GCE

Mathematics

Advanced Subsidiary GCE

Unit **4722:** Core Mathematics 2

Mark Scheme for June 2012

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.

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1. **Annotations**

Annotation in scoris	Meaning
✓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
^	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

2. **Subject-specific Marking Instructions**

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 (eg 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)		$(3 + 2x)^5 = 243 + 810x + 1080x^2 + 720x^3 + 240x^4 + 32x^5$	M1*	Attempt expansion – products of powers of 3 and $2x$	Must attempt at least 5 terms. Each term must be an attempt at a product, including binomial coeffs if used. Allow M1 for no, or incorrect, binomial coeffs. Powers of 3 and $2x$ must be intended to sum to 5 within each term (allow slips if intention correct). Allow M1 even if powers used incorrectly with the $2x$ ie $2x^3$ not $(2x)^3$ can get M1. Allow M1 for powers of ${}^2/_3x$ from expanding $k(1 + {}^2/_3x)^5$, any k (allow if powers only applied to x and not ${}^2/_3$) .
				M1d*	Attempt to use correct binomial coefficients	At least 5 correct from 1, 5, 10, 10, 5, 1 - allow missing or incorrect (but not if raised to a power). May be implied rather than explicit. Must be numerical eg ${}^5C_1$ is not enough. They must be part of a product within each term. The coefficient must be used in an attempt at the relevant term ie 5 x 3^3 x $(2x)^2$ is M0. Allow M1 for correct coefficients from expanding $k(1 + {}^2/_3x)^5$, any k.
				A1	Obtain at least four correct simplified terms	Either linked by '+' or as part of a list.
				A1	Obtain fully correct expansion	With all coefficients simplified. Terms must be linked by '+' and not just commas.
				[4]		**SR for reasonable expansion attempt:** M2 for attempt involving all 5 brackets resulting in a quintic with at most one term missing A1 for four correct, simplified, terms A1 for fully correct, simplified, expansion

Question			Answer	Marks	Guidance	
1	(ii)		$(3 + 2x)^5 + (3 - 2x)^5$ $= 486 + 2160x^2 + 480x^4$	M1	Attempt to change signs of relevant terms	Must change the sign on all of the relevant terms from their expansion, and no others. Expansion in part (i) must have at least 5 terms. Allow M1 even if no attempt to then combine expansions, or if difference rather than sum found. If expanding $(3 - 2x)^5$, then it must be a reasonable attempt, involving the product of correct binomial coeffs, powers of 2 and powers of $-3x$, and each term must be of the correct sign.
				A1 FT **[2]**	Obtain $486 + 2160x^2 + 480x^4$, from their **(i)**	Must have been a 6 term quintic in (i) to get FT mark. A0 if subsequent division by a common factor, so not isw.

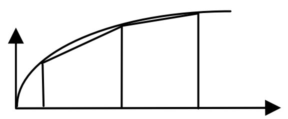
Question			Answer	Marks	Guidance	
2	(i)		$\int(x^2-2x+5)\mathrm{d}x=\frac{1}{3}x^3-x^2+5x+c$	M1	Attempt integration	An increase in power by 1for at least 2 terms. Allow if the +5 disappears.
				A1	Obtain two correct (algebraic) terms	Allow if the coefficient if x^2 isn't yet simplified.
				A1	Obtain fully correct expression (allow no + c)	Allow if the coefficient if x^2 isn't yet simplified. A0 if integral sign or dx still present in their answer (but allow $\int$ = ...). A0 if a list of terms rather than an expression.
				[3]		
2	(ii)		$y=\frac{1}{3}x^3-x^2+5x+c$	M1*	State or imply y = their integral from (i)	Must have come from integration attempt ie the M1 must have been gained in part (i). Allow slips when transferring expression from (i). Can still get this M1 if no + c. The y does not have to be explicit - it could be implied by eg 11 = F(3) (but not by 3 = F(11)). Using definite integration with limits of 3 & 11 is M0. M0 if they start with y = their integral from (i), but then attempt to use y - 11 = m (x - 3). This is a re-start and gains no credit.
			$11=9-9+15+c\Rightarrow c=-4$	M1d*	Attempt to find c using (3, 11)	Need to get as far as attempting c. M1 could be implied by eg 11 = 9 – 9 + 15 and then an attempt to include a constant to balance the eqn, even though + c never actually seen. M0 if no + c seen or implied. M0 if using x = 11, y = 3.
			hence $y=\frac{1}{3}x^3-x^2+5x-4$	A1	Obtain $y=\frac{1}{3}x^3-x^2+5x-4$	Coeff of x^2 now needs to be simplified (A0 for -1x^2). Must be an equation ie y = ..., so A0 for 'f(x) = ...' or 'equation = ...' Allow aef, such as $3y=x^3-3x^2+15x-12$.
				[3]		

Question			Answer	Marks	Guidance	
3	(i)		$72^{o} = 72 \times {}^{\pi}/_{180} = {}^{2\pi}/_{5}$ radians	B1 **[1]**	State $\frac{2\pi}{5}$, $\frac{2}{5}\pi$ or 0.4π	Must be simplified. B0 for decimal equiv (1.26), but isw if exact simplified value seen but then given in decimals.
3	(ii)		$\frac{1}{2} \times r^2 \times {}^{2\pi}/_{5} = 45\pi$	M1	Equate attempt at area using $(\frac{1}{2})r^2\theta$ to 45π and attempt to solve for r	Condone omission of ½, but no other error. Must be equated to 45π (so M0 for = 45) except for $(\frac{1}{2})r^2 \times {}^{2}/_{5} = 45$ (assuming π has been cancelled). Allow M1 for using 0.4 or 1.26π. Allow if using incorrect angle from part (i), as long as clearly intended to be in radians. Allow equivalent method using fractions of the circle. Valid method using degrees can get M1 (and A1 if exact). Must get as far as attempt at r. Allow M1 for T&I, as long as comparing to 45π.
			$r = 15$ cm	A1 **[2]**	Obtain $r = 15$	Must be exact working only – any use of decimals is A0 (but allow 15.0 if giving previously exact answer to 3sf). Any evidence of 15 having come from rounding an inaccurate answer is A0.
3	(iii)		area triangle = $\frac{1}{2} \times 15^2 \times \sin({}^{2\pi}/_{5}) = 106.99$	M1*	Attempt area of triangle using $(\frac{1}{2})r^2\sin\theta$	Condone omission of ½, but no other error. Must be using their r and angle linked to their θ. Could be using degrees or radians. Allow even if evaluated in incorrect mode (deg mode gives 2.47, rad mode gives 28.66). If using a right-angled triangle, it must be ½bh, any valid use of trig to find b and h.
			area segment = $45\pi - 106.99$	M1d*	Attempt 45π – area of triangle	Must be using 45π (not 45), decimal equiv of 141.4 or $\frac{1}{2} \times 15^2 \times 1.26$ (or better), so M0 for any other value. M0 if area of triangle is greater than 45π. Using $\frac{1}{2} \times 15^2 \times (\theta - \sin\theta)$ with incorrect θ is M1M0.
			$= 34.4$ cm^2	A1 **[3]**	Obtain 34.4 cm^2	If >3sf then allow any values rounding to 34.4.

Question			Answer	Marks	Guidance	
4			$4(1-\sin^2 x) + 7\sin x - 7 = 0$	M1	Use $\cos^2 x = 1 - \sin^2 x$	Must be used and not just stated Must be used correctly, so M0 for $1 - 4\sin^2 x$.
			$4\sin^2 x - 7\sin x + 3 = 0$	A1	Obtain correct quadratic	aef, as long as three term quadratic with all the terms on one side of the equation. Condone $4\sin^2 x - 7\sin x + 3$ ie no = 0.
			$(\sin x - 1)(4\sin x - 3) = 0$	M1	Attempt to solve quadratic in $\sin x$	Not dependent on previous M1, so could get M0M1 if $\cos^2 x = \sin^2 x - 1$ used. This M mark is just for solving a 3 term quadratic (see guidance sheet for acceptable methods). Condone any substitution used, inc $x = \sin x$.
			$\sin x = 1$, $\sin x = {}^3/_4$	M1	Attempt to find x from roots of quadratic	Attempt $\sin^{-1}$ of at least one of their roots. Allow for just stating $\sin^{-1}$ (their root) inc if $\|\sin x\| > 1$. Not dependent on previous marks so M0M0M1 poss. If going straight from $\sin x = k$ to $x = \ldots$, then award M1 only if their angle is consistent with their k.
			$x = 90°$ $x = 48.6°, 131°$	A1	Obtain two correct solutions	Allow 3sf or better. Must come from a correct solution of the correct quadratic – if the second bracket was correct but the first was $(\sin x + 1)$ then A0 even though 2 solutions will be as required. Allow radian equivs – ${}^\pi/_2$ or 1.57 / 0.848 / 2.29.
				A1	Obtain all 3 correct solutions, and no others	Must now all be in degrees. Allow 3sf or better. A0 if other incorrect solutions in range $0^o - 360^o$ (but ignore any outside this range).
				[6]		**SR** If no working shown then allow **B1** for each correct solution (max of **B2** if in radians, or if extra solns in range).

Question			Answer	Marks	Guidance	
5	(a)	(i)	$u_2 = ½$ $u_3 = 4$	B1 B1 FT **[2]**	State ½ State 4, following their u_2	Allow 0.5 or $^2/_4$. Follow through on their u_2 (simplifying if possible). B0 for $^2/_{0.5}$, $^2/_{½}$ etc.
5	(a)	(ii)	periodic / alternating / repeating / oscillating / cyclic	B1 **[1]**	Any correct description	Allow associated words eg 'repetitive'. Must be a mathematical term rather than a description such as 'it changes between 4 and ½' or 'odd terms are 4, even terms are ½. Mark independently of any values given in part (i). Ignore irrelevant terms (eg 'recursive'), but B0 if additional incorrect terms (eg 'geometric').
5	(b)		$a + 8d = 18$ $^9/_2\ (2a + 8d) = 72$ $a + 8d = 18$ and $2a + 8d = 16$ $a = -2,\ d = ^5/_2$	B1 B1 M1 A1 A1 **[5]**	State $a + 8d = 18$ State $^9/_2\ (2a + 8d) = 72$ Attempt to solve simultaneously Obtain either $a = -2$ or $d = ^5/_2$ Obtain both $a = -2,\ d = ^5/_2$	Allow any equivalent, including unsimplified. Must be correct when seen – can't be implied by eg being stated but with incorrect a substituted. Allow any equivalent, including unsimplified. Must be correct when seen – as above. M1 is awarded for eliminating a variable from two linear equations in a and d, from attempt at $u_9 = 18$ and attempt at $S_9 = 72$ (formulas must be recognisable, and for APs, but not necessarily correct). Don't need to actually solve. If balancing equations, then there must be intention to subtract (but allow $a = 2$). If substituting then allow sign errors (eg $a = 8d - 18$), but not operational errors (eg $a = ^{18}/_{8d}$). A1 is given for the first correct value, from 2 correct eqns. Allow $d = 2½$ or 2.5, but not unsimplified fractions. A1 is given for obtaining second correct value. Allow $d = 2½$ or 2.5, but not unsimplified fractions.

Question			Answer	Marks	Guidance	
			OR		**Alternative method using $^n/_2(a + l)$**	**NB If using $a + (n-1)d = 18$ and $^9/_2\ (2a + (n-1)d) = 72$ and solving simultaneously to get a and d, then mark as per scheme below.**
			$^9/_2\ (a + 18) = 72$	B1*	State $^9/_2\ (a + 18) = 72$	Allow any equivalent. Award B1 as soon as seen correct, even if subsequent error.
			$a = -2$	B1d*	Obtain $a = -2$	Must come from correct equation.
			$-2 + 8d = 18$ or $^9/_2\ (-4 + 8d) = 72$	M1	Attempt use of either u_9 or S_9	Must be attempting either $u_9 = 18$ or $S_9 = 72$. Must be using correct formula.
				A1FT	Obtain correct equation, following their a	Allow any equivalent, including unsimplified.
			$d = {}^5/_2$	A1	Obtain $d = {}^5/_2$	Allow $d = 2½$ or 2.5, but not unsimplified fractions.

Question			Answer	Marks	Guidance	
6	(i)		$0.5 \times 4 \times (4\sqrt{1} + 8\sqrt{5} + 4\sqrt{9})$	M1*	Attempt y-values at $x = 1, 5, 9$ only	Must be using y, not an attempt at integration. Allow slips eg $\sqrt{(4x)}$ as long as clearly intended as y. Allow decimal equiv for y_1 (8.94). Allow M1 for 4, 20, 72 (ie omitting the $\sqrt{}$). M0 if other y-values found (unless not used in trap rule).
			$= 2(16 + 8\sqrt{5})$	M1d*	Attempt correct trapezium rule, inc $h = 4$	Correct structure, including 'big brackets' seen or implied. Allow 2 used for ½ h – no need for ½ x 4 to be explicit. Allow slips when calculating y values, but all other aspects must be correct. Could use two separate trapezia.
			$= 32 + 16\sqrt{5}$ **AG**	A1 **[3]**	Obtain $32 + 16\sqrt{5}$	Must come from exact working, so A0 if answer first found in decimals (67.777…) which is then stated to be the same as $32 + 16\sqrt{5}$. However, isw if exact answer found first, and then decimal equiv stated.
6	(ii)			B1*	Sketch showing correct graph of $y = 4\sqrt{x}$ and two trapezia (allow if only tops of trapezia seen as chords)	Correct graph shown, existing for at least $1 \le x \le 9$. Exactly two trapezia must be shown, of roughly equal widths, with top vertices on the curve.
			Curve is above tops of trapezia	B1d* **[2]**	Reason comparing the tops of trapezia to the curve, or referring to the gap between the trapezia and the curve	Must refer to the tops of the trapezia so B0 for 'trapezia are below curve' (ie 'top' not used). Allow 'trapezium' rather than 'trapezia'. Could shade gaps on their diagram but some text also reqd. B0 for 'some area not calculated' unless clear which area. Concave / convex is B0, as is comparing to exact area. B1 for decreasing gradient (but B0 for decreasing curve). B0 (rather than isw) if explanation is partially incorrect. No sketch is B0, irrespective of explanation given. **SR B1** for correct explanation, and trapezia, and correct graph of $y = 4\sqrt{x}$ for $1 \le x \le 9$ but incorrect outside range (eg curvature / y-intercept / not just in first quadrant).

Question			Answer	Marks	Guidance	
6	(iii)		$\int_1^9 4x^{\frac{1}{2}}\,dx = \left[\frac{8}{3}x^{\frac{3}{2}}\right]_1^9$	M1	Obtain $k\,x^{\frac{3}{2}}$	Any numerical k, including 4. Any exact equiv for the index.
			$= 72 - \frac{8}{3}$	A1	Obtain $\frac{8}{3}x^{\frac{3}{2}}$	Allow unsimplified coefficient, inc $\frac{4}{1.5}$ or $\frac{2}{3}\times 4$. Allow non exact decimal ie 2.7, 2.67 etc. Allow $+ c$.
			$= 69^1/_3$	M1	Attempt correct use of limits	Must be F(9) – F(1) ie subtraction with limits in the correct order. Allow use in any function other than the original, including from differentiation. Allow processing errors eg $\left(\frac{8}{3}\times 9\right)^{1.5}$.
				A1	Obtain $69^1/_3$, or any exact equiv	Allow improper fraction, or recurring decimal. A0 for 69.333…. A0 for $69^1/_3 + c$.
				[4]		Answer only is 0/4.

Question			Answer	Marks	Guidance	
7	(a)	(i)	$\cos\alpha = {}^{5}/_{\sqrt{29}}$	M1	Attempt cos α	Could draw triangle and use Pythagoras to find the hypotenuse, or use trig identities. Must get as far as attempting cos α. Must be working in exact values for M1. Must be using correct ratios for tan α and cos α.
				A1	Obtain ${}^{5}/_{\sqrt{29}}$	Allow any exact equiv, including rationalised surd or $\sqrt{({}^{25}/_{29})}$ isw if decimal equiv subsequently given. Answer only gets full credit.
				[2]		**SR B1** for exact answer following decimal working.
7	(a)	(ii)	$\cos\beta = {}^{-\sqrt{40}}/_{7}$	M1	Attempt cos *β*	Could draw triangle and use Pythagoras to find the adjacent, or use trig identities. Must get as far as attempting cos *β*. Must be working in exact values for M1. Must be using correct ratios for sin α and cos α.
				A1	Obtain ${}^{\sqrt{40}}/_{7}$	Allow any exact equiv, including $\sqrt{({}^{40}/_{49})}$. Allow $\pm\,{}^{\sqrt{40}}/_{7}$ (from using $\cos^2 x = 1 - \sin^2 x$). isw if decimal equiv subsequently given. Answer only gets M1A1.
				A1 FT	Obtain ${}^{-\sqrt{40}}/_{7}$, or –ve of their exact numerical value for cos *β*	A1 FT can only be awarded following M1. isw if decimal equiv subsequently given. Answer only gets full credit.
				[3]		**SR B1** for ${}^{\sqrt{40}}/_{7}$, or equiv, following decimal working **SR B2** for ${}^{-\sqrt{40}}/_{7}$, or equiv, following decimal working **SR B1** for decimal answer in range [-0.904, -0.903]

Question			Answer	Marks	Guidance	
7	(b)		$\frac{\sin\gamma}{6} = \frac{\sin 60}{8}$	M1*	Attempt use of correct sine rule	Must be correct sine rule, either way up (just need to substitute values in – no rearrangement needed).
				M1d*	Use $\sin 60° = \sqrt{3}/_2$	Could be implied eg $\frac{6}{\sin\gamma} = \frac{16}{3}\sqrt{3}$
			$\sin\gamma = \frac{3\sqrt{3}}{8}$	A1	Obtain $\sin\gamma$ as $\frac{3\sqrt{3}}{8}$	Must be seen simplified to this, or $0.375\sqrt{3}$ or $\frac{9}{8\sqrt{3}}$, but isw if decimal equiv subsequently given. isw any attempt to find the angle. A0 if only ever seen as $\sin^{-1}\frac{3\sqrt{3}}{8}$
				[3]		

Question			Answer	Marks	Guidance	
8	(i)		$f(2) = 8 + 2a – 6 + 2b = 0$ $g(2) = 24 + 4 + 10a + 4b = 0$	M1	Attempt at least one of f(2), g(2)	Allow for substituting x =2 into either equation – no need to simplify at this stage. Division – complete attempt to divide by $(x – 2)$. Coeff matching - attempt all 3 coeffs of quadratic factor.
				M1	Equate at least one of f(2) and g(2) to 0	Just need to equate their substitution attempt to 0 (but just writing eg f(2) = 0 is not enough). It could be implied by later working, even after attempt to solve equations. Division - equating their remainder to 0. Coeff matching – equate constant terms.
			$2a + 2b = –2$, $5a + 2b = –14$	A1	Obtain two correct equations in a and b	Could be unsimplified equations. Could be $8a + 2b = –26$ (from f(2) = g(2)).
			hence $3a = –12$	M1	Attempt to find a (or b) from two simultaneous eqns	Equations must come from attempts at two of f(2) = 0, g(2) = 0, f(2) = g(2). M1 is awarded for eliminating a or b from 2 sim eqns – allow sign slips only. Most will attempt a first, but they can also gain M1 for finding b from their simultaneous equations.
			so $a = –4$ **AG**	A1	Obtain $a = –4$, with necessary working shown	If finding b first, then must show at least one line of working to find a (unless earlier shown explicitly eg $a = – 1 – b$).
			$b = 3$	A1	Obtain $b = 3$	Correct working only
				[6]		**SR Assuming a = -4** **Either use this scheme, or the original, but don't mix elements from both** M1 Attempt either f(2) or g(2) M1 Equate f(2) or g(2) to 0 (also allow f(2) = g(2)) A1 Obtain $b = 3$ A1 Use second equation to confirm a = -4, b = 3

Question			Answer	Marks	Guidance	
8	(ii)		$f(x) = (x - 2)(x^2 + 2x - 3)$ $= (x - 2)(x + 3)(x - 1)$	M1	Attempt full division of their $f(x)$ by $(x - 2)$ Could also be for full division attempt by $(x - 1)$ or $(x + 3)$ if identified as factors	Must be using $f(x) = x^3 - 7x + k$. 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 their cubic. Coefficient matching – must be valid attempt at all 3 quadratic coeffs, considering all relevant terms each time. Factor theorem – must be finding 2 more factors / roots.
				A1	Obtain x^2 and at least one other correct term, from correct $f(x)$	Could be middle or final term depending on method. Coeff matching – allow for stating values eg $A = 1$ etc. Factor theorem – state factors of $(x + 3)$ and $(x - 1)$.
				A1	Obtain $(x - 2)(x + 3)(x - 1)$	Must be seen as a product of three linear factors. Answer only gains all 3 marks.
			$g(x) = (x - 2)(3x^2 + 7x - 6)$ $= (x - 2)(x + 3)(3x - 2)$ **OR** $g(1) = -4$, $g(-3) = 0$	M1	Attempt to verify two common factors	Possible methods are: Factorise $g(x)$ completely – $f(x)$ must have been factorised. Find quadratic factor of $g(x)$ and identify $x = -3$ as root. Test their roots of $f(x)$ in $g(x)$. Just stating eg $g(-3) = 0$ is not enough – working required. If $f(x)$ hasn't been factorised, allow M1 for using factor thm on both functions to find common factor, or for factorising $g(x)$ and testing roots in $f(x)$.
			Hence common factor of $(x + 3)$	A1 **[5]**	Identify $(x + 3)$ as a common factor	Just need to identify $(x + 3)$ - no need to see $(x - 2)$ or to explicitly state 'two common factors'. Need to see $(x + 3)$ as factor of $g(x)$ – just showing $g(-3) = 0$ and then stating 'common factor' is not enough. CWO (inc A0 for $g(x) = (x - 2)(x + 3)(x - {}^2/_3)$). If using factor thm, no need to find $g(1)$ if $g(-3)$ done first. Just stating $(x + 3)$ with no supporting evidence is M0A0. A0 if referring to -3 (and 2) as 'factors'. A0 if additional incorrect factor given.

Question			Answer	Marks	Guidance	
9	(a)	(i)	$u_4 = \log_2 27 + 3\log_2 x$	**M1**	Use $u_4 = a + 3d$	Allow missing / incorrect / inconsistent log bases. Starting with $\log_2 27 + \log_2 x^3$ is M0M0. Starting with $\log_2 27$ x $3\log_2 x$ is M0 (but can get M1 below). Starting with $\log_2 27 + \log_2 x + \log_2 x + \log_2 x$ can get full credit.
			$= \log_2 27 + \log_2 x^3$	**M1**	Use $b \log a = \log a^b$ on $3\log_2 x$	u_4 must still be shown as two terms. Could get M1 if using $a + 4d$. Could get M1 for $\log_2 27$ x $3\log_2 x = \log_2 27$ x $\log_2 x^3$ or for $\log_2 27$ x $3\log_2 x = \log_2 27 + \log_2 x^3$. Allow missing / incorrect / inconsistent log bases.
			$= \log_2(27x^3)$ **AG**	**A1** **[3]**	Show $\log_2(27x^3)$ convincingly	Can go straight from $\log_2 27 + \log_2 x^3$ to final answer. CWO, including using base 2 throughout. **SR – finding consecutive terms (each step must be explicit)** **B1** for $u_2 = \log_2 27 + \log_2 x = \log_2 27x$ **B1** for $u_3 = \log_2 27x + \log_2 x = \log_2 27x^2$ **B1** for $u_4 = \log_2 27x^2 + \log_2 x = \log_2 27x^3$
9	(a)	(ii)	$27x^3 = 2^6$	B1*	State correct equation no longer involving $\log_2 x$	Equation could still involve constant terms such as $\log_2 27$ or $\log_2 3$. Allow truncated or rounded decimals.
			$x = {}^4/_3$	B1d* **[2]**	Obtain ${}^4/_3$	Must be ${}^4/_3$, $1{}^1/_3$ or an exact recurring decimal only (not 1.333….). A0 if cube root still present. Working must be exact, so sight of decimals in method used is B0, even if final answer is exact. Answer only gets full credit.

Question			Answer	Marks	Guidance	
9	(b)	(i)	½ < y < 2	**M1**	Identify at least one of ½ and 2 as end-points	Only one end-point required. Ignore if additional incorrect end-point also given. Ignore any signs used.
				A1	Obtain ½ < y < 2	Not two separate inequalities, unless linked by 'and'. A0 for ½ ≤ y ≤ 2.
				[2]		
9	(b)	(ii)	$\frac{\log_2 27}{1-\log_2 y}=3$	B1	State $\frac{\log_2 27}{1-\log_2 y}=3$	Allow B1 if no base stated, but B0 if incorrect base. Must be equated to 3 for B1.
			$\log_2 27 = 3 - 3\log_2 y$ $\log_2 27 = 3 - \log_2 y^3$ $\log_2(27y^3) = 3$	M1*	Attempt to rearrange equation to $\log_2 f(y) = k$	Must be using $\frac{\log_2 27}{\pm 1 \pm \log_2 y}$ (but allow for no bases). Allow at most 2 manipulation errors (eg +/– or x/÷ muddles, or slips when expanding brackets) but M0 if other errors (eg incorrect use of logs).
			$27y^3 = 8$	M1d*	Use $f(y) = 2^k$ as inverse of $\log_2 f(y) = k$	Must have first been arranged to $\log_2 f(y) = k$. No need to go any further than stating their $f(y) = 2^k$.
				A1*	Obtain correct exact equation no longer involving $\log_2 y$	Equation could still involve constant terms such as $\log_2 27$ or $\log_2 3$. Sight of decimals used is A0, even if answer is exact.
			$y^3 = {}^8/_{27}$ $y = {}^2/_3$	A1d*	Obtain ${}^2/_3$	Allow equiv recurring decimal, but not 0.666… A0 if still cube root present.
				[5]		**SR** answer only is **B3** Correct $S_\infty = 3$, then answer with no further working is **B3.**

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 an extra, incorrect, solution is 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 $4ac$). Sign slips are allowed on b and $4ac$, but all other aspects of the formula must be seen correct, either algebraic or numerical. The division line must extend under the entire numerator (seen or implied by later working). If the algebraic formula is quoted then candidates are allowed to make one slip when substituting their values. Condone not dividing by $2a$ as long as it has been seen earlier.

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