		$\tan^{-1} 3$ [PI by 71.(56..)°]
	$\{\frac{1}{2}x =\}\quad \pi + \alpha$;	m1		Correct quadrant; condone degrees or mix
	$\frac{1}{2}x = 1.249\ldots;\ 4.3906\ldots$			
	$x = 2.498... = 2.50$ to 3 sf	A1		Condone 2.5 otherwise deduct **max** of 1 mark throughout Q8 from A marks if 'correct' rads. but to 2sf or final answers in degrees. (143°, 503°)
	$x = 8.781... = 8.78$ to 3 sf	A1	4	As usual, accept greater accuracy answers. Ignore extra values outside the given interval (0 to12.6). If > 2 values inside interval lose an A mark for each one. NB M1m0A1A0 is possible
	SC after M0 for error $\tan x = 6$; Either x = 1.40(5), 4.54(7), 7.68(8), 10.8(3) or x = 80.5º, 260.5 º, 440.5º, 620.5º SC B1 (accept each rounded or truncated to 3 sf)			
(c)	$\cos\theta = 0$, $\sin\theta - 3\cos\theta = 0$	M1		Need both
	$\tan\theta = \frac{\sin\theta}{\cos\theta}$ or $\tan\theta = 3$	M1		$\tan\theta = \frac{\sin\theta}{\cos\theta}$ seen/used
	$\cos\theta = 0 \Rightarrow \theta = \frac{\pi}{2} = 1.57(07\ldots)$	B1		Accept $\frac{\pi}{2}$
	or $\theta = \frac{3\pi}{2} = 4.71(23..)$	B1		Accept $\frac{3\pi}{2}$
	$\tan\theta = 3 \Rightarrow$ $\theta = 1.249..;\ 4.3906\ldots = 1.25,\ 4.39$ to 3sf	A1√	5	If not correct, ft on **(b)** NB M0M1(B0B0)A1ft is possible 90°; 270°; 71.5(6)°; 251.5(6)°
	Total		**11**	
	TOTAL		**75**	

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MPC2 Pure Core 2

Mark Scheme

2007 examination - January series

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Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334).
Registered address: AQA, Devas Street, Manchester M15 6EX *Dr Michael Cresswell Director General*

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
1(a)	{Area of sector =} $\frac{1}{2}r^2\theta$	M1		
	$= 0.5 \times 36 \times 1.2 = 21.6\ \text{cm}^2$	A1	2	Condone missing/wrong units throughout the paper
(b)	Arc = $r\theta$	M1		
	$= 6 \times 1.2 = 7.2$	A1		
	Perimeter = 12 + 7.2 = 19.2 cm	A1ft	3	Ft on incorrect evaluation of 6×1.2
	Total		**5**	
2	$h = 1$	B1		PI
	$f(x) = \sqrt{2^x}$			
	Area $\approx h/2\{\ldots\}$			OE summing of areas of the 'trapezia'..
	$\{\ldots\} = f(0)+f(3)+2[f(1)+f(2)]$	M1		
	$\{\ldots\} = 1 + \sqrt{8} + 2(\sqrt{2} + 2)$	A1		OE
	(Area $\approx$) 5.3284… = 5.328 (to 3dp)	A1	4	CAO Must be 5.328
	Total		**4**	
3(a)(i)	$\{p =\}\ 2$	B1		Condone '$64 = 8^2$'
(ii)	$\{q =\}\ -2$	B1ft		Ft on '$-p$' if q not correct
(iii)	$\{r =\}\ 0.5$	B1	3	Condone '$\sqrt{8} = 8^{0.5}$'
(b)	$\frac{8^x}{8^{0.5}} = 8^{-2} \Rightarrow 8^{x-0.5} = 8^{-2}$ OE	M1		Using parts (a) **<u>&</u>** valid index law to stage $8^c = 8^d$ (PI)
	$\Rightarrow x - 0.5 = -2 \quad \Rightarrow x = -1.5$	A1ft	2	Ft on c's $(q + r)$ if not correct (Accept correct answer without working)
	ALT: $\log 8^x = \log k$, $x\log 8 = \log k$; $x = -1.5$			(M1 A1)
	Total		**5**	
4(a)	$6^2 = 4^2 + 5^2 - 2(4)(5)\cos\theta$	M1		Use of the cosine rule
	$\cos\theta = \frac{4^2 + 5^2 - 6^2}{2(4)(5)}$	m1		Rearrangement
	$\cos\theta = \frac{5}{40} = \frac{1}{8}$	A1	3	CSO **AG** (be convinced)
(b)	$\cos^2\theta + \sin^2\theta = 1$	M1		Stated or used (PI)
	$\sin^2\theta = \frac{63}{64}$	A1		Or better
	$\sin\theta = \frac{\sqrt{63}}{8} = \frac{\sqrt{9\times7}}{8} = \frac{3\sqrt{7}}{8}$	A1	3	**AG** (be convinced)
(c)	Area of triangle = $0.5 \times 4 \times 5 \times \sin\theta$.	M1		
	….. = $\frac{30\sqrt{7}}{8}\ \text{cm}^2$.	A1	2	OE (Condone 9.92)
	Total		**8**	

MPC2

Q	Solution	Marks	Total	Comments
5(a)	$ar = 48$; $ar^3 = 3$	B1		For either. OE
	$\Rightarrow 16r^2 = 1$	M1		Elimination of *a* OE
	$r^2 = \frac{1}{16} \Rightarrow r = -\frac{1}{4}$	A1		CSO **AG** Full valid completion. **SC** Clear explicit verification (max B2 out of 3.)
	or $r = \frac{1}{4}$	B1	4	
(b)(i)	$a = -192$	B1	1	
(ii)	$\frac{a}{1-r} = \frac{a}{1-\left(-\frac{1}{4}\right)}$	M1		$\frac{a}{1-r}$ **<u>used</u>**
	$S_\infty = \frac{-768}{5}$ $(= -153.6)$	A1ft	2	Ft on candidate's value for *a*. i.e. $\frac{4}{5}a$ **SC** candidate uses $r = 0.25$, gives $a = 192$ and sum to infinity = 256. (max. B0 M1A1)
	Total		**7**	

MPC2

Q	Solution	Marks	Total	Comments
6(a)(i)	$y = x + 1 + 4x^{-2} \Rightarrow \frac{dy}{dx} = 1 - 8x^{-3}$	M1 A2,1,0	3	Power $p \to p-1$ (A1 if $1 + ax^n$ with $a = -8$ or $n = -3$)
(ii)	$1 - 8x^{-3} = 0$	M1		Puts c's $\frac{dy}{dx} = 0$
	$x^3 = 8$	m1		Using $x^{-k} = \frac{1}{x^k}$ to reach $x^a = b$, $a>0$ or correct use of logs.
	$x = 2$ When $x = 2$, $y = 4$	A1 A1ft	4	
(iii)	At (1, 6), $\frac{dy}{dx} = 1 - 8 = -7$	M1		Attempt to find $y'(1)$
	Gradient of normal = $\frac{1}{7}$	M1		Use of or stating $m \times m' = -1$
	Equation of normal is $y - 6 = m[x - 1]$	M 1		m numerical
	$y - 6 = \frac{1}{7}(x - 1)$ $\{\frac{y-6}{x-1} = \frac{1}{7};\ 7y = x + 41\}$	A1ft	4	OE ft on c's answer for (a)(i) provided at least A1 given in (a)(i) and previous 3M marks awarded
(b)(i)	$\int x\left(+1 + \frac{4}{x^2}\right) dx =$ …….. $= \frac{x^2}{2} + x - 4x^{-1}\ \{+c\}$	M1 A2,1,0	3	One of three terms correct. For A2 need all <u>three</u> terms as printed or better (A1 if 2 of 3 terms correct)
(ii)	{Area=} $\int_1^4 x + 1 + \frac{4}{x^2} dx =$ $\left[\frac{x^2}{2} + x - \frac{4}{x}\right]_1^4 = (8 + 4 - 1) - \left(\frac{1}{2} + 1 - 4\right)$	M1		Dealing correctly with limits; F(4)–F(1) (must have integrated)
	= 13.5	A1	2	
	Total		**16**	

MPC2

Q	Solution	Marks	Total	Comments
7(a)	$(1+2x)^8$ $=1+\binom{8}{1}(2x)^1+\binom{8}{2}(2x)^2+\binom{8}{3}(2x)^3+$	M1		Any valid method. PI by correct value for a, b or c
	$= 1 + 16x + 112x^2 + 448x^3 + \ldots$	A1A1		A1 for each of a, b, c
	$\{a = 16,\ b = 112,\ c = 448\}$	A1	4	
(b)	x^3 terms from expn. of $\left(1+\frac{1}{2}x\right)(1+2x)^8$			
	are cx^3 and $\frac{1}{2}x\left(bx^2\right)$	M1		Either
	$cx^3 + \frac{1}{2}x\left(bx^2\right)$	A1		b, c or candidate's values for b and c from **(a)**
	Coefficient of x^3 is $c + 0.5b = 504$	A1ft	3	Ft on candidate's $(c + 0.5b)$ provided b and c are positive integers >1
	Total		**7**	

MPC2

Q	Solution	Marks	Total	Comments
8(a)	$\{x =\}\cos^{-1}(0.3) = 1.266\ldots \quad \{= \beta\}$	M1		$\cos^{-1}(0.3)$ PI by eg 72° or 73°
	$\{x =\}\ 2\pi - \beta$	m1		Condone degrees or mix.
	$x = 1.27, \quad 5.02$	A1	3	Accept 1.26 to 1.27 with 5.01 to 5.02 inclusive
(b)(i)	$M(\pi, -1)$	B1;B1	2	B1 for each coordinate
(ii)	$\{x_Q =\}\ 2\pi - \alpha$	B1	1	OE (unsimplified)
(c)	Stretch **(I)** in x-direction **(II)** scale	M1		Need**(I)** & one of **(II),(III)**
	factor $\frac{1}{2}$ **(III)**	A1	2	
(d)	$\cos 2x = \cos\frac{4\pi}{5} \Rightarrow 2x = \frac{4\pi}{5}$	B1		OE. (From correct work)
	$\Rightarrow x = \frac{2\pi}{5}\ (= \alpha)$			Condone decimals/degrees
	$x = \pi - \alpha$; OE	M1		OE eg $2x = 2\pi - \frac{4\pi}{5}$ Correct quadrant; condone degrees/decimals/mix
	$x = \pi + \alpha$; $x = 2\pi - \alpha$; OE	m1		Need both (OE for $2x$=) with no extras (quadrants) within the given interval. Condone degrees/decimals/mix
	$x = \frac{2\pi}{5}, \frac{3\pi}{5}, \frac{7\pi}{5}, \frac{8\pi}{5}$	A1	4	Need all 4 solutions for x but condone unsimplified provided in terms of π Ignore extra values outside the given interval.
	Total		**12**	

MPC2

Q	Solution	Marks	Total	Comments
9(a)	$3\log_a x = \log_a 8 \Rightarrow \log_a x^3 = \log_a 8$	M1		OE use of the log law
	$x^3 = 8 \Rightarrow x = 2$	A1	2	
(b)	$3\log_a 6 - \log_a 8 = \log_a 6^3 - \log_a 8$	M1		Correct use of one log law
	$= \log_a \dfrac{6^3}{8}$	M1		Correct use of a different log law
	$= \log_a \dfrac{216}{8} = \log_a 27$	A1	3	CSO **AG** (be convinced)
(c)(i)	$\{p =\}3\log_{10} 3 - \log_{10} 8$	M1		Substitute $x = 3$
	$p = \log_{10} \dfrac{3^3}{8} = \log_{10} \dfrac{27}{8}$	A1	2	**AG** (be convinced)
(ii)	Gradient of $PQ = \dfrac{q-p}{6-3}$	M1		used $\dfrac{\text{difference in } y\text{-coords}}{\text{difference in } x\text{-coords}}$
	……. $= \dfrac{\log_{10} 27 - \log_{10} \frac{27}{8}}{3}$	A1		Any correct exact form
	……. $= \dfrac{1}{3}\log_{10}\left(27 \div \dfrac{27}{8}\right)$	m1		Correct use of log law
	Gradient $= \dfrac{1}{3}\log_{10} 8 = \log_{10} 2$	A1	4	**AG** (be convinced)
	Total		**11**	
	TOTAL		**75**	

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General Certificate of Education

Mathematics 6360

MPC2 Pure Core 2

Mark Scheme

2007 examination - June series

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MPC2

Q	Solution	Marks	Total	Comments
1(a)(i)	x^2	B1	1	
(ii)	$x^{\frac{1}{2}} = \sqrt{x}$	B1	1	Accept either form
(iii)	x^3	B1	1	
(b)(i)	$\int 3x^{\frac{1}{2}}\,dx = \dfrac{3}{\frac{3}{2}}x^{\frac{3}{2}} \quad \{+c\}$	M1 A1		Index raised by 1 Simplification not yet required
	$= 2x^{\frac{3}{2}} + c$	A1	3	Need simplification **and** the + c OE
(ii)	$\int_1^9 3x^{\frac{1}{2}}\,dx = (2 \times 9^{\frac{3}{2}}) - (2 \times 1^{\frac{3}{2}})$	M1		F(9) – F(1), where F(x) is candidate's answer to (b)(i) [or clear recovery]
	= 52	A1ft	2	Ft on (b)(i) answer of form $kx^{1.5}$ i.e. $26k$
	Total		**8**	
2(a)	$u_1 = 12$ $u_2 = 3 \times 4^2 = 48$	B1 B1	2	CSO AG (be convinced)
(b)	$r = 4$	B1	1	
(c)(i)	$\{S_{12} =\}\dfrac{a(1-r^{12})}{1-r}$	M1		OE Using a correct formula with n = 12
	$= \dfrac{12(1-4^{12})}{1-4}$	A1ft		Ft on answer for u_1 in (a) and r in (b)
	$= \dfrac{12(1-4^{12})}{-3} = -4(1-4^{12}) = 4^{13} - 4$	A1	3	CAO Accept k = 13 for 4^{13} term
(ii)	$\sum_{n=2}^{12} u_n = (4^{13} - 4) - u_1$ $= 67108848$	B1	1	
	Total		**7**	

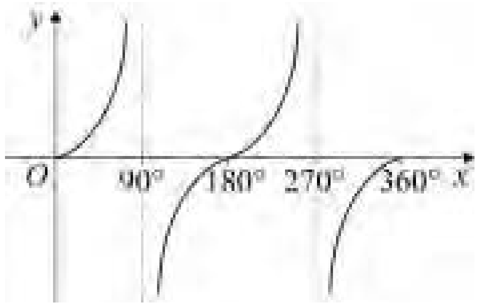
MPC2 (cont)

Q	Solution	Marks	Total	Comments
3(a)	Arc = $r\theta$	M1		For $r\theta$ or 20θ or PI by 20×1.4
	$28 = 20\theta \Rightarrow \theta = 1.4$	A1	2	AG
(b)	Area of sector = $\frac{1}{2}r^2\theta$	M1		$\frac{1}{2}r^2\theta$ OE seen
	$= \frac{1}{2}20^2(1.4) = 280$ (cm^2.)	A1	2	Condone absent cm^2.
(c)(i)	Area triangle = $\frac{1}{2} \times 15 \times 20 \times \sin 1.4$ (= 147.8….)	M1		Use of $\frac{1}{2}ab\sin C$ OE
	Shaded area = Area of sector – area of triangle	M1		
	= 280 – 147.8 = 132 (cm^2.) (3sf)	A1ft	3	Ft on [ans (b) – 147.8…] to 3sf provided [….] > 0
(ii)	$\{BD^2 =\} 15^2 + 20^2 - 2 \times 15 \times 20\cos 1.4$	M1		RHS of cosine rule used
	$= 225 + 400 - 101.98...$	m1		Correct order of evaluation
	$\Rightarrow BD = \sqrt{523.019...} = 22.86..$ = 22.9 (cm) to 3 sf	A1	3	Condone absent cm
	Total		**10**	
4(a)	$\{S_{29} =\} \frac{29}{2}\left[2a + 28d\right]$	M1		Formula for S_n with n = 29 substituted and with a and d
	29 (a + 14d) = 1102	m1		Equation formed then some manipulation
	$a + 14d = \frac{1102}{29} \Rightarrow a + 14d = 38$	A1	3	CSO AG
(b)	$u_2 = a + d \quad u_7 = a + 6d$	B1		Either expression correct
	$u_2 + u_7 = 13 \Rightarrow 2a + 7d = 13$	M1		Forming equation using u_2 & u_7 both in form $a + kd$
	e.g. 21d = 63; 3a = – 12	m1		Solving a +14d = 38 with candidate's '2a + 7d = 13' to at least stage of elimination of either a or d
	a = – 4 d = 3	A1	4	Both correct
	Total		**7**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$y_P = 4$	B1	1	
(b)	$y = 1 + \frac{2}{x} + \frac{2}{x} + \frac{4}{x^2}$ $y = 1 + 4x^{-1} + 4x^{-2}$	B2,1,0	2	(B1 if only one error in the expansion) For B2 the last line of the candidate's solution must be correct
(c)	$\frac{dy}{dx} = -4x^{-2} - 8x^{-3}$	M1 A1ft A1	3	Index reduced by 1 after differentiating x to a negative power At least 1 term in x correct ft on expn CSO Full correct solution. ACF
(d)	When $x = 2$, $\frac{dy}{dx} = -4 \times 2^{-2} - 8 \times 2^{-3}$ Gradient $= -1 - 1 = -2$	M1 A1	2	Attempt to find $y'(2)$. AG (be convinced-no errors seen)
(e)	$-2 \times m' = -1$ $y - 4 = m(x - 2)$ $y - 4 = \frac{1}{2}(x - 2)$ $x - 2y + 6 = 0$	M1 M1 A1ft A1	4	$m_1 \times m_2 = -1$ OE stated or used. PI C's y_P from part (**a**) if not recovered; m must be numerical. Ft on candidate's y_P from part (**a**) if not recovered. CAO Must be this or $0 = x - 2y + 6$
	Total		**12**	
6(a)	$y_A = 3(2^0 + 1)$ $= 6$	M1 A1	2	Substituting $x = 0$ PI
(b)	$h = 2$ Integral = $h/2$ {……} {….} = $f(0) + 2[f(2) + f(4)] + f(6)$ {} = $6 + 2[3\times5 + 3\times17] + 3\times65$ $= 6 + 2[15 + 51] + 195$ Integral = 333	B1 M1 A1 A1	4	PI OE summing of areas of the three traps. Condone 1 numerical slip {ft on (**a**) for f(0) if not recovered} [Sum of 3 traps. = 21 + 66 + 246] CAO
(c)(i)	$21 = 3(2^x + 1) \Rightarrow 2^x = 6$	B1	1	AG (be convinced)
(ii)	$\log_{10} 2^x = \log_{10} 6$ $x\log_{10} 2 = \log_{10} 6$ $x = \frac{\lg 6}{\lg 2} = 2.5849\ldots = 2.58$ to 3sf	M1 m1 A1	3	Take ln or $\log_{10}$ of both sides of $a^x = b$ or other relevant base if clear. The equation $a^x = b$ used must be correct. Use of $\log 2^x = x\log 2$ OE Both method marks must have been awarded.
	Total		**10**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
7(a)		M1 A1 A1	 3	Correct shape of branch from O {to 90°} **or** correct shapes of branches from 90°-360° Complete graph for $0^\circ \le x \le 360^\circ$ (Asymptotes not explicitly required but graphs should show 'tendency') Correct scaling on x-axis $0^\circ \le x \le 360^\circ$
(b)	61° ; 241°	B1 B1	 2	For 61° For 241° and no 'extras' in the interval $0^\circ \le x \le 360^\circ$
(c)(i)	$\sin\theta = -\cos\theta \;\Rightarrow \dfrac{\sin\theta}{\cos\theta} = -1$ $\Rightarrow \tan\theta = -1.$	B1	1	AG; be convinced that the identity $\dfrac{\sin\theta}{\cos\theta} = \tan\theta$ is known and validly used
(ii)	$\Rightarrow \tan(x - 20^\circ) = -1$ $x - 20^\circ = \tan^{-1}(-1)$ $x - 20^\circ = 135^\circ, 315^\circ \ldots$ $x = 155^\circ$; 335°	M1 m1 A1 A1ft	 4	 Ft on (180 + "155") and no 'extras' in the given interval.
(d)	Translation $\begin{bmatrix} 20 \\ 0 \end{bmatrix}$	B1 B1	 2	'Translation'/'translate(d)' Accept equivalent in words provided linked to 'translation/move/shift' (Note: B0B1 is possible)
(e)	f(x) = tan 4x	B1	1	For tan 4x
	Total		**13**	
8(a)	$\log_a n = \log_a 3(2n-1)$ $\Rightarrow n = 3(2n-1)$ $\Rightarrow 3 = 5n \Rightarrow n = \dfrac{3}{5}$	M1 m1 A1	 3	OE Log law used PI by next line OE, but must **not** have any logs.
(b)(i)	$\log_a x = 3 \Rightarrow x = a^3$	B1	1	
(ii)	$\log_a y - \log_a 2^3 = 4$ $\log_a \dfrac{y}{2^3} = 4 \begin{cases} xy = a^7 \times a^{(3\log_a 2)} \\ \text{or} \\ y = a^4 \times a^{(3\log_a 2)} \end{cases}$ $\dfrac{y}{2^3} = a^4 \qquad \begin{cases} xy = a^7 \times 2^3 \\ \text{or} \\ y = a^4 \times 2^3 \end{cases}$ $by = a^3 \times 8a^4$ or $8a^7$	M1 M1 ml A1	 4	$3\log 2 = \log 2^3$ seen or used any time in **(ii)** Correct method leading to an equation involving y (or xy) and a log but **not** involving + or − Correct method to eliminate **ALL** logs e.g. using $\log_a N = k \Rightarrow N = a^k$ or using $a^{\log_a c} = c$
	Total		**8**	
	TOTAL		**75**	

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ASSESSMENT and QUALIFICATIONS ALLIANCE

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Mathematics 6360

MPC2 Pure Core 2

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2008 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
1(a)	Area of sector = $\frac{1}{2}r^2\theta = \frac{1}{2}\times 6^2 \times \theta$	M1		$\frac{1}{2}r^2\theta$ seen or used
	6 × 3 = 2 × $\frac{1}{2}\times 6^2\times\theta$	m1		OE Forming equation
	$36\theta = 18 \Rightarrow \theta = 0.5$	A1	3	AG
(b)	Arc = 6θ;	M1		$r\theta$ seen or used
	….. = 3 cm	A1		PI by a correct perimeter
	⇒ Perimeter = 12 + arc = 15 cm	A1F	3	Ft wrong evaluation of 6θ. Condone missing/wrong units throughout the question.
	Total		**6**	
2(a)	(d) = 7	B1	1	7
(b)	(101^{st} term) = a + (101−1) d	M1		
	…………… = 51 + 100(7) = 751	A1F	2	Ft on c's answer for d. NMS/rep. addn., give both marks for '751'. **SC** if M0, award B1 for 7n+44 OE
(c)	$S_n = \frac{100}{2}[751+1444]$ **or** $S_n = \frac{100}{2}[2\times 751+(100-1)7]$	M1		Formula for{S_n}with [any **3** of a = c's 751 (condoning '751'±d) **or** d = c's 7 **or** n =100 **or** l = 1444 substituted] or [$S_{200}-S_k$ with k=100, (condoning k=99 or 101) stated/used with correct ft substitution in S_{200} or S_k]
	= 109 750	A1	2	
	Total		**5**	
3(a)	$\frac{BC}{\sin 72} = \frac{18.7}{\sin 50}$ [=24.4….]	M1		Use of the sine rule
	$BC = \frac{18.7\sin 72}{\sin 50}$	m1		Rearrangement
	(BC)=23.21(6..){= 23.2 to nearest 0.1cm}	A1	3	AG Need >1dp if using cm eg 23.21 or 23.22; at least 1dp if using mm.
(b)	Angle C = 180° – (50°+72°) = 58°	M1		Valid method to find either angle C (PI eg by sin C =0.848(04..)) or side AB
	Area of triangle = 0.5×18.7×23.2..×sin C	M1		OE eg 0.5×18.7×AB×sin72º
	….. = 184 cm^2	A1	3	Accept 183.8 to 184.2 Condone missing/wrong units
	Total		**6**	

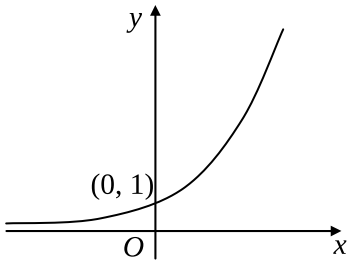
MPC2 (cont)

Q	Solution	Marks	Total	Comments
4	$h = 1$	B1		PI
	$\text{I} \approx \frac{h}{2}\{\ldots\}$	M1		OE summing of areas of the three 'trapezia'
	$\{\ldots\}=$ f (0)+f(3)+2[f(1)+f(2)] $\{\ldots\}= \sqrt{3} + \sqrt{12} + 2[\sqrt{4} + \sqrt{7}]$	A1		(∑trap=1.866.+2.3228.+3.0549)
	$(\text{I} \approx)\ \frac{1}{2}[5.19615. + 2\times 4.64575...]$			
	$= \frac{1}{2}[14.4876..] = 7.2438.. = 7.244$	A1	4	CAO Must be 3dp.
	Total		**4**	
5a(i)	$\frac{dy}{dx} = 4\times\frac{1}{2}x^{-\frac{1}{2}} - \frac{3}{2}x^{\frac{1}{2}} = 2x^{-\frac{1}{2}} - \frac{3}{2}x^{\frac{1}{2}}$	M1 A1A1	3	A power decreased by 1 A1 for each correct term
(ii)	At $P(4,0)$, $\frac{dy}{dx} = \frac{2}{\sqrt{4}} - \frac{3}{2}\times 2$	M1		Attempts $\frac{dy}{dx}$ when $x = 4$
	$= 1-3 = -2$	A1	2	AG
(iii)	Gradient of normal = $\frac{1}{2}$	M1		Use of or stating $m\times m' = -1$
	Equation of normal is $y - 0 = m[x - 4]$	M1		m numerical; can be awarded even if $m = -2$
	$y - 0 = \frac{1}{2}(x-4) \Rightarrow 2y = x - 4$	A1	3	ACF of the equation
(iv)	At Q, $x = 0$, $2y = 0 - 4$ $y_Q = -2$ Area of triangle $OPQ = 0.5\times 4\times \lvert y_Q \rvert$	M1 A1F		PI Ft on a linear equation for normal provided y_Q is negative and prev A1 is lost
	$= 4$	B1F	3	Ft on c's negative y_Q
(v)	$2x^{-\frac{1}{2}} - \frac{3}{2}x^{\frac{1}{2}} = 0 \Rightarrow 2x^{-\frac{1}{2}} = \frac{3}{2}x^{\frac{1}{2}}$	M1		Puts c's $\frac{dy}{dx} = 0$ and a 1st step in attempt to solve.
	$2 = \frac{3}{2}x$; $\Rightarrow x = \frac{4}{3}$	m1; A1	3	Valid method to $ax=b$ Condone 1.3 or better
(b)(i)	$\int \left(4x^{\frac{1}{2}} - x^{\frac{3}{2}}\right) dx = 4\frac{x^{\frac{3}{2}}}{1.5} - \frac{x^{\frac{5}{2}}}{2.5}\ \{+ c\}$	M1 A1,A1	3	One power correct Condone absence of "+c"
	$= \frac{8}{3}x^{\frac{3}{2}} - \frac{2}{5}x^{\frac{5}{2}}\ \{+ c\}$			
(ii)	Area under curve = $4\frac{4^{\frac{3}{2}}}{1.5} - \frac{4^{\frac{5}{2}}}{2.5} - \{0\}$	M1		F(4) − {F(0)}
	Total area = F(4) + area triangle OPQ	m1		
	Total area = $\frac{128}{15} + 4 = \frac{188}{15}$ = 12.5 (3…)	A1	3	Accept 3 sf if clear
	Total		**20**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$(1+x)^3 = 1+3x+3x^2+x^3$	M1		Any valid method to expand $(1+x)^3$ fully
		A1	2	
(ii)	$(1+x)^4 = 1+4x+6x^2+4x^3+x^4$	M1		Any valid method to expand $(1+x)^4$ fully
		A1	2	
(b)(i)	$(1+4x)^3 = 1+3(4x)+3(4x)^2+(4x)^3$	M1		
	$(1+4x)^3 = 1+12x+48x^2+64x^3$	A1√	2	Ft on one numerical slip in (a)(i)
(ii)	$(1+3x)^4$ $= 1+4(3x)+6(3x)^2+4(3x)^3+(3x)^4$	M1		
	$= 1 + 12x + 54x^2 + 108x^3 + 81x^4$	A1√	2	Ft on one numerical slip in (a)(ii)
(c)	$(1+3x)^4 - (1+4x)^3 = 1 + 12x + 54x^2 + 108x^3 + 81x^4 - (1+12x+48x^2+64x^3)$	M1		Subtracts the answers to (b) with correct number of terms and combines at least two pairs of like terms.
	= 6*x*2 + 44*x*3 +81*x*4	A1	2	CAO
				SC: If no attempt in (b) but full expansions given in working for (c), mark retrospectively.
	Total		**10**	
7(a)	$x = 8$	B1	1	No clear log law errors seen. Condone answer left as $\frac{16}{2}$
(b)	$\log_a y = \log_a 3^2 + \log_a 4 + 1$	M1		One law of logs used correctly
	$\log_a y = \log_a \left(3^2 \times 4\right) + 1$	M1		Either a second law of logs used correctly or the 1 written as $\log_a a$
	$\log_a y = \log_a \left(3^2 \times 4\right) + \log_a a = \log_a 36a$			
	$\Rightarrow y = 36a$	A1	3	CSO
	Total		**4**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
8(a)		B1 B1	 2	Shape (graph must clearly go below the intersection pt.). Condone if *x*-axis is a tangent Only intersection with *y*-axis at (0, 1) stated/indicated … (accept 1 on *y*-axis as equivalent) 0
(b)(i)	Stretch **(I)** in *x*-direction **(II)** scale factor 0.5 **(III)**	M1 A1	 2	Need**(I)** & one of **(II),(III)** M0 if >1 transformation
(ii)	Translation; $\begin{bmatrix} -1 \\ 0 \end{bmatrix}$	B1; B1	 2	Must be 'Translation' or 'translate(d)' for 1st B mark Accept **full** equivalent to vector in words provided linked to 'translation/ move/shift' and **negative** *x*-direction (Note: B0 B1 is possible)
	ALTn: Stretch **(I)** in *y*-direction **(II)** scale factor 3 **(III)**			[Mark the alternative as in (b)(i).]
(c)(i)	$9^x = (3^2)^x = 3^{2x} = (3^x)^2 = Y^2$; $3^{x+1} = 3^x \times 3^1 = 3Y$ $9^x - 3^{x+1} + 2 = 0 \Rightarrow Y^2 - 3Y + 2 = 0$ $\Rightarrow (Y-1)(Y-2) = 0$	M1 A1	 2	Justifying either $9^x = Y^2$ or $3^{x+1} = 3Y$ AG
(ii)	$Y = 1 \Rightarrow 3^x = 1 \Rightarrow x = 0$	B1		AG (Accept direct substitution if convinced)
	$Y = 2 \Rightarrow 3^x = 2$ $\log_{10} 3^x = \log_{10} 2$	M1		Takes logs of both, PI by 'correct' value(s) later. or $x = \log_3 2$ seen
	$x \log_{10} 3 = \log_{10} 2$	m1		Use of $\log 3^x = x \log 3$ or $\log_3 2 = \frac{\lg 2}{\lg 3}$ OE (PI by $\log_3 2$ = 0.630 or 0.631 or better)
	$x = \frac{\lg 2}{\lg 3} = 0.630929....$ =0.6309 to 4dp	A1	4	Must show that logarithms have been used otherwise 0/3
	Total		**12**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
9(a)	$\frac{3+\sin^2\theta}{\cos\theta-2}=3\cos\theta$			
	$\Rightarrow \frac{3+(1-\cos^2\theta)}{\cos\theta-2}=3\cos\theta$	M1		$\cos^2\theta + \sin^2\theta = 1$ stated or used [If cand starts with cos $\theta = -½$ and gets $\sin^2\theta = ¾$ without explicitly finding value for θ and verifies 1st equation is true, award M1moA0]
	$\Rightarrow \frac{4-\cos^2\theta}{\cos\theta-2}=3\cos\theta$			
	$\Rightarrow \frac{(2-\cos\theta)(2+\cos\theta)}{\cos\theta-2}=3\cos\theta$	m1		Difference of two squares or division (PI by next line)
	$\Rightarrow -1(2+\cos\theta)=3\cos\theta$	A1		
	$\Rightarrow -2=4\cos\theta \Rightarrow \cos\theta=-\frac{1}{2}$	A1	4	CSO AG
	Alternative for (a)			
	$3+1-\cos^2\theta=3\cos^2\theta-6\cos\theta$	(M1)		$\cos^2\theta + \sin^2\theta = 1$
	$(4\cos\theta+2)(\cos\theta-2)=0$	(m1)		Factorising or formula
	$\cos\theta - 2 \neq 0$	(A1)		Indicates rejection of $\cos\theta = 2$
	$\Rightarrow 4\cos\theta=-2 \Rightarrow \cos\theta=-\frac{1}{2}$	(A1)		AG Be convinced
(b)	$\theta = 3x \Rightarrow \cos 3x = -\frac{1}{2}$	M1		Uses part (a) to reach either cos $3x = -0.5$ or cos$3x = 0.5$
	$\cos^{-1}\left(-\frac{1}{2}\right) = 120^\circ$	m1		Or $\cos^{-1}(0.5) = 60^\circ$ Condone radians here
	$3x = 120^\circ, 240^\circ, 480^\circ, \ldots$			
	$x = 40^\circ, 80^\circ, 160^\circ$	A2,1,0	4	A1 for at least <u>two</u> correct. If >3 solutions in the interval $0^\circ < x < 180^\circ$, deduct 1 mark from any A marks for each extra solution. Deduct 1 mark from any A marks if answers in radians. Ignore extra values outside the given interval.
	Total		**8**	
	TOTAL		**75**	

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General Certificate of Education

Mathematics 6360

MPC2 Pure Core 2

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2008 examination - June series

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MPC2

Q	Solution	Marks	Total	Comments
1(a)	$\sqrt{x^3} = x^{\frac{3}{2}}$	B1	1	OE; accept 'k = 1.5'
(b)(i)	$\frac{dy}{dx} = 2x - \frac{3}{2}x^{\frac{1}{2}}$	M1		At least one index reduced by 1 and no term of the form $\sqrt{ax^2}$.
		B1		For $2x$
		A1F	3	For $-1.5\, x^{0.5}$ .Ft on ans (a) non-integer k
(ii)	When $x = 4$, $y = 8$	B1		
	$y'(4) =$;	M1		Attempt to find $\frac{dy}{dx}$ when $x = 4$
	$= 2(4) - 1.5(\sqrt{4}) = 5$	A1F		Ft on one earlier error provided non-integer powers in (a) and (b)(i)
	Tangent: $y - 8 = 5(x - 4)$	m1		$y - y(4) = y'(4)[x - 4]$ OE
	$y = 5x - 12$	A1	5	CSO; must be $y = 5x - 12$
	Total		**9**	
2(a)	Arc $PQ = r\theta$	M1		$r\theta$
	$= 6\pi$ (cm)	A1	2	Condone missing units throughout the paper
(b)	$\alpha + \alpha + \frac{3\pi}{7} = \pi$	M1		OE
	$\alpha = \frac{2\pi}{7}$	A1	2	Accept equivalent fractions eg $\frac{4\pi}{14}$ and condone 0.286π or better
(c)	Chord $PQ = 2 \times 14 \times \cos\alpha$	M1		OE eg $2 \times 14 \times \sin\frac{3\pi}{14}$ or 17.45-17.5 inclusive or $\sqrt{14^2 + 14^2 - 2 \times 14^2 \times \cos\frac{3\pi}{7}}$
	Perimeter = 17.45… + 6π = 36.307… = 36.3 (cm)	A1	2	Condone > 3sf
	Total		**6**	
3(a)	$r = 16 \div 20 = 0.8$	B1	1	OE
(b)	$\frac{a}{1-r} = \frac{20}{1-0.8}$	M1		OE Using a correct formula with $a = 20$ or r = c's 0.8
	$= 100$	A1F	2	ft on c's value of r provided $\lvert r \rvert < 1$
(c)	$\{S_{20} =\}\frac{a(1-r^{20})}{1-r}$	M1		OE Using a correct formula with $n = 20$
	$= 100(1-0.8^{20}) = 98.847\{07..\}$	A1	2	Condone > 3dp
(d)	nth term $= 20\, r^{n-1} = 20(0.8)^{n-1}$	M1		Ft on c's r . Award even if 16^{n-1} seen
	$= 20 \times 0.8^{-1} \times 0.8^{n}$			
	$= 25 \times 0.8^{n}$	A1	2	CSO; AG
	Total		**7**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$\{BC^2 =\}\ 7.6^2 + 8.3^2 - 2\times 7.6\times 8.3\cos 65$	M1		RHS of cosine rule used
	….. $= 57.76 + 68.89 - 53.3175...$	m1		Correct order of evaluation
	$BC = \sqrt{73.33..} = 8.563..$ (= 8.56 m)	A1	3	AG; must see $\sqrt{73.33....}$ or > 3sf value
(b)	Area triangle $= \frac{1}{2}\times 7.6\times 8.3\times \sin 65$	M1		Use of $\frac{1}{2}bc\sin A$ OE
	= 28.58… = 28.6 (m^2)	A1	2	Condone > 3sf
(c)	Area of triangle = 0.5× *BC* × *AD*	M1		Or valid method to find sin*B* or sin*C*
	AD = [Ans (b)] ÷ [0.5×Ans (a)]	m1		Or *AD* = 7.6sin*B*; Or *AD* = 8.3sin*C*
	AD = 6.67.. = 6.7 (m)	A1	3	If not 6.7 accept 6.65 to 6.69 inclusive.
	Total		**8**	
5(a)(i)	$\log_a 1 = 0$	B1	1	
(ii)	$\log_a a = 1$	B1	1	
(b)	$\log_a x = \log_a(5\times 6) - \log_a 1.5$	M1		One law of logs used correctly
	$\log_a x = \log_a\left(\frac{5\times 6}{1.5}\right)$	M1		A second law of logs used correctly
	$\log_a x = \log_a 20 \Rightarrow x = 20$	A1	3	
	Total		**5**	
6(a)	$8 = -8p + q$	M1		Either equation. PI eg by combined eqn.
	$4 = 8p + q$	A1		Both (condone embedded values for the M1A1)
		m1		Valid method to solve two simultaneous equations in *p* **and** *q* to find either *p* or *q*
	$q = 6$	A1		AG (condone if left as a fraction)
	$p = -0.25$	B1	5	OE
(b)	$u_4 = 5$	B1F	1	Ft on (6 + 4*p*)
(c)(i)	$L = pL + q$; ($L = -0.25L + 6$)	M1	1	OE
(ii)	$L = \frac{q}{1-p}$	m1		Rearranging
	$L = \frac{6}{1.25} = 4.8$	A1F	2	Ft on $\frac{6}{1-p}$ Dependent on previous two marks
	Total		**9**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$\left(1+\frac{4}{x^2}\right)^3 =$			
	$\left[1^3\right]+3(1^2)\left(\frac{4}{x^2}\right)+3(1)\left(\frac{4}{x^2}\right)^2+\left[\left(\frac{4}{x^2}\right)^3\right]$	M1		Any valid method as far as term(s) in $1/x^2$ and term(s) in $1/x^4$
	$=[1]+\frac{12}{x^2}+\frac{48}{x^4}+\left[\frac{64}{x^6}\right]$	A1		$p = 12$ Accept $\frac{12}{x^2}$ even within a series
		A1	3	$q = 48$ Accept $\frac{48}{x^4}$ even within a series
(b)(i)	$\int \left(1+\frac{4}{x^2}\right)^3 \mathrm{d}x$			
	$=\int (1+\frac{p}{x^2}+\frac{q}{x^4}+\frac{64}{x^6})\,\mathrm{d}x$	M1		Integral of an 'expansion', at least 3 terms PI by the next line
	$= x-px^{-1}-\frac{q}{3}x^{-3}-\frac{64}{5}x^{-5}$ $(+\ c)$	m1 A2F,1	4	At least two powers correctly obtained Ft on c's non-zero integer values for p and q (A1F for two terms correct; can be unsimplified)
	$= x-12x^{-1}-16x^{-3}-\frac{64}{5}x^{-5}$ $(+\ c)$			Condone missing c but check that signs have been simplified at some stage before the award of both A marks.
(ii)	$\left(2-\frac{p}{2}-\frac{q}{3(8)}-\frac{64}{5(32)}\right)-$			
	$\left(1-p-\frac{q}{3}-\frac{64}{5}\right)$	M1		F(2) − F(1), where F(x) is cand's answer or the correct answer to (b)(i).
	$= 33.4$	A1	2	CSO
	Total		**9**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
8(a)(i)	$h = 0.5$ Integral = $h/2$ {……}	B1		PI
	$\{..\}=\text{f}(0)+2[\text{ f}\left(\frac{1}{2}\right)+\text{f}(1)+\text{ f}\left(\frac{3}{2}\right)]+\text{f}(2)$	M1		OE summing of areas of the four traps.
	$\{\}= 1+2\left[\sqrt{6}+6+6\sqrt{6}\right]+36$ = 1+2[2.449..+ 6 + 14.6969..] + 36 = 37 + 2 × 23.146.. = 83.292…	A1		Condone 1 numerical slip. Accept 3sf values if not exact.
	Integral = 0.25 × 83.292.. = 20.8 (3sf)	A1	4	CAO; must be 20.8
(ii)	Relevant trapezia drawn on a copy of given graph	M1		Accept single trapezium with its sloping side above the curve
	{Approximation is an}overestimate	A1	2	Dep. on 4 trapezia with each of their upper vertices lying on the curve
(b)(i)	Stretch **(I)** in x-direction **(II)**	M1		Need **(I)** and one of **(II)**, (**III**) M0 if more than one transformation
	(scale factor) $\frac{1}{3}$ **(III)**	A1	2	
(ii)	$6^{3x} = 84$	M1		PI
	$\log_{10} 6^{3x} = \log_{10} 84$	M1		Take logs of both sides of $a^x = b$, PI by 'correct' value(s) later or $3x = \log_6 84$
	$3x\log_{10} 6 = \log_{10} 84$	m1		Use of $\log 6^{3x} = 3x\log 6$ OE or $3x = \log_6 84$ seen
	$x = \frac{\lg 84}{3\lg 6}$			
	$x =$ 0.82429…. = 0.824 (to 3dp)	A1	4	Must see that logs have been used before any of the last 3 marks are awarded in (b)(ii). Condone > 3dp
(c)	$\text{f}(x) = 6^{x-1} - 2$	B2,1	2	B1 for either $6^{x-1}+2$ or for $6^{x+1}-2$
	Total		**14**	
9(a)	$2x = 48$ $2x = 180 - 48$ $2x = 360 + 48$ and $2x = 360+180-48$ $x = 24°, 66°, 204°, 246°$	B1 M1 M1 A1	 4	PI by $x = 24°$ Accept equivalents for x Accept equivalents for x CAO; need all four, no extras in given interval
(b)	$\frac{\sin\theta}{\cos\theta} = \tan\theta$	M1		Stated or used
	$2\sin\theta - 3\cos\theta = 0 \Rightarrow \tan\theta = 1.5$ $\theta = 56.3°$ $\theta = 56.3° + 180° = 236.3°$	A1 A1 A1F	 4	 Condone > 1dp Ft on c's PV+180° dep only on the M1 provided no 'extra' solutions in the given interval.
	Total		**8**	
	TOTAL		**75**	

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General Certificate of Education

Mathematics 6360

MPC2 Pure Core 2

Mark Scheme

2009 examination - January series

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Set and published by the Assessment and Qualifications Alliance.

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
1(a)	{Area of sector =} $\frac{1}{2}r^2\theta$	M1		$\frac{1}{2}r^2\theta$ stated or used for area of sector. PI
	$=\frac{1}{2}\times 10^2\times 0.8=40$ {cm^2}	A1	2	
(b)(i)	{Arc =} $r\theta$ …. = 8	M1 A1		$r\theta$ stated or used for arc length. PI PI
	Perimeter = 20 + $r\theta$ = 28 (cm)	A1ft	3	ft on 20 + $r\times\theta$
(ii)	Area of square = $\left[\frac{\text{c's answer for (b)(i)}}{4}\right]^2$	M1		PI
	= 49 {cm^2}	A1cao	2	
	Total		**7**	
2(a)	h = 1.5 $\mathrm{f}(x)=x^2\sqrt{x^2-1}$ Integral = h/2 {….}	B1		PI
	{….} = $\mathrm{f}(1.5)+2\left[\mathrm{f}(3)+\mathrm{f}(4.5)\right]+\mathrm{f}(6)$	M1		For the M1 covered range must be 1.5 to 6 OE summing of areas of the three traps.
	{….} = 2.51(5..)+2[25.4(5..)+88.8(4..)]+212(.9..)	A1		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
	Integral = 0.75 × 444.1 = 333 to 3sf	A1cao	4	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
(b)	Increase the number of ordinates	E1	1	OE eg increase the number of strips
	Total		**5**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
3(a)	{Area =} $\frac{1}{2}\times 7.4\times 5.26\times \sin 63°$	M1		
	= 17.3(407…) {m^2}	A1	2	Accept any value from 17.3 to 17.341
(b)	$\{BC^2 =\}\ 5.26^2+7.4^2-2\times 5.26\times 7.4\cos 63$	M1		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 {m} to 3sf	A1	3	AG. Cand. must show a 4th 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		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	2	If not 0.68, accept AWRT any value from 0.682 to 0.684 inclusive
	<u>ALTn</u> $\frac{1}{2}\times 7.4\times(6.86..)\times\sin B=\text{c's ans (a)}$	(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
	Total		**7**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$\frac{dy}{dx} = 3x^{\frac{1}{2}}$	M1		$kx^{\frac{1}{2}}$ with or without + c
	$= 6$ {when $x = 4$}	A1cao	2	Must be 6 and seen in (a)(i) 6 + c is A0
(ii)	y-coordinate of $A = 2\times 4^{\frac{3}{2}}$ (= 16)	M1		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 1st M1 in (a)(ii) m must be numerical
	$y - 16 = -\frac{1}{6}(x-4)$	A1	4	ACF
(b)(i)	$\int 8x^{\frac{1}{2}}\,dx = \frac{8}{3/2}x^{\frac{1}{2}+1}$ {+ c}	M1		Index raised by 1
	$= \frac{16}{3}x^{\frac{3}{2}}$ {+ c}	A1	2	Condone missing '+ c' Coefficient must be simplified
(ii)	$\int 2x^{\frac{3}{2}}\,dx = \frac{2}{5/2}x^{\frac{5}{2}}$ {+ c} {= $\frac{4}{5}x^{\frac{5}{2}}$ {+ c}}	B1		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	4	Accept any value from 17.04 to 17.1 inclusive in place of 256/15
(c)	Translation	B1		Accept 'translat…' as equivalent [T or Tr is NOT sufficient]
	$\begin{bmatrix}-3\\0\end{bmatrix}$	B1	2	Accept equivalent in words provided linked to 'translation/move/shift' (B0B0 if >1 transformation)
	Total		**14**	

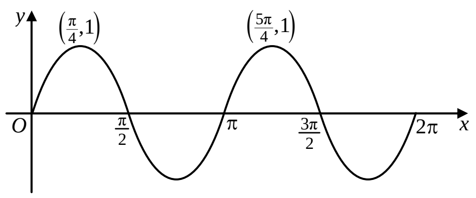
MPC2 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$(1+2x)^4 = 1+4(2x)+6(2x)^2+4(2x)^3+(2x)^4$	M1		(1), 4, 6, 4, (1) OE unsimplified with correct powers of *x* Algebraic multiplication must be a full method
	$= 1 + 8x$	A1		Accept $a = 8$ provided 1st term is 1
	$+ 24x^2$	A1		$b = 24$
	$+ 32x^3$ $\{+ 16x^4\}$	A1	4	$c = 32$
(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*
	$(1 + 2x)^4 + (1 - 2x)^4$ $= 1 + 8x + 24x^2 + 32x^3 + 16x^4$ $+ 1 - 8x + 24x^2 - 32x^3 + 16x^4$ $= 2 + 48x^2 + 32x^4$	A1cso	3	AG Be convinced
(c)	$\frac{dy}{dx} = 96x + 128x^3$	M1		A correct power of *x* OE
	For st. pt. $96x + 128x^3 = 0$	A1		
	$32x(3 + 4x^2) = 0$ Since $3+4x^2 > 0$ there is only one stationary point	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 **only** stationary point
	Total		**11**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$\log_a 40$	B1	1	Accept '$k = 40$'
(ii)	$\log_a 8$	B1	1	Accept '$k = 8$'
(iii)	$\log_a 125$	B1	1	Accept '$k = 125$' but not '$k = 5^3$'
(b)	$\log_{10}\left[(1.5)^{3x}\right] = \log_{10} 7.5$	M1		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
	$x = \frac{\lg 7.5}{3\lg 1.5} = 1.65645\ldots = 1.656$ to 3dp	A1	3	Both method marks must have been awarded with clear use of logarithms seen
(c)	$\log_2 p = m \Rightarrow p = 2^m$; $\log_8 q = n \Rightarrow q = 8^n$	M1		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 $p = 2^m$
	$pq = 2^m \times \left(2^3\right)^n = 2^m \times 2^{3n}$ so $pq = 2^{m+3n}$	A1	3	Accept $y = m + 3n$
	Total		**9**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$\{x =\}\ \sin^{-1}(0.8) = 0.927(29\ldots)\quad \{=\beta\}$	M1		$\sin^{-1}(0.8)$ PI
	$\{x =\}\ \pi - \beta$	m1		
	$x = 0.927(29\ldots),\quad 2.21(42\ldots)$	A1	3	Both Ignore values outside interval 0–2π but A0 if 'extra' values inside the given interval
(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		OE eg $RS = PQ = (\pi - \alpha) - \alpha$
	$= \pi - 2\alpha$	A1	2	Must be simplified
(c)		B1		Sine curve with positive gradient at O with at least 3 stationary points between 0 and 2π
		B1		Correct shaped curve with 2 max and 2 min between 0 and 2π
		B1		All 5 correct points of intersection with x-axis with $\frac{\pi}{2}$, π and $\frac{3\pi}{2}$ clearly shown
	Maximum points $\left(\frac{\pi}{4}, 1\right)$ and $\left(\frac{5\pi}{4}, 1\right)$ stated or clearly shown on the sketch	B2,1	5	B1 for either: 1 as the y-coordinate of max pt(s) or: two max pts between 0 and 2π with correct x-coordinates
	Total		**13**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
8(a)	{S_{40} =} $\frac{40}{2}\left[2a+(40-1)d\right]$	M1		
	20(2a + 39d) = 1250	A1		
	{25th term =} $a + (25-1)d$	M1		
	$a + 24d = 38$	A1		
		m1		Dep on both previous two Ms. Solving two equations in a and d simultaneously
	$18d = 27 \Rightarrow d = 1.5$	A1cso	6	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)
(b)	$a = 38 - 24 \times 1.5$	M1		PI if using a = 2 **in (b)**
	$= 2$			If using eg a = 38 award this M mark at stage: no. of terms $\frac{100-38}{1.5}+1+24$
	$a + (n-1)1.5 < 100$	M1		
	$n < \frac{100-a}{1.5}+1$			
	$n < 66.333…..$ $\Rightarrow$ number of terms < 100 is 66	A1	3	NMS mark as B3 for 66 else B0
	Total		**9**	
	TOTAL		**75**	

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General Certificate of Education

Mathematics 6360

MPC2 Pure Core 2

Mark Scheme

2009 examination - June series

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

MPC2

Q	Solution	Marks	Total	Comments
1(a)	$5^2 = 7^2 + 8^2 - 2\times 7\times 8\cos\theta$	M1		Use of the cosine rule – must be correct (PI by the correct line below)
	$\cos\theta = \dfrac{7^2+8^2-5^2}{2\times7\times8}\ \left(=\dfrac{88}{112}=0.7857\ldots\right)$	m1		Rearrangement
	$\theta = 38.21\ldots. = 38.2°$ (to nearest 0.1°)	A1	3	CSO (Must see either exact value for $\cos\theta$ or at least 4sf value for either $\cos\theta$ or θ before the printed answer 38.2°) AG
(b)	Area = $\dfrac{1}{2}\times 7\times 8\sin\theta$	M1		OE eg Area = $\sqrt{10(10-5)(10-8)(10-7)}$ $(=\sqrt{300})$
	= 17.3 {cm²} to 3sf	A1	2	Condone 17.31 to 17.33 inclusive
	Total		**5**	
2(a)	$(n =) - 4$	B1	1	Accept x^{-4}
(b)	$\left(1+\dfrac{3}{x^2}\right)^2 = 1+\dfrac{6}{x^2}+\dfrac{9}{x^4}$	B2,1,0	2	Apply ISW after B2 stage (B1 if correct but unsimplified seen)
(c)	$\int \left(1+\dfrac{3}{x^2}\right)^2 \mathrm{d}x = x - 6x^{-1} - 3x^{-3} + c$	M1		At least one power of x correctly obtained in the integration of an expansion
		A2,1,0	3	A2 terms correct **and** '+ c' (A1F two terms in x correct ft on expansion provided integrating x to a negative power)
(d)	$\int_1^3 \left(1+\dfrac{3}{x^2}\right)^2 \mathrm{d}x = \left[x-\dfrac{6}{x}-\dfrac{3}{x^3}\right]_1^3$			
	$= \left(3-\dfrac{6}{3}-\dfrac{3}{27}\right)-(1-6-3)$	M1		Dealing correctly with limits; F(3) − F(1) (must have attempted integration to get F)
	$= 8\dfrac{8}{9}$	A1	2	CSO; OE provided value is **exact**, eg $\dfrac{80}{9}, \dfrac{240}{27}$; ISW dec value after exact value seen NMS scores 0/2
	Total		**8**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$24 = 16k + 12$ $k = 12 \div 16 = 0.75$	M1 A1	 2	Condone with 0.75 (OE) subst for k AG; OE fraction; if verification must explicitly state the conclusion
(b)	$u_3 = 30$ $u_4 = 34.5$	B1 B1F	 2	 ft on 0.75 × cand's u_3 + 12
(c)(i)	$L = 0.75L + 12$	M1	1	Replacing u_{n+1} and u_n by L
(ii)	$L = \frac{12}{1-k} = \frac{12}{1-0.75}$ $L = 48$	m1 A1	 2	PI, but previous M **must** be scored SC: (c)(i) incorrect and then in (c)(ii) $L = 0.75L + 12$ leading to $L = 48$ scores B2
	Total		**7**	
4(a)	$h = 2$ $g(x) = \sqrt{x^3+1}$ I ≈ $h/2\{\ldots\}$ $\{\ldots\} = g(0) + g(6) + 2[g(2) + g(4)]$ $\{\ldots\} = 1 + \sqrt{217} + 2(3 + \sqrt{65})$ $1 + 14.73... + 2(3 + 8.06\ldots)$ (I ≈) 37.8554… = 37.86 (to 4sf)	B1 M1 A1 A1	 4	PI OE summing of areas of the 'trapezia'.. Can award even if MR expression for g(x) but must be using from 0 to 6 OE Accept 2dp evidence for surds Must be 37.86
(b)	$f(x) = \sqrt{(2x)^3+1} = \sqrt{8x^3+1}$	M1 A1	 2	$\sqrt{kx^3+1}$, $k \neq 1$ or 0 or $f(x) = g(2x)$ Either form acceptable
	Total		**6**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$\frac{dy}{dx}=\frac{45}{2}x^{\frac{1}{2}}-\frac{5}{2}x^{\frac{3}{2}}$	M1 A2,1,0	3	One power correctly obtained A1 for each term on the RHS coeffs simplified
(b)	$\frac{45}{2}x^{\frac{1}{2}}-\frac{5}{2}x^{\frac{3}{2}}=0$	M1		cand's (a) = 0
	$\frac{5}{2}x^{\frac{1}{2}}(9-x)=0$	m1		Must be solving eqn of form $ax^m+bx^n=0$, m and n non-zero, with at least one of m and n non-integer and reaching a stage from which the non-zero value of x can be stated PI. Must deal with powers of x correctly and any squaring of kx^p terms or expressions must be correct.
	At M, $x=9$	A1		
	$y_M=162$	A1	4	M1 must be scored, else 0/4
(c)	At $P(1, 14)$, $\frac{dy}{dx}=\frac{45}{2}-\frac{5}{2}=20$	M1		Attempt to find $y'(1)$
	Tangent at P: $y-14=m(x-1)$	m1		m = cand's value of $y'(1)$
	$y-14=20x-20$; $y=20x-6$	A1	3	CSO; AG
(d)	Tangent at M: $y=162$	B1F		ft y = cand's y_M
	At R, $162=20x-6$; $x=8.4$	M1		Solving cand's numerical $y_M=20x-6$ to find a value for x
	Distance $RM=\lvert x_M-x_R\rvert=9-8.4=0.6$	A1F	3	ft on coordinates of M
	Total		**13**	
6	{Area of sector =} $\frac{1}{2}r^2\theta$	M1		$\frac{1}{2}r^2\theta$ seen or used for the area; PI
	$r^2=\frac{33.75}{\frac{1}{2}\theta}$ (= 56.25)	m1		Correct rearrangement to $r^2=\ldots$ or $r=\ldots$
	$r=7.5$	A1		PI eg by a correct arc length
	{Arc =} $r\theta$	M1		$r\theta$ seen or used for the arc length
	…. = 9	A1F		ft on 1.2 × cand's r provided the **two** M's scored; if not explicit, PI by ft on 3.2 × cand's r for perimeter
	{Perimeter =} 24 {cm}	A1	6	CAO
	Total		**6**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$ar = 375$; $ar^4 = 81$	B1		For either OE or PI by next line
	$\Rightarrow 375r^3 = 81$	M1		Elimination of a OE
	$r^3 = \frac{81}{375} = \frac{27}{125} = 0.216 \Rightarrow r = 0.6$	A1	3	CSO AG Full valid completion SC: Clear explicit verification, with statement max B1 out of 3. (If considers uniqueness then 3 is possible)
(ii)	$0.6a = 375$ $a = 625$	M1 A1	 2	OE; PI
(b)	$\frac{a}{1-r} = \frac{a}{1-0.6}$	M1		$\frac{a}{1-r}$ **used** with $\lvert$ value of $r \rvert < 1$
	$S_\infty = \frac{625}{0.4} = 1562.5$	A1F	2	ft on cand's value for a…. ie $2.5 \times a$
(c)	$\sum_{n=6}^{\infty} u_n = \sum_{n=1}^{\infty} u_n - \sum_{n=1}^{5} u_n$	M1		
	$u_3 = 0.6u_2$ (= 225) and $u_4 = 0.6^2 u_2$ (= 135)	M1		Valid method to either find u_3 and u_4 or use of $\{S_n =\}\frac{a(1-r^n)}{1-r}$ for either $n = 5$ or $n = 6$
	$\sum_{n=1}^{5} u_n = 625+375+225+135+81$ (= 1441)	A1		
	$\sum_{n=6}^{\infty} u_n = 1562.5 - 1441 = 121.5$	A1	4	
	Alternative for (c):			
	Recognise that the sum to infinity with first term u_6 is required	(M1)		
	Valid method to find u_6 (= $0.6u_5$)	(M1)		
	$\sum_{n=6}^{\infty} u_n = \frac{81 \times 0.6}{1-0.6}$	(A1)		
	$= 121.5$	(A1)		
	Total		**11**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
8(a)	$\frac{\sin\theta}{\cos\theta} - \frac{\cos\theta}{\cos\theta} = 4$			
	$\tan\theta - 1 = 4$	M1		$\tan\theta = \frac{\sin\theta}{\cos\theta}$ stated or used
	$\tan\theta = 5$	A1	2	AG; CSO
(b)(i)	$2\cos^2 x - \sin x = 1$ $2(1 - \sin^2 x) - \sin x = 1$	M1		**Use** of $\cos^2 x + \sin^2 x = 1$
	$2 - 2\sin^2 x - \sin x = 1$ $\Rightarrow 2\sin^2 x + \sin x - 1 = 0$	A1	2	AG; CSO
(ii)	$(\sin x + 1)(2\sin x - 1) = 0$	M1		Factorisation or use of formula; PI by **both** correct values for $\sin x$
	$\sin x = -1, \quad \sin x = 0.5$	A1		Need both
	$(\sin x = -1)$ so $x = 270°$	B1		
	$(\sin x = 0.5)$ so $x = 30°$	A1		30° as the only acute angle
	$x = 180 - 30 = 150°$	B1F	5	ft for 2nd angle from c's $\sin x$ = non-integer
				Ignore values outside interval 0°–360° but extras inside interval lose the corresp. B, A or B1F mark. If using rads, accepting either equivalent exact vals (in terms of pi) or 2dp values instead of degrees, penalise max of 1 mark from any of the final three marks (B1A1B1F) awarded NMS: 270° (B1); 30°, 150° (B1) [max 2/5]
	Total		**9**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
9(a)(i)	$\sqrt{125} = \sqrt{25 \times 5} = 5\sqrt{5}$	M1		OE eg $\sqrt{125} = \sqrt{5^3}$ or $5^{1.5}$ seen
	$5^p = \sqrt{125} \Rightarrow p = 1.5$	A1	2	Correct value of p must be explicitly stated
	Alternative for (a)(i):			
	$p\log 5 = \frac{1}{2}\log 125$	(M1)		OE eg $p\log 5 = \log 11.18$ or eg $p = \log_5 \sqrt{125}$
	$p\log 5 = \frac{3}{2}\log 5 \Rightarrow p = \frac{3}{2}$	(A1)		Correct value of p must be explicitly stated
(ii)	$5^{2x} = \sqrt{125} = 5^p \Rightarrow x = 0.5p = 0.75$	B1F	1	Must be 0.5 × c's value of p SC: $x = 0.75$ with c's ans (a)(i) $5^{1.5}$ scores B1F
(b)	$3^{2x-1} = 0.05$ $(2x-1)\log 3 = \log 0.05$	M1		Take logs of both sides and use 3rd law of logs. PI eg by $2x - 1 = \log_3 0.05$ seen
	$x = \frac{\log_{10} 0.05}{2\log_{10} 3} + \frac{1}{2}$	m1		Correct rearrangement to $x = \ldots.$ PI
	$= -0.8634(165\ldots) = -0.8634$ to 4dp	A1	3	Condone > 4dp. Must see logs clearly **used** in solution, so NMS scores 0/3
(c)	$\log_a x = 2(\log_a 3 + \log_a 2) - 1$			
	$= 2\log_a(3 \times 2) - 1$	M1		A valid law of logs used
	$= \log_a(6^2) - 1$	M1		Another valid law of logs used
	$= \log_a 36 - \log_a a$	B1		$\log_a a = 1$ quoted or used or $\log_a \frac{x}{k} = -1 \Rightarrow \frac{x}{k} = a^{-1}$ OE
	$\log_a x = \log_a\left(\frac{36}{a}\right) \Rightarrow x = \frac{36}{a}$	A1	4	CSO Must be $x = \frac{36}{a}$ or $x = 36a^{-1}$
	Total		**10**	
	TOTAL		**75**	

Version 1.0: 0110

General Certificate of Education

Mathematics 6360

MPC2 Pure Core 2

Mark Scheme

2010 examination - January series

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Registered address: AQA, Devas Street, Manchester M15 6EX *Dr Michael Cresswell Director General*

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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

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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
1(a)(i)	{Area of sector =} $\frac{1}{2}r^2\theta$	M1		Stated or explicitly used
	$= \frac{1}{2}\times 15^2 \times 1.2$ = 135 (cm^2)	A1	2	AG Must see some substitution
(ii)	{Arc =} $r\theta$	M1		PI
	…. = 18 (cm)	A1	2	
(b)	PB = 5 (cm)	B1		Accept even if only on a diagram or within an expression for the perimeter
	$\{AP^2 =\}\ 15^2 + 10^2 - 2\times 15\times 10\cos 1.2$	M1		RHS of cosine rule used
	= 325 − 300cos1.2 = 216.2926…	m1		Correct order of evaluation
	AP = 14.7(068..)	A1		PI eg within an expression for perimeter
	Perimeter = 5 + 18 + 14.7…. = 37.7 (cm)	A1	5	3sf or better
	Total		**9**	
2(a)	$\sqrt{x^5} = x^{\frac{5}{2}}$	B1	1	Accept k = 2.5
(b)	$\int\left(7\sqrt{x^5} - 4\right)\mathrm{d}x = \frac{7}{3.5}x^{3.5} - 4x\ (+\ c)$	M1		Index 'k' raised by 1 in integrating x^k
		A1F		1st term correct follow through on non-integer k
		B1	3	For − 4x as integral of − 4
(c)	$y = 2x^{3.5} - 4x + c$ (*)	B1F		y = c's answer to (b) with '+ c' ('y =' PI by next line)
	When x = 1, y = 3 $\Rightarrow$ 3 = 2 – 4 + c	M1		Subst. (1, 3) in attempt to find constant of integration
	$y = 2x^{3.5} - 4x + 5$	A1	3	Accept c = 5 after correct eqn * which must include 'y =' Coefficients must be tidied
	Total		**7**	
3(a)(i)	(x =) 1	B1	1	CAO
(ii)	(x =) 3	B1	1	CAO
(b)	$\log_a n^2 = \log_a 18(n-4)$	M1		A valid law of logs applied to correct logs
		M1		A second valid law of logs applied to correct logs
	$n^2 - 18n + 72 = 0$	A1		ACF of these terms eg $n^2 - 18n = -72$
	$(n-6)(n-12) = 0$	m1		Valid method to solve quadratic, dep on both the previous Ms
	n = 6, n = 12	A1	5	Both values required **SC** NMS max (out of 5) B3 for both 6 and 12 without uniqueness considered; max B1 for either 6 or 12 only
	Total		**7**	

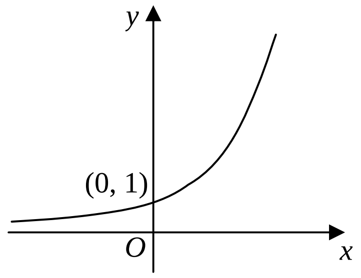
MPC2 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$\{S_{31} =\}\ \frac{31}{2}\left[2a+(31-1)d\right]$	M1		
	$31\left(a+15d\right)=310$	m1		Forming eqn and eliminating fraction or bracket
	a + 15d = 310/31; a + 15d = 10	A1	3	AG Completion to printed answer
(b)	a + (21 − 1)d = 2[a + (16 − 1)d]	M1		a + (n − 1)d used for at least one term
	$\Rightarrow$ a = − 10d ; $\Rightarrow$ − 10d + 15d = 10	m1		Solving a + 15d = 10 simultaneously with an eqn in a and d obtained from a+20d = k[a+15d] with k=2 or with k=1/2
	d = 2	A1	3	
(c)	$u_1 = a = -20$	B1F		ft on c's value for d in a + 15d = 10 or in another correct (dep on m1) equation in a and d The value for a must appear within c's soln for (c)
	$\sum_{n=1}^{k} u_n = S_k = \frac{k}{2}\left[2a+(k-1)d\right]$	M1		Condone n for k in M1 and A1F lines provided n replaced by k at a later stage
	$\frac{k}{2}\left[-40+2k-2\right]=0$	A1F		'= 0' can be implied by later line; ft on c's non-zero values for a and d
	k = 21	A1	4	Condone presence of k = 0 **SC** NMS k = 21 and with d = 2 found earlier award B2. If k = 21 but never see d = 2, award 0/4
	Total		**10**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
5(a)	$\frac{1}{x^3} = x^{-3}$	B1		PI by its correct derivative
	$\frac{\mathrm{d}y}{\mathrm{d}x} = -3x^{-4} + 48$	M1		A power decreased by 1; could be the +48 or the ft after B0
		A1	3	
(b)	$-3x^{-4} + 48 = 0$	M1		c's answer to (a) equated to 0
	$x^{-4} = 16$	A1F		To $x^p = q$ but only ft on eqns of the form $ax^{2k} + 48 = 0$, where a and k are **negative integers**
	$x = \pm\frac{1}{2}$	A1		
	Eqns of tangents: $y = 32$ and $y = -32$	A1F	4	Only ft if answer is of the form $y = \pm k$
(c)	When $x = 1$, $\frac{\mathrm{d}y}{\mathrm{d}x} = -3 + 48 = 45$	M1		Attempt to find value of $\frac{\mathrm{d}y}{\mathrm{d}x}$ at $x = 1$
	Gradient of normal at (1, 49) is $-\frac{1}{45}$	m1		Correct use of $m \times m' = -1$ with c's value of $\frac{\mathrm{d}y}{\mathrm{d}x}$ when $x = 1$
	Normal at (1, 49): $y - 49 = -\frac{1}{45}(x-1)$	A1	3	CSO. Apply ISW after ACF; accept 49.02 or better in place of $49\frac{1}{45}$
	Total		**10**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
6(a)	 	B1 B1	 2	Shape with some indication of asymptotic behaviour in 2nd quadrant below pt of intersection with *y*-axis Only intersection is with *y*-axis at (0, 1) stated/indicated … (accept 1 on *y*-axis as equivalent)
(b)(i)	$h = 0.5$ $\mathrm{f}(x) = 2^x$ $\mathrm{I} \approx h/2\{\ldots\}$ $\{\ldots\} = \mathrm{f}(0)+\mathrm{f}(2)+2[\mathrm{f}(0.5)+\mathrm{f}(1)+\mathrm{f}(1.5)]$	B1 M1		PI OE summing of areas of the 4 'trapezia'
	$\{\ldots\} = 1 + 4 + 2(\sqrt{2} + 2 + \sqrt{8})$ $= 5 + 2 \times 6.2426\ldots = 17.485\ldots$	A1		OE Accept 2dp (rounded or truncated) as evidence for surds
	$(\mathrm{I} \approx)$ $4.3713\ldots = 4.37$ (to 3sf)	A1	4	CAO Must be 4.37 **SC** for those who use 5 strips, max possible is B0M1A1A0
(ii)	Increase the number of ordinates	E1	1	OE
(c)	Translation;	B1;		Accept 'translat…' as equivalent [T or Tr is NOT sufficient]
	$\begin{bmatrix} -7 \\ 3 \end{bmatrix}$	B1;B1	3	B1 for each component of the vector. Condone if the equiv 2 vectors are given. Accept **full** equivalent to vector(s) in words provided linked to 'translation/ move/shift' and **correct** directions. (No marks if **different** transformations)
(d)	$8 = 2^k + 3 \Rightarrow 2^k = 5$	M1		Correct subst. and an attempted rearrangement to $2^k = N$. PI by $k = \dfrac{\log 5}{\log 2}$
	$k = \log_2 5$	A1	2	Accept $m = 2$, $n = 5$
	Total		**12**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$(1+2x)^7$ $=1+\binom{7}{1}(2x)^1+\binom{7}{2}(2x)^2+\binom{7}{3}(2x)^3+$	M1		Any valid method. PI by a correct value for either *a* or *b* or *c*
	$= 1 + 14x + 84x^2 + 280x^3 + \ldots.$ $\{a = 14,\ b = 84,\ c = 280\}$	A1 × 3	4	A1 for each of *a*, *b*, *c* **SC** $a = 7$, $b = 21$, $c = 35$ either explicitly or within expn (M1A0)
(b)	$\left(1-\frac{1}{2}x\right)^2 = 1 - x + \frac{1}{4}x^2$	B1		Correct expansion stated explicitly or used later
	x^3 terms from expn of $\left(1-\frac{1}{2}x\right)^2(1+2x)^7$ are cx^3 and $-x\left(bx^2\right)$ and $\frac{1}{4}x^2(ax)$	M1		Any one of the three, or ft on c's non-zero values for *a*, *b* or *c*. Must be from products of terms using c's two expansions
	$cx^3 - x\left(bx^2\right) + \frac{1}{4}x^2(ax)$	A1F		ft c's two expansions provided all three combinations of terms are present
	Coefficient of x^3 is $c - b + 0.25a = 199.5$	A1	4	OE eg 399/2 Condone $199.5x^3$
	Total		**8**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
8(a)	$x + 52° = (22°)$, $180° + 22°$; $360° + 22°$ $(x = 180 + 22 - 52;\ x = 360 + 22 - 52)$	M1;M1		$x + 52 = 180 +$ AWRT 22, 360 + AWRT 22 OE (max of M1 if extras in range) LHS could be any letter but not x unless final answer shows recovery Ms can be PI
	$x = 150°$, $330°$	A1	3	Both CAO with no extras in $0° \le x \le 360°$ Ignore anything outside $0° \le x \le 360°$
(b)(i)	$3\tan\theta = \dfrac{8}{\sin\theta} \Rightarrow 3\dfrac{\sin\theta}{\cos\theta} = \dfrac{8}{\sin\theta}$	M1		$\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ used/seen
	$\dfrac{3(1-\cos^2\theta)}{\cos\theta} = 8$	M1		$\sin^2\theta = 1 - \cos^2\theta$ **used**
	$\Rightarrow 3 - 3\cos^2\theta = 8\cos\theta$ $\Rightarrow 3\cos^2\theta + 8\cos\theta - 3 = 0$	A1	3	CSO AG Completion
(ii)	$(3\cos\theta - 1)(\cos\theta + 3) = 0$	M1		Any valid method to solve the quadratic
	$\cos\theta = \dfrac{1}{3}$	A1	2	CSO Must only be the one value
(iii)	$\cos 2x = \dfrac{1}{3}$	M1		Using (ii) OE to get or use $\cos 2x = k$ where $-1 \le k \le 1$
	$(2x =)$ 70.528..	B1		Award for $\cos^{-1}(1/3)$ = value from 70 to 71 inclusive, even if θ used. PI
	$2x = 360° - 70.528..$ (= 289.47…)	m1		$2x = 360 - \cos^{-1}$(c's k) OE No extras inside the range
	$x = 35°$, $145°$ (to the nearest degree)	A1	4	Both, condoning greater accuracy, with no extras in $0° \le x \le 180°$ Ignore anything outside $0° \le x \le 180°$ **SC for (b)(iii) only when c's answer for (b)(ii) is** $\boldsymbol{\cos\theta = -\frac{1}{3}}$ **:** max mark M1B1 (val 70-71 or val 109-110 inclusive) m1A0
	Total		**12**	
	TOTAL		**75**	

Version 1.0

General Certificate of Education
June 2010

Mathematics MPC2

Pure Core 2

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MPC2

Q	Solution	Marks	Total	Comments
1(a)	{Area of sector =} $\frac{1}{2}r^2\theta$	M1		$\frac{1}{2}r^2\theta$ seen or used for the area
	$= \frac{1}{2}\times 8^2 \times 1.4$ = 44.8 {m²}	A1	2	Must be exact, not rounded to
(b)(i)	{Arc =} $r\theta$	M1		$r\theta$ seen or used for the arc length
	…. = 11.2	A1		PI Condone AWRT 11.2
	Perimeter of sector = 16+11.2 = 27.2 {m}	A1F	3	Ft on c's evaluation of 8×1.4
(ii)	$27.2 = 2\pi x$	M1		[c's numerical answer for (b)(i)] = $2\pi x$
	$x = \frac{27.2}{2\pi}$ = 4.329… = 4.33 to 3sf	A1	2	Condone >3sf
	Total		**7**	
2(a)	$u_2 = 6.8$	B1		OE eg 34/5
	$u_3 = 8.72$	B1F	2	Ft on 6+0.4×c's u_2
(b)	$L = 6 + 0.4L$	M1		Replacing u_{n+1} and u_n by L
	$L = \frac{6}{1-0.4}$	m1		PI provided M scored
	$L = 10$	A1	3	Must form an equation in L otherwise 0/3
	Total		**5**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$\frac{6}{\sin\theta}=\frac{15}{\sin 150}$	M1		Sine rule OE PI
	$\sin\theta=\frac{6\times\sin 150}{15}$ {= 0.2}	m1		Rearrangement
	θ = 11.53(6..) = 11.5° {to nearest 0.1°}	A1	3	AG Must see at least 4sf value or an exact value for $\sin\theta$ (0.2, 3/15, OE) before seeing the printed value 11.5
(b)	Angle B = 180 − (150+θ) = 18.5 {to 3sf}	B1		Award for B = any value between 18 and 19 inclusive [18.463041….]
	Area = $\frac{1}{2}\times 6\times 15\sin B$	M1		
	= 14.3 {cm^2} to 3sf	A1	3	Accept a value 14.2 to 14.3 inclusive Note: For methods involving AC, for the M1 need both a correct method to find AC and a correct area formula
	Total		**6**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$p = -3$; $q = 3$	B1;B1	2	Accept even if just embedded in the expansion
(b)(i)	$\int \left(1-\frac{1}{x^2}\right)^3 \mathrm{d}x =$			
	$\int \left(1-3x^{-2}+3x^{-4}-x^{-6}\right) \mathrm{d}x$	M1		Uses (a) with indication of integration and indication of $\frac{1}{x^n}=x^{-n}$ PI
	$= x+3x^{-1}-x^{-3}+\frac{1}{5}x^{-5}$ $\{+c\}$	m1		At least three powers of x correctly obtained
		A2F,1F	4	Ft on c’s non-zero integers p and q. A1F if 3 of the 4 terms are correct (ft) or if all correct (ft) but left unsimplified Condone missing $+c$.
(ii)	$\int_{\frac{1}{2}}^{1} \left(1-\frac{1}{x^2}\right)^3 \mathrm{d}x =$			
	$\left(1+3-1+\frac{1}{5}\right)-\left(\frac{1}{2}+6-8+\frac{32}{5}\right)$	M1		Attempting to calculate F(1)−F(1/2) where F is c's answer to part (b)(i) provided F is not the integrand or the c's equivalent of the integrand $(1-\frac{1}{x^2})^3$.
	$= -\frac{17}{10}$	A1	2	OE exact answer eg −1.7
	Total		**8**	

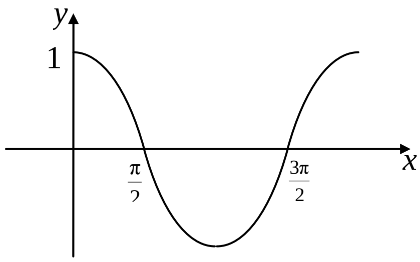
MPC2 (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	$\{S_\infty =\}\ \frac{a}{1-r} = \frac{10}{1-r}$	M1		$\frac{a}{1-r}$ <u>used</u>
	$\frac{10}{1-r} = 50$ so $1 - r = \frac{10}{50} \Rightarrow r = \frac{4}{5}$	A1	2	AG Condone verification with the correct final statement but be convinced.
(ii)	2^{nd} term = ar	M1		ar stated or used for the 2^{nd} term. PI by ans'8'
	= 8	A1	2	
(b)(i)	4^{th} term = $a + 3d$; 8^{th} term = $a + 7d$	M1		Uses $a + (n - 1)d$ correctly at least once
	$a + 3d = 10$, $a + 7d = 8$	A1F		Both eqns. correct ft on c's (a)(ii) OE eg $8 = 10 + 4d$
	$\Rightarrow 4d = -2 \quad \Rightarrow d = -0.5$	A1	3	OE fraction.
(ii)	$a + 3(-0.5) = 10$	M1		An appreciation that a is required in **<u>(b)(ii)</u>** and a valid method to find a anywhere or PI if $a = 11.5$ seen/used
	$\Rightarrow a = 11.5$	A1F		Ft on c's non-zero value for d ie using $a = 10-3d$ or a= c's 8 $-7d$. [c's 8 is candidate's answer to (a)(ii)]
	$\sum_{n=1}^{40} u_n = S_{40} = \frac{40}{2}\left[2a + (40-1)d\right]$	M1		$\frac{40}{2}\left[2a + (40-1)d\right]$ OE
	= 70	A1	4	
	Total		**11**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
6(a)	$\sqrt{x} = x^{\frac{1}{2}}$	B1		PI
	$\frac{x^3+\sqrt{x}}{x} = \frac{x^3}{x} + \frac{\sqrt{x}}{x} = x^2 + x^{-\frac{1}{2}}$	B1;B1	3	Accept $p = 2$; $q = -\frac{1}{2}$
(b)(i)	$\frac{dy}{dx} = 2x - \frac{1}{2}x^{-\frac{3}{2}}$	M1 A1	2	Reduces both powers by 1 ACF
(ii)	When $x = 1$, $y = 2$	B1		PI if not stated explicitly eg the '2' may appear in the correct posn. in later eqn.
	When $x = 1$, $\frac{dy}{dx} = 2 - \frac{1}{2} = \frac{3}{2}$	M1		Attempt to find $\frac{dy}{dx}$ when $x = 1$ PI
	Gradient of normal = $-\frac{2}{3}$	m1		$-$ 1/(c's value of dy/dx when x = 1) either stated as the gradient of the normal or used as the gradient in the equation of the normal
	Equation of normal: $y - 2 = -\frac{2}{3}(x-1)$	A1F	4	Only ft on c's $\frac{dy}{dx}$ in part (b)(i). ACftF
(c)(i)	$\frac{d^2y}{dx^2} = 2 + \frac{3}{4}x^{-\frac{5}{2}}$	M1 A1F	2	Reduces both powers by 1. Ft on (b)(i) provided at least one power to be differentiated is both negative and fractional
(ii)	(Since x>0,) $\frac{d^2y}{dx^2}$ >0 For a maximum point $\frac{d^2y}{dx^2}$ is **not** positive so C has no maximum points	E2,1,0	2	E1 for attempt to find the sign of $\frac{d^2y}{dx^2}$; either in general terms or at the pt(s) where c's dy/dx = 0 for the remaining E mark a correct justification for why $\frac{d^2y}{dx^2}$ >0 and also a full correct concluding statement must be made.
	Total		**13**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
7(a)		B1 B1	 2	Correct shape meeting positive *y*-axis and only one oscillation within interval 0 to 2π The three correct intercepts stated; Accept 1.57 for π/2 and 4.71 for 3π/2 but must be evidence of radian vals. not just degrees Ignore any parts of the graph clearly indicated as outside the given interval
(b)(i)	$1-\cos^2\theta = \cos\theta(2-\cos\theta)$ $1 = 2\cos\theta \Rightarrow \cos\theta = \frac{1}{2}$	M1 A1	 2	$\cos^2\theta + \sin^2\theta = 1$ used CSO AG Completion
(ii)	$\sin^2 2x = \cos 2x(2-\cos 2x)$ $\Rightarrow \cos 2x = \frac{1}{2}$ $\{2x =\}\quad \cos^{-1}\left(\frac{1}{2}\right) = 1.04(7..)$ $x = 0.524,\ 2.62$ $x = 0.523(59..),\ 2.61(7..)$	 M1 m1 A2,1,0	 4	 Uses (b)(i) PI Accept 1.05, $\frac{\pi}{3}$; Condone 60º Condone >3sf; Condone *x* = 0.525, 2.62 Accept truncated '3sf' vals *x* =0.523, 2.61 Deduct 1 mark for each extra (>2 solns) in the given interval from A marks to a min of A0. Ignore any solns outside the given interval 0 to *π*. Accept, as equivalent, the exact answers $x = \frac{\pi}{6}$ and $x = \frac{5\pi}{6}$ when seen and apply ISW if 'errors' converting these to decimals. If not A2 then A1 if • one soln correct. • 30º , 150º ie solns left in degrees • AWRT 0.52, 2.6 ie correct vals to only 2sf. Must see an indication that (b)(i) has been used otherwise 0/4 so just stating the two correct answers with nothing else scores 0/4.
	Total		**8**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
8(a)	(y =) 1	B1	1	
(b)	$h = 0.2$	B1		PI
	f(x) = 2^{4x} I ≈ h/2{…} {.}=f(0)+f(1)+2[f(0.2)+f(0.4)+f(0.6)+f(0.8)]	M1		OE summing of areas of the 'trapezia'..
	{.} = 1 + 16+2($2^{0.8}$ + $2^{1.6}$ +$2^{2.4}$ +$2^{3.2}$) =1+16+2(1.741..+3.031..+5.278..+9.1895..) = [17+2×19.24...]	A1		OE Accept 2dp rounded or truncated evidence
	I = 5.55 (to2dp)	A1	4	Must be 5.55
(c)	Stretch(**I**) in y-direction(**II**) scale	M1		Need (**I**) **and** either (**II**) or (**III**)
	factor $\frac{1}{8}$ (**III**)	A1	2	Need (**I**) and (**II**) and (**III**)
	<u>ALTn</u>: Translation with an indication that the translation is in the x-direction (B1) $\begin{bmatrix} \frac{3}{4} \\ 0 \end{bmatrix}$ (B1)			Combination of **<u>different</u>** transformations scores 0/2
(d)	g(x) = $2^{4(x-1)} - \frac{1}{2}$	B2,1,0		B1 for either $2^{4(x+1)} - \frac{1}{2}$ or for $2^{4(x-1)} + \frac{1}{2}$ or for $2^{4x-1} - \frac{1}{2}$
	At Q, $y = 0 \Rightarrow 2^{4(x-1)} = 2^{-1}$	M1		Reaches a stage from which linear eqn can be stated directly eg an alternative stage is $4(x-1)\log 2 = -\log 2$
	$\Rightarrow 4x - 4 = -1 \Rightarrow x = 0.75$	A1	4	NMS mark as 4 or 0
(e)(i)	$\log_a k = \log_a 2^3 + \log_a 5 - \log_a 4$	M1		One law of logs used
	$\log_a k = \log_a (2^3 \times 5) - \log_a 4$	M1		A second law of logs used; could be $\log_a k = \log_a 2^3 + \log_a (\frac{5}{4})$
	$\log_a k = \log_a (\frac{2^3 \times 5}{4}) = \log_a 10 \Rightarrow k = 1$	A1	3	CSO AG
(ii)	$2^{4x-3} = \frac{5}{4}$ so $(4x-3)\log_{10} 2 = \log_{10} \frac{5}{4}$	M1		Equate y's, take logs (to any base) of both sides **<u>and</u>** apply 3rd law of logs. Altn $4x \log 2 = \log\left(\frac{5}{4} \times 2^3\right)$
	$x = \dfrac{3\log_{10} 2 + \log_{10}\left(\frac{5}{4}\right)}{4\log_{10} 2}$	m1		Rearrange correctly to x = …. Altn $4x \log 2 = \log 10$ In both cases, log term(s) must have same base and expressions must be in an exact form, ie not approx. dec. vals
	$x = \dfrac{\log_{10} 10}{4\log_{10} 2}$ so $x = \dfrac{1}{4\log_{10} 2}$	A1	3	CSO AG Must be clear evidence that base 10 is used, also be convinced
	Total		**17**	
	TOTAL		**75**	

Version1.0

General Certificate of Education (A-level)
January 2011

Mathematics MPC2

(Specification 6360)

Pure Core 2

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.

MPC2

Q	Solution	Marks	Total	Comments
1(a)	Arc = $r\theta$	M1		arc = $r\theta$ seen or used. PI by correct θ
	$4 = 5\theta \Rightarrow \theta = \frac{4}{5} = 0.8$	A1	2	$(\theta =)\ \frac{4}{5}$ OE
(b)	Area of sector = $\frac{1}{2}r^2\theta$	M1		Area = $\frac{1}{2}r^2\theta$ seen or used within **(b)**. PI
	$= \frac{1}{2}\times 5^2 \times 0.8 = 10$ (cm^2)	A1F	2	Ft on 12.5×c's exact value for θ in part (a) provided 5 ≤ c's area ≤ 20
	Total		**4**	
2(a)(i)	(p =) 3	B1	1	
(ii)	(q =) –3	B1F	1	If not correct, ft on $-p$
(iii)	$(r =)\ \frac{1}{2}$	B1	1	OE
(b)	$2^{\frac{1}{2}} \times 2^x = 2^{-3} \Rightarrow 2^{\frac{1}{2}+x} = 2^{-3}$	M1		Using a law of indices or logs correctly to combine at least two of the powers of 2 PI
	$\Rightarrow x = -3\frac{1}{2}$	A1F	2	If not correct, ft on $x = q - r$ provided method shown
	Total		**5**	
3(a)	$10^2 = 8^2 + 5^2 - 2\times8\times5\cos\theta$	M1		Use of the cosine rule PI by next line
	$\cos\theta = \frac{8^2+5^2-10^2}{2\times8\times5} \left(= -\frac{11}{80} = -0.1375\right)$	m1		Rearrangement
	θ = 97.90(32...) = 97.9º (to nearest 0.1º)	A1	3	CSO (Must see either exact value for $\cos\theta$ or at least 4sf value for either $\cos\theta$ or θ before the printed answer 97.9º) AG
(b)(i)	Area = $\frac{1}{2}\times 8\times 5\sin\theta$	M1		OE
	= 19.810… = 19.8 (cm^2) to 3sf	A1	2	Condone > 3sf
(ii)	Area of triangle = $0.5\times BC\times AD$	M1		Or valid method to find sin B or sin C or B or C
	AD = [Ans.**(b)(i)**]÷[0.5×BC]	m1		Or AD = 5 sin B; or AD = 8 sin C OE
	$AD = \frac{19.810..}{5} = 3.962.. = 3.96$ (cm) to 3sf	A1	3	Condone > 3sf
	Total		**8**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
4(a)	$h = 0.5$	B1		PI
	$f(x) = \sqrt{27x^3+4}$			
	$I \approx h/2\{\ldots\}$			
	$\{\ldots\}= f(0)+ f(1.5)+2[f(0.5)+ f(1)]$	M1		OE summing of areas of the 'trapezia'..
	$\{\ldots\}= \sqrt{4} + \sqrt{95.125} + 2(\sqrt{7.375} + \sqrt{31})$ $= 2+9.7532... +2(2.7156\ldots+5.5677\ldots)$	A1		OE Accept 2dp rounded or truncated as evidence for surds
	$(I \approx)$ $0.25\times 28.32012\ldots = 7.08$ (to 3sf)	A1	4	Must be 7.08
(b)	$g(x) = \sqrt{27\left(\frac{1}{3}x\right)^3+4} = \sqrt{x^3+4}$	M1		Any form which simplifies to $\sqrt{kx^3+4}$, $k\neq 27$, $k\neq 0$ or which simplifies to $x^3 + 4$
		A1	2	ACF
	Total		**6**	
5(a)	$(1-x)^3 = 1-3x+3x^2-x^3$	M1		3 terms correct or 1 (±)3 (±)3 (±)1 seen
		A1	2	All correct
(b)	$(1+y)^4 = 1+4y+6y^2+4y^3+y^4$	M1		4 terms correct, accept unsimplified
		A1		All 5 terms correct and simplified at some stage
	$(1+y)^4-(1-y)^3 =$ $(4y+3y)+(6y^2-3y^2)+(4y^3+y^3)+y^4$ $= 7y+3y^2+5y^3+y^4$ (as required with p=3 and q=5)	A2,1	4	A2 Be convinced as part answer is given (A1 for three terms found correctly or if found correct values for p and q but did not show $7y+y^4$.)
(c)	$\int \left[\left(1+\sqrt{x}\right)^4-\left(1-\sqrt{x}\right)^3\right] dx =$			
	$\int\left(7\sqrt{x}+3x+5x\sqrt{x}+x^2\right) dx$	M1		Use of part (**b**)….$y\rightarrow \sqrt{x}$ OE before any integration
	$\int\left(7x^{0.5}+3x+5x^{1.5}+x^2\right) dx$			
	$= \frac{7x^{1.5}}{1.5}+\frac{3x^2}{2}+\frac{5x^{2.5}}{2.5}+\frac{x^3}{3}$ $(+c)$	m1		Correct integration of an x^k term where k is non-integer
	$= \frac{14}{3}x^{1.5}+\frac{3}{2}x^2+2x^{2.5}+\frac{1}{3}x^3$ $(+c)$	A2,1F	4	Coeffs simplified; condone absent $(+c)$ Ft on c's p and q ie 2nd term $+\frac{p}{2}x^2$ and 3rd term is $+\frac{2q}{5}x^{2.5}$. (A1F for three of these four ft terms or for four correct ft terms unsimplified)
	Total		**10**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$ar^2 = 36$; $ar^5 = 972$;	M1		For $ar^2 = 36$ or $ar^5 = 972$ or for seeing $36r^3 = 972$
	$r^3 = \frac{972}{36}$ $(= 27)$ $\Rightarrow r = 3$	A1	2	CSO AG Full valid completion.
(ii)	$a \times 3^2 = 36$	M1		OE. PI
	$a = 4$	A1	2	Correct answer without working scores the two marks
(b)(i)	$\sum_{n=1}^{20} u_n = S_{20} = \frac{a(1-r^{20})}{1-r}$	M1		OE
	$= \frac{4(1-3^{20})}{-2} = -2(1 - 3^{20}) = 2\left(3^{20} - 1\right)$	A1	2	CSO AG Be convinced
(ii)	$u_n = a \times 3^{n-1}$	B1		Seen or used
	$4 \times 3^{n-1} > 4 \times 10^{15} \Rightarrow 3^{n-1} > 10^{15}$			
	$(n-1)\log 3$ $(>)$ $\log 10^{15}$	M1		Or finds values of u_n for appropriate adjacent integer values of n so that u_n 's are either side of 4×10^{15}
	$n - 1 > \frac{15}{\log_{10} 3}$; $n - 1 > 31.4...$			
	($n > 32.4...$ and n is an integer so least value of n is) $n = 33$	A1	3	CSO
	Total		**9**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$y = x + 3 + \frac{8}{x^4} = x + 3 + 8x^{-4}$	B1		For $\frac{8}{x^4} = 8x^{-4}$ PI by correct differentiation of 3rd term
	$\frac{dy}{dx} = 1 - 32x^{-5}$ or $1 - \frac{32}{x^5}$	M1 A1	3	$k\,x^{-5}$ OE For either
(b)	When $x = 1$, $y = 12$	B1		
	When $x = 1$, $\frac{dy}{dx} = 1 - 32 = -31$	M1		Attempt to find value of $\frac{dy}{dx}$ when x=1
	Tangent: $y - 12 = -31(x - 1)$	A1F	3	Only ft on c's answer to (**a**). Any correct (ft on c's (a)) form.
(c)	$1 - 32x^{-5} = 0$	M1		$1 - 32x^{-5} = 0$ or c's $\frac{dy}{dx} = 0$
	$\Rightarrow x^5 = 32$	m1		Attempt to form x^n = const ($\neq$0). PI by next line
	$\Rightarrow x = 2$	A1		CSO
	(Coordinates of M) (2, 5.5)	A1	4	CSO
(d)(i)	$\int \left(x + 3 + \frac{8}{x^4}\right)\, dx$			
	$= \frac{x^2}{2} + 3x - \frac{8}{3}x^{-3} + c$	M1		Power −3 correctly obtained
		A1		$-\frac{8}{3}x^{-3}$
		B1	3	$\frac{x^2}{2} + 3x + c$
(ii)	Area = $\left[\frac{x^2}{2} + 3x - \frac{8}{3}x^{-3}\right]_1^2$			
	$= \left(2 + 6 - \frac{1}{3}\right) - \left(\frac{1}{2} + 3 - \frac{8}{3}\right)$	M1		Attempting to calculate F(2) − F(1) where F(x) is c's answer to part (d)(i) provided F is not just the c's integrand (x+3+8/x^4)
	$= \frac{9}{2} + \frac{7}{3} = \frac{41}{6}$	A1	2	OE Accept 6.83 or better provided d(i) used
(e)	$k = -5.5$	B1F	1	Ft on $-y_M$ from part (c).
	Total		**16**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
8(a)	$\log_k x^2 - \log_k 5 = 1$	M1		A valid law of logs used correctly
	$\log_k \dfrac{x^2}{5} = 1$	M1		Another valid law of logs used correctly **or** correct method to reach log f(x) = log 5k
	$\log_k \dfrac{x^2}{5} = \log_k k$ [or $\log x^2 = \log 5k$]	A1		PI by next line
	$\Rightarrow \dfrac{x^2}{5} = k$ ie $k = \dfrac{x^2}{5}$	A1	4	Accept either of these two forms.
(b)	$\log_a y = \dfrac{3}{2}$; $\log_4 a = b + 2$			
	$\Rightarrow y = a^{\frac{3}{2}}$ $\Rightarrow a = 4^{b+2}$	M1		For either equation
	$y = (4^{b+2})^{\frac{3}{2}}$	m1		Elimination of a from two correct equations not involving logarithms
	$y = 2^{3(b+2)}$; $y = 2^{3b+6}$	A1	3	CSO Either form acceptable
	Total		**7**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
9(a)	$\tan x = -3$ $\Rightarrow x = \tan^{-1}(-3) \quad (= -71.56...)^{\circ}$	M1		PI eg by 71(.56..) or −71(.56..) seen
	x = 108º, 288º	A1,A1	3	Condone more accurate answers. (108.4349…, 288.4349…). [Ignore answers outside interval; If more than 2 answers inside interval −1 from A marks for each extra to a min of 0]
(b)(i)	$7\sin^2\theta + \sin\theta\cos\theta = 6(\cos^2\theta + \sin^2\theta)$	M1		$\cos^2\theta + \sin^2\theta = 1$ used; OE
	$7\sin^2\theta - 6\sin^2\theta + \sin\theta\cos\theta - 6\cos^2\theta = 0$ $\Rightarrow \sin^2\theta + \sin\theta\cos\theta - 6\cos^2\theta = 0$			
	$\Rightarrow \dfrac{\sin^2\theta}{\cos^2\theta} + \dfrac{\sin\theta}{\cos\theta} - 6 = 0$	M1		$\dfrac{\sin\theta}{\cos\theta} = \tan\theta$ used
	$\Rightarrow \tan^2\theta + \tan\theta - 6 = 0$	A1	3	CSO AG
(ii)	$(\tan\theta + 3)(\tan\theta - 2) = 0$	M1		Factorise or other valid method to solve quadratic
	$\tan\theta = -3$ or $\tan\theta = 2$	A1		Need both
	θ = 108º, 288º; θ = 63º, 243º;	B2F,1F	4	**Only** ft on (a) for the c's two +'ve $\tan^{-1}(-3)$ vals. [B1 if 3 correct (ft)] Condone more accurate answers. (108.4349…, 288.4349…; 63.4349…, 243.4349…) [Ignore answers outside interval; If more than 2 answers for each inside interval, −1 for each extra from Bs to a min of 0]
	Total		**10**	
	TOTAL		**75**	

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Mathematics MPC2

(Specification 6360)

Pure Core 2

Final

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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.

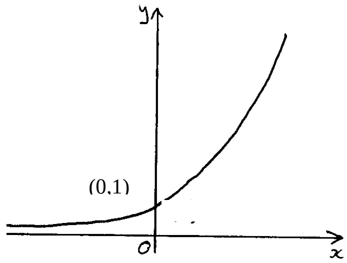
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

Q	Solution	Marks	Total	Comments
1(a)	$\dfrac{10}{\sin\theta} = \dfrac{9}{\sin 54}$	M1		Sine rule, with $\sin\theta$ being the only unknown
	$\sin\theta = \dfrac{10 \times \sin 54}{9}$ $\left\{= \dfrac{8.09...}{9}\right\}$ $\left\{= \dfrac{10}{11.12...}\right\}$	m1		Correct rearrangement to '$\sin\theta = \ldots$' or to '$\theta = \sin^{-1}(\ldots)$'
	$\sin\theta = 0.898(9...)$, $\theta = 64.01(48\ldots)$ $\theta = 64^{\circ}$ {to nearest degree}	A1	3	AG m1 must have been awarded and must see at least 3sf value either for $\sin\theta$ so that $0.898 \le \sin\theta \le 0.8993$ or for θ so that $64.0 \le \theta \le 64.1$ as well as seeing 'θ(OE)= 64'
(b)	Angle $C = 180 - (54+\theta) = 62$ {to 2sf}	B1		$C = 62$. AWRT 62. PI if '$C = 180 - (54+\theta)$' and accurate later work.
	Area = $\dfrac{1}{2} \times 10 \times 9 \sin 62$	M1		OE Ft c's value for C ($C \ne 54$, $C \ne \theta$)
	= 39.73.. = 40{cm^2 to nearest sq cm}	A1	3	If not 40 condone a value 39.7 to 39.8 inclusive.
	Total		**6**	

Q	Solution	Marks	Total	Comments
2(a)	{Area of sector =} $\dfrac{1}{2}r^2\theta = \dfrac{1}{2} \times 6^2 \times 0.5$	M1		$\dfrac{1}{2}r^2\theta$ seen within (a) or used for the area
	= 9 (cm^2)	A1	2	Condone missing/incorrect units
(b)(i)	{Arc =} $r\theta = 6 \times 0.5$	M1		$r\theta$ seen within (b) or used for the arc length
	= 3 (cm)	A1	2	Condone missing/incorrect units
(ii)	Perimeter of sector = 6+6+arc length = 15 (cm) (= 5×3)	M1		PI by value of 12+c's (b)(i) answer
	Perimeter (of sector) = 5×(length of) arc	A1	2	Completion, including concluding statement
	Total		**6**	

Q	Solution	Marks	Total	Comments
3(a)	$(2+x^2)^3$ $= [(2)^3] + 3(2)^2(x^2) + 3(2)(x^2)^2\ [+(x^2)^3]$	M1		For either (1),3,3,(1) OE unsimplified or $\binom{3}{1}2^2x^2 + \binom{3}{2}2(x^2)^2$ OE. PI
	$p = 3(2)^2 = 12$	A1		AG Be convinced. Condone left as $12x^2$
	$q = 6$	B1	3	Accept left as $6x^4$
(b)(i)	$\int \frac{(2+x^2)^3}{x^4}\,dx = \int x^{-4}(8+12x^2+qx^4+x^6)\,dx$ or $\int \left(\frac{8}{x^4}+\frac{12}{x^2}+q+x^2\right)dx$	M1		Uses (a) and either an indication that $\frac{1}{x^n} = x^{-n}$ in a product PI or cancelling to get at least 3 correct ft terms
	$\int (8x^{-4}+12x^{-2}+q+x^2)\,dx$	A1F		Ft on c's non-zero q. PI by next line in solution
	$= \frac{8x^{-3}}{-3}+\frac{12x^{-1}}{-1}+qx+\frac{x^3}{3}\ \{+c\}$	M1		Correct integration of either $8x^{-4}$ or $12x^{-2}$; accept unsimplified
		A1		Correct integration of both $8x^{-4}$ and $12x^{-2}$; accept unsimplified coefficients
	$= \ldots\ldots\ldots\ldots + 6x + \frac{x^3}{3} + c$ $\left(= -\frac{8}{3}x^{-3} - 12x^{-1} + 6x + \frac{x^3}{3} + c\right)$	B1F	5	For $\text{"6"}x + \frac{x^3}{3} + c$ simplified. The only ft is "6" replaced by c's value for q where q is a non-zero integer.
(b)(ii)	$\int_1^2 \frac{(2+x^2)^3}{x^4}\,dx = \{-\frac{8}{3}(2)^{-3} - 12(2^{-1}) + 6(2) + \frac{2^3}{3}\} -$ $\{-\frac{8}{3}(1)^{-3} - 12(1)^{-1} + 6(1) + \frac{1^3}{3}\}$	M1		Dealing correctly with limits; F(2)−F(1) (must have attempted integration to get F ie c's F is not just the integrand)
	$= \left(-\frac{1}{3}-6+12+\frac{8}{3}\right) - \left(-\frac{8}{3}-12+6+\frac{1}{3}\right)$			
	$= 16\frac{2}{3}$	A1	2	OE **exact** answer eg 50/3. NMS scores 0
	Total		**10**	

Q	Solution	Marks	Total	Comments
4(a)		B1		Any graph only crossing the *y*–axis at (0, 1) stated /indicated … (accept 1 on *y*-axis as equivalent) and not drawn **below** *x*-axis
		B1	2	Correct shaped graph, must clearly go below the intersection pt and an indication of correct behaviour of curve for large positive and large negative values of *x*. Ignore any scaling on axes.
(b)	Translation;	B1		Accept 'transl…' as equivalent [T or Tr is NOT sufficient]
	$\begin{bmatrix} 0 \\ -5 \end{bmatrix}$	B1	2	If vector not given, accept **full** equivalent to vector in words provided linked to 'transl../ move/shift' (B0B0 if >1 transformation)
(c)(i)	$4^x = (2^2)^x = 2^{2x} = (2^x)^2 = Y^2$ $2^{x+2} = 2^x \times 2^2 = 4Y$	M1		Justifying either $4^x = Y^2$ or $2^{x+2} = 4Y$ with no errors seen
	$4^x - 2^{x+2} - 5 = 0 \Rightarrow Y^2 - 4Y - 5 = 0$	A1	2	AG Be convinced; must have justified both of the above.
(ii)	$(Y-5)(Y+1) = 0$	M1		Correct factorising or use of quadratic formula or completing sq. PI by both solns 5& −1 seen
	(Since) $2^x>0$ (for all real x,) $2^x=5$ so only one (real) solution	E1		Rejection of 2^x (condone Y) negative, with justification, (condone "2^x not negative") followed by statement
	$\log 2^x = \log 5 \Rightarrow x\log 2 = \log 5$	M1		Eqn of form $p^x = q \Rightarrow x\log p = \log q$ provided $p > 0$ & $q > 0$ OE eg $x = \log_2 5$
	$x = 2.3219\ldots = 2.322$ (to 3dp)	A1	4	Condone > 3dp but must see explicit use of logs and must only be the one solution.
	Total		**10**	

Q	Solution	Marks	Total	Comments
5(a)		B1		For either 6 or $6x^0$
	$\frac{\mathrm{d}y}{\mathrm{d}x} = 6 - 3x^{\frac{1}{2}}$	M1		$Ax^{\frac{3}{2}-1}$, $A\neq 0$ OE
		A1	3	$6-3x^{\frac{1}{2}}$ or $6-3\sqrt{x}$ with no '+c' [If unsimplified here, A1 can be awarded retrospectively if correct simplified expression is seen explicitly in (b)(i).]
(b)(i)	$6-3x^{\frac{1}{2}} = 0$	M1		Equating c's $\frac{\mathrm{d}y}{\mathrm{d}x}$ to 0 PI by correct ft rearrangement of c's dy/dx=0
	$x^{\frac{1}{2}} = 2 \Rightarrow x = 2^2$	m1		$x^{\frac{1}{2}} = k$ (k>0), to $x = k^2$. PI by correct value of x if no error seen
	M(4, 8)	A1	3	SC If M0 award B1 for (4, 8)
(ii)	Eqn of normal at M is $x = 4$	B1F	1	Ft on x = c's x_M
(c)(i)	When $x=\frac{9}{4}$, $\frac{\mathrm{d}y}{\mathrm{d}x} = 6-3\times\frac{3}{2}=\frac{3}{2}$	M1		Attempt to find $\frac{\mathrm{d}y}{\mathrm{d}x}$ when $x=\frac{9}{4}$
	Gradient of normal at P = $-\frac{2}{3}$	m1		$m \times m' = -1$ used
	Eqn of normal: $y-\frac{27}{4} = -\frac{2}{3}\left(x-\frac{9}{4}\right)$	A1		ACF eg $y=-\frac{2}{3}x+\frac{33}{4}$
	$12y-81=-8x+18 \Rightarrow 8x+12y=99$	A1	4	Coeffs and constant must now be positive integers, but accept different order eg $12y + 8x = 99$
(ii)	$8(4) + 12y = 99$	M1		Solving c's answer (b)(ii), (must be in form x = positive const), with c's answer (c)(i). PI by correct earlier work and <u>correct</u> coordinates for R.
	$R\left(4, \frac{67}{12}\right)$	A1	2	Accept 5.58 or better as equivalent to $\frac{67}{12}$
	Total		**13**	

Q	Solution	Marks	Total	Comments
6(a)	$h = 0.5$ $f(x) = \sin x$ $I \approx h/2\{\ldots\}$ $\{.\}=f(0)+f(2)+2[f(0.5)+f(1)+f(1.5)]$	B1 M1		$h = 0.5$ stated or used. (PI by x-values 0, 0.5, 1, 1.5, 2 provided no contradiction) OE summing of areas of 'trapezia'..
	$\{.\}=$ $0+0.90929..+2[0.4794..+0.84147..+0.99749..]$ $\{=0.90929..+2[2.318..]\}=\{0.90929..+4.636..\}$	A1		Min. of 2dp values rounded or truncated. Can be implied by later correct work provided >1 term or a single term which rounds to 1.39
	$(I \approx)$ 0.25[5.546..] = 1.3865.. = 1.39 (to 3sf)	A1	4	CAO Must be 1.39
(b)	Stretch(**I**) in y-direction(**II**) scale factor 2(**III**)	M1 A1	 2	Need (**I**) **and** either (**II**) or (**III**) All correct. Need (**I**) and (**II**) and (**III**) [>1 transformation scores 0/2]
(c)	$\frac{\sin x}{\cos x} = \frac{1}{2}$; $\tan x = 0.5$	M1		$\frac{\sin x}{\cos x} = \tan x$ used to get $\tan x = k$ or identity $\cos^2 x+\sin^2 x = 1$ used to get either $\sin^2 x=p$ or to get $\cos^2 x=q$, (p and q must be between 0 and 1)
	$\tan x = 0.5$	A1		Either $\tan x = \frac{1}{2}$ or $\cos x = \pm\sqrt{\frac{4}{5}}$ $(=\pm 0.894..)$ or $\sin x = \pm\sqrt{\frac{1}{5}}$ $(=\pm 0.447..)$
	$x = \alpha$ or $\pi + \alpha$ where $\alpha = \tan^{-1}(k)$	m1		Correct method to find 2nd angle. Any in wrong ft quadrants then m0. In case of squaring method candidates must also have rejected the extra 'quadrants' for the m1. Condone degrees or mixture
	$x = 0.464, 3.61$	A1	4	Both. Condone>3sf [0.463(6..), 3.60(5..or 6.)] Accept **<u>pair</u>** of truncated values [0.463, 3.60] Ignore any answers outside interval 0 to 6.28
	Total		**10**	

Q	Solution	Marks	Total	Comments
7(a)	$48 = 60p + q$ $12 = 12p + q$	M1 M1		M1 for each equation in ACF (Condone embedded values for the M1M1)
	$36 = 48p$ or $p = \frac{36}{48}$	m1		Valid method to solve the correct two simultaneous eqns in *p* <u>and</u> *q* to at least the stage *ap* = *b* or *cq* = *d*
	$p = \frac{3}{4}$	A1		AG (condone if left as equiv. decimal)
	$q = 3$	B1	5	Can award if seen **<u>explicitly</u>** in (b) and no contradiction [ie not attempted in (a)]
(b)	$u_3 = 36 + q = 39$	B1F	1	If not 39, ft on (36 + c's *q*)
	Total		**6**	

Q	Solution	Marks	Total	Comments
8	$\ldots = 9\sin^2 x + 6\sin x\cos x + \cos^2 x +$ $\sin^2 x - 6\sin x\cos x + 9\cos^2 x$	M1		Attempt at expanding both sets of brackets. Minimum requirement either one of the two expansions correct or 4 of these 6 terms seen. Expanding and simplifying the given expression in one step to get the correct two terms scores this M1 and next A1
	$\ldots = 10\cos^2 x + 10\sin^2 x$	A1		Either correct pair of expansions and simplification to remove sin*x*cos*x* terms or full collecting of like terms within the original correct expansion
	$= 10(1 - \sin^2 x) + 10\sin^2 x$	M1		$\cos^2 x + \sin^2 x = 1$ clearly used. If identity is applied correctly, but not directly, it must be stated at the relevant point in the proof.
	= 10 (which is an integer)	A1	4	CSO [all previous 3 marks must have been scored] Condone absence of statement after 10 obtained correctly
	Total		**4**	

Q	Solution	Marks	Total	Comments
9(a)	$\{S_\infty =\}\ \dfrac{a}{1-r} = \dfrac{12}{1-\frac{3}{8}}$	M1		$\dfrac{a}{1-r}$ used
	$\{S_\infty =\}\ 19.2$	A1	2	19.2 OE NMS mark as 2/2 or 0/2
(b)	{6th term = } ar^{6-1}	M1		Stated or used
	$= 12\times\left(\dfrac{3}{8}\right)^5 = 2\times2\times3\times\left(\dfrac{3}{2\times2\times2}\right)^5$	m1		Changing 8 and 12 in correct expression to correct products/powers of 2 and 3
	$= \dfrac{2\times2\times3\times3^5}{(2^3)^5} = \dfrac{2^2\times3^6}{2^{15}} = \dfrac{3^6}{2^{13}}$	A1	3	AG Be convinced
(c)(i)	$\{u_n =\}\ 12\times\left(\dfrac{3}{8}\right)^{n-1}$	B1	1	OE. eg $32(3/8)^n$
(ii)	$\log u_n = \log 12 + \log\left(\dfrac{3}{8}\right)^{n-1}$ $\log u_n = \log 12 + (n-1)\log\left(\dfrac{3}{8}\right)$			Log laws $\log(PQ) = \log P + \log Q$; $\log\left(\dfrac{P}{Q}\right) = \log P - \log Q$ $\log(P)^k = k\log P$
	$\log u_n = \log 12 + (n-1)[\log 3 - \log 8]$	M1		Using (c)(i) and taking logs: one log law used correctly, on a correct expression for u_n.
		M1		a second different log law used correctly, indep of prev M error and ft on cand's (c)(i) provided cand's u_n expression has a power involving n.
	$\log u_n = \log 3 + 2\log 2 + (n-1)[\log 3 - 3\log 2]$	m1		A third different log law used correctly (or equivalent valid step) to reach a correct RHS whose terms are all multiples of log2 and log3. Dep on both prev two Ms
	$\log u_n = n\log 3 - 3n\log 2 + 5\log 2$ $\log_a u_n = n\log_a 3 - (3n-5)\log_a 2$	A1	4	CSO AG Be convinced, no slips although we will condone the absence of the bases a even in the final line.
	Total		**10**	

General Certificate of Education (A-level)
January 2012

Mathematics MPC2

(Specification 6360)

Pure Core 2

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from: aqa.org.uk

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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

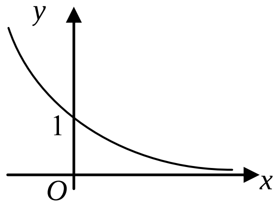
Q	Solution	Marks	Total	Comments
1(a)	{Area of sector =} $\frac{1}{2}r^2\theta = \frac{1}{2}\times 6^2 \times \theta$	M1		$\frac{1}{2}r^2\theta$ seen in **(a)** or used for the area
	21.6 = 18θ so θ = 1.2	A1	2	Must be exact, not rounded to
(b)	{Arc =} $r\theta$	M1		$r\theta$ seen in **(b)** or used for the arc length
	…. = 7.2 {cm}	A1F	2	Ft on 6×c's value for θ provided 4<arc<10.
	Total		**4**	
2(a)	$h = 1$	B1		h = 1 stated or used. (PI by x-values 0,1,2,3,4 provided no contradiction)
	$\mathrm{f}(x) = \dfrac{2^x}{x+1}$ I ≈ h/2{…} {.}=f(0)+f(4)+2[f(1)+f(2)+f(3)]	M1		OE summing of areas of the 'trapezia'..
	{.} = $1+\frac{16}{5}+2\left(\frac{2}{2}+\frac{4}{3}+\frac{8}{4}\right)$ =1+3.2+2(1+1.33…+2)	A1		OE Accept 1dp evidence. Can be implied by later correct work provided >1 term or a single term which rounds to 6.43
	(I ≈) 0.5[4.2+2×4.333..] =6.43 (to 3sf)	A1	4	CAO Must be 6.43
(b)	Increase the number of ordinates	E1	1	OE eg increase the number of strips.
	Total		**5**	
3(a)	$\sqrt[4]{x^3} = x^{\frac{3}{4}}$	B1	1	Accept $k = ¾$ OE
(b)	$\dfrac{1-x^2}{\sqrt[4]{x^3}} = \dfrac{1}{\sqrt[4]{x^3}} - \dfrac{x^2}{\sqrt[4]{x^3}}$ $= x^{-k} - \dfrac{x^2}{\sqrt[4]{x^3}}$ [or $\dfrac{1}{\sqrt[4]{x^3}} - x^{2-k}$]	M1		Split followed by at least one correct index law used to remove denominator.
	$= x^{-\frac{3}{4}} - x^{\frac{5}{4}}$	A1F	2	If incorrect, ft on c's non-integer k value answer to part (a), provided M1 has been awarded. Accept answer given in form of values for p and q.
			3	

Q	Solution	Marks	Total	Comments
4(a)	Area = $\frac{1}{2}\times 10\times AC\sin 150$	M1		$\frac{1}{2}\times 10\times AC\sin 150$
	$40 = 2.5AC$ so $AC = 16$ (m)	A1	2	AG Be convinced
(b)	$\{BC^2 =\}10^2 + 16^2 - 2\times 10\times 16\times\cos 150$ $= 100 + 256 + 277.128\ldots$ $BC = \sqrt{633.128\ldots} = 25.162\ldots = 25.16$m	M1 m1 A1	 3	RHS of cosine rule used Correct order of evaluation AWRT 25.16
(c)	$\frac{10}{\sin C} = \frac{BC}{\sin 150}$ (or $\frac{BC}{\sin 150} = \frac{AC}{\sin B}$)	M1		A correct equation using sine rule or cosine rule or area formula for either B or C. Subst of BC or AC not required for this M.
	$\sin C = \frac{10\sin 150}{"25.16"}$ (=0.1987..) (or $\sin B = \frac{16\sin 150}{"25.16"}$ (=0.317… or 0.318))	m1		Correct rearrangement to either sin$C$ or cos$C$ or sin$B$ or cos$B$ equal to numerical expression ft on c's numerical value for BC. PI by correct C or (by correct B if Mscored)
	Smallest angle, (C =) 11.5º to 1dp	A1	3	Accept a value 11.4 to 11.5 inclusive.
			8	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	Stretch(**I**) in x-direction(**II**) scale factor $\frac{1}{6}$ (**III**)	M1 A1	2	Need (**I**) **and** either (**II**) or (**III**) Need (**I**) and (**II**) and (**III**)
(ii)	$(\text{g}(x) =) = \left(1+\frac{x-3}{3}\right)^6$	M1		OE Replaces $\frac{x}{3}$ by $\frac{x-3}{3}$
	$= \left(\frac{x}{3}\right)^6$ or $\frac{x^6}{3^6}$ or $\frac{x^6}{729}$	A1	2	Must be simplified
(b)	$\left(1+\frac{x}{3}\right)^6 = 1+\binom{6}{1}\frac{x}{3}+\binom{6}{2}\left(\frac{x}{3}\right)^2+\binom{6}{3}\left(\frac{x}{3}\right)^3 \ldots$			
	$= (1+)\ 2x$	B1		a=2. Condone '$2x$'
	$+\frac{6!}{4!2!}\left(\frac{x}{3}\right)^2+\frac{6!}{3!3!}\left(\frac{x}{3}\right)^3$	M1		Either (1 6) 15 20 seen or $\binom{6}{2}$, $\binom{6}{3}$ written (PI) in terms of factorials (OE)
	$= (1+2x) + \frac{15}{9}x^2+\frac{20}{27}x^3$ (a=2) $b=\frac{5}{3}$, $c=\frac{20}{27}$	A1 A1	4	$b=\frac{5}{3}$ (or $1\frac{2}{3}$). Condone …+$\frac{5}{3}x^2$ $c=\frac{20}{27}$. Condone …+$\frac{20}{27}x^3$ Accept equivalent recurring decimals Ignore terms with higher powers of x **SC** If A0A0 award A1 for either $+15\frac{x^2}{9}$, $+20\frac{x^3}{27}$ seen or $+\frac{15x^2}{9}$, $+\frac{20x^3}{27}$ seen
	Total		**8**	

Q	Solution	Marks	Total	Comments
6(a)	$\{S_{25} =\}\ \frac{25}{2}\left[2a+(25-1)d\right]$	M1		$\frac{25}{2}\left[2a+(25-1)d\right]$ OE
	$\frac{25}{2}\left[2a+24d\right]=3500$			
	$25(2a+24d)=7000$ or $\left[\frac{50a+600d}{2}=3500\right]$	m1		Forming equation and attempt to remove fraction or to expand brackets or better
	$50a+600d=7000$ (or better) so $a + 12d = 140$	A1	3	CSO AG Be convinced.
(b)	5^{th} term $= a + 4d$	M1		$a + (5 - 1)d$ used correctly
	$a + 12d = 140,\ a + 4d = 100$ $\Rightarrow 8d = 40$	M1		Solving $a + 12d = 140$ simultaneously with either $a+4d = 100$ or $a+5d = 100$ as far as eliminating either a or d.
	$\Rightarrow d = 5$	A1		
	$\Rightarrow a = 80$	A1	4	
(c)	$33\left(3500-\sum_{n=1}^{k}u_n\right)=67\sum_{n=1}^{k}u_n$	M1		Recognition that $\sum_{n=1}^{25}u_n = 3500$
	$33\times3500=67\sum_{n=1}^{k}u_n+33\sum_{n=1}^{k}u_n$	m1		Correct rearrangement PI
	$100\times\sum_{n=1}^{k}u_n = 33\times3500 \Rightarrow \sum_{n=1}^{k}u_n = 1155$	A1	3	
	Total		**10**	

Q	Solution	Marks	Total	Comments
7(a)		B1		Correct shaped graph in 1st two quadrants only and indication of correct behaviour of curve for large positive and negative vals. of x. Ignore any scaling on axes.
		B1	2	y-intercept indicated as 1 on diagram or stated as intercept=1 or as coords (0, 1).
(b)	$\frac{1}{2^x}=\frac{5}{4} \Rightarrow 2^{-x}=\frac{5}{4}$ (or $2^x=\frac{4}{5}$ or $2^{2-x}=5$)	M1		Correct 'rearrangement' to eg $2^x=\frac{4}{5}$ or $2^{-x}=\frac{5}{4}$ or $0.5^x=1.25$ PI or $\log 1-\log 2^x=\log(5/4)$ or better
	$\log 2^{-x}=\log 1.25 \Rightarrow -x\log 2=\log 1.25$ [$\log 2^x=\log 0.8 \Rightarrow x\log 2=\log 0.8$] [$\log 2^{2-x}=\log 5 \Rightarrow (2-x)\log 2=\log 5$] [2^x=0.8, $x=\log_2 0.8$]; [0.5^x=1.25, $x=\log_{0.5} 1.25$]	M1		Takes logs of both sides of eqn of form either $2^x=k$ or $2^{-x}=k$ OE and uses 3rd law of logs or log to base 2 (or base ½) correctly
	$x=-0.321928\ldots$ so $x=-0.322$ (to 3sf)	A1	3	Condone >3sf [Logs must be seen to be used otherwise **max** of M1M0A0]
(c)	$\log_a b^2+3\log_a y=3+2\log_a\left(\frac{y}{a}\right)$			
	$\log_a b^2+3\log_a y=3+2[\log_a y-\log_a a]$	M1		A log law used correctly; condone missing base a.
	$\log_a b^2+\log_a y=3-2\log_a a$ $\log_a b^2 y=3-2\log_a a$	M1		A different log law used correctly condone missing base a.
	$\log_a b^2 y=3-2(1)$ [or $\log_a b^2 y+\log_a a^2=3$]	M1		Either a further different log law used correctly condone missing base a or $\log_a a=1$ stated/used.
	$\Rightarrow \log_a b^2 y=1 \Rightarrow b^2 y=a$	m1		$\log_a Z=k \Rightarrow Z=a^k$ used or a correct method to eliminate logs (dep on no misapplication of any log law OE in the whole solution) Rearrangements which require only two of the above Ms to eliminate logs correctly: award the remaining M with the m mark.
	$\Rightarrow y=ab^{-2}$	A1	5	ACF of RHS
	Total		**10**	

Q	Solution	Marks	Total	Comments
8(a)	$2\sin\theta = 7\cos\theta \Rightarrow \dfrac{\sin\theta}{\cos\theta} = \dfrac{7}{2}$	M1		$\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ clearly used to reach either $2\tan\theta=7$ or $2/7\tan\theta=1$ or $\tan\theta=3.5$ or even $\tan\theta= 2/7$ after seeing $\dfrac{\sin\theta}{\cos\theta} = \dfrac{2}{7}$
	$\Rightarrow \tan\theta = \dfrac{7}{2}$	A1	2	$\dfrac{7}{2}$ OE eg 3.5
(b)(i)	$6\sin^2 x = 4 + \cos x$ $6(1-\cos^2 x) = 4 + \cos x$	M1		$\cos^2 x + \sin^2 x = 1$ used
	$6 - 6\cos^2 x = 4 + \cos x$ $\Rightarrow\ 6\cos^2 x + \cos x - 2 = 0$	A1	2	CSO AG Be convinced.
(ii)	$6\sin^2 x = 4 + \cos x \Rightarrow$ $6\cos^2 x + \cos x - 2 = 0$	M1		Uses (b)(i)
	$(3\cos x + 2)(2\cos x - 1)\quad (=0)$	m1 A1		$(3c \pm 2)(2c \pm 1)$ or by formula Correct factorisation or quadratic formula with $b^2 - 4ac$ evaluated correctly. (PI by both correct values for cos x)
	$\cos x = -\dfrac{2}{3},\ \cos x = \dfrac{1}{2}$	A1		CSO Both values for cos x correct. Accept 3sf rounded or truncated.
	$x = 132^\circ, 228^\circ, 60^\circ, 300^\circ$	B2,1,0	6	B1 for any 3 of the 4 values correct. Condone greater accuracy (131.810..; 228.189..). Ignore answers outside the given interval. Deduct 1 mark from these two B marks for each extra solution if more than 4 answers in the given interval to a min of B0 NMS: max possible is B2
	Total		**10**	

MPC2 (cont)

Q	Solution	Marks	Total	Comments
9(a)	$\frac{dy}{dx} = 12 - 5x^{\frac{2}{3}}$	M1 A1	2	$kx^{\frac{2}{3}}$ term. ACF
(b)(i)	When x=0, $\frac{dy}{dx} = 12$	B1F		Ft on c's y' evaluated correctly at x=0
	Eqn of tangent at O is $y = 12x$	B1F	2	OE Ft on c's value for $y'(0)$ provided $y'(0)>0$.
(ii)	When $x = 8$, $\frac{dy}{dx} = 12 - 5 \times (8)^{\frac{2}{3}}$	M1		Attempt to find $\frac{dy}{dx}$ when $x = 8$
	Equation of tangent at (8, 0) is $y - 0 = y'(8)[x - 8]$	m1		$y = y'(8)[x - 8]$ OE
	$y = -8(x-8) \Rightarrow y + 8x = 64$	A1	3	CSO AG
(c)	$\int \left(12x - 3x^{\frac{5}{3}}\right) dx = \frac{12x^2}{2} - \frac{3x^{\frac{8}{3}}}{\frac{8}{3}}$ (+c)	M1		$kx^{\frac{5}{3}+1}$ term after integrating, condone k left unsimplified for this M mark.
	$= 6x^2 - \frac{9}{8}x^{\frac{8}{3}}$ (+c)	B1		For $6x^2$ OE eg ($12x^2/2$)
		A1	3	For $-\frac{9}{8}x^{\frac{8}{3}}$ OE
(d)	Area bounded by curve and x-axis $= \int_0^8 \left(12x - 3x^{\frac{5}{3}}\right) dx = 6 \times 8^2 - \frac{9}{8} \times (8)^{\frac{8}{3}}$	M1		± F(8) {− F(0)} PI following integration
	= 384 − 288 = 96	A1		PI by correct final answer if evaluation not seen here
	At P, $12x + 8x = 64$	M1		Solving y +8x =64 and c's y=kx, k>0, down to an eqn in one variable… [y+2y/3=64]
	($x_P = 3.2$) $y_P = 38.4$	A1		For $y_P = 38.4$ OE [If using integration to find area of triangle, award A1 if both '$x_P = 3.2$' and correct integration of correct eqns of the 2 lines]
	Area of triangle $OPA = \frac{1}{2} \times 8 \times y_P$	M1		OE Need perpendicular ht to be linked to $y_P > 0$.
	Area of shaded region =Area Δ OPA− $\int_0^8 \left(12x - 3x^{\frac{5}{3}}\right) dx$	M1		M0 if evaluated to a value <0
	= 153.6 −96 = 57.6	A1	7	OE eg 288/5
	Total		**17**	
	TOTAL		**75**	

Version 1.0

General Certificate of Education (A-level)
June 2012

Mathematics MPC2

(Specification 6360)

Pure Core 2

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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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.

Q	Solution	Marks	Total	Comments
1(a)	(common difference) = 9	B1	1	9
(b)	(100th term) = 23 + (100 − 1) d	M1		23 + (100 −1) d or better seen (or used with d = 9 or with d = c's answer (a))
	= 914	A1	2	914 NMS mark as B2 or B0
(c)	(Sum of series) = $\frac{280}{2}(23+2534)$ {or $\frac{280}{2}[2\times 23+(280-1)(9)]$ }	M1		Substitution of n = 280, l = 2534, a = 23 (or c's value of a used in (b)), d = 9 (or c's answer to (a)) into $\frac{n}{2}(a+l)$ PI or $\frac{n}{2}[2a+(n-1)d]$ PI
	= 357 980	A1	2	357 980 NMS mark as B2 or B0
	Total		**5**	
2(a)	(Area) = $\frac{1}{2}(26)(31.5)\sin\theta$	M1		$\frac{1}{2}(26)(31.5)\sin(\theta)$ stated or used
	$\frac{1}{2}(26)(31.5)\times\frac{5}{13}$ = 157.5 (cm^2)	A1	2	OE eg $\frac{315}{2}$ Condone AWRT 157.50 NMS: 157.5 or AWRT 157.50 scores B2
(b)	$(\cos\theta =)\frac{12}{13}$	B1	1	$\frac{12}{13}$ OE exact fraction
(c)	{AC^2 =} $31.5^2 + 26^2 - 2 \times 31.5 \times 26 \times \cos(\theta)$	M1		RHS of cosine rule
	= 992.25 + 676 − 1512 = 1668.25 − 1512 = 156.25	m1		Correct order of evaluation. Do not award if evaluation leads to or would lead to RHS value being outside interval 120 to 195
	$AC = \sqrt{156.25}$ = 12.5 (cm)	A1	3	12.5 OE with no sight of premature approximation clearly used
	(Alternative)			
	{AC^2 =} $(26\sin\theta)^2 + (31.5 - 26\cos\theta)^2$	(M1)		
	= $10^2 + 7.5^2$	(m1)		
	$AC = \sqrt{156.25}$ = 12.5 (cm)	(A1)	(3)	
	Total		**6**	

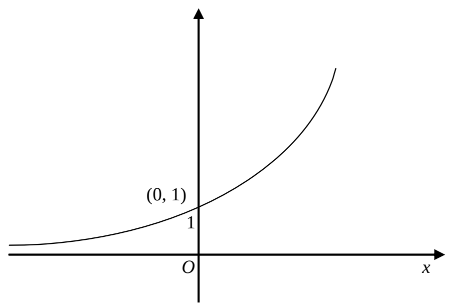
Q	Solution	Marks	Total	Comments
3(a)	$\ldots\ldots = \left(x^{\frac{3}{2}}\right)^2 - 2x^{\frac{3}{2}} + 1 = x^3 - 2x^{\frac{3}{2}} + 1$	B2,1,0	2	B2 for $x^3 - 2x^{\frac{3}{2}} + 1$ or $x^3 - 2x\sqrt{x} + 1$ (B1 fully correct unsimplified expression. seen eg $\left(x^{\frac{3}{2}}\right)^2 - x^{\frac{3}{2}} - x^{\frac{3}{2}} + 1$ or B1 for either $x^3 - 2x^{\frac{3}{2}} \ldots$ OE seen or $x^3 + 2x^{\frac{3}{2}} + 1$ OE seen or B1 for $-x^3 + 2x^{\frac{3}{2}} - 1$ OE seen)
(b)	$\int \left(x^{\frac{3}{2}} - 1\right)^2 \mathrm{d}x = \frac{x^4}{4} - \frac{2x^{\frac{5}{2}}}{2.5} + x \ (+ c)$	B1F		Ft on correct integration of all non $x^{\frac{3}{2}}$ terms (at least two) in c's expression. in (a)
		M1		Integration of a $kx^{\frac{3}{2}}$ as $\lambda x^{\frac{5}{2}}$ (ie power correct)
	{$= 0.25x^4 - 0.8x^{2.5} + x\ (+ c)$}	A1F	3	Correct integration of c's $x^{\frac{3}{2}}$ term(s) ACF
(c)	$\int_1^4 \left(x^{\frac{3}{2}} - 1\right)^2 \mathrm{d}x$			
	$= \left(\frac{4^4}{4} - \frac{2(4^{\frac{5}{2}})}{2.5} + 4\right) - \left(\frac{1}{4} - \frac{2}{2.5} + 1\right)$	M1		F(4) − F(1) attempted following integration. If F(x) incorrect, ft c's answer to (b) provided integration attempted
	{$= \frac{212}{5} - \frac{9}{20} = 42.4 - 0.45$} $= 41.95$	A1	2	41.95 OE eg 839/20 Since 'Hence' NMS scores 0/2
	Total		**7**	

Q	Solution	Marks	Total	Comments
4(a)	$u_1 = 12$	B1		CAO Must be 12
	$u_2 = 48 \times \frac{1}{16} = 3$	B1F	2	If not correct, ft on c's $u_1 \times \frac{1}{4}$
(b)	$r = \frac{1}{4}$	B1F	1	Only ft on *r* = (c's u_2)÷ (c's u_1) if $\lvert r \rvert$ <1. Answers may be in equivalent fraction form or exact decimal form. If other notation used award the mark if correct or ft value confirmed in (c)
(c)	$(S_\infty =) \frac{u_1}{1-r} = \frac{12}{1-\frac{1}{4}}$	M1		Use of $\frac{a}{1-r}$, ft on c's u_1 and c's *r* in (a) and (b) if not recovered, provided $\lvert r \rvert < 1$
	= 16	A1F	2	If not 16, ft on c's u_1 and c's *r* in (a) and (b) provided $\lvert r \rvert < 1$.
(d)	$\sum_{n=4}^{\infty} u_n = S_\infty - \sum_{n=1}^{3} u_n$	M1		OE eg RHS $S_\infty - (u_1 + u_2 + u_3)$
	$u_3 = \frac{3}{4}$ (or $\sum_{n=1}^{3} u_n = \frac{12(1-0.25^3)}{1-0.25}$)	B1		Either result, or better eg $\sum_{n=1}^{3} u_n = 15.75$
	$\sum_{n=4}^{\infty} u_n = 0.25$	A1	3	NMS scores 0/3 **<u>SC</u>** For c's scoring 0/3 in (d); Award B1 to candidates who used $S_\infty - S_4$ for $\sum_{n=4}^{\infty} u_n$ and obtained the answer $\frac{1}{16}$ OE
	(Alternative)			
	$(\sum_{n=4}^{\infty} u_n = \frac{u_4}{1-r})$	(M1)		
	$(u_4 = \frac{3}{16}$ (= 0.1875))	(B1)		
	$(\sum_{n=4}^{\infty} u_n = \frac{3}{16} \div \frac{3}{4} = \frac{1}{4})$	(A1)	(3)	(NMS scores 0/3)
	Total		**8**	

Q	Solution	Marks	Total	Comments
5(a)	{Arc =} $r\theta$	M1		$r\theta$ seen or used for the arc length
	$= 18\times\frac{2\pi}{3} = 12\pi$ (m)	A1	2	12π
(b)(i)	$\alpha = \frac{\pi}{3}$	B1	1	$\frac{1}{3}\pi$ OE expression which simplifies to $\frac{1}{3}\pi$
(ii)	{Area of sector =} $\frac{1}{2}r^2\theta = \frac{1}{2}\times 18^2\times\frac{2\pi}{3}$	M1		$\frac{1}{2}r^2\theta$ seen or used for the sector area
	$= 108\pi$ (=339.(29..))	A1		If not exact accept 3sf or better PI by final correct answer
	$\tan\frac{\pi}{3} = \frac{TP}{18}$ {or $\tan\frac{\alpha}{2} = \frac{18}{TP}$ } {or $PQ = 2\times 18\sin\frac{\pi}{3}$ }{or $\frac{1}{2}PQ = 18\sin\frac{\pi}{3}$ } { or $\cos\frac{\pi}{3} = \frac{18}{OT}$ } { or $\sin\frac{\alpha}{2} = \frac{18}{OT}$ }	M1		OE Correct method (PI) to find either TP or TQ (=TP) or OT or PQ or $\frac{1}{2}PQ$. If α not π/3 then ft c's value for α in (b)(i). If c finds two of TP/TQ, OT and $PQ/\frac{1}{2}PQ$ and gets one correct, one wrong, mark correct one ie M1A1 (M1A0 possible if no correct length)
	$TP=18\sqrt{3}=31.1769\ldots$ exact or 31.1 to 31.2 incl} {or $PQ=18\sqrt{3}=31.1769...$ exact or 31.1 to 31.2 incl} {or OT = 36}; {$\frac{1}{2}PQ = 9\sqrt{3}$ or 15.5 to 15.6 incl}	A1		Correct TP or TQ or PQ or $\frac{1}{2}PQ$ or OT either exact value or in range indicated PI by value 561 to 561.3 inclusive for the area of the kite.
	Area of kite $PTQO = 2\times\frac{1}{2}\times 18\times TP$ {or Area $=\frac{1}{2}(18^2)\sin\frac{2\pi}{3}+\frac{1}{2}TP^2\sin\alpha$ } {or area kite $=\frac{1}{2}\times PQ\times\left[18\div\cos\frac{\pi}{3}\right]$} {or area kite $=\frac{1}{2}\times 2\times 18\sin\frac{\pi}{3}\times OT$ } {$=18^2\sqrt{3}$ }{$= 2\times 162\sqrt{3}$ };{$243\sqrt{3} + 81\sqrt{3}$ }	M1		OE valid method to find area of kite, down to a correct expression with no more than 1 unknown length; ft on c's value of α. For method using > one unknown length this M is dependent on previous M for length PI by value $324\sqrt{3}$ or a numerical expression which simplifies to $324\sqrt{3}$; or a value 561 to 561.3 inclusive for the area of the kite. Can also be implied by award of the final A1
	Alternative Area triangle $PTQ = \frac{1}{2}\ TP^2\sin\alpha$ and Area triangle $POQ = \frac{1}{2}\ 18^2\sin(2\pi/3)$	(M1)		OE Alternative: Award this method mark if **both** area of triangle PTQ (=$243\sqrt{3}$) and area of triangle POQ (=$81\sqrt{3}$) are found with or without finding area of kite
	Area of shaded region = $561.(18...) - 108\pi$ = 221.89… = 222 (m^2) to 3sf	A1	6	If not 222, condone value from 221.7 to 222.0 inclusive
	Alternative Area of shaded region = $243\sqrt{3} - (108\pi - 81\sqrt{3})$ = 221.89…= 222 (m^2) to 3sf	(A1)	(6)	
	Total		**9**	

Q	Solution	Marks	Total	Comments
6(a)(i)	(When $x = 2$) $\frac{dy}{dx}$ = 12−1−11 = 0	B1	1	AG Must see intermediate evaluations
(ii)	$\frac{4}{x^2} = 4x^{-2}$ {so $\frac{dy}{dx} = 3x^2 - 4x^{-2} - 11$}	B1		$\frac{4}{x^2} = 4x^{-2}$, seen in (a)(ii) or earlier. PI by $\pm 8x^{-3}$ term in answer
	$\frac{d^2y}{dx^2} = 6x + 8x^{-3}$	M1		Correct powers of x correctly obtained from differentiating the first two terms
		A1		$6x + 8x^{-3}$ ACF
	When $x = 2$, $\frac{d^2y}{dx^2}$ = 12 + 8/8 = 13	A1	4	
(iii)	Since $\frac{d^2y}{dx^2} > 0$, P is a minimum point.	E1F	1	Ft on c's value of $y''(2)$ in (a)(ii) but must see reference to sign of $y''(2)$ either explicitly or as inequality, as well as the correct ft conclusion
(b)	$\int\left(3x^2 - \frac{4}{x^2} - 11\right)dx = x^3 + 4x^{-1} - 11x(+c)$	M1		Attempt to integrate $\frac{dy}{dx}$ with at least two of the three terms integrated correctly
	(y =) $x^3 + 4x^{-1} - 11x$ (+ c)	A1		For $x^3 + 4x^{-1} - 11x$ OE even unsimplified
	When $x = 2$, $y = 1$ $\Rightarrow$ 1 = 8 + 2 – 22 + c	M1		Substituting. $x = 2$, $y = 1$ into $y = F(x)$ + 'c' in attempt to find constant of integration, where F(x) follows attempted integration of expression for $\frac{dy}{dx}$
	$y = x^3 + 4x^{-1} - 11x + 13$	A1	4	ACF
	Total		**10**	

Q	Solution	Marks	Total	Comments
7(a)	$\tan\theta = -1$ $\sin^2\theta = 3\cos^2\theta$	B1		
	$\dfrac{\sin^2\theta}{\cos^2\theta} = \tan^2\theta$	M1		$\dfrac{\sin\theta}{\cos\theta} = \tan\theta$ used on $\sin^2\theta - 3\cos^2\theta$ or forms and solves a correct quadratic in sin or cos and then uses to find $\tan\theta$
	$\tan^2\theta = 3$	A1		$\tan^2\theta = 3$ or $\tan^2\theta - 3 = 0$ or $\left(\tan\theta + \sqrt{3}\right)\left(\tan\theta - \sqrt{3}\right) = 0$ or $\tan\theta = \sqrt{3}$ or $\tan\theta = -\sqrt{3}$
	$\tan\theta = \pm\sqrt{3}$	A1	4	Both
(b)	$\tan\theta = -1$, $\tan\theta = \sqrt{3}$, $\tan\theta = -\sqrt{3}$	M1		Uses part (a), at least as far as attempting to solve $\tan\theta = k$, where k is any one of c's values for $\tan\theta$
	(θ =) 135º, (θ =) 60º, (θ =) 120º	A2,1,0	3	If not A2 for all three correct, award A1 for two values correct **Special Case** If $\tan^2\theta = \dfrac{1}{3}$ in part (a) and M1 scored in (a) and in (b) then apply ft in part (b) ie A2F for θ = 135º, 30º, 150º. (A1F if two of these ft values) **Special Case**: If M0 then award B1 for any two correct values provided no incorrect extras in given interval. If > 3 answers in the given interval, deduct 1 mark for each extra in the given interval from any A marks awarded in (b). Ignore any answers outside $0 \le \theta \le 180$
	Total		**7**	

Q	Solution	Marks	Total	Comments
8(a)		B1 B1	 2	Correct shape, curve in 1st two quadrants only, crossing positive *y*-axis once and asymptotic to negative *x*-axis. Coordinates (0, 1). Accept *y*-intercept indicated as 1 on diagram or stated as ‘intercept = 1’ B0 if graph clearly drawn crossing axes at more than one point
(b)(i)	$y^2 - 12 = y$ OE; $7^{2x} - 12 = 7^x$ OE	M1		Eliminates either *x* or *y* correctly
	$(y-4)(y+3)$ (= 0) ; $(7^x - 4)(7^x + 3)$ (= 0)	A1		Correct factors or $y = \frac{1 \pm \sqrt{49}}{2}$ or better or $7^x = \frac{1 \pm \sqrt{49}}{2}$ or better
	Since y $(=7^x) > 0$, [y $(=7^x) \neq -3$] (there is exactly one point of intersection)	E1		Clear indication that c’s negative solution(s) has/have been considered and rejected
	y-coordinate is 4	B1	4	
(ii)	$7^x = 4$ so $x \log 7 = \log 4$ [or $x = \log_7 4$]	M1		OE ft on $7^x = k$, where *k* is positive, to either $x \log 7 = \log k$ or $x = \log_7 k$
	$x = 0.712(414\ldots) = 0.712$ to 3SF	A1	2	Condone > three significant figures. If use of logarithms not explicitly seen then score 0/2
	Total		**8**	

Q	Solution	Marks	Total	Comments
9(a)	$h = 0.25$	B1		PI
	$f(x) = \log_{10}(x^2+1)$			
	I $\approx h/2\{\ldots\}$			
	$\{.\} = f(0) + f(1) +$ $2\,[f(0.25) + f(0.5) + f(0.75)]$	M1		OE summing of areas of the 'trapezia'
	$\{.\} =$ $\log 1 + \log 2 + 2\left[\log\frac{17}{16} + \log\frac{5}{4} + \log\frac{25}{16}\right]$			
	$= 0 + 0.3010... +$ $2\,(0.0263... + 0.0969... + 0.1938...)$	A1		OE Accept 1sf evidence
	$= 0.3010...+2(0.317058...) = 0.935147\ldots$			
	(I $\approx$) $0.125\,[0.935147\ldots] = 0.117$ (to 3SF)	A1	4	CAO Must be 0.117
(b)	$\begin{bmatrix}0\\1\end{bmatrix}$	B1	1	
(c)(i)	$\log_{10}(10x^2) = \log_{10}10 + \log_{10}x^2$	M1		Condone missing bases for M mark. Accept $\log x^2$ replaced by $2\log x$ in M1 line
	$= 1 + 2\log_{10}x$	A1	2	AG. Bases must be included or statement '$\log_{10}10 = 1$' given.
				Condone missing bases in (c)(ii) & (c)(iii)
(ii)	$y = 1 + 2\log_{10}x = \log_{10}(10x^2)$	M1		PI
	Either $y = 2\log_{10}(\sqrt{10}\,x)$ (to compare $y = 2\log x$) or both $y = \log_{10}x^2$ and $y = \log_{10}(\sqrt{10}\,x)^2$	A1		Writing in correct form so that stretch details can be stated directly
	(Stretch) parallel to x-axis, sf $\frac{1}{\sqrt{10}}$ OE	B2,1,0	4	B2 for correct direction and scale factor ACF (B1 for correct exact scale factor ACF) (or B1 for 'x-direction, scale factor 1/10 ') (or B1for 'x-direction, scale factor $\sqrt{10}$ ') Apply ISW if dec follows exact values. (OE scale factor must be in exact form)
(iii)	$\log_{10}(10x^2) = \log_{10}(x^2+1)$	M1		PI by $10x^2 = x^2 + 1$ or correct x
	($10x^2 = x^2 + 1$, $9x^2 = 1$ and since $x > 0$) $x = \frac{1}{3}$	A1		$x = \frac{1}{3}$ OE stated or used; accept $\sqrt{\frac{1}{9}}$, $\frac{1}{\sqrt{9}}$
	(y-coordinate of P) $y = \log_{10}\frac{10}{9}$ Or $y = \log\left(\frac{1}{9}+1\right)$	A1		PI by $3\log\frac{10}{9}$ OE for the gradient of OP
	Gradient of OP = $3\log_{10}\frac{10}{9} = \log_{10}\frac{1000}{729}$	A1	4	$\log\frac{1000}{729}$; Accept 'a=1000, b=729'
	Total		**15**	
	TOTAL		**75**	

Version

General Certificate of Education (A-level)
January 2013

Mathematics MPC2

(Specification 6360)

Pure Core 2

Final

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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**.

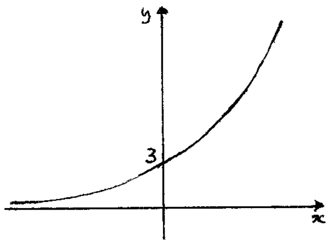
Otherwise we require evidence of a correct method for any marks to be awarded.

Q	Solution	Marks	Total	Comments
1(a)	Arc = $r\theta$ (= 1.25r)	M1		Within (a), $r\theta$ or 15 used for the arc length PI
	P = $r + r + r\theta$ =39	m1		Use of $r + r + r\theta$ for the perimeter. m0 if no indication that '15' comes from $r\theta$.
	3.25r = 39 $r = \frac{39}{3.25}$ = 12	A1	3	CSO AG
(b)	{Area of sector =} $\frac{1}{2}r^2\theta$	M1		Within (b), $\frac{1}{2}r^2\theta$ stated or used for the sector area.
	$= \frac{1}{2}\times 12^2 \times 1.25$ = 90 (cm^2)	A1	2	NMS: 90 scores 2 marks
	Total		**5**	
2(a)	h = 1	B1		PI
	$f(x) = \frac{1}{x^2+1}$			
	I ≈ $\frac{h}{2}${f(1)+f(5)+2[f(2)+f(3)+f(4)]}	M1		$\frac{h}{2}$ {f(1)+f(5)+2[f(2)+f(3)+f(4)]} OE summing of areas of the four 'trapezia'…
	$\frac{h}{2}$ with {…} $= \frac{1}{2}+\frac{1}{26}+2\left(\frac{1}{5}+\frac{1}{10}+\frac{1}{17}\right)$ = 0.5 + 0.03(84...)+2[0.2+0.1+0.05(88...)] = 0.538(46…)+2[0.358(82...)]=1.256(108…)	A1		OE Accept 2dp (rounded or truncated) for non-terminating decs. equiv.
	(I ≈) 0.628054… = $\frac{694}{1105}$ = 0.628 (to 3sf)	A1	4	CAO Must be 0.628
				SC for those who use 5 strips, max possible is B0M1A1A0
(b)(i)	$\int\left(x^{-\frac{3}{2}}+6x^{\frac{1}{2}}\right)dx = \frac{x^{-\frac{1}{2}}}{-1/2}+\frac{6x^{\frac{3}{2}}}{3/2}$ (+c)	M1 A1		One term correct (even unsimplified) Both terms correct (even unsimplified)
	$= -2x^{-0.5}+4x^{1.5}$ (+c)	A1	3	Must be simplified.
(ii)	$\int_1^4\left(x^{-\frac{3}{2}}+6x^{\frac{1}{2}}\right)dx$			
	= [−2(4$^{-0.5}$)+4(4$^{1.5}$)] − [−2(1$^{-0.5}$)+4(1$^{1.5}$)]	M1		Attempt to calculate F(4)−F(1) where F(x) follows integration and is not just the integrand
	= (−1+32) − (−2+4) = 29	A1	2	Since 'Hence' NMS scores 0/2
	Total		**9**	

Q	Solution	Marks	Total	Comments
3(a)	$\frac{1}{2}\times 5\times 6\sin C = 12.5$	M1		(Area=) $\frac{1}{2}\times 5\times 6\sin C$
	$\sin C = 0.833(3..)$	A1		AWRT 0.83 or 5/6 OE PI by e.g. seeing 56 or better
	(C is obtuse) $C = 123.6°$	A1	3	AWRT 123.6
(b)	$\{AB^2 =\}5^2 + 6^2 - 2\times 5\times 6\cos C$	M1		RHS of cosine rule used
	$= 61 - 60\times(-0.553\ldots) = 94.1(66\ldots)$	m1		Correct ft evaluation, to at least 2 sf, of AB^2 or AB using c's value of C.
	(AB =) 9.7 (cm to 2sf)	A1	3	If not 9.7 accept AWRT 9.70 or AWRT 9.71
	Total		**6**	
4	$\log_a N - \log_a x = \frac{3}{2}$ $\log_a \frac{N}{x} = \frac{3}{2}$	M1		A log law used correctly. PI by next line.
	$\frac{N}{x} = a^{\frac{3}{2}}$	m1		Logarithm(s) eliminated correctly
	$x = a^{-\frac{3}{2}}N$	A1	3	ACF of RHS
	Total		**3**	

Q	Solution	Marks	Total	Comments
5(a)	$\frac{8}{x^2} = 8x^{-2}$	B1		PI by its derivative as $16x^{-3}$ or $-16x^{-3}$
	$\frac{dy}{dx} = 2 + 16x^{-3}$	M1		Differentiating either 6+2x correctly or differentiating $-8/x^2$ correctly.
		A1	3	$2 + 16x^{-3}$ OE
(b)	At $P(2, 8)$, $\frac{dy}{dx} = 2 + 16 \times 2^{-3}$ (= 4)	M1		Attempt to find $\frac{dy}{dx}$ when $x = 2$
	Gradient of normal at $P = -\frac{1}{4}$	m1		$m \times m' = -1$ used
	Eqn. of normal at P: $y - 8 = -\frac{1}{4}(x - 2) \Rightarrow x + 4y = 34$	A1	3	CSO AG
(c)(i)	At St. Pt $\frac{dy}{dx} = 0$, $2 + 16x^{-3} = 0$	M1		Equating c's $\frac{dy}{dx}$ to 0 Accept '$\frac{dy}{dx}$ =0 so $x = -2$' stated with no errors seen
	$(16x^{-3} = -2)$ $x = -2$	A1		$x = -2$
	When $x = -2$, $y = 6-4-2=0$; $M(-2,0)$ lies on x-axis	A1	3	Need statement and correct coords.
(c)(ii)	Tangent at M has equation $y = 0$	B1	1	$y = 0$ OE
(d)	Intersects normal at P when $x + 0 = 34$	M1		PI Solving c's eqn. of tangent with ans (b) as far as correctly eliminating one variable.
	T (34, 0)	A1	2	Accept $x = 34$, $y = 0$
	Total		**12**	

	Solution	Marks	Total	Comments
6(a)(i)	$r = \frac{294}{420} = 0.7$	B1	1	AG. Accept any valid justification to the given answer
(ii)	$\{S_\infty =\}\ \frac{a}{1-r} = \frac{420}{1-0.7}$	M1		$\frac{a}{1-r}$ <u>used</u>
	$\{S_\infty =\}\ 1400$	A1	2	1400 NMS mark as 2/2 or 0/2
(iii)	nth term = $600\times(0.7)^n$	B2	2	If not B2 award B1 for $420 \times (0.7)^{n-1}$ OE
(b)(i)	$\{u_n =\} 248 - 8n$	B1	1	Accept ACF
(ii)	$u_k = 0 \Rightarrow 8k = 248$	M1		$248-8k=0$ OE e.g. $240+(k-1)(-8)=0$ ft if no recovery, on c's (b)(i) answer
	$k = 31$	A1		
	$\sum_{n=1}^{k} u_n = 240+232+\ldots+0 = \frac{k}{2}[240+0]$	M1		For $\frac{k}{2}[240+0]$ or for $\frac{k}{2}[\text{c's } u_1 + 0]$ OE e.g. $\frac{k}{2}[2\times \text{c's } u_1 + (k-1)(-8)]$
	$\sum_{n=1}^{k} u_n \quad (= 15.5\times 240) = 3720$	A1	4	3720
	Total		**10**	

Q	Solution	Marks	Total	Comments
7(a)	Stretch(**I**) in *y*-direction(**II**) scale factor 3(**III**)	M1		OE Need (**I**) **and** either (**II**) or (**III**)
		A1	2	All correct. Need (**I**) and (**II**) and (**III**) [>1 transformation scores 0/2]
(b)		B1		Shape with indication of correct asymptotic behaviour in 2nd quadrant below pt of intersection with *y*-axis
		B1	2	Only intersection is with *y*-axis, and only intercept is 3 stated/indicated
(c)	$3\times 4^{x} = 4^{-x}$	M1		OE eqn. in *x*
	$\log 3+\log 4^{x} = \log 4^{-x}$	m1		Log Law 1 (or Law 2 applied to $\frac{4^{x}}{4^{-x}}=3$ or $\frac{1}{3}$ OE) used correctly or correct rearrangement to $4^{2x}=1/3$ OE simplified e.g. $16^{x}=3^{-1}$ or $4^{x}=(1/\sqrt{3})$
	$\log 3+x\log 4=-x\log 4$	m1		Log Law 3 applied correctly twice (dependent on both M1 & m1) or a correct method using logs to solve an eqn. of form $a^{kx}=b$, $b>0$ (including case $k=1$) (dependent on M1 and valid method to a^{kx})
	$x=\frac{-\log 3}{2\log 4}$ $\left(=\frac{-\log 3}{\log 16}\right)$	A1		Correct expression for *x* or for –*x* e.g. $x=\frac{1}{2}\log_4\left(\frac{1}{3}\right)$ PI by correct 3sf value or better
	$x=-0.396(2406\ldots)$ $=-0.396$ (to 3sf)	A1	5	If logs not used explicitly then max of M1m1m0.
	Total		**9**	

Q	Solution	Marks	Total	Comments
8(a)	$\left(1+\frac{4}{x}\right)^2 = 1+\frac{8}{x}+\frac{16}{x^2}$ (or $1+8x^{-1}+16x^{-2}$)	B1	1	Unsimplified equivalent answers, e.g. $1+\frac{4}{x}+\frac{4}{x}+\left(\frac{4}{x}\right)^2$ etc. must be correctly simplified in part (c) to one of the two forms in 'solution' to retrospectively score the B1 here
(b)	$\left(1+\frac{x}{4}\right)^8 = \{1+\}\binom{8}{1}\left(\frac{x}{4}\right)+\binom{8}{2}\left(\frac{x}{4}\right)^2+\binom{8}{3}\left(\frac{x}{4}\right)^3+\ldots$	M1		Any valid method. PI by a correct value for either *a* or *b* or *c*
	$=\{1+\}2x+\frac{7}{4}x^2+\frac{7}{8}x^3+\ldots$	A1A1A1		A1 for each of *a, b, c*
	$\{a = 2,\ b = 1.75$ OE, $c = 0.875$ OE$\}$		4	**SC** $a = 8,\ b = 28,\ c = 56$ or $a = 32,\ b = 448,\ c = 3584$ either explicitly or within expn (M1A0)
(c)	$(1+\frac{8}{x}+\frac{16}{x^2})\left(1+2x+\frac{7}{4}x^2+\frac{7}{8}x^3\right)$	M1		Product of c's two expansions either stated explicitly or used
	x terms from expansion of $\left(1+\frac{4}{x}\right)^2\left(1+\frac{x}{4}\right)^8$ are ax and '8'bx and '16'cx	m1		Any **two** of the three, **ft** from products of non-zero terms using c's two expansions. May just use the coefficients.
	ax + '8'bx + '16'cx	A1F		Ft on c's non-zero **values** for *a*, *b* **and** *c* and also ft on c's non-zero coeffs. of $1/x$ and $1/x^2$ in part (a). Accept *x*'s missing i.e. sum of coeffs. PI by the correct final answer.
	Coefficient of x is $2+14+14 = 30$	A1	4	OE Condone answer left as $30x$. Ignore terms in other powers of *x* in the expansion.
	Total		**9**	

Q	Solution	Marks	Total	Comments
9(a)	$x + 30^\circ = 79^\circ$, $x + 30^\circ = 180^\circ + 79^\circ$			
	$x = 49^\circ$	B1		49 as the only solution in the interval $0^\circ \le x < 90^\circ$
	$x = 229^\circ$	B1	2	AWRT 229. Not given if any other soln. in the interval $90^\circ \le x \le 360^\circ$. Ignore anything outside $0^\circ \le x \le 360^\circ$
(b)	Translation;	B1		Accept 'translat…' as equivalent. [T or Tr is NOT sufficient]
	$\begin{bmatrix} -30^\circ \\ 0 \end{bmatrix}$	B1	2	OE Accept **full** equivalent to vector in words provided linked to 'translation/ move/shift' and **correct** direction. (0/2 if >1 transformation).
(c)(i)	$5 + \sin^2\theta = (5 + 3\cos\theta)\cos\theta$ $\Rightarrow 5 + \sin^2\theta = 5\cos\theta + 3\cos^2\theta$	B1		Correct RHS.
	$5 + 1 - \cos^2\theta = 5\cos\theta + 3\cos^2\theta$	M1		$\sin^2\theta = 1 - \cos^2\theta$ used to get a quadratic in cos .
	$6 = 5\cos\theta + 4\cos^2\theta$ or $4\cos^2\theta + 5\cos\theta - 6\ (= 0)$	A1		ACF with like terms collected.
	$\Rightarrow$ $(4\cos\theta - 3)(\cos\theta + 2)$ $(= 0)$	m1		**Correct** quadratic and $(4c \pm 3)(c \pm 2)$ or by formula OE PI by 'correct' 2 values for $\cos\theta$.
	Since $\cos\theta \ne -2$, $\cos\theta = \frac{3}{4}$	A1	5	CSO AG. Must show that the 'soln' $\cos\theta = -2$ has been considered and rejected
(ii)	$5 + \sin^2 2x = (5 + 3\cos 2x)\cos 2x$ $\Rightarrow$ $\cos 2x = \frac{3}{4}$	M1		Using (c)(i) to reach $\cos 2x = ¾$ **or** finding at least 3 solutions of $\cos\theta = 3/4$ **and** dividing them by 2.
	$2x = 0.722(7…)$, $2\pi - 0.722(7…)$, $2\pi + 0.722(7…)$, $4\pi - 0.722(7...)$,	m1		Valid method to find all four 'positions' of solutions.
	$x = 0.361$, 2.78, 3.50, 5.92	A1	3	CAO Must be these four 3sf values but ignore any values outside the interval $0 < x < 2\pi$.
	Total		**12**	
	TOTAL		**75**	

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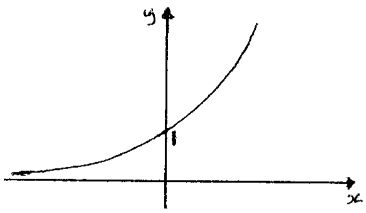
Otherwise we require evidence of a correct method for any marks to be awarded.

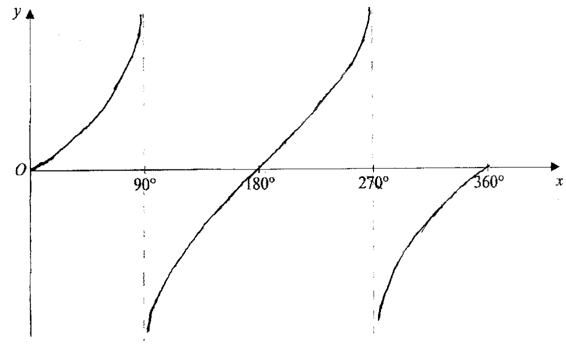
Q	Solution	Marks	Total	Comments
1(a)	20	B1	1	20
(b)	$\{S_\infty =\}\ \frac{a}{1-r} = \frac{80}{1-\frac{1}{2}}$	M1		$\frac{a}{1-r}$ <u>used</u> with $a = 80$ and $r = 0.5$ OE
	$\{S_\infty =\}$ 160	A1	2	NMS 160 gets 2 marks unless rounding seen
(c)	$\{S_{12} =\}\ \frac{80(1-r^{12})}{1-r} = 160(1-0.5^{12})$	M1		$\frac{80(1-r^{12})}{1-r}$ seen (or used with r=0.5 OE)
	= 159.96(0937.) = 159.96 to 2dp	A1	2	Condone > 2dp
	Total		**5**	
2(a)	{Arc =} $r\theta$ = 20 × 0.8 …. = 16 (cm)	M1 A1	2	$r\theta$ seen in **(a)** or used for the arc length
(b)	{Area of sector =} $\frac{1}{2}r^2\theta = \frac{1}{2}\times 20^2 \times 0.8$	M1		$\frac{1}{2}r^2\theta$ OE seen in **(b)** or used for the area
	…… = 160 (cm^2)	A1	2	
(c)	{Let D = angle ODB} $\frac{20}{\sin D} = \frac{15}{\sin 0.8}$	M1		Sine rule, ACF with sin D being the only unknown PI by next line
	$\sin D = \frac{20\times\sin 0.8}{15}$ $\left\{=\frac{14.3(471...)}{15}\right\}$ $\left\{=\frac{20}{20.9(10...)}\right\}$ = 0.956(474…) Acute 'D' = 1.27(467…)	m1		Correct rearrangement to 'sin$D$ = …' or to 'D =sin^{-1} (…)' OE. PI by at least 3sf correct value 1.27(467…) radians or 73(.033)° for acute angle or PI by at least 3sf value 1.86(692…) rounded or truncated for D .
	$D = \pi$ − Acute 'D' in rads	m1		<u>Dep on previous 2 marks</u> being awarded. PI by correct ft evaluation of π−c's acute D to at least 3 sf value or seeing 1.86(692…), rounded or truncated, for D
	{Angle ODB } = 1.87 {to 3sf}	A1	4	Condone >3sf.
	Total		**8**	

Q	Solution	Marks	Total	Comments
3(a)(i)	$\{(2+y)^3 =\}\ \ 8+12y+6y^2+y^3$	M1		At least 3 terms simplified and correct
		A1	2	All correct
(ii)	$(2+x^{-2})^3 = 8+12x^{-2}+6(x^{-2})^2+(x^{-2})^3$	M1		A replacement of y by x^{-2} in c's (a)(i) working. PI
	$(2-x^{-2})^3 = 8-12x^{-2}+6(x^{-2})^2-(x^{-2})^3$	A1F		Ft one incorrect coefficient in (a)(i) expansion.
	$(2+x^{-2})^3+(2-x^{-2})^3 = 16+12x^{-4}$	A1	3	CSO Be convinced. **SC2** for a fully correct solution, not using 'Hence'
(b)(i)	$\int \left[(2+x^{-2})^3+(2-x^{-2})^3\right]\, \mathrm{d}x = 16x - 4x^{-3} (+c)$	M1		Valid method to obtain the correct power of x after integrating qx^{-4}.
		A1F	2	$16x - 4x^{-3}$ or $16x - 4/x^3$ condone missing '$+c$'. Ft on c's p and q values. Coefficients and signs must be simplified
(ii)	$\int_1^2 \ldots\ldots\ \mathrm{d}x = [16(2)-4(2^{-3})]-[16-4]$	M1		F(2)−F(1) following integration **(b)(i)**
	$= 31.5 - 12 = 19.5$	A1F	2	OE Ft on c's <u>**positive**</u> <u>**integer**</u> values of p and q. Since 'Hence' NMS scores 0/2
	Total		**9**	
4(a)		B1		Correct graph, must clearly go below the intersection pt and an indication of correct behaviour of curve for large positive and large negative values of x. Ignore any scaling on axes.
		B1	2	Only one y-intercept, marked/stated as 1 or as coords (0, 1) with graph having no other intercepts on either axes.
(b)	$9^x = 15 \Rightarrow x \log 9 = \log 15$	M1		OE eg $x = \log_9 15$
	$(x =)\ 1.23(2486\ldots) = 1.23$ to 3sf	A1	2	Condone > 3sf. Must see evidence of logs used so NMS scores 0/2
(c)	$\{\mathrm{f}(x) =\}\ \ 9^{-x}$	B1	1	OE
	Total		**5**	

Q	Solution	Marks	Total	Comments
5(a)	$h = 0.5$ $f(x) = \sqrt{8x^3+1}$ $I \approx \frac{h}{2}\{f(0)+f(2)+2[f(0.5)+f(1)+f(1.5)]\}$	B1 M1		$h = 0.5$ stated or used. $I \approx \frac{h}{2}\{f(0)+f(2)+2[f(0.5)+f(1)+f(1.5)]\}$ OE
	$\frac{h}{2}$ with $\{\ldots\} = \sqrt{1}+\sqrt{65}+2\left(\sqrt{2}+\sqrt{9}+\sqrt{28}\right)$ = 1 + 8.06... +2(1.41…+ 3 + 5.29…) = 9.0622… + 2×9.7057…	A1		OE Accept 1dp evidence. Can be implied by later correct work provided more than one term or a single term which rounds to 7.12
	($I \approx$) 0.25[28.47…] {= 7.118..} = 7.12 (to 3sf)	A1	4	CAO Must be 7.12
(b)	Stretch(**I**) in *x*-direction(**II**) scale factor 2 (**III**)	M1		Need (**I**) **and** either (**II**) or (**III**)
		A1	2	Need (**I**) and (**II**) and (**III**) More than 1 transformation scores 0/2
(c)	$g(x) = \sqrt{(x-2)^3+1} - 0.7$	M1		$\sqrt{(x-2)^3+1} - 0.7$ or $\sqrt{(x-2)^3+1} + 0.7$ or $\sqrt{(x+2)^3+1} - 0.7$ or $\sqrt{(x-2)^3+1-0.7}$ or their equivalents
		A1		$\sqrt{(x-2)^3+1} - 0.7$ OE
	g(4) = 2.3	A1	3	2.3 OE
	<u>**Altn**</u>			
	(4, …) on $y = g(x)$ comes from translating (2, 3) on $y = \sqrt{x^3+1}$	(M1) (A1)		from (2, ….) on $y = \sqrt{x^3+1}$ from (2, 3) on $y = \sqrt{x^3+1}$
	(2, 3) after translation becomes (4, 2.3) so g(4) = 2.3	(A1)	(3)	2.3 OE
	Total		**9**	

Q	Solution	Marks	Total	Comments
6(a)	$\sqrt{x} = x^{0.5}$	B1		$\sqrt{x} = x^{0.5}$ or $\sqrt{x} = x^{\frac{1}{2}}$ seen or used
	$\dfrac{12 + x^2\sqrt{x}}{x} = \dfrac{12 + x^{2.5}}{x}$ $= 12x^{-1} + x^{1.5}$	B1		$12x^{-1}$ or $p = -1$
		B1	3	$x^{1.5}$ or $q = \dfrac{3}{2}$ (=1.5)
(b)(i)	$\dfrac{dy}{dx} = -12x^{-2}$	B1F		Ft on c's p only if c's p is a negative integer
	$+1.5x^{0.5}$	B1F	2	Ft on c's q only if c's q is a pos non-integer
(ii)	When $x = 4$, $y = 11$	B1		
	When $x = 4$, $\dfrac{dy}{dx} = \dfrac{-12}{16} + 3 = \dfrac{9}{4}$	M1		Attempt to find $\dfrac{dy}{dx}$ when $x = 4$ PI
	Gradient of normal = $-\dfrac{4}{9}$	m1		$m \times m' = -1$ used
	Eqn of normal: $y - 11 = -\dfrac{4}{9}(x-4)$	A1	4	ACF eg $4x + 9y = 115$
(iii)	At St Pt $\dfrac{dy}{dx} = -12x^{-2} + 1.5x^{0.5} = 0$	M1		Equating c's $\dfrac{dy}{dx}$ to zero.
	$\Rightarrow x^2x^{0.5} = 8$, $\Rightarrow x^{\frac{5}{2}} = 8 \Rightarrow x = 8^{\frac{2}{5}}$	A1		A correct eqn in the form $x^n = c$ or $x = c^{\frac{1}{n}}$ correctly obtained.
	$\Rightarrow x = (2^3)^{\frac{2}{5}} \Rightarrow x = 2^{\frac{6}{5}}$	A1	3	CSO $x = 2^{\frac{6}{5}}$. All working must be correct and in an exact form. If 'x=0' also appears then A0 CSO
			12	

Q	Solution	Marks	Total	Comments
7(a)	$72 = 96p + q$ $24 = 24p + q$	M1 M1		 OE
	48 = 72*p*	m1		Valid method to solve the correct two simultaneous eqns in *p* and *q* to at least the stage 48 = 72*p* OE
	$p \left(= \frac{48}{72}\right) = \frac{2}{3}$	A1	4	AG CSO
(b)	*q* = 8	B1		Award if seen at any stage in Q7
	$u_3 = 48 + q \qquad (u_3 =)\ 56$	B1F	2	If not 56, ft on (48 + c's *q*) provided at least M1 scored in part (a).
	Total		**6**	
8(a)	$b = a^c$	B1	1	
(b)	$2\log_2(x+7) - \log_2(x+5) = 3$ $\log_2(x+7)^2 - \log_2(x+5) = 3$	M1		A law of logs used correctly on a correct expression.
	$\log_2 \frac{(x+7)^2}{x+5} = 3$	M1		A further correct use of law of logs on a correct expression.
	$= 3\log_2 2 = \log_2 2^3$ $\Rightarrow \frac{(x+7)^2}{x+5} = 2^3$	B1		$3 = 3\log_2 2$ or $3 = \log_2 2^3$ (= $\log_2 8$) seen or eg $\log f(x) = 3 \Rightarrow f(x) = 2^3$ (=8) OE
	$\Rightarrow (x+7)^2 = 8(x+5)$	A1		Correct equation having eliminated logs and fractions
	$\Rightarrow x^2 + 14x + 49 = 8x + 40$ $\Rightarrow x^2 + 6x + 9\ (= 0)$	A1		
	Since $6^2 - 4(1)(9) = 0$, (there is only) one value of *x* (which satisfies the given equation).	A1	6	OE CSO Need conclusion which is also correctly justified
	Total		**7**	

Q	Solution	Marks	Total	Comments
9(a)(i)		B1 B1 B1	 3	Ignore any part of the graph drawn outside interval $0° \le x \le 360°$ in (a) A 3 branch curve between 0 and 360 meeting the *x*-axis at or very close to 0, 180, 360 only A 3 branch curve between 0 and 360 with correct shape tending to infinity at, at least 3, of the 4 relevant ends Correct graph for $0° \le x \le 360°$, with correct intercepts. Asymptotes not explicitly required but graphs should show correct 'tendency' close to 90 and 270.
(ii)	135° ; 315°	B2,1,0	2	B2 for both 135 and 315 and no 'extras' in interval $0° \le x \le 360°$ (If not B2 then award B1 for either 135 or 315 with or without extras)
(b)(i)	$6\tan\theta\sin\theta = 5 \Rightarrow 6\dfrac{\sin\theta}{\cos\theta}\sin\theta = 5$ $6\dfrac{\sin^2\theta}{\cos\theta} = 5 \Rightarrow 6\dfrac{1-\cos^2\theta}{\cos\theta} = 5$ $6 - 6\cos^2\theta = 5\cos\theta \Rightarrow 6\cos^2\theta + 5\cos\theta - 6 = 0$	M1 m1 A1	 3	$\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ used $\sin^2\theta$ replaced by $1-\cos^2\theta$ throughout Completion AG Be convinced
(ii)	$6\tan 3x\sin 3x = 5 \Rightarrow 6\cos^2 3x + 5\cos 3x - 6 = 0$	M1		Using (b)(i) with θ=3*x* PI by attempting to solve eg for theta then dividing soln(s) by 3
	$(3\cos 3x - 2)(2\cos 3x + 3)$ (=0) (cos3*x* = 2/3, −3/2)	m1		Correct factorisation or correct subst into the quadratic formula PI by two 'correct' roots
	$\cos 3x = \dfrac{2}{3}$ = cos 48.1(89..) [= cos α] 3*x* = α , 360−α , 360+α .	m1		Dep on M1 only, 3*x* =α , 360−α , 360+α for c's α. from an eqn cos3*x* = *k* where −1<*k*<1 OE PI and no solns from *k* outside $-1 \le k \le 1$
	x = 16º, 104º, 136º	B1 B1 B1	 6	AWRT 16, 104, 136. Deduct one mark (from any award of these 3 B marks) if more than three solns given inside the interval $0° \le x \le 180°$. Ignore any solutions outside the interval $0° \le x \le 180°$. NMS Max. is B3/6
	Total		**14**	
	TOTAL		**75**	

A-LEVEL
MATHEMATICS
Pure Core 2 – MPC2
Mark scheme

6360
June 2014

Version/Stage: Final V1.0

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

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.

Q	Solution	Mark	Total	Comment
1(a)	(Area =) $\frac{1}{2}\times 5\times 12\times \sin 47$	M1		$\frac{1}{2}\times 5\times 12\times \sin A$ stated or used
	$= 21.94\ldots = 22$ (cm^2)	A1	**2**	Correct area. If not 22 condone 21.9… NMS 22 or 'better' scores 2 marks
(b)	$(BC^2 =)\ 5^2 + 12^2 - 2\times5\times12\times\cos47$	M1		RHS of cosine rule used correctly
	$= 25 + 144 - 81.8(39..)$ (=87.16..)	m1		Correct evaluation of the three terms. PI by eg evaluation to a value 87 to 88 inclusive or correct final answer
	$BC = 9.3(359\ldots) = 9.3$ (cm)	A1	**3**	If not 9.3 accept 9.34 or 9.33 or 9.33…
	Total		**5**	

Condone absent/incorrect units throughout this question.

(a) Candidates who find a perpendicular height do not score the M1 until 1/2base×height used ie the equivalent of $\frac{1}{2}\times 5\times 12\times \sin A$.

(a)(b) Cand who uses 47 rads can score a max of (a) M1A0 (b) M1m0A0

(b) Example: $169 - 120\cos47$ (M1) $= 49\cos47$ (m0) $= 33.4\ldots$

(b) $5^2 + 12^2 - 2\times5\times12\times\cos47$ (M1); $(BC=)\ 9.33$ (m1A1)

Q	Solution	Mark	Total	Comment
2(a)	$\int\left(1+3x^{\frac{1}{2}}+x^{\frac{3}{2}}\right)\mathrm{d}x = x + 2x^{1.5} + \frac{2}{5}x^{2.5}\ (+c)$	B1; B1 B1	**3**	ACF B1 for each correct term. Condone missing $+c$. (Can be left unsimplified)
(b)(i)	$(n =)\ 3$	B1	**1**	Correct value of n. Condone '$3y^2$'
(b)(ii)	$\left(1+\sqrt{x}\right)^3 = 1 + 3\sqrt{x} + 3\sqrt{x}^2 + \sqrt{x}^3$	B1F	**1**	Correct four term expansion ft c's n. Allow 'correct' alternatives eg $1+3x^{1/2}+"3"x+x^{3/2}$
(c)	$\int\left(1+\sqrt{x}\right)^3\mathrm{d}x = \int\left(1+3x^{\frac{1}{2}}+"3"x+x^{\frac{3}{2}}\right)\mathrm{d}x$ $= x + 2x^{1.5} + \frac{"3"x^2}{2} + \frac{2}{5}x^{2.5}\ (+c)$	B1F		Correct integration. If not correct, ft on c's answer to (a) + $\frac{nx^2}{2}$ for c's value of n in (b)(ii).
	$\int_0^1\left(1+\sqrt{x}\right)^3\mathrm{d}x =$ $1 + 2(1)^{1.5} + \frac{3(1)^2}{2} + \frac{2}{5}(1)^{2.5} - (0)$	M1		PI Attempt to find F(1)−F(0) following 'attempt' at integration. Condone the '−(0)' missing if cand's F(x) leads to F(0)=0.
	$= \frac{49}{10}\ (= 4.9)$	A1	**3**	OE correct value. NMS ie 4.9 without any other work in (c) scores 0/3
	Total		**8**	

Apply ISW after a correct answer but do not award the B1F in (c) if, for example, an incorrect simplification in (a) has been used in (c) and marked as 3/3 ISW in (a).

(c) Allow M1 PI if cand. has evaluated F(1) – F(0) correctly for their F(x), following integration.

(c) If 4.9 follows from incorrect working then A0 FIW

Q	Solution	Mark	Total	Comment
3(a)	$\{S_\infty =\}\ \frac{a}{1-r} = \frac{54}{1-\frac{8}{9}}$	M1		$\frac{a}{1-r}$ used with a=54 and r= 8/9 OE
	$\{S_\infty =\}$ 486	A1	2	Correct exact value for S_∞. 486 scores 2 marks unless rounding of a value to 486 seen in which case M1A0.
(b)	{2nd term =} $ar = 48$	B1	1	Correct value for 2nd term
(c)	{12th term =} ar^{12-1}	M1		ar^{12-1} stated or used. PI by 14.7(8…)
	$= 54\times\left(\frac{8}{9}\right)^{11} = 2\times3\times3\times3\times\left(\frac{2\times2\times2}{3\times3}\right)^{11}$	m1		Changing at least two of 54 and 8 and 9 in correct expression to correct products/powers of 2 and 3
	$= \frac{2\times3^3\times(2^3)^{11}}{(3^2)^{11}}$			
	$= \frac{3^3\times2^{34}}{3^{22}} = \frac{2^{34}}{3^{19}}$ $(p = 34,\ q = 19)$	A1	3	Showing 12th term $= \frac{2^{34}}{3^{19}}$ in a convincing manner
	Total		**6**	
(a)	Accept 0.8 or 0.9 or better as an OE to 8/9 or 0.2 or 0.1 or better as OE to 1−8/9 but a must be 54 (No MR)			
(c)	$54\times\frac{8}{9}^{11}$ (M1)			
(c)	$54\times\left(\frac{8}{9}\right)^{11}$ **(M1)** $= 54\times\left(\frac{8}{3^3}\right)^{11} = 2\times3\times3\times3\times\left(\frac{2\times2\times2}{3^3}\right)^{11}$ **(m1)** since 54 and 8 have been written as correct products of 2 and 3 starting with a correct expression, $54\times\left(\frac{8}{9}\right)^{11}$.			

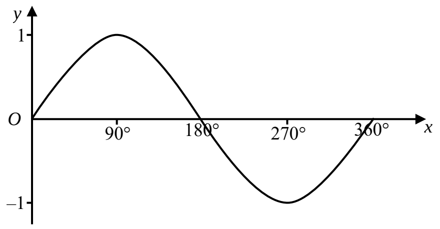
Q	Solution	Mark	Total	Comment
4(a)	$\frac{1}{x^2} = x^{-2}$	B1		$\frac{1}{x^2} = x^{-2}$. PI by its **correct** derivative
	$(y = \frac{1}{x^2} + 4x)$ $(\frac{dy}{dx} =)$ $-2x^{-3} + 4$	M1		Correct differentiation of either $\frac{1}{x^2}$ or $4x$
		A1	3	Correct $\frac{dy}{dx}$ ACF
(b)	When $x = -1$, $\frac{dy}{dx} = -2(-1)^{-3} + 4$ $(= 6)$	M1		Attempt to find the value of $\frac{dy}{dx}$ when $x = -1$
	Gradient of normal = $-\frac{1}{6}$	m1		Correct use of $m \times m' = -1$, with c's value of $\frac{dy}{dx}$ when $x = -1$
	(Eqn of normal) $y + 3 = -\frac{1}{6}(x+1)$	A1F	3	A correct ft equation for normal with signs simplified; ft on c's $\frac{dy}{dx}$ expression in **(a)** **SC** $\frac{dy}{dx}$ = const in **(a)**, mark **(b)** as M1A1F eg for $\frac{dy}{dx}$=4 in (a); grad of normal= $-\frac{1}{4}$ (M1), eqn $y + 3 = -\frac{1}{4}(x+1)$ (A1F)
(c)	$-2x^{-3} + 4 = -12$	M1		C's answer to (**a**) equated to −12 (or to 12) seen or used.
	$x^{-3} = 8$	A1F		PI Correct rearrangement of $ax^{-n} + b = \pm 12$ or $\frac{a}{x^n} + b = \pm 12$ OE to form $x^{-n} = q$ or to form $x^n = p$, but only ft in case of n positive
	$x = 0.5$	A1		$x = 0.5$ OE
	When $x = 0.5$, $y = 6$	A1F		Correct ft y coordinate from $y_c = x_c^{-2} + 4x_c$. Only ft if values are exact.
	(Eqn of tangent) $y - 6 = -12(x - 0.5)$ (or eg $y = -12x + 12$)	A1	5	Correct tangent equation ACF Apply ISW after ACF
	Total		**11**	

(a) Rearrange to $\frac{1+4x^3}{x^2}$ and then use quotient rule $(\frac{\pm vu' \pm uv'}{v^2})$M1; A1(for correct v^2 and a correct term in the numerator); A1 (Correct $\frac{dy}{dx}$ ACF)

(b) Final answer as $y - (-3) = -\frac{1}{6}(x - (-1))$ is M1m1A0 as signs not simplified.

(c) Apply the PI only for the correct value of x with a correct M1 equation seen ie $-2x^{-3} + 4 = -12$, x= ½ (M1A1FA1)

Q	Solution	Mark	Total	Comment
5	(Area of sector) = $\frac{1}{2}r^2\theta$	M1		$\frac{1}{2}r^2\theta$ seen, or used, for the sector area
	$\frac{1}{2}r^2\theta = 12$	A1		$\frac{1}{2}r^2\theta = 12$ OE
	(Arc length) = $r\theta$	M1		$r\theta$ seen, or used, for the arc length
	$r + r + r\theta = 4r\theta$	m1		$r + r + r\theta = 4r\theta$ OE in terms of r and θ or used with their value of $r\theta$.
	$3r\theta = 2r \Rightarrow \theta = \frac{2}{3}$	A1		$\theta = \frac{2}{3}$. Condone 0.66 or 0.67 or better PI by eg $\frac{1}{3}r^2 = 12$ OE
	$\frac{1}{3}r^2 = 12 \Rightarrow r = 6$	A1	6	$r = 6$ only with no evidence of a value seen being rounded to 6 .
	Total		**6**	
	Example: $\frac{1}{2}r^2\theta = 12$ (M1A1) $r\theta = 4r\theta$ (M1m0) Example: $r + r + r\theta = 4r\theta$ (M1m1) θ=0.67 (A1) $r^2\theta = 12$ (M0A0) Example: $\frac{1}{2}r^2\theta = 12$ (M1A1) $2r + r\theta = 4r\theta$ (M1 m1) $2r^2 + r^2\theta = 4r^2\theta$, $2r^2 + 24 = 96$, $2r^2 = 72$ (A1) $\Rightarrow r = \pm 6$ (A0, since −6 still present)			

Q	Solution	Mark	Total	Comment
6(a)		B2,1,0	**2**	Ignore parts of graph outside 0º≤x≤360º. B2: Correct graph including correct intersections and stationary points at/close to 90º and 270º with correct y values, 1 and −1 stated. If not B2 then award B1 for correct shape graph with either (i) at least 4 of the 5 critical points (intersections and stationary points) having x-coords. drawn within tolerance or (ii) at least 3 of the 5 critical points (intersections and stationary points) having x-coords. drawn within tolerance and y values, 1 and −1 stated for max and min respectively
(b)	Stretch (**I**) in x-direction (**II**) scale factor $\frac{1}{5}$ (**III**)	M1 A1	**2**	Need (**I**) **and** either (**II**) or (**III**) Need (**I**) and (**II**) and (**III**) More than one transformation scores 0/2.
(c)	Translation $\begin{bmatrix} -2^\circ \\ 0 \end{bmatrix}$	E2,1,0	**2**	E2: 'translat…' and $\begin{bmatrix} -2 \\ 0 \end{bmatrix}$ OE. If not E2 award E1for either 'translat… 2 in x-dir' OE. or 'translat…' and $\begin{bmatrix} -10 \\ 0 \end{bmatrix}$ OE. More than one transformation scores 0/2.
	Total		**6**	

(a)	For guidance, 'close to' means max pt is vertically above any part of the printed '90º' and min pt is vertically below any part of the printed '270º'. As a guideline, generally accept graph through 180 and 360 if graph goes through the printed x-axis markers at these points.
(b)	**Stretch** by **0.2** in **x** (direction) is sufficient for M1A1. Accept 'horizontal…' in place of 'x'
(c)	Lots of "correct" answers: eg translate 70º in x-direction {in fact any translation of −2(mod72)º in x-direction would be correct} eg reflect in x=17º {in fact any reflection in x=17(mod36)º would be correct}
(c)	Examples: 'translate horizontally 2' scores E1; 'translating horizontally −2' scores E2; 'translated 2 in negative x ' scores E2 If using 'reflection' if not E2 then award E1 for eg 'reflection in x=19' OE (ie correct 17 replaced by 19)

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Q	Solution	Mark	Total	Comment
7(a)	$\frac{\cos^2 x + 4\sin^2 x}{1-\sin^2 x} = \frac{\cos^2 x + 4\sin^2 x}{\cos^2 x}$ (=7)	M1		A correct use of identity $\sin^2 x + \cos^2 x = 1$
	$(1+\frac{4\sin^2 x}{\cos^2 x}=7)$; $\Rightarrow 1 + 4\tan^2 x = 7$	m1		Correct use of identity $\tan^2 x = \frac{\sin^2 x}{\cos^2 x}$ to obtain a correct equation in $\tan^2 x$ only.
	$\Rightarrow 4\tan^2 x = 6 \Rightarrow \tan^2 x = \frac{3}{2}$	A1	3	AG $\tan^2 x = \frac{3}{2}$ obtained convincingly
(b)	$\tan^2 2\theta = \frac{3}{2}$	M1		Using printed answer to part **(a).** PI by either $\tan 2\theta = \sqrt{\frac{3}{2}}$ or $\tan 2\theta = -\sqrt{\frac{3}{2}}$ or later equivalent work
	$\tan 2\theta = \pm\sqrt{\frac{3}{2}} = \pm 1.22(47..)$,	A1		$\tan 2\theta = \pm\sqrt{\frac{3}{2}}$ OE Must see the ±
	(θ =) 25°, 65°, 115°, 155°	B2,1,0	4	B2: All 4 integer values correct. If not B2 award B1 for 2 AWRT correct integer values. If more than 4 solutions inside given interval deduct 1 mark (to min of B0) for each extra solution. Ignore values outside given interval
	Total		**7**	
(a)	Altn. Finding value for $\cos^2 x$ and value for $\sin^2 x$ then using to find $\tan^2 x$ Example: $\cos^2 x + 4\sin^2 x = 7(1-\sin^2 x)$; $1 + 3\sin^2 x = 7(1-\sin^2 x)$ (M1); $10\sin^2 x = 6$; $\sin^2 x = 3/5$; So $\cos^2 x = 1 - 3/5 = 2/5$; $\tan^2 x = \frac{\sin^2 x}{\cos^2 x} = \frac{3/5}{2/5}$ (m1) $= \frac{3}{2}$ (A1)			
(b)	Eg. $\tan 2\theta = \sqrt{\frac{3}{2}}$ (M1); $\theta = 25.4,\ 115.4$ (B1) Example showing the M1 PI $\tan x = \sqrt{\frac{3}{2}}$; x=50.76… , 230.76.. ; (no marks yet) θ = 25.4, 115.4 (M1B1) Cand solving tan$x$ = 3/2 and dividing answers for x by 2 will score 0/4 since not taken sq root. Candidate who solves $\tan^2 x = \frac{3}{2}$ without ever linking it with 2θ (eg by dividing answers for x by 2) will score 0/4.			

Q	Solution	Mark	Total	Comment
8(a)	[S_5=] $\frac{5}{2}\left[2a+(5-1)d\right]$	M1		$\frac{5}{2}\left[2a+(5-1)d\right]$ OE
	$\frac{5}{2}\left[2a+(5-1)d\right]$=575; 5(2$a$+4$d$)=575×2	m1		Forming correct eqn and attempt to remove fraction or expand brackets or better
	2a+4d=115×2 $\Rightarrow$ $a+2d=115$	A1	**3**	AG $a+2d=115$ convincingly obtained
(b)	$a+(10-1)d=87$	M1		$87=a+(10-1)d$ OE
	$a+2d=115,\ a+9d=87 \Rightarrow 7d=87-115$	m1		Solving $a+2d=115$ simultaneously with $a+9d=87$ as far as eliminating either a or d.
	$7d=-28,\quad d=-4$	A1	**3**	$d=-4$
(c)	When $d=-4,\ a=123$	B1F		Correct value of a or correct ft value for a. Ft only on $a=115-2\times$ cand's d
	$u_k=123+(k-1)(-4)>0$ $u_{k+1}=123+(k)(-4)<0$	M1		Either inequality, ft c's values for a and d. Condone equality and also n written for k.
	$k<31.75,\ k>30.75 \Rightarrow k=31$	E1		Justification of k=31 with no errors seen in relevant working and k=31 stated or used.
	$\sum_{n=1}^{31}u_n=\frac{31}{2}\left[2a+(31-1)d\right]$	M1		$\sum_{n=1}^{31}u_n=\frac{31}{2}\left[2a+(31-1)d\right]$ OE Must be using 31 for n.
	$=1953$	A1	**5**	$\sum_{n=1}^{k}u_n=1953$ dep. on previous B1FM1M1 being awarded
	Total		**11**	
(b)	Cand who recognises **(a)** answer as 3rd term = 115: 115+7d=87 (M1m1) $d=-4$ (A1)			
(c)	Can award the B1F for the value of a if seen in (b) with no contradiction in (c).			
(c)	Examples sufficient for the E1: $123+(k-1)(-4)>0$, $k<31.75$, $\Rightarrow k=31$ (E1); $123+(k)(-4)<0$, $k>30.75 \Rightarrow k=31$ (E1); (T&I approach) M1 for either $u_{31}=3$ **or** $u_{32}=-1$ $u_{31}=3$ **and** $u_{32}=-1$ $\Rightarrow k=31$ (E1);			
(c)	Example $123+(n-1)(-4)=0$ (M1), $n=31.75$ (no E yet) **and d<0** (OE) so n=31 (E1)			
(c)	An OE for 2nd M1 is $\sum_{n=1}^{31}u_n=\frac{31}{2}\left[a+3\right]$			

Q	Solution	Mark	Total	Comment
9(a)	$6 = 3\times 12^k$; $12^k = 2$	B1		$6 = 3\times 12^k$ OE Condone x for k throughout.
	$k\log 12 = \log 2$	M1		From $12^k = c$, correct application of 3rd law of logs OE eg $k = \log_{12} c$
	$(k =)$ 0.27894… = 0.279 (to 3sf)	A1	3	Must see logs being used. Condone >3sf.
(b)	$h = 0.5$	B1		$h = 0.5$ stated or used. (PI by x-values 0, 0.5, 1, 1.5 provided no contradiction)
	$F(x) = 3\times 12^x$ $I \approx \frac{h}{2}\{F(0)+F(1.5)+2[F(0.5)+F(1)]\}$	M1		$h/2\{F(0)+F(1.5)+2[F(0.5)+F(1)]\}$ OE summing of areas of the 'trapezia'..
	$\frac{h}{2}$ with $\{\ldots\}=3+36\sqrt{12}+2\left(3\sqrt{12}+36\right)$ = 3+124.7...+2(10.39… + 36) = 127.7… + 2×46.39… (I ≈ 0.25[220.492..] (= 55.1..))	A1		OE Accept 2sf or better evidence for surds. Can be implied by later correct work provided >1 term or a single term which rounds to 55 or is 55
	= 55 (to 2sf)	A1	4	CAO Must be 55 SC 4 strips used: **max** B0M1A0; 52 A1
(c)	$f(x) = 3\times 12^{x-1} + p$	M2,1,0		M2 for $3\times 12^{x-1} + p$; M1 if one sign error
	$f(0) = 0 \Rightarrow 3\times 12^{-1} + p = 0 \Rightarrow p = -0.25$	A1	3	$p = -1/4$ OE identified
	Altn			
	(0, ..) on y=f(x) from translating $(-1, 3\times 12^{-1})$	(M1)		PI by seeing 3×12^{-1} equated to p or $-p$
	(.., 0) on y=f(x) from translating (…, $-p$)	(M1)		PI
	$-p = 3\times 12^{-1} \Rightarrow p = -0.25$	(A1)	(3)	
(d)	$2^{2-x} = 3\times 12^x$	B1		$2^{2-x} = 3\times 12^x$ OE Elimination of y
	$(2-x)\log_2 2 = \log_2\left(3\times 12^x\right)$	M1		Attempting to takes logs of both sides of a correct eqn and applies a law of logs correctly to either side; condone missing base
	$(2-x)\log_2 2 = \log_2 3 + \log_2 12^x$ $= \log_2 3 + x\log_2 12$ $= \log_2 3 + x(\log_2 3 + \log_2 4)$	m1		Using log laws correctly to reach a correct eqn where any log terms other than log3 are of the form logN where N = 2,4 or 8. condone missing base.
	$2 - x = \log_2 3 + x\log_2 3 + 2x$	A1		$\log_2 2 = 1$ used to reach a correct eqn involving no log terms other than $\log_2 3$
	$2 - \log_2 3 = x\log_2 3 + 3x$ $x = \frac{2-\log_2 3}{3+\log_2 3}$ $(q = 3)$	A1	5	$x = \frac{2-\log_2 3}{3+\log_2 3}$ obtained convincingly
	Total		**15**	
	TOTAL		**75**	
(a)	$6 = 3\times 12^x$ (B1); $\log 6 = \log 3 + \log 12^x$ (M not scored yet); $\log 6 = \log 3 + x\log 12$ (M1)			
(b)	For guidance sep. trap. 3.34…+11.59..+40.17.. . (b) MR of F(x) **max** B1M1A0A0			
(d)	NB $(2-x)\log_2 2 = 2 - x\log_2 2 = 2-x$			
(d)	$4 = 3\times 24^x$ (B1); $\log 4 = \log 3 + \log 24^x$ (M1); $\log 4 = \log 3 + x\log 24$; $\log 4 = \log 3 + x(\log 3 + \log 8)$ (m1) $2 = \log_2 3 + x(\log_2 3 + 3)$ (A1); $x = \frac{2-\log_2 3}{3+\log_2 3}$ (A1).			
(d)	Example: $2^{2-x} = 3\times 12^x$ (B1) $\log 2^{2-x} = \log 3\times x\log 12 = x\log 36$, $2 - x\log 2 = x\log 36$ **(M1m0)**			

A-LEVEL

Mathematics

Pure Core 2 – MPC2
Mark scheme

6360
June 2015

Version/Stage: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

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.

Q1	Solution	Mark	Total	Comment
	(Area of sector =) $\frac{1}{2}r^2\theta$	M1		$\frac{1}{2}r^2\theta$ seen, or used, for the sector area
	$\frac{1}{2}(5^2)\theta = 15$ $\left(\theta = \frac{15}{12.5}\right)$	A1		A correct equation in θ or in $r\theta$ eg $2.5r\theta = 15$
	(Perimeter of sector =) $5 + 5 + 5\theta$	M1		$r + r + r\theta$ seen, or used, for the perimeter
	$= 10 + 5 \times \frac{6}{5} = 16$ (cm)	A1	4	16
	Total		**4**	

Q2	Solution	Mark	Total	Comment
(a)	$\frac{AC}{\sin 48^\circ} = \frac{20}{\sin 72^\circ}$	M1		Correct use of sine rule with *AC* being the only unknown
	$AC = \frac{20\sin 48^\circ}{\sin 72^\circ}$ $\left(= \frac{14.86...}{0.951...}\right)$	A1		Correct expression for *AC*. PI by 15.62(7774..)
	= 15.62(7774..) = 15.6 (cm to 3 sf)	A1	3	AG Need some intermediate evaluation between $\frac{20\sin 48^\circ}{\sin 72^\circ}$ and 15.6
(b)	Angle *ACB* = 60º	B1		Either *ACB* = 60º stated or used or seen on diagram or *AB* = AWRT 18.2
	$(AM^2=) 10^2 + (15.6)^2 - 2\times10\times15.6\times\cos C$	M1		RHS of relevant cosine rule used correctly
	$= 10^2 + (15.6)^2 - 156$	m1		$10^2 + (15.6)^2 - 156$ OE; accept evaluation to, 187 to 188 incl., as evidence
	AM = 13.7 (cm to 3 sf)	A1	4	Condone more accurate answer
	Total		**7**	
(b) **(b)**	Allow use of 15.6 or better for *AC* **Altn using perpendicular from *A* to *BC*** Either *ACB* = 60º stated or used or seen on diagram or *AB* = AWRT 18.2 (**B1**) $(AM^2=)\ (15.6\sin 60)^2 + (10 - 15.6\cos 60)^2$ OR $(AM^2=)\ (18.2\sin 48)^2 + (18.2\cos 48 - 10)^2$ (**M1**) $= (13.5)^2 + (2.2)^2$ (**m1**) Correct evaluations to at least 1dp accept evaluation to, 187 to 188 incl., as evidence. *AM* = 13.7 (cm to 3 sf) (**A1**) Condone more accurate answer			

Q3	Solution	Mark	Total	Comment
(a)	(3rd term=) $ar^2 = 48(0.6)^2$	M1		ar^{3-1} stated or used
	$= 17.28$	A1	2	OE fraction eg 432/25. NMS 17.28 OE scores 2 marks unless FIW.
(b)	$\{S_\infty =\}\ \frac{a}{1-r} = \frac{48}{1-0.6}$	M1		$\frac{a}{1-r}$ used with $a = 48$ and $r = 0.6$ OE
	$\{S_\infty =\}$ 120	A1	2	Correct exact value for S_∞. NMS 120 scores 2 marks unless FIW.
(c)	$\sum_{n=4}^{\infty} u_n = S_\infty - \sum_{n=1}^{3} u_n$	M1		OE eg RHS = $S_\infty - (a + ar + ar^2)$
	$\sum_{n=1}^{3} u_n$ = (48+28.8 + c's (**a**))	A1F		OE eg $\sum_{n=1}^{3} u_n = \frac{48(1-0.6^3)}{1-0.6}$ (=94.08) PI
	$\sum_{n=4}^{\infty} u_n = 120 - 94.08 = 25.92$	A1	3	25.92 OE exact value
	Altn.			
	$\sum_{n=4}^{\infty} u_n = \frac{u_4}{1-r}$	(M1)		
	$u_4 = 17.28 \times 0.6 = 10.368$	(A1F)		Ft on c's **(a)**×0.6. PI by $\sum_{n=4}^{\infty} u_n$ = correct evaluation of 1.5×c's**(a)**
	$\sum_{n=4}^{\infty} u_n = \frac{10.368}{1-0.6} = 25.92$	(A1)		25.92 OE exact value
	Total		7	

Q4	Solution	Mark	Total	Comment
(a)	$\frac{2}{x^2}=2x^{-2}$	B1		PI by its derivative as $-4x^{-3}$ or $4x^{-3}$
	$\frac{d^2y}{dx^2}=-4x^{-3}-\frac{1}{4}$	M1 A1	3	Differentiating one term correctly. ACF
(b)(i)	$\frac{2}{x^2}-\frac{x}{4}=0$	M1		
	$(x_M=)\quad 2$	A1	2	**NMS** 2/2 for correct answer.
(b)(ii)	(At M) $\frac{d^2y}{dx^2}=-\frac{4}{8}-\frac{1}{4}<0$, so max.	E1	1	Using c's x_M and c's $\frac{d^2y}{dx^2}$ to show $\frac{d^2y}{dx^2}$ is negative and stating conclusion ie max.
(b)(iii)	$\int\left(\frac{2}{x^2}-\frac{x}{4}\right)dx=-2x^{-1}-\frac{x^2}{8}(+c)$	M1		Attempt to integrate $\frac{dy}{dx}$ with at least one of the two terms integrated correctly.
	$(y=)\ -2x^{-1}-\frac{x^2}{8}\ (+c)$	A1		$-2x^{-1}-\frac{x^2}{8}$ OE ; condone unsimplified
	When $x=2$, $y=2.5 \Rightarrow 2.5=-1-0.5+c$	M1		Subst. x = c's **(b)**, $y=2.5$ into $y=\mathrm{F}(x)$+'c' in attempt to find constant of integration, where F(x) follows attempted integration of expression for $\frac{dy}{dx}$
	$y=-2x^{-1}-\frac{x^2}{8}+4$	A1	4	ACF but with signs and coeffs simplified
	Total		**10**	

Q5	Solution	Mark	Total	Comment
(a)	$132 = 160p + q$	M1		Seen or used
	$20 = 20p + q$	M1		Seen or used
	$112 = 140p$	m1		Valid method to solve the correct two simultaneous eqns in p and q to at least the stage $112 = 140p$ OE or $28 = 7q$ OE PI by correct values for both p and q from two correct simultaneous equations
	$p = \frac{112}{140} \quad \left(= \frac{4}{5}\right)$	A1		ACF
	$q = 4$	A1	5	$q = 4$
(b)	$160 = \frac{4}{5}u_1 + 4 \qquad u_1 = 195$	B1F	1	Ft on $u_1 = \frac{160 - \text{c's } q}{\text{c's } p}$, provided u_1 is exact and p and q are both positive.
	Total		6	

Q6	Solution	Mark	Total	Comment
(a)	$\sin^{-1} 0.6 = 0.64(35...) \quad (=\beta)$	B1		PI by one correct value for x to at least 2dp or 2sf
	$x + 0.7 = \beta, \quad x + 0.7 = \pi - \beta$ (=2.4(98..))	M1		$x + 0.7 = \beta$ and $x + 0.7 = \pi - \beta$ where β is the c's value for $\sin^{-1} 0.6$
	$x = -0.056$, 1.8 (to 2 sf)	A1	3	Must be correct 2sf values ie −0.056 , 1.8 Ignore any values outside given interval. **SC NMS** Condone>2sf and mark as B1 B1 max. {−0.056(498..); 1.7(9809..)}
(b)(i)	$5\cos^2\theta - \cos\theta = 1 - \cos^2\theta$	M1		Replacing $\sin^2\theta$ by $1 - \cos^2\theta$
	$6\cos^2\theta - \cos\theta - 1 = 0$	A1		
	$(2\cos\theta - 1)(3\cos\theta + 1)$ (= 0)	m1		$(2\cos\theta \pm 1)(3\cos\theta \pm 1)$ PI by the two 'correct' roots with correct/incorrect signs
	(Possible values of $\cos\theta =$) $\frac{1}{2}, \ -\frac{1}{3}$	A1	4	The two correct values of $\cos\theta$.
(b)(ii)	When $\cos\theta = -\frac{1}{3}$, $\sin^2\theta = \frac{8}{9}$	B1		
	$\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{(\pm)\sqrt{\frac{8}{9}}}{-\frac{1}{3}}$	M1		$\tan\theta = \frac{\sin\theta}{\cos\theta}$ **used**; could be used with either of c's values of $\cos\theta$ from **(b)(i)** and a corresponding value of $\sin\theta$
	So a (+'ve) value for $\tan\theta$ is $-\sqrt{\frac{8}{9}} \div \left(-\frac{1}{3}\right) = \sqrt{8} = 2\sqrt{2}$	A1	3	CSO A.G. Be convinced.
	Total		**10**	
(a)	Eg NMS $x = -0.06$, 1.80 scores B0B1			
(b)(ii) Alt	$\sec\theta = -3$, $\sec^2\theta = 9$ **(B1)**; $\tan^2\theta = \sec^2\theta - 1 = 9 - 1$ **(M1); (**+'ve) value of $\tan\theta$ is $\sqrt{8} = 2\sqrt{2}$ **(A1CSO)**			

Q7	Solution	Mark	Total	Comment
(a)(i)	Translation $\begin{bmatrix}0\\1\end{bmatrix}$	**E2,1,0**	**2**	E2: 'translat…' and $\begin{bmatrix}0\\1\end{bmatrix}$ OE. If not E2 award E1for 'translat… in y-dir' OE. More than one transformation scores 0/2
(a)(ii)	Stretch (**I**) in x-direction (**II**) scale factor 9 (**III**)	**M1** **A1**	 **2**	Need (**I**) **and** either (**II**) or (**III**) Need (**I**) and (**II**) and (**III**) More than one transformation scores 0/2
(b)(i)	$\int_0^9\left(1+\sqrt{x}\right)\mathrm{d}x = 9 + 18 = 27$	**B1**	**1**	27
(b)(ii)	$h = 2.25$ $\mathrm{f}(x) = 4^{\frac{x}{9}}$ $\mathrm{I} \approx \frac{h}{2}\{\mathrm{f}(0)+\mathrm{f}(9)+2[\mathrm{f}(2.25)+\mathrm{f}(4.5)+\mathrm{f}(6.75)]\}$ $\frac{h}{2}$ with $\{\ldots\}=1+4+2\left(4^{\frac{1}{4}}+4^{\frac{1}{2}}+4^{\frac{3}{4}}\right)$ $= 5+2\left(\sqrt{2}+2+2\sqrt{2}\right) = 9+6\sqrt{2}$ $(\mathrm{I} \approx \frac{2.25}{2}[9+8.48...]=1.125\times 17.485..)$ (= 19.67…) = 19.7 (to 1 dp)	**B1** **M1** **A1** **A1**	 **4**	h = 2.25 OE stated or used. (PI by x-values 0, 2.25, 4.5, 6.75, 9 provided no contradiction) h/2{f(0)+f(9)+2[f(2.25)+f(4.5)+f(6.75)]} OE summing of areas of the 'trapezia'.. OE Accept 2sf or better evidence for surds. Can be implied by later <u>correct</u> work provided >1 term or a single term which rounds to 19.7 CAO Must be 19.7 **SC** 5strips used: **Max** B0M1A0, 19.6 A1
(b)(iii)	Area of shaded region ≈ $\int_0^9\left(1+\sqrt{x}\right)\mathrm{d}x - \int_0^9 4^{\frac{x}{9}}\,\mathrm{d}x$ $= 27 - 19.7 = 7.3$ Since trapezia cover larger area than area under lower curve, 19.7 is overestimate so subtracting this from the true area, 27, under upper curve will lead to an **underestimate** of the true area of shaded region.	 **M1** **A1F** **E1**	 **3**	Ft on [c's **(b)(i)** − c's **(b)(ii)**] provided this gives a value>0. Need both the final answer '**underestimate**' plus mention of the fact that the trapezium rule gives overestimate as trapezia cover larger area-cand could show this on a diagram. (E1 is dep on M1 but not on the A1F)
	Total		**12**	
(a)(i)	Example: 'translating 1 in positive y' OE (**E2**)			
(b)(ii)	For guidance, separate trap. 2.71(5..) + 3.84(0..)+5.43(1..)+7.68(1..). NB 3/4 possible if values to 2sf			
(b)(ii)	MR of f(x), but <u>**NOT**</u> from an attempted integration, <u>**max**</u> **B1M1A0A0**			

Q8	Solution	Mark	Total	Comment
	Gradient of the line $3y-2x=1$ is $\frac{2}{3}$	B1		(Gradient) $\frac{2}{3}$ seen or used. Condone 0.66, 0.67 or better for $\frac{2}{3}$.
	$\frac{dy}{dx}=\frac{1}{2}x^{-0.5}$	B1		Correct differentiation of $x^{\frac{1}{2}}$
	At A, $\frac{1}{2}x^{-0.5}=\frac{2}{3}$	M1		c's $\frac{dy}{dx}$ expression = c's numerical gradient of given line.
	$A\left(\frac{9}{16},\frac{3}{4}\right)$	A1		Correct exact coordinates of A
	Eqn of tang at A: $y-\frac{3}{4}=\frac{2}{3}\left(x-\frac{9}{16}\right)$	A1	5	ACF eg $y=\frac{2}{3}x+\frac{3}{8}$ or eg $3y-2x=\frac{9}{8}$ must be exact
	Total		**5**	
Examples	Cand. writes $0.5x^{-0.5}=k$, and stops, where $k=-\frac{2}{3}$ or 2 or –2. Mark these types as (**B0, B1, M1A0A0**)			

Q9	Solution	Mark	Total	Comment
(a)	$3x\log 2=\log 5$	M1		OE eg $3x=\log_2 5$ or eg $x\log 8=\log 5$
	$x=0.773(976...)$ $=0.774$ (to 3sf)	A1	2	Condone > 3sf. If use of logarithms not explicitly seen then score 0/2
(b)	$\log_a \dfrac{k}{2}=\dfrac{2}{3}$	M1		Either $\log k-\log 2=\log\dfrac{k}{2}$ or $\dfrac{2}{3}=\log a^{\frac{2}{3}}$ seen at any stage
	$\dfrac{k}{2}=a^{\frac{2}{3}}$	A1		OE eqn with logs eliminated with no incorrect work
	$a^{\frac{2}{3}}=\dfrac{k}{2}\ \Rightarrow\ a=\left(\dfrac{k}{2}\right)^{\frac{3}{2}}$	m1		$a^{\frac{m}{n}}=C\Rightarrow a=C^{\frac{n}{m}}$
		A1	4	$a=\left(\dfrac{k}{2}\right)^{\frac{3}{2}}$ OE exact form with no obvious incorrect working
(c)(i)	$(1+2x)^3=1+3(2x)+3(2x)^2+(2x)^3$ $=1+6x+12x^2+8x^3$	B3,2,1	3	B3: expansion correct and simplified B2: 3 of the 4 terms correct and simplified B2; 4 terms correct but not all simplified B1 2 of the 4 terms correct and simplified (ignore the ordering of the terms)
(c)(ii)	$[(1+2n)^3-8n]=1-2n+12n^2+8n^3$	B1F		Ft at most two incorrect coefficients in **(c)(i)**
	$\log(1+2n)+\log 4(1+n^2)=\log 4(1+n^2)(1+2n)$	M1		Log law 1 applied correctly to RHS of given eqn., ignore base. Those who rearrange the terms first before applying log law 2 correctly must also attempt to deal with the resulting fraction in a correct manner.
	Given equation becomes $1-2n+12n^2+8n^3=8n^3+4n^2+8n+4$ $8n^2-10n-3$ (=0)	A1		Correct three term quadratic
	$(4n+1)(2n-3)$ (= 0)	A1		PI by correct two roots from a correct quadratic equation
	$n=-\dfrac{1}{4}$, $n=\dfrac{3}{2}$	A1	5	Need both as the final two values of n with no extras
	Total		**14**	
(b)	Example: $\log k-\log 2=\dfrac{\log k}{\log 2}=\dfrac{2}{3}$, $\dfrac{\log k}{\log 2}=\log a^{\frac{2}{3}}$ **(M1)**, $\dfrac{k}{2}=a^{\frac{2}{3}}$ **(A0)**, $a=\left(\dfrac{k}{2}\right)^{\frac{3}{2}}$ **(m1) (A0)**			