CAMBRIDGE
International Education

Cambridge O Level

ADDITIONAL MATHEMATICS **4037/22**

Paper 2 **May/June 2025**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Mathematics-Specific Marking Principles

1 Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.

2 Unless specified in the question, non-integer answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.

3 Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.

4 Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).

5 Where a candidate has misread a number or sign in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 A or B mark for the misread.

6 Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	More information required
	Accuracy mark awarded zero
	Accuracy mark awarded one
	Accuracy mark awarded two
	Accuracy mark awarded three
	Independent mark awarded zero
	Independent mark awarded one
	Independent mark awarded two
	Independent mark awarded three
	Benefit of the doubt
	Communication mark
	Incorrect
	Follow through
Highlighter	Highlight a key point in the working
	Ignore subsequent work
	Method mark awarded zero
	Method mark awarded one
	Method mark awarded two
	Method mark awarded three

Annotation	Meaning
MR	Misread
O	Omission
Off-page comment	Allows comments to be entered at the bottom of the RM marking window and then displayed when the associated question item is navigated to.
On-page comment	Allows comments to be entered in speech bubbles on the candidate response.
Pre	Premature rounding/approximation
SC	Special case
SEEN	Indicates that work/page has been seen
TE	Transcription error
	Correct
XP	Correct answer from incorrect working

MARK SCHEME NOTES

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method marks, awarded for a valid method applied to the problem.

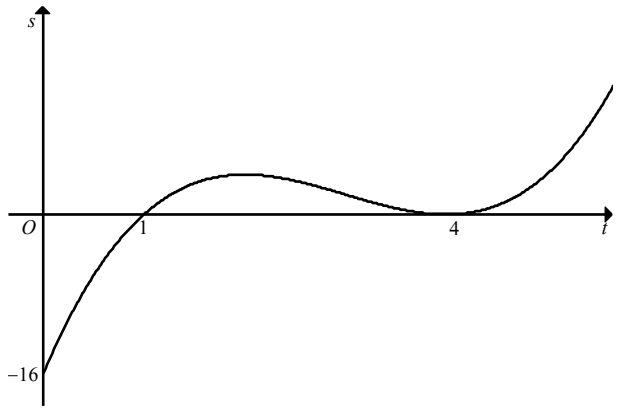
A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

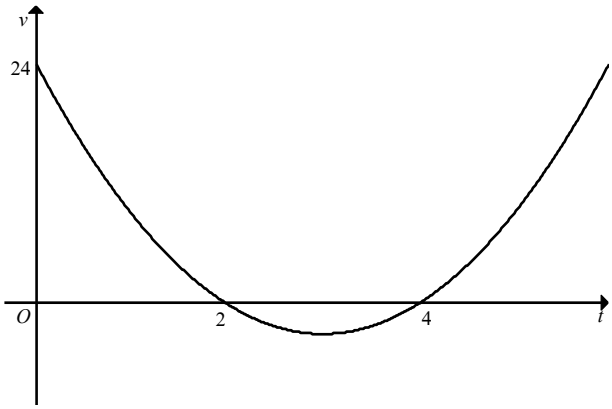
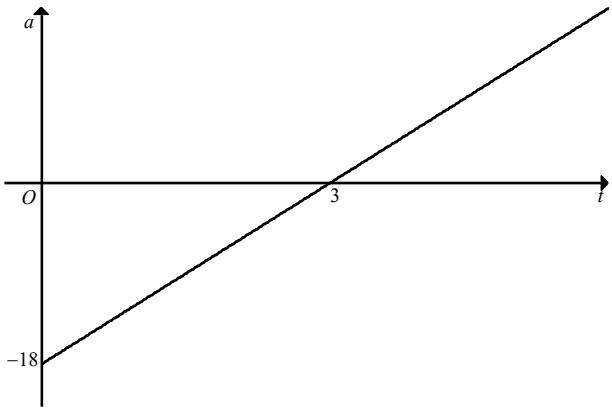
B Mark for a correct result or statement independent of Method marks.

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 M or B mark is dependent on an earlier mark in the scheme.

Abbreviations

awrt answers which round to
cao correct answer only
dep dependent
FT follow through after error
isw ignore subsequent working
nfww not from wrong working
oe or equivalent
rot rounded or truncated
SC Special Case
soi seen or implied

Question	Answer	Marks	Partial marks
1	$5x+2*3$ and $5x+2*-3$ oe	**M1**	where * could be = or any inequality sign
	Critical values: $\frac{1}{5}$, –1 soi	**A2**	**A1** for one correct value
	$x \leqslant -1 \quad x \geqslant \frac{1}{5}$ oe mark final answer	**A1**	
	Alternative method		
	$(5x+2)^2 * 3^2$	**(M1)**	where * could be = or any inequality sign
	Critical values: $\frac{1}{5}$, –1 soi	**(A2)**	**A1** for $25x^2+20x-5[*0]$
	$x \leqslant -1 \quad x \geqslant \frac{1}{5}$ oe mark final answer	**(A1)**	
2 (a)	Fully correct graph with all intercepts stated  	**2**	**B1** for correct cubic shape with maximum in the first quadrant, a point of tangency to the *t*-axis at the minimum point; must meet the *s*-axis **B1** for correct intercepts; must have attempted the correct shape
2(b)	v: $2(t-4)(t-1)+(t-4)^2$ (1) or s: $t^3-9t^2+24t-16$ **and** v: $3t^2-18t+24$	**M1**	
	v: $3(t-4)(t-2)$	**A1**	

Question	Answer	Marks	Partial marks
2(c)	Fully correct graph with all intercepts stated  	**B2**	**B1** for correct quadratic shape with minimum in the fourth quadrant; must meet the v-axis **B1** for correct intercepts; must have attempted the correct shape
2(d)	$6t - 18$ or $3(t - 4) + (3t - 6)$ oe	**B1**	**FT** *their* 3-term quadratic expression oe for v Correct linear expression for a from their v which must be either a 3-term quadratic or an expression that would simplify to a 3-term quadratic
2(e)	Fully correct ruled graph with all intercepts stated  	**3**	**B1** for a single ruled line with positive gradient in fourth and first quadrants; must meet the a-axis and cross the t-axis **B1 FT** for a line with t-intercept 3 **FT** *–thei r*(–18)÷ *their* 6 providing *their a* is a linear expression of the form $mt + c$ **B1 FT** for a line with a-intercept –18 **FT** *their* (–18) providing *their a* is a linear expression of the form $mt + c$

Question	Answer	Marks	Partial marks
3	$\frac{3\sqrt{x+2}}{\sqrt{x+2}+4}=1$ soi OR $g(x)=f^{-1}(1)$ and $f^{-1}(x)=\frac{4x}{3-x}$ oe	**2**	**M1** for $f(\sqrt{x+2})$ $[=1]$ soi or for $g(x)=f^{-1}(1)$ soi
	$x=2$ nfww	**2**	**M1 FT** for correct equation without an algebraic fraction e.g. $\sqrt{x+2}=2$ **FT** *their* $\frac{3\sqrt{x+2}}{\sqrt{x+2}+4}=1$ providing **M1** previously awarded and fg(x) is an algebraic fraction
	Alternative method		
	Solves $\frac{3x}{x+4}=1$ to find $x = 2$ and states $g(x)=2$	**(2)**	**M1** for solving $f(x)=1$ to find $x = k$ and states $g(x)=k$, where k is a constant
	$x=2$ nfww	**(2)**	**M1 FT** for $\sqrt{x+2}=k$ **FT** $g(x)=k$ *their* providing **M1** previously awarded

Question	Answer	Marks	Partial marks
4(a)	$\left[\frac{dy}{dx}=\right]$ $4\left(\cos 2x(2\cos 2x)+\sin 2x(-2\sin 2x)\right)$ oe	**M1**	Use of the product rule with correct structure
	$\left[\frac{dy}{dx}=\right]$ $4\left(\cos 2x(2\cos 2x)+\sin 2x(-2\sin 2x)\right)$ oe, isw	**A1**	
	$\left[\left.\frac{dy}{dx}\right\|_{x=\frac{\pi}{6}}=\right] 4\left(2\cos^2\frac{2\pi}{6}-2\sin^2\frac{2\pi}{6}\right)$ oe	**M1**	**dep** on previous **M1** **FT** *their* $\frac{dy}{dx}$ providing it is of the form $a\cos^2 2x - b\sin^2 2x$ or equivalent where *a, b* are positive integers
	$\left[\left.\frac{dy}{dx}\right\|_{x=\frac{\pi}{6}}=\right] -4$	**A1**	

Question	Answer	Marks	Partial marks
4(b)	$\left[\text{When } x=\frac{\pi}{6}\right]\ y=\sqrt{3}$	**B1**	
	Gradient of normal = $\frac{1}{4}$	**M1**	**FT** $\frac{-1}{\textit{their}\left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=\frac{\pi}{6}}}$ from part **(a)**
	Equation of normal: $y=\frac{1}{4}x+\sqrt{3}-\frac{\pi}{24}$ or $y=\frac{1}{4}x+c$ and $\sqrt{3}=\frac{1}{4}\left(\frac{\pi}{6}\right)+c$ or $y-\sqrt{3}=\frac{1}{4}\left(x-\frac{\pi}{6}\right)$ oe	**M1**	**FT** $\frac{-1}{\textit{their}\left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=\frac{\pi}{6}}}$ and *their y* , providing *their y* ≠ 0
	$0-\sqrt{3}=\frac{1}{4}\left(x-\frac{\pi}{6}\right)$	**M1**	**FT** *their* equation of normal providing gradient is $\frac{-1}{\textit{their}\left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=\frac{\pi}{6}}}$
	$\left(\frac{\pi}{6}-4\sqrt{3},0\right)$ or exact equivalent; mark final answer	**A1**	**dep** on all previous marks awarded and a fully correct solution to (a) or a correct derivative and gradient of tangent at $x=\frac{\pi}{6}$ stated in this part
5(a)(i)	300	**B1**	
5(a)(ii)	252	**2**	**M1** for 21 × 4 × 3 × 1 oe OR Starts with 5 OR ends with 0: 1 × 4 × 3 × 5 oe or 60 or Starts with 2, 4, 6 or 8 OR ends with 2, 4, 6 or 8: 4 × 4 × 3 × 4 oe or 192 OR [All possible –] ends with 5: 4 × 4 × 3 × 1 oe or 48

Question	Answer	Marks	Partial marks
5(a)(iii)	108	**2**	**M1** for $9 \times 4 \times 3 \times 1$ oe OR Ends with 5: $4 \times 4 \times 3 \times 1$ oe or 48 or Ends with 0: $5 \times 4 \times 3 \times 1$ oe or 60 OR Starts 5, ends 0: $1 \times 4 \times 3 \times 1$ oe or 12 or Does not start 5: $4 \times 4 \times 3 \times 2$ oe or 96
5(b)	Correct simplified equation: $(n+1)^2 = 33 \times 12 \times 11$ oe, nfww	**B2**	**B1** for an equation with simplified algebraic component $(n+1)^2$ oe or simplified numerical component $33 \times 12 \times 11$ oe, nfww
	$n = 65$	**B1**	**dep** on **B2**; must be the only solution

Question	Answer	Marks	Partial marks
6	$r = 3$ nfww	**B1**	stated or very clearly implied
	$2\pi = 4\pi r^2 \times \frac{dr}{dt}$ soi or $\frac{dr}{dt} = \frac{1}{2r^2}$ oe and $\frac{dS}{dr} = 8\pi r$	**M1**	Uses relevant chain rule e.g. $\frac{dV}{dt} = \frac{dV}{dr} \times \frac{dr}{dt}$ to find the derivatives and values of $\frac{dr}{dt}$ and $\frac{dS}{dr}$
	$\frac{dr}{dt} = \frac{1}{18}$ and $\frac{dS}{dr} = 24\pi$ soi	**A1**	
	Correct chain rule including $\frac{dS}{dt}$	**B1**	e.g. $\frac{dS}{dt} = \frac{dS}{dr} \times \frac{dr}{dt}$ or $\frac{dr}{dt} = \frac{dS}{dt} \times \frac{dr}{dS}$ oe
	$\frac{dS}{dt} = \frac{4\pi}{3}$ isw or 4.19 or 4.188 to 4.1888	**2**	**M1** for $\frac{dS}{dt} = 24\pi \times \frac{1}{18}$
	Alternative method 1		
	$r = 3$ nfww	**(B1)**	stated or very clearly implied
	$\frac{dV}{dr} = 4\pi r^2$ and $\frac{dS}{dr} = 8\pi r$	**(M1)**	Finds correct expressions for and values of $\frac{dV}{dr}$ and $\frac{dS}{dr}$
	$\frac{dV}{dr} = 36\pi$ and $\frac{dS}{dr} = 24\pi$ soi	**(A1)**	
	Correct chain rule including $\frac{dS}{dt}$	**(B1)**	e.g. $\frac{dS}{dt} = \frac{dS}{dr} \times \frac{dr}{dV} \times \frac{dV}{dt}$ or $\frac{dS}{dt} = \frac{dS}{dV} \times \frac{dV}{dt}$
	$\frac{dS}{dt} = \frac{4\pi}{3}$ isw or 4.19 or 4.188 to 4.1888	**(2)**	**M1** for $\frac{dS}{dt} = 24\pi \times \frac{1}{36\pi} \times 2\pi$ or $\frac{2}{3} \times 2\pi$

Question	Answer	Marks	Partial marks
6	**Alternative method 2**		
	$r = \sqrt[3]{\frac{3V}{4\pi}}$ nfww	**(B1)**	stated or very clearly implied
	$S = 4\pi\left(\sqrt[3]{\frac{3V}{4\pi}}\right)^2 \rightarrow \frac{\mathrm{d}S}{\mathrm{d}V} = 4\pi \times \left(\frac{3}{4\pi}\right)^{\frac{2}{3}} \times \frac{2}{3}V^{-\frac{1}{3}}$	**(M1)**	
	$\frac{\mathrm{d}S}{\mathrm{d}V} = \frac{2}{3}$ oe soi	**(A1)**	
	Correct chain rule including $\frac{\mathrm{d}S}{\mathrm{d}t}$	**(B1)**	e.g. $\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{\mathrm{d}S}{\mathrm{d}V} \times \frac{\mathrm{d}V}{\mathrm{d}t}$
	$\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{4\pi}{3}$ isw or 4.19 or 4.188 to 4.1888	**(2)**	**M1**for $\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{2}{3} \times 2\pi$
	Alternative method 3		
	$r = 3$ nfww	**(B1)**	stated or very clearly implied
	$r = \sqrt{\frac{S}{4\pi}}, V = \frac{4}{3}\pi\left(\sqrt{\frac{S}{4\pi}}\right)^3$, $\frac{\mathrm{d}V}{\mathrm{d}S} = \frac{4}{3}\pi \times \frac{1}{(4\pi)^{\frac{3}{2}}} \times \frac{3}{2}S^{\frac{1}{2}}$	**(M1)**	
	$S = 36\pi$ **and** $\frac{\mathrm{d}V}{\mathrm{d}S} = \frac{3}{2}$ oe soi	**(A1)**	
	Correct chain rule including $\frac{\mathrm{d}S}{\mathrm{d}t}$	**(B1)**	e.g. $\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{\mathrm{d}S}{\mathrm{d}V} \times \frac{\mathrm{d}V}{\mathrm{d}t}$
	$\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{4\pi}{3}$ isw or 4.19 or 4.188 to 4.1888	**(2)**	**M1** for $\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{1}{1.5} \times 2\pi$

Question	Answer	Marks	Partial marks
7(a)	Forms a correct equation from which the logarithms can be eliminated : has consistent powers of ln$x$ in all terms $\frac{n}{2}\left(12\ln x+\left(n-1\right)\times 4\ln x\right)*43\times 24\ln x$ oe, soi OR uses log laws to combine terms $\ln\left(x^{6n}\times x^{2n(n-1)}\right)*\ln x^{24\times 43}$ or better	**3**	where * is = or any inequality sign **M2** for $a = 6$ **and** $d = 4$ or $a = 6\ln x$ soi **and** $d = 4\ln x$ soi or $a = \ln x^6$ soi **and** $d = \frac{2}{3}\ln x^6$ soi or $a = \frac{3}{2}\ln x^4$ soi **and** $d = \ln x^4$ soi or for $\ln x^{12\times\frac{n}{2}}+\ln x^{4(n-1)\times\frac{n}{2}}*\ln x^{24\times 43}$ oe or **M1** for any correct expression for d or for a correct expression for the sum to n terms using *their a* and *their d* providing *their d* is not one of the given terms
	$2n^2+4n-1032\left[*0\right]$ oe	**A1**	
	Solves *their* 3-term quadratic in n	**M1**	**dep** on attempt at the sum of an AP
	$n = 22$ cao, nfww	**A1**	**dep** on all previous marks awarded

Question	Answer	Marks	Partial marks
7(b)	Correct term e.g. $[u_{25} =]$ $6\ln x + 24 \times 4\ln x$ or $\ln x^6 + 24 \times \frac{2}{3}\ln x^6$ or $\frac{3}{2}\ln x^4 + 24\ln x^4$ or $2\ln x^3 + 24 \times \left(2\ln x^7 - 5\ln x^2\right)$ oe or $2\ln x^3 + 24 \times \left(5\ln x^2 - 2\ln x^3\right)$ oe	**B1**	
	Forms and correctly simplifies an equation e.g. $102\ln x = 408$ or $17\ln x^6 = 408$ or $\frac{51}{2}\ln x^4 = 408$ or $\ln \frac{x^6 \times x^{336}}{x^{240}} = 408$ or $\ln \frac{x^6 \times x^{240}}{x^{144}} = 408$	**M1**	**FT** *their* u_{25} providing it is an expression for the term of an AP which requires the simplification/collection of two natural logarithms
	$x = e^4$	**A1**	

Question	Answer	Marks	Partial marks
8	For A: $x = \frac{1}{3}$	**B1**	
	$\frac{dy}{dx} = -\frac{15}{x^2} + \frac{10}{x^3}$ oe. isw OR $\frac{dy}{dx} = \frac{-15x^2 + 10x}{x^4}$ oe, isw	**B2**	**B1** for each correct term OR for $\frac{dy}{dx} = \frac{-15x^2 + ...}{x^4}$ oe or $\frac{...+10x}{x^4}$
	Solves $their \frac{dy}{dx} = 0$ as far as x = …	**M1**	**FT** *their* $\frac{dy}{dx}$ providing at least one term is correct
	B: $\left(\frac{2}{3}, \frac{45}{4}\right)$ oe, nfww	**A2**	**A1** for each correct coordinate
	Correct plan e.g. $\int_{their\frac{1}{3}}^{their\frac{2}{3}} \left(\frac{15}{x} - \frac{5}{x^2}\right) dx - \frac{1}{2} \times their\frac{45}{4} \times \left(their\frac{2}{3} - their\frac{1}{3}\right)$ or $\int_{their\frac{1}{3}}^{their\frac{2}{3}} \left(\frac{15}{x} - \frac{5}{x^2} - \left(their\frac{135}{4}x - their\frac{45}{4}\right)\right) dx$	**M1**	
	$\int \left(\frac{15}{x} - \frac{5}{x^2}\right) dx = 15\ln x + \frac{5}{x}$ oe	**B2**	**B1** for $15\ln x$ or $k\ln x + \frac{5}{x}$ oe
	$\left(15\ln\frac{2}{3} + \frac{15}{2}\right) - \left(15\ln\frac{1}{3} + 15\right)$ or exact equivalent	**M1**	**FT** *their* $\frac{1}{3}$ and *their* $\frac{2}{3}$ providing at least **B1** awarded for integration
	Area of shaded region: $15\ln2 - 9.375$ or $15\ln 2 - \frac{75}{8}$ or exact equivalent	**A1**	**dep** on all previous marks awarded
9(a)	$\tan 3x = \frac{1}{\sqrt{3}}$ or $\frac{\sqrt{3}}{3}$ or 0.57735…	**B2**	**B1** for $\frac{3}{\cos 3x} = \frac{\sqrt{3}}{\sin 3x}$ oe
	$3x$ = 30 or 210 or –150 or –330	**M1**	Finds one correct and valid triple angle May be in radians for this mark implied by one correct value of x
	x: 10, 70, –50, –110 and no extras in range	**A2**	**A1** for any two correct angles ignoring extras

Question	Answer	Marks	Partial marks
9(b)	$\sin\left(y+\frac{\pi}{3}\right)=0$	**B1**	
	$\cos\left(y+\frac{\pi}{3}\right)=\frac{1}{2}$	**B1**	
	$y+\frac{\pi}{3}=0$ or π or 2π or $\frac{\pi}{3}$ or $\frac{5\pi}{3}$	**M1**	Finds one correct and valid compound angle May be in degrees for this mark
	y: $\frac{2\pi}{3}$, $\frac{5\pi}{3}$, 0, $\frac{4\pi}{3}$ oe, nfww	**A2**	**A1** for any two correct angles ignoring extras
10	$n = 6$ stated; nfww	**B2**	**B1** for first term: $\left(3x^2\right)^n$ or $\left(3x^2\right)^6$ soi
	$-6\left(3x^2\right)^5 a+2\left(729x^{10}\right)=972x^{10}$ oe and $\frac{6\times5\left(3x^2\right)^4(-a)^2}{2}+6\left(3x^2\right)^5\times\frac{2}{x^2}(-a)+729x^8=bx^8$ oe	**B3**	**B2** for one correct equation **OR** **B1** for second term: $n(-a)\left(3x^2\right)^{n-1}$ or $6(-a)\left(3x^2\right)^5$ or $-1458ax^{10}$ soi **B1** for third term: $\frac{n(n-1)(-a)^2\left(3x^2\right)^{n-2}}{2}$ or $\frac{6(5)(-a)^2\left(3x^2\right)^4}{2}$ or $1215a^2x^8$ soi **B1** for 1 [+] $\frac{2}{x^2}$ [+] $\frac{1}{x^4}$ soi
	$a=\frac{1}{3}$	**B2**	**B1** for $-1458a+1458=972$ soi
	$b = -108$	**B2**	**B1** for $1215a^2 - 2916a + 729$ soi