

INTERNATIONAL AS MATHEMATICS

MA01

(9660/MA01) Unit P1 Pure Mathematics

Mark scheme

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Key to mark scheme abbreviations

M	Mark is for method
m	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	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
sf	Significant figure(s)
dp	Decimal place(s)
ISW	Ignore subsequent working

Q	Answer	Marks	Comments
1(a)(i)	$\lceil x_1 \rceil$ 15	B1	
		1	

Q	Answer	Marks	Comments
1(a)(ii)	$[n =]$ 10	B1	
		1	

[illegible]

	Question 1 Total	6	
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[illegible][illegible]

	Question 2 Total	6	
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Q	Answer	Marks	Comments
3(a)	$\left[\begin{array}{l} \text{Gradient of } l_1 = \frac{-4 - (-3)}{6 - (-1)} \\ \\ -\frac{1}{7} \text{ and } 7 \\ \\ y - (-3) = 7(x - (-1)) \\ \text{and} \\ y = 7x + 4 \end{array} \right]$	M1	oe Correct method for finding the gradient of l_1
		M1	Sight of both gradients
		A1	oe Uses gradient and coordinates of Q to form equation leading to the required result May see use of $y = 7x + c$ and substitution of coordinates of Q to find c but must be a complete method A1 dependent on at least M1 awarded
		3	

Q	Answer	Marks	Comments
3(b)(i)	$(a - (-1))^2 + (7a + 4 - (-3))^2 [= 360a]$ or $(a + 1)^2 + (7a + 7)^2 [= 360a]$ or $\sqrt{(a - (-1))^2 + (7a + 4 - (-3))^2} [= 6\sqrt{10a}]$ or $\sqrt{(a + 1)^2 + (7a + 7)^2} [= 6\sqrt{10a}]$	M1	Correct expression for QR^2 or QR
	$a^2 + 2a + 1 + 49a^2 + 98a + 49 [= 360a]$	M1	Expands their brackets of the form $(a + m)^2 + (7a + n)^2$ oe correctly
	$50a^2 + 100a + 50 = 360a$ or $50a^2 - 260a + 50 = 0$ and $5a^2 - 26a + 5 = 0$	A1	Set equal to $360a$ before AG Must be convincingly shown.
		3	

Q	Answer	Marks	Comments
3(b)(ii)	$\lceil 5a^2 - 26a + 5 = 0 \Rightarrow \rceil$ $(5a - 1)(a - 5) [= 0]$ $\left(\frac{1}{5}, \frac{27}{5} \right) \text{ and } (5, 39)$	M1 M1 A1	Correct attempt to solve the quadratic equation. May see quadratic formula used but must be a correct substitution. PI by the correct x-coordinates of the possible positions of <i>R</i> M1: At least one correct pair of coordinates. A1: Both correct pairs of coordinates.
		3	
	Question 3 Total	9	

Q	Answer	Marks	Comments
4(a)	$(5p - 67) - (2p - 18) = 2((2p - 18) - (p - 4))$ $3p - 49 = 2(p - 14)$ or $3p - 49 = 2p - 28$ and $p = 21$	M1	oe Correct equation in p
		A1	oe Second line of working before AG
		2	

Q	Answer	Marks	Comments
4(b)	$[d = 24 - 17 =] 7$	B1	PI Correct value for the common difference.
	$[a = 17 - 14 =] 3$	B1	PI Correct value for the first term.
	$3 + (m - 1) \times 7 = 990$ or $7m - 4 = 990$	M1	oe Correct equation equating an expression for the m th term to 990
	$[m =] 142$	A1	CAO
		4	

Q	Answer	Marks	Comments
4(c)	$[142 \div 2 =] 71$	B1ft	Number of terms in the series of even terms. ft their $142 \div 2$ provided that it is even.
	$[S =] \frac{1}{2} \times 71 \times (10 + 990)$	M1	oe Correct use of a formula for the sum of an arithmetic series. ft their 71 provided that it is a positive integer.
	$[S =] 35500$	A1ft	ft their 71 provided that it is a positive integer.
		3	

	Question 4 Total	9	
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[illegible]

Q	Answer	Marks	Comments
5(b)	$y = 7x - 3k$ $3x^2 + (4k + 5)x + 10k + 9 - 7k = 7x - 3k$ $3x^2 + (4k - 2)x + 6k + 9 [= 0]$ $(4k - 2)^2 - 4 \times 3 \times (6k + 9) [> 0]$ $\left[16k^2 - 16k + 4 - 72k - 108 > 0 \Rightarrow \right]$ $16k^2 - 88k - 104 [> 0]$ or $2k^2 - 11k - 13 [> 0]$ $(2k - 13)(k + 1) [> 0]$ $[k =] -1 \text{ and } [k =] \frac{13}{2}$ $k < -1 \text{ or } k > \frac{13}{2}$	B1 M1 A1 M1 M1 M1 A1 A1	PI Correct equation of L oe Substitutes $a = 9 - 7k$ and sets equal to their $7x - 3k$ Simplified to quadratic equation in x set equal to zero with like terms collected. PI by correct discriminant oe Correct discriminant for their quadratic equation in x ft their quadratic equation in x Simplifies their quadratic equation to a correct three-term quadratic equation in k ft their discriminant. oe Correct attempt to solve the correct quadratic equation May see quadratic formula used but must be a correct substitution PI by both correct critical values. oe Correct critical values. Accept $\frac{13}{2}$ unsimplified. oe CAO Correct inequalities Condone $k < -1$, $k > \frac{13}{2}$ but not $k < -1$ and $k > \frac{13}{2}$ Accept $\frac{13}{2}$ unsimplified.
		8	
	Question 5 Total	10	

Q	Answer	Marks	Comments
6(a)	$(0, p)$	B1	
		1	

Q	Answer	Marks	Comments
6(b)	$(x-4)^2 \dots$ or $x^2 - 8x + 16 \dots$ $6(x-4)^2 - 96 + 103$ $6(x-4)^2 + 7$ Translation $\begin{bmatrix} 4 \\ 7-p \end{bmatrix}$	M1 A1 A1 E1 E1ft	Allow $6 \left[(x-4)^2 - 16 \right] + 103$ $6 \left[(x-4)^2 - 16 + \frac{103}{6} \right]$ $6 \left[(x-4)^2 + \frac{7}{6} \right]$ $6(x-4)^2 - 6 \times 16 + 103$ CAO Allow $6(x-4)^2 + p + (7-p)$ If incorrect ft their completed square form and their answer to part (a) Must be given as a vector.
		5	

	Question 6 Total	6	
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Q	Answer	Marks	Comments
7(a)	$\left[\left(12x^{\frac{4}{5}} + 1 \right) x^{-\frac{4}{5}} - 12 \right] = \left[12 - 144x^{\frac{4}{5}} + x^{-\frac{4}{5}} - 12 \right]$ and $x^{-\frac{4}{5}} - 144x^{\frac{4}{5}}$	B1	oe Correct expansion unsimplified and AG
		1	

Q	Answer	Marks	Comments
7(b)	$\left[\int \left(12x^{\frac{4}{5}} + 1 \right) \left(x^{-\frac{4}{5}} - 12 \right) dx \right]$ $\left[= 5x^{\frac{1}{5}} - \frac{5}{9} \times 144x^{\frac{9}{5}} \right] + c =$ $5x^{\frac{1}{5}} - 80x^{\frac{9}{5}} \left[+ c \right]$ $5x^{\frac{1}{5}} \left(1 - 16x^{\frac{8}{5}} \right) + c$	M1 A1 A1	M1: Correct integration of a term in x simplified or unsimplified. A1: Correct integration simplified or unsimplified. CAO Must have '+c'
		3	

	Question 7 Total	4	
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Q	Answer	Marks	Comments
8(a)	$[f(x) =] kx^{-\frac{1}{2}} - \frac{6}{5}x^{\frac{1}{2}} + \frac{9}{2}$ $[f'(x) =] -\frac{k}{2}x^{-\frac{3}{2}} + \frac{5}{2}x^{-\frac{1}{2}}$ $\left[x = \frac{1}{4} \Rightarrow f'\left(\frac{1}{4}\right) = \right]$ $-\frac{k}{2}\left(\frac{1}{4}\right)^{-\frac{3}{2}} + \frac{5}{2}\left(\frac{1}{4}\right)^{-\frac{1}{2}}$ or $-\frac{k}{2} \times 8 + \frac{5}{2} \times 2$ and $5 - 4k$	B1 M1 A1ft A1	oe Correct equation for C with at least one term in index form. PI by correct differentiation. oe ft their equation of C provided there is at least one term that is a fractional power of x Can be simplified or unsimplified. Allow terms not given in index form. M1: At least one correct term for their $f(x)$ A1ft: Correct derivative. oe $x = \frac{1}{4}$ substituted into the correct derivative and AG
		4	

Q	Answer	Marks	Comments
8(b)(i)	$-43 = 5 - 4k$ and $k = 12$	B1	$\frac{dy}{dx} = -43$ substituted and AG
		1	

Q	Answer	Marks	Comments
8(b)(ii)	$[y =] \frac{12 - 6\sqrt{\frac{1}{4}} + 5 \times \frac{1}{4}}{\sqrt{\frac{1}{4}}} + \frac{9}{2}$ or $[y =] \frac{12 - 6 \times \frac{1}{2} + 5 \times \frac{1}{4}}{\frac{1}{2}} + \frac{9}{2}$ $[= 25]$ $y - 25 = -43 \left(x - \frac{1}{4} \right)$ or $y = -43x + \frac{143}{4}$ $172x + 4y = 143$	M1 m1 A1	oe $k = 12$ and $x = \frac{1}{4}$ substituted into the equation of C ft their equation of C in index form from part (a) if used. PI by correct y-coordinate of P oe ft their y-coordinate of P Correct equation of tangent. May see use of $y = -43x + c$ and coordinates of P substituted but must be a complete method. oe CAO Correct equation in the correct form.
		3	

Q	Answer	Marks	Comments
8(c)	$\left[\frac{dy}{dx} = -6x^{-\frac{3}{2}} + \frac{5}{2}x^{-\frac{1}{2}} \Rightarrow \right]$ $\left[\frac{d^2y}{dx^2} = \right] 9x^{-\frac{5}{2}} - \frac{5}{4}x^{-\frac{3}{2}}$ $\left[x = \frac{12}{5} \Rightarrow \frac{d^2y}{dx^2} = \right] 9\left(\frac{12}{5}\right)^{-\frac{5}{2}} - \frac{5}{4}\left(\frac{12}{5}\right)^{-\frac{3}{2}}$ $[= 0.67239...]$ $\left[x = \frac{12}{5} \Rightarrow \frac{d^2y}{dx^2} = \right] 0.67239...$ and since $\frac{d^2y}{dx^2} > 0$ then Q is a minimum.	B1ft M1 E1	oe ft their first derivative from part (a) provided there is at least one term that is a fractional power of x Correct attempt to evaluate their second derivative at $x = \frac{12}{5}$ PI by AWRT 0.7 Must be working with the correct second derivative for this mark. Correct value for the second derivative at $x = \frac{12}{5}$ AWRT 0.7 and Indication that second derivative is positive at Q with the correct conclusion.
		3	

Q	Answer	Marks	Comments
8(d)	$x > \frac{12}{5}$	B1ft	oe ft their answer to part (c)
		1	

	Question 8 Total	12	
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Q	Answer	Marks	Comments
9(b)(ii)	$\left[\int_{0.5}^{1.5} \left(\frac{1}{4x^2} + \frac{x^3}{6} \right) dx = \right]$ $\left(-\frac{1}{4(1.5)} + \frac{(1.5)^4}{24} \right) - \left(-\frac{1}{4(0.5)} + \frac{(0.5)^4}{24} \right)$ $= \left(-\frac{1}{6} + \frac{27}{128} \right) - \left(-\frac{1}{2} + \frac{1}{384} \right)$ $= \left(\frac{17}{384} \right) - \left(-\frac{191}{384} \right)$ $= \frac{13}{24}$	M1 A1	ft their answer to part (b)(i) Must see limits substituted PI by at least 3 of $-\frac{1}{6}$, $\frac{27}{128}$, $-\frac{1}{2}$ and $\frac{1}{384}$ oe used or seen CAO Integral correctly evaluated from correct working. If M0 then allow SC1 for $\frac{13}{24}$
		2	

Q	Answer	Marks	Comments
9(c)	$0.566 - \frac{13}{24} \times 100 \quad [= 4.49230\dots]$ $\frac{13}{24}$ or $0.566 - \frac{13}{24} \quad [= 0.044923\dots]$ $\frac{13}{24}$ Since the percentage difference is 4.5% the student is correct. or As the difference as a fraction is 0.045 the student is correct.	B1ft Correct unsimplified expression for the percentage difference. ft Their 0.566 and $\frac{13}{24}$ PI by AWRT 4 or 4.5 or Correct unsimplified expression for the difference as a fraction of the exact value. ft Their 0.566 and $\frac{13}{24}$ PI by AWRT 0.04 or 0.045 ft their 0.566 and 0.5417 Correct value for the percentage difference and statement that the student is correct or correct conclusion based upon their percentage difference provided B1 awarded. AWRT 4.5% or 4% Condone omission of the % sign. E1ft or ft their 0.566 and 0.5417 Correct value for the difference as a fraction of the exact value and statement that the student is correct or correct conclusion based upon their fraction provided B1 awarded. AWRT 0.04 or 0.045	2

Q	Answer	Marks	Comments
9(c) ALT	Either [5% of exact value =] $\frac{13}{480}$ or 0.02708... and [Difference = $0.566 - \frac{13}{24} =$] $\frac{73}{3000}$ or 0.02433... or [105% of exact value = $\frac{13}{24} \times 1.05 =$] $\frac{91}{160}$ or 0.56875 The student is correct and $0.02433... < 0.02708...$ or [0.51458 <] $0.566 < 0.56875$	B1ft E1ft	Either Correctly calculates 5% of the exact value and the difference in the approximation. ft their 0.566 and $\frac{13}{24}$ Accept decimal equivalents to 2 sf or better. or Correctly calculates 105% of the exact value. ft their $\frac{13}{24}$ Accept decimal equivalent rounded or truncated to 3sf or better. Correct statement based upon their values and a comparison of values provided B1 awarded. ft their 5% of the exact value and the difference in the approximation, or their 105% of the exact value.
		2	

Q	Answer	Marks	Comments
9(d)	Increase the number of strips (or ordinates)	E1	Correct, valid reason.
		1	

	Question 9 Total	12	
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Q	Answer	Marks	Comments
10	$[r =] x^2$ $\frac{x^2}{1-x^2} = \frac{49}{32}$ $32x^2 = 49 - 49x^2$ or $81x^2 = 49$ or $x^2 = \frac{49}{81}$ $[x =] \frac{7}{9}$ $[P =] 4 \times \frac{\frac{7}{9}}{1 - \frac{7}{9}}$ or $[P =] 4 \times \frac{7}{2}$ $[P =] 14$	B1 M1 M1 A1 M1 A1	Correct common ratio for the series of areas. PI in later working. oe Forms a correct equation using the formula for S_∞ equated to $\frac{49}{32}$ oe Clears the fractions obtaining a correct equation in x^2 PI by the correct value for x Condone $x = -\frac{7}{9}$ seen. oe Substitutes their positive value for x into the formula for S_∞ and forms an expression for the sum of the perimeters. CAO Ignore units if included.
	Question 10 Total	6	