GCE

Mathematics

Unit **4722**: Core Mathematics 2

Advanced Subsidiary GCE

Mark Scheme for June 2015

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Annotations and abbreviations

Annotation in scoris	**Meaning**
BP	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
NGE	Not good enough
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
cwo	Correct working only

Subject-specific Marking Instructions for GCE Mathematics Pure strand

a Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the

establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the question.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question			Answer	Marks	Guidance	
1	**(i)**		$r = -2$	B1	State –2	Not $^{-6}/_{3}$ as final answer No need to see $r = \ldots$, and also condone other variables
				[1]		
	(ii)		$3 \times (-2)^{10} = 3072$	M1	Attempt u_{11}	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}
				A1	Obtain 3072	CWO Allow A1 BOD for $3 \times \ -2^{10} = 3072$ If listing terms, then need to indicate that 3072 is the required value
				[2]		
	(iii)		$\dfrac{3(1-(-2)^{20})}{1-(-2)} = -1048575$	M1	Attempt S_{20}	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 $\dfrac{3(1+2^{20})}{1+2}$ as long as correct general formula is also seen
				A1	Obtain –1048575	Could also come from manually summing terms **NB** $\dfrac{3(1--2^{20})}{1--2}$ gives 1048577
				[2]		

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 $k(y_0 + y_n + 2(y_1 + \ldots + y_{n-1}))$	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 **[4]**	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
	(ii)		Use more strips / narrower strips	B1 **[1]**	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

Question			Answer	Marks	Guidance	
3	(i)		sector = $\frac{1}{2} \times 8^2 \times 1.2$ (= 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
			$\frac{1}{2} \times 2.6 \times 5.2 \times \sin 1.2$ (= 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 $\frac{1}{2} \times b \times h$, 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 $\sqrt{24}$	A1	Obtain $CD = 4.90$ or $\sqrt{24}$	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	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 = ...'
				[7]		

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]		

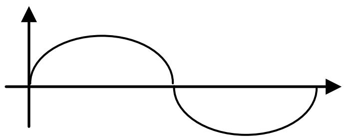
Question			Answer	Marks	Guidance	
	(ii)		$\left[\frac{1}{4}x^4 - \frac{19}{2}x^2 + 30x\right]_{-5}^{3}$	M1*	Attempt integration	Increase in power by 1 for at least 2 terms
				A1	Obtain correct integral	Could also have + c present; condone dx or $\int$ still present
			= 24.75 – (– 231.25)	M1d*	Attempt 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 $-5 \le x \le 3$	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 $-5 \le x \le 3$, 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 $2 \le x \le 3$ 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* M1d* A1	Attempt sum from u_N to u_{2N} Use $n = N + 1$ Correct unsimplified sum = 2750	Correct formula, $a = 5 + 3(N - 1)$, $d = 3$, and $n = N$ or $N + 1$ Use $n = N + 1$ only Just equate to 2750, no need to rearrange
			$9N^2 + 13N - 5496 = 0$ $(9N + 229)(N - 24) = 0$	A1 M1 dd*	Obtain correct quadratic Attempt to solve 3 term quadratic	Or ${}^{N+1}/_2\,((5 + 3(N - 1)) + (5 + 3(2N - 1)))$ from ${}^1/_2 n\,(a + l)$ 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]		

APPENDIX 1

Guidance for marking C2

Accuracy

Allow answers to 3sf or better, unless an integer is specified or clearly required.
Answers to 2 sf are penalised, unless stated otherwise in the mark scheme.
3sf is sometimes explicitly specified in a question - this is telling candidates that a decimal is required rather than an exact answer eg in logs, and more than 3sf should not be penalised unless stated in mark scheme.
If more than 3sf is given, allow the marks for an answer that falls within the guidance given in the mark scheme, with no obvious errors.

Extra solutions

Candidates will usually be penalised if any extra, incorrect, solutions are given. However, in trigonometry questions only look at solutions in the given range and ignore any others, correct or incorrect.

Solving equations

With simultaneous equations, the method mark is given for eliminating one variable. Any valid method is allowed ie balancing or substitution for two linear equations, substitution only if at least one is non-linear.

Solving quadratic equations

Factorising - candidates must get as far as factorising into two brackets which, on expansion, would give the correct coefficient of x^2 and at least one of the other two coefficients. This method is only credited if it is possible to factorise the quadratic – if the roots are surds then candidates are expected to use either the quadratic formula or complete the square.
Completing the square - candidates must get as far as $(x + p) = \pm \sqrt{q}$, with reasonable attempts at p and q.
Using the formula - candidates need to substitute values into the formula, with some attempt at evaluation (eg calculating $4ac$). The correct formula must be seen, either algebraic or numerical. If the algebraic formula is quoted then candidates are allowed to make one slip when substituting their values. The division line must extend under the entire numerator (seen or implied by later working). Condone not dividing by $2a$ as long as it has been seen earlier.

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