## GCE

## Mathematics

Advanced Subsidiary GCE

## Mark Scheme for June 2013

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

1. Annotations

| Annotation in scoris | Meaning |
| :--- | :--- |
| $\checkmark$ and $\mathbf{x}$ |  |
| 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 |
| $\wedge$ | Omission sign |
| MR | Misread |
| NGE | Not good enough |
| Highlighting |  |
| Other abbreviations <br> in mark scheme | Meaning |
| E1 | Mark for explaining |
| U1 | Marf for correct units |
| G1 | Mark for a correct feature on a graph |
| M1 D* | 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 |
| AG | Answer given |

## 2. Subject-specific Marking Instructions for GCE Mathematics (OCR) 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.

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 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 2 | (i) | $1 / 2 x=53.1^{\circ}, 126.9^{\circ}$ $x=106^{\circ}, 254^{\circ}$ | B1 <br> M1 <br> A1 <br> [3] | Obtain $106^{\circ}$, or better <br> Attempt correct solution method to find second angle <br> Obtain $254^{\circ}$, or better | Allow answers in the range [106.2, 106.3] Ignore any other solutions for this mark Must be in degrees, so 1.85 rad is B 0 <br> Could be $2\left(180^{\circ}-\right.$ their $\left.53.1^{\circ}\right)$ or $\left(360^{\circ}-\right.$ their $\left.106^{\circ}\right)$ <br> Allow valid method in radians, but M0 for eg (360-1.85) <br> Allow answers in the range [253.7 ${ }^{\circ}$, $254^{\circ}$ ] <br> A0 if in radians (4.43) <br> A0 if extra incorrect solutions in range <br> SR If no working shown then allow B1 for $106^{\circ}$ and B2 for $254^{\circ}$ (max B2 if additional incorrect angles) |
| 2 | (ii) | $\tan x=3$ $x=71.6^{\circ}, 252^{\circ}$ | B1 <br> M1 <br> A1 <br> [3] | State $\tan x=3$ <br> Attempt to solve $\tan x=k$ <br> Obtain $71.6^{\circ}$ and $252^{\circ}$, or better | Allow B1 for correct equation even if no, or an incorrect, attempt to solve <br>  equation is seen or implied at some stage <br> Not dep on B1, so could gain M1 for solving eg $\tan x=1 / 3$ Could be implied by a correct solution <br> A0 if extra incorrect solutions in range <br> Alt method: <br> B1 Obtain $10 \sin ^{2} x=9$ or $10 \cos ^{2} x=1$ <br> M1 Attempt to solve $\sin ^{2} x=k$ or $\cos ^{2} x=k$ (allow M1 if just the positive square root used) <br> A1 Obtain $71.6^{\circ}$ and $252^{\circ}$, with no extra incorrect solutions in range <br> SR If no working shown at all then allow B1 for each correct angle (max B1 if additional incorrect angles), but allow full credit if $\tan x=3$ seen first |


| Question |  | Answer$(2+5 x)^{6}=64+960 x+6000 x^{2}$ | Marks |  | Guidance |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 3 | (i) |  | M1 | Attempt at least first 2 termsproducts of binomial coeff and correct powers of 2 and $5 x$ | Must be clear intention to use correct powers of 2 and $5 x$ Binomial coeff must be 6 soi; ${ }^{6} \mathrm{C}_{1}$ is not yet enough Allow BOD if 6 results from $6 / 1$ Allow M1 if expanding $k\left(1+\frac{5}{2} x\right)^{6}$, any $k$ |
|  |  |  | A1 | Obtain $64+960 x$ | Allow $2^{6}$ for 64 <br> Allow if terms given as list rather than linked by ' + ' |
|  |  |  | M1 | Attempt 3rd term - product of binomial coeff and correct powers of 2 and $5 x$ | Allow M1 for $5 x^{2}$ rather than $(5 x)^{2}$ <br> Binomial coeff must be $15 \mathrm{soi} ;{ }^{6} \mathrm{C}_{2}$ is not yet enough Allow M1 if expanding $k\left(1+\frac{5}{2} x\right)^{6}$, any $k$ $1200 x^{2}$ implies M1, as long as no errors seen (including no working shown) |
|  |  |  | A1 [4] | Obtain 6000x ${ }^{2}$ | A0 if an otherwise correct expansion is subsequently spoiled by attempt to simplify eg $4+60 x+375 x^{2}$ <br> If expanding brackets: <br> Mark as above, but must consider all 6 brackets for the M marks (allow irrelevant terms to be discarded) |
| 3 | (ii) | $(9+6 c x \ldots)(64+960 x+\ldots)$ | M1* | Expand first bracket and attempt at least one relevant product | Expansion of first bracket does not have to be correct, but must be attempted so M0 if using $(3+c x)(64+960 x . .$. No need to see third term in expansion of first bracket Must then consider a product and not just use $6 c+960$ Expansion could include irrelevant / incorrect terms Using an incorrect expansion associated with part (i) can get M1 M1 |
|  |  | $\begin{aligned} & (9 \times 960)+(6 c \times 64)=4416 \\ & 8640+384 c=4416 \\ & 384 c=-4224 \end{aligned}$ | M1d* | Equate sum of the two relevant terms to 4416 and attempt to solve for $c$ | Must now consider just the two relevant terms M0 if additional terms, even if error has resulted in $k x$ BOD if presence of $x$ is inconsistent within equation |
|  |  | $c=-11$ | $\begin{aligned} & \text { A1 } \\ & \text { [3] } \end{aligned}$ | Obtain $c=-11$ | A 0 for $c=-11 x$ |

\begin{tabular}{|c|c|c|c|c|c|c|}
\hline \multicolumn{3}{|c|}{Question} \& Answer \& Marks \& \multicolumn{2}{|r|}{Guidance} <br>
\hline \multirow[t]{3}{*}{4} \& \multirow[t]{3}{*}{(a)} \& \multirow[t]{3}{*}{} \& \multirow[t]{3}{*}{$5 / 4 x^{4}-3 x^{2}+x+c$} \& M1 \& Attempt integration \& Increase in power by 1 for at least two of the three terms Allow M1 if the +1 disappears <br>
\hline \& \& \& \& A1 \& Obtain at least 2 correct (algebraic) terms \& Integral must be of form $a x^{4}+b x^{2}+c x$ Allow for unsimplified $\frac{6}{2} x^{2}$ and/or $1 x$ <br>
\hline \& \& \& \& A1
[3] \& Obtain a fully correct integral, including $+c$ \& Coeff of $x^{2}$ must now be simplified, as well as $x$ not $1 x$ A0 if integral sign or $\mathrm{d} x$ still present in final answer Ignore notation on LHS such as $\int=\ldots, y=\ldots,{ }^{\mathrm{d} y} / \mathrm{dx}=\ldots$ <br>
\hline \multirow[t]{2}{*}{4} \& \multirow[t]{2}{*}{(b)} \& \multirow[t]{2}{*}{(i)} \& \multirow[t]{2}{*}{$-12 x^{-2}+c$} \& M1 \& Obtain integral of form $k x^{-2}$ \& Any $k$, including unsimplified <br>
\hline \& \& \& \& A1

[2] \& Obtain fully correct integral, including $+c$ \& Coeff must now be simplified A0 if integral sign or $\mathrm{d} x$ still present in final answer Do not penalise again if already penalised in part (a), even if different error including omission of $+c$ Ignore notation on LHS such as $\int=\ldots, y=\ldots,{ }^{\text {dy }} / \mathrm{d} x=\ldots$ <br>
\hline \multirow[t]{4}{*}{4} \& \multirow[t]{4}{*}{(b)} \& \multirow[t]{4}{*}{(ii)} \& $(0)-\left(-12 a^{-2}\right)=3$ \& M1* \& Attempt $\mathrm{F}(\infty)-\mathrm{F}(a)$ and use or imply that $\mathrm{F}(\infty)=0$ \& Must be subtraction and correct order Could use a symbol for the upper limit, eg $s$, and then consider $s \rightarrow \infty$ $0-12 a^{-2}$, with no other supporting method, is M0 as this implies addition Allow BOD for $-12 \times(0)^{-2}$ as long as it then becomes 0 Allow M1 for using incorrect integral from (b)(i) as long as it is of the form $k x^{-n}$ with $n \neq 3$ <br>

\hline \& \& \& $$
a^{2}=4
$$ \& M1d* \& Equate to 3 and attempt to find $a$ \& Dependent on first M1 soi Allow muddle with fractions eg $a^{2}=1 / 4$ <br>

\hline \& \& \& $a=2$ \& A1 \& Obtain $a=2$ only \& A0 if -2 still present as well <br>

\hline \& \& \& \& [3] \& \& | Answer only is $0 / 3$ |
| :--- |
| NB watch for $a=2$ as a result of solving $24 a^{-3}=3$, which gets no credit | <br>

\hline
\end{tabular}

| Question |  |  | $\begin{array}{\|c\|} \hline \text { Marks } \\ \hline \text { M1* } \end{array}$ | Guidance |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 5 | (i) | $\begin{aligned} \text { sector area } & =1 / 2 \times 16^{2} \times 0.8 \\ & =102.4 \end{aligned}$ | M1* | Attempt area of sector using $(1 / 2) r^{2} \theta$, or equiv | Condone omission of $1 / 2$, but no other errors <br> Must have $r=16$, not 7 <br> M0 if $0.8 \pi$ used not 0.8 <br> M0 if $(1 / 2) r^{2} \theta$ used with $\theta$ in degrees <br> Allow equiv method using fractions of a circle |
|  |  | $\begin{aligned} \text { triangle area } & =1 / 2 \times 16 \times 7 \times \sin 0.8 \\ & =40.2 \end{aligned}$ | M1* | Attempt area of triangle using ( $1 / 2$ ) $a b s i n C$ or equiv | Condone omission of $1 / 2$, but no other errors <br> Angle could be in radians ( 0.8 not $0.8 \pi$ ) or degrees ( $45.8^{\circ}$ ) Must have sides of 16 and 7 <br> Allow even if evaluated in incorrect mode (gives 0.78 ) If using $1 / 2 \times b \times h$, then must be valid use of trig to find $b$ and $h$ |
|  |  |  | M1d* | Attempt area of sector - area of triangle | Using $1 / 2 \times 16^{2} \times(0.8-\sin 0.8)$ will get M1 M0 M0 |
|  |  | area $B D C=62.2 \mathrm{~cm}^{2}$ | $\begin{aligned} & \text { A1 } \\ & \text { [4] } \end{aligned}$ | Obtain 62.2, or better | Allow answers in range [62.20, 62.25] if > 3sf |
| 5 | (ii) | $\begin{aligned} & B D^{2}=\left(16^{2}+7^{2}-2 \times 16 \times 7 \times \cos 0.8\right) \\ & B D=12.2 \end{aligned}$ | M1 | Attempt length of $B D$ using correct cosine rule | Must be correct cosine rule <br> Allow M1 if not square rooted, as long as $B D^{2}$ seen <br> M0 if $0.8 \pi$ used not 0.8 <br> Allow if evaluated in degree mode (gives 9.00) <br> Allow if incorrectly evaluated - using $\left(16^{2}+7^{2}-2 \times 16 \times 7\right) \times \cos 0.8 \text { gives } 7.51$ <br> Allow any equiv method, as long as valid use of trig Attempting the cosine rule in part (i) will only get credit if result appears in part (ii) |
|  |  |  | A1 | Obtain 12.2, or better | Allow any answer rounding to 12.2, with no errors seen Could be implied in method rather than explicit |
|  |  | $\operatorname{arc} B C=16 \times 0.8=12.8$ | B1 | State or imply that arc $B C$ is 12.8 | Allow if $16 \times 0.8$ seen, even if incorrectly evaluated |
|  |  | per $=12.2+12.8+9=34.0 \mathrm{~cm}$ | $\begin{aligned} & \text { A1 } \\ & {[4]} \end{aligned}$ | Obtain 34, or better | Accept 34 or 34.0 , or any answer rounding to 34.0 if $>3$ sf |


| Question |  | Answer | Marks | Guidance |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 6 | (i) | $\begin{aligned} & S_{30}=3 / 2(2 \times 6+29 \times 1.8) \\ & \\ &=963\end{aligned}$ | A1 | Use $d=1.8$ in AP formula | Could be attempting $S_{30}$ or $u_{30}$ <br> Formula must be recognisable, though not necessarily fully correct, so allow M1 for eg $15(6+29 \times 1.8)$, $15(12+14 \times 1.8)$ or even $15(12+19 \times 1.8)$ <br> Must have $d=1.8$ (not 1.3), $n=30$ and $a=6$ |
|  |  | $=963$ |  | Correct unsimplified $S_{30}$ | Formula must now be fully correct Allow for any unsimplified correct expression If using $\frac{1}{2} n(a+l)$ then $l$ must be correct when substituted |
|  |  |  | A1 <br> [3] | Obtain 963 | Units not required |
| 6 | (ii) | $r=7.8 /{ }_{6}=1.3$ | M1 | Use $r=1.3$ in GP formula | Could be attempting $S_{N}, u_{N}$ or even $S_{\infty}$ <br> Formula must be recognisable, though not necessarily <br> fully correct <br> Must have $r=1.3$ (not 1.8) and $a=6$ |
|  |  | $\frac{6\left(1-1.3^{N}\right)}{1-1.3} \leq 1800$ | A1 | Correct unsimplified $S_{N}$ | Formula must now be fully correct <br> Allow for any unsimplified correct expression |
|  |  | $1-1.3^{N} \geq-90$ | M1 | Link sum of GP to 1800 and attempt to rearrange to $1.3^{N} \leq k$ | Must have used correct formula for $S_{N}$ of GP <br> Allow $=, \geq$ or $\leq$ <br> Allow slips when rearranging, including with indices, so rearranging to $7.8^{N} \leq k$ could get M1 |
|  |  | $1.3^{N} \leq 91 \quad$ AG | A1 | Obtain given inequality | Must have correct inequality signs throughout Correct working only, so A0 if $6 \times 1.3^{N}$ becomes $7.8^{N}$, even if subsequently corrected |


| Question | Answer | Marks |  | Guidance |
| :---: | :---: | :---: | :---: | :---: |
|  | $N \log 1.3 \leq \log 91$ | M1 | Introduce logs throughout and attempt to solve equation / inequality | Must be using $1.3^{N} \leq 91,1.3^{N}=91$ or $1.3^{N} \geq 91$ <br> This M1 (and then A1) is independent of previous marks <br> Must get as far as attempting $N$ <br> M0 if no evidence of use of logarithms <br> M0 if invalid use of logarithms in attempt to solve |
|  | $N \leq 17.19$ hence $N=17$ | A1 | Conclude $N=17$ | Must come from solving $1.3^{N} \leq 91$ or $1.3^{N}=91$ (ie not incorrect inequality sign) <br> Answer must be integer value <br> Answer must be equality, so A0 for $N \leq 17$ |
|  |  |  |  | SR <br> Candidates who use numerical value(s) for $N$ can get <br> M1 Use $r=1.3$ in a recognisable GP formula (M0 if $N$ is not an integer value) <br> A1 Obtain a correct unsimplified $S_{N}$ |
|  |  |  |  | Candidates who solve $1.3^{N} \leq 91$ and then use a value associated with their $N$ (usually 17 and/or 18) in a GP formula will be eligible for the M1A1 for solving the inequality and also the M1A1 in the SR above |
|  |  | [6] |  |  |


| Question |  | Answer | Marks | Guidance |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 7 | (i) | $\int_{1}^{4}\left(x^{\frac{3}{2}}-1\right) \mathrm{d} x=\left[\frac{2}{5} x^{\frac{5}{2}}-x\right]_{1}^{4}$$=(12.8-4)-(0.4-1)$ | M1 | Attempt integration | Increase in power by 1 for at least one term - allow the -1 to disappear |
|  |  |  | A1 | Obtain fully correct integral | Coeff could be unsimplified eg $1 / 2.5$ Could have $+c$ present |
|  |  |  | M1 | Attempt correct use of limits | Must be explicitly attempting $\mathrm{F}(4)-\mathrm{F}(1)$, either by clear substitution of 4 and 1 or by showing at least (8.8) - ( -0.6 ) Allow M1 if $+c$ still present in both $\mathrm{F}(4)$ and $\mathrm{F}(1)$, but M0 if their $c$ is now numerical Allow use in any function other than the original |
|  |  |  | A1 [4] | Obtain $9^{2} / 5$ | AG, so check method carefully Allow ${ }^{47} / 5$ or 9.4 |
| 7 | (ii) | $\begin{aligned} & m=\frac{3}{2} \times \sqrt{4}=3 \\ & y=3 x-5 \end{aligned}$ <br> tangent crosses $x$-axis at $\left(\frac{5}{3}, 0\right)$ $\begin{aligned} \text { area of triangle } & =1 / 2 \times(4-5 / 3) \times 7 \\ & =8^{1 / 6} \end{aligned}$ <br> shaded area $=9^{2} /{ }_{5}-8^{1} /{ }_{6}=1^{7} / 30$ | M1* | Attempt to find gradient at $(4,7)$ using differentiation | Must be reasonable attempt at differentiation ie decrease the power by 1 <br> Need to actually evaluate derivative at $x=4$ |
|  |  |  | M1d* | Attempt to find point of intersection of tangent with $x$-axis or attempt to find base of triangle | Could attempt equation of tangent and use $y=0$ <br> Could use equiv method with gradient eg $3={ }^{7} / 4-x$ <br> Could just find base of triangle using gradient eg $3=\frac{7}{\mathrm{~h}} \mathrm{~b}$ |
|  |  |  | A1 | Obtain $x=\frac{5}{3}$ as pt of intersection or obtain ${ }^{7} / 3$ as base of triangle | Allow decimal equiv, such as $1.7,1.67$ or even 1.6 www Allow M1M1A1 for $x=5 / 3$ with no method shown |
|  |  |  | M1d** | Attempt complete method to find shaded area | Dependent on both previous M marks <br> Find area of triangle and subtract from $9^{2} / 5$ <br> Must have $1<$ their $x<4$, and area of triangle $<9^{2} / 5$ <br> If using $\int(3 x-5) \mathrm{d} x$ then limits must be 4 and their $x$ <br> M1 for area of trapezium - area between curve and $y$-axis |
|  |  |  | A1 <br> [5] | Obtain $1^{7 /} 30$, or exact equiv | A0 for decimal answer (1.23), unless clearly a recurring decimal (but not eg 1.2333...) |


| Question |  |  | Answer | Marks B1 | Guidance |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 8 | (i) | (a) | $(0,1)$ |  | State (0, 1) | Allow no brackets <br> B1 for $x=0, y=1$ - must have $x=0$ stated explicitly <br> B0 for $y=a^{0}=1$ (as $x=0$ is implicit) |
|  |  | (b) | $(0,4)$ | B1 [1] | State (0, 4) | Allow no brackets <br> B1 for $x=0, y=4$ - must have $x=0$ stated explicitly <br> B0 for $y=4 b^{0}=4$ (as $x=0$ is implicit) |
|  |  | (c) | State a possible value for $a$ | B1 | Must satisfy $a>1$ | Must be a single value Could be irrational eg $e$ Must be fully correct so B0 for eg 'any positive number such as 3' |
|  |  |  | State a possible value for $b$ | B1 <br> [2] | Must satisfy $0<b<1$ | Must be a single value <br> Could be irrational eg $e^{-1}$ <br> Must be fully correct <br> SR allow B1 if both $a$ and $b$ given correctly as a range of values |

\begin{tabular}{|c|c|c|c|c|c|}
\hline \multicolumn{2}{|r|}{Question} \& Answer \& Marks \& \multicolumn{2}{|r|}{Guidance} \\
\hline 8 \& (ii) \& \(\log _{2} a^{x}=\log _{2}\left(4 b^{x}\right)\) \& M1 \& Equate \(a^{x}\) and \(4 b^{x}\) and introduce logarithms at some stage \& Could either use the two given equations, or \(b\) could have already been eliminated so using two eqns in \(a\) only Must take logs of each side soi so M0 for \(4 \log _{2}\left(b^{x}\right)\) Allow just log, with no base specified, or \(\log _{2}\) Allow logs to any base, or no base, as long as consistent \\
\hline \& \& \(\log _{2} a^{x}=\log _{2} 4+\log _{2} b^{x}\) \& M1 \& Use \(\log a b=\log a+\log b\) correctly \& \begin{tabular}{l}
Or correct use of \(\log \frac{a}{b}=\log a-\log b\) \\
Used on a correct expression eg \(\log _{2}\left(4 b^{x}\right)\) or \(\log _{2} 4\left({ }^{2} / a\right)^{x}\) \\
Equation could either have both \(a\) and \(b\) or just \(a\) \\
Must be used on an expression associated with \(a^{x}=4 b^{x}\), \\
either before or after substitution, so M0 for \(\log _{2}(a b)=1\) \\
hence \(\log _{2} a+\log _{2} b=1\) \\
Could be an equiv method with indices before using logs eg \(a^{2 x}=4 \times 2^{x}\) hence \(a^{2 x}=2^{2+x}\)
\end{tabular} \\
\hline \& \& \[
x \log _{2} a=\log _{2} 4+x \log _{2} b
\] \& M1 \& Use \(\log a^{b}=b \log a\) correctly at least once \& Allow if used on an expression that is possibly incorrect Allow M1 for \(x \log _{2} a=x \log _{2} 4 b\) as one use is correct Equation could either have both \(a\) and \(b\) or just \(a\) \\
\hline \& \& \(x \log _{2} a=\log _{2} 4+x \log _{2}(2 / a)\) \& B1 \& Use \(b={ }^{2} / a\) to produce a correct equation in \(a\) and \(x\) only \& \begin{tabular}{l}
Can be gained at any stage, including before use of logs If logs involved then allow for no, or incorrect, base as long as equation is fully correct - ie if \(\log 2^{k}=k\) used then base must be 2 throughout equation Could be an equiv method eg \((a \times a)^{x}=4(a \times b)^{x}\) hence \(a^{2 x}=4 \times 2^{x}\) \\
Must be eliminating \(b\), so \(\left({ }^{2} / b\right)^{x}=4 b^{x}\) is B0 unless the equation is later changed to being in terms of \(a\)
\end{tabular} \\
\hline \& \& \[
\begin{aligned}
\& x \log _{2} a=2+x \log _{2} 2-x \log _{2} a \\
\& x\left(2 \log _{2} a-1\right)=2 \\
\& x=\frac{2}{2 \log _{2} a-1} \text { AG }
\end{aligned}
\] \& A1

[5] \& Obtain given relationship with no wrong working \& | Proof must be fully correct with enough detail to be convincing |
| :--- |
| Must use $\log _{2}$ throughout proof for A1 - allow 1 slip |
| Using numerical values for $a$ and $b$ will gain no credit Working with equation(s) involving $y$ is M0 unless $y$ is subsequently eliminated | <br>

\hline
\end{tabular}

| Question |  | Answer | Marks |  | Guidance |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 9 | (i) | $f(2)=32-14-3=15$ | M1 <br> A1 <br> [2] | Attempt f(2) or equiv <br> Obtain 15 | M0 for using $x=-2$ (even if stated to be $\mathrm{f}(2)$ ) <br> At least one of the first two terms must be of the correct sign <br> Must be evaluated and not just substituted Allow any other valid method as long as remainder is attempted (see guidance in part (ii) for acceptable methods) <br> Do not ISW if subsequently given as -15 If using division, just seeing 15 on bottom line is fine unless subsequently contradicted by eg -15 or ${ }^{15} / x-2$ |
| 9 | (ii) | $\mathrm{f}\left(\mathrm{l}^{-1} / 2\right)={ }^{-1} / 2+7 / 2-3=0 \quad \text { AG }$ $\mathrm{f}(x)=(2 x+1)\left(2 x^{2}-x-3\right)$ | B1 | Confirm $f\left({ }^{-1} / 2\right)=0$, with at least one line of working <br> Attempt complete division by ( $2 x+1$ ), or another correct factor | $4\left({ }^{-1} / 2\right)^{3}-7\left({ }^{-1} / 2\right)-3=0$ is enough <br> B0 for just $f\left({ }^{-1} / 2\right)=0$ <br> If, and only if, $\mathrm{f}^{-1 / 2}$ ) is not attempted then allow B1 for other evidence such as division / coeff matching etc If using division must show '0' on last line or make equiv comment such as 'no remainder' If using coefficient matching must show ' $\mathrm{R}=0$ ' Just writing $\mathrm{f}(x)$ as the product of the three correct factors is not enough evidence on its own for B1 <br> Could divide by $(x+1),(x+1 / 2),(2 x-3),(x-3 / 2)$ 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 <br> Coefficient matching - must be valid attempt at all coeffs of quadratic, considering all relevant terms each time |


| Question | Answer | Marks |  | Guidance |
| :---: | :---: | :---: | :---: | :--- | :--- |


| Question |  | Answer | Marks | Guidance |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 9 | (iii) | $\begin{aligned} & 2 \cos \theta+1=0 \quad \cos \theta+1=0 \\ & 2 \cos \theta-3=0 \end{aligned}$ | M1* | Identify relationship between factors of $\mathrm{f}(\cos \theta)$ and factors of $\mathrm{f}(x)$ | Replace $x$ with $\cos \theta$ in at least one of their factors (could be implied by later working, inc their solutions) |
|  |  | $\begin{array}{ll} \cos \theta=-1 / 2 & \cos \theta=-1 \\ \cos \theta=3 / 2 \end{array}$ | M1d* | Attempt to solve $\cos \theta=k$ at least once | Must actually attempt $\theta$, with $-1 \leq k \leq 1$ |
|  |  | $\theta=2 \pi / 3,4 \pi / 3 \quad \theta=\pi$ | A1 | Obtain at least 2 correct angles | Allow angles in degrees $\left(120^{\circ}, 240^{\circ}, 180^{\circ}\right)$ <br> Allow decimal equivs ( $2.09,4.19,3.14$ ) <br> Allow if $2 \cos \theta+1=0$ is the only factor used, or if other incorrect factors are also used <br> Allow M1M1A1 for 2 correct angles with no working shown |
|  |  |  | A1 | Obtain all 3 correct angles | Must be exact and in radians <br> A0 if additional incorrect angles in range <br> Allow full credit if no working shown <br> Angles must come from 3 correct roots of $\mathrm{f}(x)$, but allow if a factor was eg $\left(x-\frac{3}{2}\right)$ not $(2 x-3)$ <br> A0 if incorrect root, even if it doesn't affect the three solutions eg one of their factors was $(2 x+3)$ not $(2 x-3)$ |
|  |  |  | [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 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 $4 a c$, 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 $2 a$ as long as it has been seen earlier

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