OCR
Oxford Cambridge and RSA

Wednesday 20 May 2015 – Morning

AS GCE MATHEMATICS

4722/01 Core Mathematics 2

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4722/01
- List of Formulae (MF1)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTIONS TO EXAMS OFFICER/INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

1 A geometric progression has first term 3 and second term -6.

(i) State the value of the common ratio. **[1]**

(ii) Find the value of the eleventh term. **[2]**

(iii) Find the sum of the first twenty terms. **[2]**

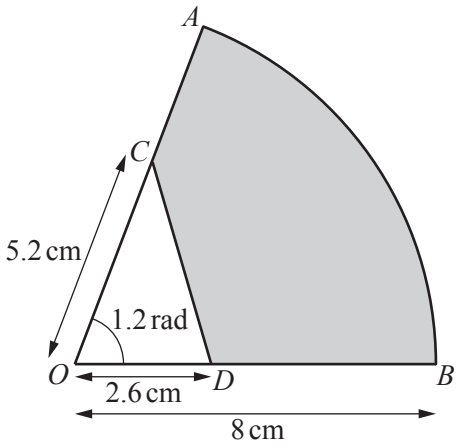
2 **(i)** Use the trapezium rule, with 4 strips each of width 1.5, to estimate the value of

$$\int_4^{10} \sqrt{2x-1}\,\mathrm{d}x,$$

giving your answer correct to 3 significant figures. **[4]**

(ii) Explain how the trapezium rule could be used to obtain a more accurate estimate. **[1]**

3



The diagram shows a sector AOB of a circle with centre O and radius 8 cm. The angle AOB is 1.2 radians. The points C and D lie on OA and OB respectively such that $OC = 5.2$ cm and $OD = 2.6$ cm. CD is a straight line.

(i) Find the area of the shaded region $ACDB$. **[4]**

(ii) Find the perimeter of the shaded region $ACDB$. **[5]**

4 **(i)** Find and simplify the first three terms in the binomial expansion of $(2 + ax)^6$ in ascending powers of x. **[4]**

(ii) In the expansion of $(3 - 5x)(2 + ax)^6$, the coefficient of x is 64. Find the value of a. **[3]**

5 A curve has an equation which satisfies $\frac{d^2y}{dx^2} = 3x^{-\frac{1}{2}}$ for all positive values of x. The point $P(4, 1)$ lies on the curve, and the gradient of the curve at P is 5. Find the equation of the curve. **[7]**

6 The cubic polynomial $f(x)$ is defined by $f(x) = x^3 - 19x + 30$.

(i) Given that $x = 2$ is a root of the equation $f(x) = 0$, express $f(x)$ as the product of 3 linear factors. **[4]**

(ii) Use integration to find the exact value of $\int_{-5}^{3} f(x)\,dx$. **[4]**

(iii) Explain with the aid of a sketch why the answer to part **(ii)** does not give the area enclosed by the curve $y = f(x)$ and the x-axis for $-5 \leqslant x \leqslant 3$. **[2]**

7 In an arithmetic progression the first term is 5 and the common difference is 3. The nth term of the progression is denoted by u_n.

(i) Find the value of u_{20}. **[2]**

(ii) Show that $\sum_{n=10}^{20} u_n = 517$. **[3]**

(iii) Find the value of N such that $\sum_{n=N}^{2N} u_n = 2750$. **[6]**

8 **(a)** Use logarithms to solve the equation

$$2^{n-3} = 18000,$$

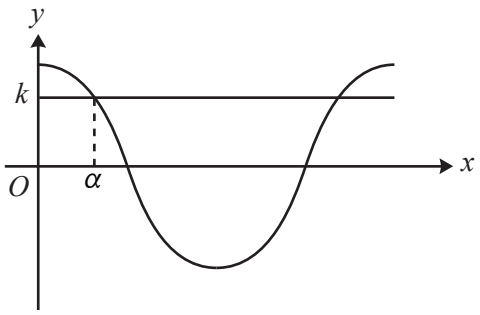
giving your answer correct to 3 significant figures. **[4]**

(b) Solve the simultaneous equations

$$\log_2 x + \log_2 y = 8, \qquad \log_2\left(\frac{x^2}{y}\right) = 7.$$ **[5]**

Question 9 begins on page 4.

9



The diagram shows part of the curve $y = 2\cos\frac{1}{3}x$, where x is in radians, and the line $y = k$.

(i) The smallest positive solution of the equation $2\cos\frac{1}{3}x = k$ is denoted by α. State, in terms of α,

(a) the next smallest positive solution of the equation $2\cos\frac{1}{3}x = k$, **[1]**

(b) the smallest positive solution of the equation $2\cos\frac{1}{3}x = -k$. **[2]**

(ii) The curve $y = 2\cos\frac{1}{3}x$ is shown in the Printed Answer Book. On the diagram, and for the same values of x, sketch the curve of $y = \sin\frac{1}{3}x$. **[2]**

(iii) Calculate the x-coordinates of the points of intersection of the curves in part **(ii)**. Give your answers in radians correct to 3 significant figures. **[4]**

END OF QUESTION PAPER

Question			Answer	Marks	Guidance	
1	(i)		$r = -2$	B1 **[1]**	State –2	Not $^{-6}/_{3}$ as final answer No need to see $r = ...$, and also condone other variables
	(ii)		$3 \times (-2)^{10} = 3072$	M1 A1 **[2]**	Attempt u_{11} Obtain 3072	Must be using correct formula, with $a = 3$ and $r = -2$, or their r from (i) Allow M1 for 3×-2^{10} Using $r = 2$ is M0, unless this was their value in (i) Allow M1 for listing terms as far as u_{11} CWO Allow A1 BOD for $3 \times -2^{10} = 3072$ If listing terms, then need to indicate that 3072 is the required value
	(iii)		$\frac{3(1-(-2)^{20})}{1-(-2)} = -1048575$	M1 A1 **[2]**	Attempt S_{20} Obtain –1048575	Must be using correct formula, with $a = 3$ and $r = -2$, or their r from (i) Allow M1 for correct formula, but with no brackets around the -2 Allow M1 for attempting to sum first 20 terms Allow M1 for $\frac{3(1+2^{20})}{1+2}$ as long as correct general formula is also seen Could also come from manually summing terms **NB** $\frac{3(1--2^{20})}{1--2}$ gives 1048577

Question			Answer	Marks	Guidance	
2	(i)		$0.5 \times 1.5 \times (\sqrt{7} + 2(\sqrt{10} + \sqrt{13} + \sqrt{16}) + \sqrt{19})$	B1	State the 5 correct y-values, and no others	B0 if other y-values also found (unless not used) Allow for unsimplified, even if subsequent error made Allow decimal equivs
				M1*	Attempt to find area between $x = 4$ and $x = 10$, using $k(y_0 + y_n + 2(y_1 + ... + y_{n-1}))$	Correct placing of y-values required y-values may not necessarily be correct, but must be from attempt at using correct x-values (allow 7, 10 etc ie no √) The 'big brackets' must be seen, or implied by later working Could be implied by stating general rule in terms of y_0 etc, as long as these have been attempted elsewhere and clearly labelled Could use other than 4 strips as long as of equal width (but M0 for just one strip)
				M1d*	Use $k = 0.5 \times 1.5$ soi	Or $k = 0.5 \times h$, where h is consistent with the number of strips used
			= 21.4	A1	Obtain 21.4, or better	Allow answers in the range [21.40, 21.41] if >3sf Answer only is 0/4 Using the trap rule on result of an integration attempt is 0/4, even if integration is not explicit Using 4 separate trapezia can get full marks Using other than 4 separate trapezia (but not just 1) can get M2, if done correctly
				[4]		
	(ii)		Use more strips / narrower strips	B1	Any reference to increasing no of strips or reducing width of strips	No need to explicitly state that it is over the same interval Ignore any reference to under- / over-estimate Ignore any attempts at sketching the curve Ignore any irrelevant comments, but penalise contradictory statements eg use more strips, which are wider Could give numerical example eg 'use 6 strips', but if giving both width and no of strips then must give total width of 6
				[1]		

Question			Answer	Marks	Guidance	
3	(i)		sector = $^1/_2 \times 8^2 \times 1.2$ (= 38.4)	M1*	Attempt area of sector using $\frac{1}{2} r^2\theta$, or equiv	Must be correct formula, including ½ M0 if 1.2π used not 1.2 M0 if $\frac{1}{2} r^2\theta$ used with θ in degrees Allow equiv method using fractions of a circle
			$^1/_2 \times 2.6 \times 5.2 \times \sin 1.2$ (= 6.3)	M1*	Attempt area of triangle using $\frac{1}{2} ab\sin C$ or equiv	Must be correct formula, including ½ Angle could be in radians (1.2 not 1.2π) or degrees (68.8°) Must have sides of 2.6 and 5.2 Allow even if evaluated in incorrect mode If using ½ × *b* × *h*, then must be valid use of trig to find *b* and *h*
			38.4 – 6.3 = 32.1	M1d*	Attempt area of sector – area of triangle	Using $\frac{1}{2} \times 8^2 \times (1.2 - \sin 1.2)$ will get M1 M0 M0 Need area of sector > area of triangle
				A1	Obtain 32.1, or better	Allow final answers rounding to 32.10 if > 3sf
				[4]		
	(ii)		8 × 1.2 = 9.6	M1*	Attempt use of $r\theta$, or equiv	Allow if 8 × 1.2 seen, even if incorrectly evaluated
			$CD^2 = 2.6^2 + 5.2^2 - 2 \times 2.6 \times 5.2 \times \cos 1.2$	M1*	Attempt use of cosine rule, or equiv, to find *CD*	Must be correct cosine rule Allow M1 if not square rooted, as long as CD^2 seen M0 if 1.2π used not 1.2 Allow if incorrectly evaluated, inc mode Allow any equiv method, as long as valid use of trig
			CD = 4.90 or √24	A1	Obtain *CD* = 4.90 or √24	Allow any answer in range [4.89, 4.90], with no errors seen Could be implied in method rather than explicit
			perimeter = 2.8 + 4.9 + 5.4 + 9.6	M1d*	Attempt perimeter of region	(8 – 5.2) + (8 – 2.6) + their *AB* + their *CD* (not their CD^2)
			= 22.7	A1	Obtain 22.7, or better	Accept any answer in range [22.69, 22.70] if >3sf
				[5]		

Question			Answer	Marks	Guidance	
4	(i)		$(2 + ax)^6 = 64 + 192ax + 240a^2x^2$	B1	Obtain 64	Allow 2^6 but not $64x^0$
				B1	Obtain $192ax$	Must be $192ax$, not unsimplified equiv
				M1	Attempt 3rd term – product of 15, 2^4 and $(ax)^2$	Allow M1 for ax^2 rather than $(ax)^2$ Binomial coeff must be 15 soi; ${}^6C_2$ is not yet enough $240ax^2$ implies M1, even if no other method shown Allow M1 if expanding $k(1 + {}^a/_2 x)^6$, any k
				A1	Obtain $240a^2x^2$	Or $240(ax)^2$ but A0 if this then becomes $240ax^2$ (ie no isw) Full marks can be awarded if terms are just listed rather than linked by '+' A0 if an otherwise correct expansion is subsequently spoiled by attempt to simplify eg $4 + 12ax + 15a^2x^2$ **If expanding brackets:** Mark as above, but must consider all 6 brackets for the M mark (allow irrelevant terms to be discarded)
				[4]		
	(ii)		$(3 \times 192a) + (-5 \times 64)$	M1	Attempt both relevant terms	M0 if additional terms used If a fuller expansion is attempted then it must be made clear which terms are being used Could be coefficients or terms still involving x, but must be consistent for both terms For M1 ignore what, if anything, the terms are equated to
			$576a - 320 = 64$	A1FT	Equate to 64, to obtain any correct equation, possibly still unsimplified	Following their expansion in (i) (which must contain the two relevant terms), ie 3(their $192a$) - 5(their 64) = 64 Presence / absence of 'x' must be consistent throughout eqn
			$576a = 384$ $a = {}^2/_3$	A1	Obtain $a = {}^2/_3$ CWO	Fraction must be simplified so A0 for ${}^{384}/_{576}$ Allow exact decimal equiv only, so A0 for 0.666... etc
				[3]		

Question			Answer	Marks	Guidance	
5			$^{dy}/_{dx} = 6x^{0.5} + c$	M1*	Attempt integration	Must be of form $px^{0.5}$, any (non-zero) numerical p, and no other algebraic terms
				A1	Obtain $6x^{0.5}$ (allow no + c)	Allow unsimplified coeff ie $^{3}/_{0.5}$, even if subsequently incorrect No need to see $^{dy}/_{dx}$ =, and ignore if incorrect (eg y = ...)
			$5 = 12 + c$	M1d*	Attempt to use x = 4, gradient = 5	Must follow attempt at integration M0 if no +c Condone incorrect notation (eg y = ...) as long as 5 used correctly Attempt to use x = 4, $^{dy}/_{dx}$ = 5 – allow slip as long as intention clear
			$c = -7$	A1	Rearrange to obtain $c = -7$	No need to see explicit expression for $^{dy}/_{dx}$
			$y = 4x^{1.5} - 7x + k$	M1 dd*	Attempt second integration	Must be of form $qx^{1.5} + rx$, any (non-zero) numerical q, r, and no other algebraic terms Dependent on at least M1 M1 awarded
			$1 = 32 - 28 + k$, hence $k = -3$	M1 ddd*	Attempt to find k using (4, 1)	Condone notation for the constant of integration being the same as previously used Dependent on all previous M marks Attempt to use x = 4, y = 1
			$y = 4x^{1.5} - 7x - 3$	A1 **[7]**	Obtain $y = 4x^{1.5} - 7x - 3$	Coefficients must now be simplified Must be an equation, ie y = ..., so A0 for 'f(x) = ...' or 'equation = ...'

Question			Answer	Marks	Guidance	
6	(i)		$f(x) = (x-2)(x^2+2x-15)$	B1	State or imply that $(x-2)$ is a factor	Could be stated explicitly, or implied by using it in an attempt at the quotient or a factorisation attempt Could also give $(2-x)$ as the factor
				M1	Attempt complete division, or equiv	Must be dividing by $(x-2)$, or by one of the two other correct factors (or the negative of any of these factors) No need to show zero remainder as told that $x = 2$ is a root Must be complete method - ie all 3 terms attempted Long division - must subtract lower line (allow one slip) Inspection - expansion must give at least three correct terms of the cubic Coefficient matching - must be valid attempt at all coeffs of quadratic, considering all relevant terms each time Synthetic division - must be using 2 (not -2) and adding within each column (allow one slip); expect to see 2 | 1 0 -19 30 2 4 1 2 -15
				A1	Obtain correct quotient of $x^2 + 2x - 15$ CWO	Or correct quotient for their factor Could be stated explicitly, seen in division attempt or implied by $A = 1$, $B = 2$, $C = -15$
			$= (x-2)(x+5)(x-3)$	A1	Obtain $(x-2)(x+5)(x-3)$	Must be written as a product of the three linear factors Allow any equiv eg $(2-x)(x+5)(3-x)$ Full credit for repeated use of factor theorem, or just writing down correct product Ignore any subsequent reference to roots **SR** A fully correct factorisation resulting from division by $(x+5)$ or $(x-3)$ can still get full credit, even though the root of $x = 2$ was not used
				[4]		

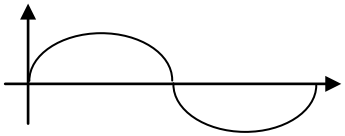
Question	Answer	Marks	Guidance	
(ii)	$\left[\frac{1}{4}x^4 - \frac{19}{2}x^2 + 30x\right]_{-5}^{3}$	M1*	Attempt integration	Increase in power by 1 for at least 2 terms
		A1	Obtain correct integral	Could also have + *c* present; condone d*x* or ∫ still present
	= 24.75 – (– 231.25)	M1d*	Attempt correct use of limits	Must be F(3) – F(-5) Must be attempting the value of the requested definite integral, so M0 if instead attempting area (ie using $x = 2$ as a limit)
	= 256	A1	Obtain 256	A0 for 256 + *c* Answer only is 0/4 - need to see evidence of integration, but use of limits does not need to be explicit
		[4]		
(iii)	Sketch positive cubic with 3 distinct roots	B1	Sketch f(*x*) for $-5 \leq x \leq 3$	Must be a positive cubic Allow if maximum point is on *y*-axis No need for roots to be labelled, but need one negative and two positive roots (or ft from an incorrect factorisation in (i) - could have fewer than 3 roots shown if this is consistent with their roots in required range) Graph must be sketched for at least $-5 \leq x \leq 3$, but it is fine if more is shown – only penalise explicitly incorrect roots
	Some of the area is below the *x*-axis which will make negative contribution to the total	B1	Explanation referring to the area below the *x*-axis giving a negative value	B0B1 is possible (including following no sketch at all) Need to mention 'negative' and identify the relevant area in some way eg 'below *x*-axis' or $2 \leq x \leq 3$ or clear shading Just referring to some area below *x*-axis is insufficient, as is any reference just to negative area B0 for statements indicating that some area is ignored / cannot be calculated within an otherwise correct statement A reason is required as to why (ii) is incorrect - it is not sufficient to just state that the actual area is larger, or to just describe how to find the area
		[2]		

Question			Answer	Marks	Guidance	
7	(i)		$u_{20} = 5 + 19 \times 3$	M1	Attempt u_{20}	Must be using correct formula, with $a = 5$ and $d = 3$ Could use $u_n = 3n + 2$ Could attempt to list terms
			$= 62$	A1	Obtain 62	If listing terms then need to indicate that 62 is the required answer
				[2]		
	(ii)		$S_{20} = {}^{20}/_{2}\,(10 + 57)$ $S_9 = {}^{9}/_{2}\,(10 + 24)$	M1	Explicitly attempt either S_{20} or S_9	Must be using correct formula with $a = 5$ and $d = 3$ Use of formula must be explicit, so M0 for eg $S_{20} = 670$ with no other evidence Could use ${}^{1}/_{2}n\,(a + l)$, with l obtained from $a + (n - 1)d$ - expect to see ${}^{20}/_{2}\,(5 + 62)$ and/or ${}^{9}/_{2}\,(5 + 29)$ Could use $\Sigma(3n + 2)$, with correct formulae for Σn and $\Sigma 1$
			${}^{20}/_{2}\,(10 + 57) - {}^{9}/_{2}\,(10 + 24)$	M1	Attempt $S_{20} - S_9$, where both summations have been shown explicitly	Can get M1 if formulae have not yet been evaluated M0 for $S_{20} - S_{10}$ (see below for one exception)
			$= 670 - 153$ $= 517$ **AG**	A1	Evaluate both summations and hence obtain 517 CWO	**AG** so detail is required - only award A1 if both unsimplified sums are seen, as well as both evaluated sums **SR** Allow **B1** if only $670 - 153 = 517$ seen Explicitly detailing only one summation will get M1M0A0 Allow 3/3 for $S_{20} - S_{10} + u_{10}$ as long as all explicit Allow 3/3 for manually summing terms as long as all terms are shown and are all correct , but no partial credit if wrong
				[3]		
			OR			
			$u_{10} = 5 + 9 \times 3 = 32$	M1	Attempt u_{10}	Must be shown explicitly
			$S = {}^{11}/_{2}\,(32 + 62)$	M1	Attempt required sum	Must have $n = 11$ Or $S = {}^{11}/_{2}\,(2\times 32 + 10\times 3)$
			$= 517$ **AG**	A1	Obtain 517	Detail reqd - award M0M1A0 if no evidence for $u_{10} = 32$

Question	Answer	Marks	Guidance	
(iii)	$S_{2N} = {}^{2N}/_{2}\,(10 + 3(2N - 1))$	B1	Correct (unsimplified) S_{2N} soi	Or ${}^{2N}/_{2}\,(5 + 5 + 3(2N - 1))$, or equiv, from ${}^{1}/_{2}n\,(a + l)$ Or ${}^{3}/_{2}\,(2N)(2N + 1) + 2(2N)$, or equiv, from $\Sigma(3n + 2)$
	$S_{N-1} = {}^{N-1}/_{2}\,(10 + 3(N - 2))$	B1	Correct (unsimplified) S_{N-1} soi Or $S_N - u_N$ soi	Or ${}^{N-1}/_{2}\,(5 + 5 + 3(N - 2))$, or equiv, from ${}^{1}/_{2}n\,(a + l)$ Or ${}^{3}/_{2}\,(N - 1)(N) + 2(N - 1)$, or equiv, from $\Sigma(3n + 2)$
	$N(6N + 7) - {}^{N-1}/_{2}\,(3N + 4) = 2750$	M1*	Subtract attempt at S_{N-1} from S_{2N} equate to 2750	Expressions could still be unsimplified Must have attempted to use correct formula, with $a = 5$, $d = 3$ and correct n each time Allow sign errors, resulting from lack of essential brackets M0 for $S_{2N} - S_N$ but M1 for $S_{2N} - S_N + u_N$
	$9N^2 + 13N - 5496 = 0$	A1	Rearrange to obtain $9N^2 + 13N - 5496\ (= 0)$	aef not involving brackets and with like terms combined
	$(9N + 229)(N - 24) = 0$	M1d*	Attempt to solve 3 term quadratic	Any valid attempt to solve quadratic (see guidance) to obtain at least the positive root If solving an incorrect quadratic then method **must** be shown for M1 to be awarded
	$N = 24$	A1	Obtain $N = 24$ only CWO	No need to consider the negative root, but A0 if found but not discarded Answer only gains full credit
		[6]		
	OR			
	${}^{N+1}/_{2}\,(2(5 + 3(N - 1)) + 3N) = 2750$	M1*	Attempt sum from u_N to u_{2N}	Correct formula, $a = 5 + 3(N - 1)$, $d = 3$, and $n = N$ or $N + 1$
		M1d*	Use $n = N + 1$	Use $n = N + 1$ only
		A1	Correct unsimplified sum = 2750	Just equate to 2750, no need to rearrange
	$9N^2 + 13N - 5496 = 0$	A1	Obtain correct quadratic	Or ${}^{N+1}/_{2}\,((5 + 3(N - 1)) + (5 + 3(2N - 1)))$ from ${}^{1}/_{2}n\,(a + l)$
	$(9N + 229)(N - 24) = 0$	M1 dd*	Attempt to solve 3 term quadratic	Quadratic must have come from sum = 2750
	$N = 24$	A1	Obtain $N = 24$ only	

Question			Answer	Marks	Guidance	
8	(a)		$\log 2^{n-3} = \log 18000$	M1*	Introduce logs and drop power	Can use logs to any base, as long as consistent on both sides, and allow no explicit base as well If taking $\log_2$ then base must be explicit Allow M1 for $n - 3 \log 2 = \log 18000$
			$(n - 3) \log 2 = \log 18000$	A1	Obtain $(n - 3) \log 2 = \log 18000$ or equiv	Or $n - 3 = \log_2 18000$ Brackets now need to be seen explicitly, or implied by later working
			$n - 3 = 14.1$	M1d*	Attempt to solve for n	Correct order of operations, and correct operations ie M0 for $\log_2 18000 - 3$ M0 if logs used incorrectly eg $n - 3 = \log (^{18000}/_2)$
			$n = 17.1$	A1	Obtain 17.1, or better	Final answer must be correct for all sig fig shown ($n = 17.13570929...$) 0/4 for answer only, or T&I If rewriting eqn as $2^{n-3} = 2^{14.1}$ then 0/4 unless evidence of use of logs to find the index of 14.1
				[4]		

Question	Answer	Marks	Guidance	
(b)	$2\log_2 x - \log_2 y = 7$	M1	Correct use of one log law - on a correct equation	Either on first eqn to get $\log_2(xy) = 8$, or on second eqn to get at least $\log_2 x^2 - \log_2 y = 7$ Allow for one correct use, even if error made with other equation Must be used on a correct equation so M0 if an error has already occurred eg $\log(x^2/y) = 2\log(xy) = 2(\log x + \log y)$ is M0
	$(\log_2 x + \log_2 y)+(2\log_2 x - \log_2 y) = 15$	M1	Attempt to eliminate one variable	To get an equation in just one variable, which may or may not still involve logs Must be a sound algebraic process with the two equations that they are using, though errors may have been made earlier with log / index laws
	$3\log_2 x = 15$	A1	Obtain correct equation in just one variable	Which may or may not still involve logs Depending on the method used, possible equations are $3\log_2 x = 15$, $\log_2 x^3 = 15$, $x^3 = 32768$ or $3\log_2 y = 9$, $\log_2 y^3 = 9$, $y^3 = 512$ The variable should only appear once so $\log_2 x^2 + \log_2 x = 15$ is A0 until the two log terms are correctly combined
	$x = 2^5$	M1	Correctly use 2^k as inverse of $\log_2$	At any stage - may even be the very first step to obtain $x^2/y = 128$ M0 for eg $\log_2 x + \log_2 y = 8$ becoming $x + y = 2^8$ as incorrect method to remove logs
	$x = 32$, $y = 8$	A1	Obtain $x = 32$, $y = 8$	Both values required, and no others Answer only, with no evidence of log or index work, is 0/5
		[5]		

Question			Answer	Marks	Guidance	
9	(i)	(a)	$6\pi - \alpha$	B1 **[1]**	State $6\pi - \alpha$	Allow unsimplified equiv Allow in degrees ie 1080 - α, or equiv
		(b)	$3\pi - \alpha$	M1 A1 **[2]**	Use period of 6π to make valid attempt at solution Obtain $3\pi - \alpha$	Allow any unsimplified equiv Allow in degrees ie 540 - α, or equiv Must be simplified, and in radians Allow a or alpha for α
	(ii)			M1 A1 **[2]**	Correct graph shape for $y = k \sin \frac{1}{3} x$ Fully correct graph	Must be one complete (positive) sin cycle, starting at (0, 0) and clearly intended to have a final root at the same x-value as the end point of the given curve – use published overlay for guidance Allow the curve to extend beyond this final root Allow any amplitude Condone a slightly inaccurate x-intercept for the middle root Condone poor curvature, including overly straight sections and stationary values that are pointed rather than curved Curve should clearly be intended to have an amplitude that is half of the given curve, but explicit labels of 1 and -1 are not required A0 if an incorrect scale is given - such as drawing at correct height but then labelling with values other than 1 and -1 A smooth, symmetrical curve is now required, with correct x-intercepts clearly intended Ignore any scale, correct or incorrect, on the x-axis

Question	Answer	Marks	Guidance	
(iii)	$\tan\frac{1}{3}x = 2$	B1	Obtain $\tan\frac{1}{3}x = 2$ soi	Allow B1 for correct equation even if no, or an incorrect, attempt to solve Give BOD on notation eg $\frac{\sin}{\cos}(\frac{1}{3}x) = 2$, as long as correct equation is seen or implied at some stage If $\tan\frac{1}{3}x = 2$ is obtained fortuitously from incorrect algebra then mark as B0M1A0A0, even if required roots are seen
	$\frac{1}{3}x$ = 1.107, 4.249	M1	Attempt to solve $\tan\frac{1}{3}x = k$	Attempt $3\tan^{-1}(k)$, any (non-zero) numerical k M0 for $\tan^{-1}(3k)$ Allow if attempted in degrees not radians M1 could be implied rather than explicit
		A1	Obtain 3.32	Must be radians and not degrees Allow answers in range [3.32, 3.33] A0 for answer given as a multiple of π
	x = 3.32, 12.7	A1	Obtain 12.7	Must be radians and not degrees Allow answers in range [12.7, 12.8] A0 for answer given as a multiple of π Max of 3/4 if additional solutions given in range [0, 6π] but ignore any solutions outside of this range Answer only, with no method shown, is 0/4 **Alt method:** **B1** Obtain $5\sin^2\frac{1}{3}x = 4$ or $5\cos^2\frac{1}{3}x = 1$ **M1** Attempt to solve $\sin^2\frac{1}{3}x = k$ or $\cos^2\frac{1}{3}x = k$ (allow M1 if just the positive square root used) **A1** Obtain 3.32 **A1** Obtain 12.7 (max 3/4 if additional solutions in range)
		[4]		