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ADDITIONAL MATHEMATICS **0606/23**

Paper 2 **May/June 2026**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

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General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: • the specific **content** defined in the mark scheme • the specific **skills** defined in the mark scheme or in the level descriptions • the **standard of response** required as exemplified by the standardisation scripts.
2	Examiners must award **whole marks** (not half marks, or other fractions).
3	Examiners must award marks **positively**. This means that: • marks are not deducted for errors or omissions • marks are awarded for correct/valid answers as defined in the mark scheme and also for **other valid answers** which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate • the quality of spelling, punctuation and grammar are judged **only** when the mark scheme indicates that these features are **specifically assessed** in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must **consistently** apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the **full range of marks** defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and **must not** award marks with grade thresholds or grade descriptions in mind.

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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.

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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

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Annotation	Meaning
	Incorrect
FT	Follow through
Highlighter	Highlight a key point in the working
ISW	Ignore subsequent work
M0	Method mark awarded zero
M1	Method mark awarded one
M2	Method mark awarded two
M3	Method mark awarded three
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

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Annotation	Meaning
XP	Correct answer from incorrect working

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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

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Question	Answer	Marks	Partial marks	Guidance
1(a)	Ruled,V-shaped graph with vertex at (−0.5, 0) and which has end points (–3, 5) and (3, 7)	**2**	**B1** for ruled V-shaped graph with vertex at (−0.5, 0) or **SC1** for a dashed V-shaped graph with vertex at (−0.5, 0) and which has end points (–3, 5) and (3, 7) or for a freehand V-shaped graph with vertex at (−0.5, 0) and which has end points (–3, 5) and (3, 7)	• Mark intent must be nearer to $y = 5$ and/or 7 than anything else at the ends • Ignore anything below the axis whether dashed or not • Allow SC1 for the freehand attempt, even if the lines are not well drawn
1(b)	Graph of $y = x + 2$	**M1**	**dep** on a V-shaped graph in part **(a)**	• intersecting with *their* $y = \|2x + 1\|$ as many times as needed
	$x < -1, x > 1$	**A2**	**A1 STRICT FT** for two correct critical values from the intersections of *their* V-shaped graph and line; **STRICT FT** *their* points of intersection providing at least **B1** earned in part **(a)**	• critical values must come from graph • ignore any algebraic checking if seen

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Question	Answer	Marks	Partial marks	Guidance
2(a)	Correct method e.g. $2\tan^{-1}(2)$ or $\cos^{-1}\left(-\frac{6}{10}\right)$ oe, nfww	**M1**		• $2\sin^{-1}\left(\frac{2}{\sqrt{5}}\right)$ or $2\cos^{-1}\left(\frac{1}{\sqrt{5}}\right)$ or $\pi - \sin^{-1}\left(\frac{4}{5}\right)$ • If they have e.g. $\tan x = 2$, $x = 1.107$, $\theta = 2x = 2.214\ldots$ this is ok for M1 A0 (2.21 is missing) • BOD M1 for $\tan\frac{\theta}{2} = 2$ $\frac{\theta}{2} = 1.1071$ $\theta = 2.21$ • Condone use of θ when finding the half angle if they then go on an double and state the sufficiently accurate angle; check any diagrams for evidence to support the method if it is suspect • 2×1.107148718
	2.214…. = 2.21 cao	**A1**		• Must see 4 or more sf

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Question	Answer	Marks	Partial marks	Guidance
2(b)	$r = \sqrt{5}$ soi	**B1**		• Check diagram if not soi by e.g. calculation
	$4^2 - \left(\frac{1}{2}\times\left(their\sqrt{5}\right)^2 \times 2.214[29...] - \frac{1}{2}\times\left(their\sqrt{5}\right)^2 \times \sin 2.214[29...]\right)$ OR $4^2 + \frac{1}{2}\times 4\,[\times 1] - \frac{1}{2}\left(their\sqrt{5}\right)^2 \times 2.214[29...]$	**M3**	**FT** $r = their\sqrt{5}$ providing $2 < r < 4$ **M1 FT** for $\frac{1}{2}\times\left(their\sqrt{5}\right)^2 \times 2.214[29...]$; **FT** $r = their\sqrt{5}$ providing $2 < r < 4$ **M1 FT** for $\frac{1}{2}\times\left(their\sqrt{5}\right)^2 \times \sin 2.214[29...]$ **FT** $r = their\sqrt{5}$ providing $2 < r < 4$ or 4^2 and $\frac{1}{2}\times 4\,[\times 1]$ **M1 FT** for a correct plan using *their* values of r and θ; *their* $r > 0$	• Condone use of 2.21 which leads to $16 - (5.525 - 2.006\ldots)$ • If correct $16 - (5.5357\ldots - 2)$ • If FT calculation must be seen, you are not expected to determine whether or not decimals follow without evidence of method • No need to see the derivation of *their r* e.g. if • $r = 3$ used B0 M3 is possible without any other evidence
	Shaded region: 12.5 or 12.46 to 12.481…	**A1**		
3(a)	$1 - 4x^2$ cao	**B1**		• Must be simplified form • Ignore subsequent equating to 0 and solving

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Question	Answer	Marks	Partial marks	Guidance
3(b)	$(1-4x^2)^{10}(1-2x)^2$ oe, soi	**B1**		
	$[1-40x^2+]\ 720x^4$ and $[1+4x^2]-4x$ oe	**B1**		• Accept $^{10}C_0[\times1]\times(4x^2)^0+{}^{10}C_1[\times1]\times(4x^2)^1$ $+{}^{10}C_2[\times1]\times(4x^2)^2$
	their 720 × *their* –4 oe	**M1**	Product of term in x^4 and term in x from *their* expansions of $(1-4x^2)^k(1-2x)^2$ where $5\leqslant k\leqslant10$ oe	• Must be free of x • Accept e.g. $^{10}C_2\times4^2\times(-4)$
	−2880	**A1**	If 0 scored, then **SCM2** for $1+20x+180x^2+960x^3+3360x^4+8064x^5$ and $1-24x+264x^2-1760x^3+7920x^4-25344x^5$ or **SCM1** for either correct	• Accept e.g. $^{10}C_0[\times1]\times(2x)^0+{}^{10}C_1[\times1]\times(2x)^1+{}^{10}C_2[\times1]\times(2x)^2$ $+{}^{10}C_3[\times1]\times(2x)^3+{}^{10}C_4[\times1]\times(2x)^4+{}^{10}C_5[\times1]\times(2x)^5$ and $^{12}C_0[\times1]\times(-2x)^0+{}^{12}C_1[\times1]\times(-2x)^1+{}^{12}C_2[\times1]\times(-2x)^2$ $^{12}C_3[\times1]\times(-2x)^3+{}^{12}C_4[\times1]\times(-2x)^4+{}^{12}C_5[\times1]\times(-2x)^5$ as a sum or in a list of terms
			SCA1 for −2880	• $-2880x^5$ is A0
4(a)	Points plotted at x^4: 0.05, 0.81, 2.01, 3.22, 3.84 y: 0.23, 0.61, 1.20, 1.81, 2.12 soi and a single, ruled, straight line of best fit drawn	**B2**	**B1** for at least 4 correctly plotted points	• Line should pass through all points – check first and last • For B2 mark line, ignore plots For B1 mark plots, ignore line • For B2: allow intent to draw the line from $x=0.05$ to $x=3.84$; may be longer • For B1 mark intent for plots

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Question	Answer	Marks	Partial marks	Guidance
4(b)	Correct method to find P e.g. $P = \frac{2.1-0.2}{3.8-.05}$ or $0.76P = 0.38$	**M1**		• Must be using linear coordinates but not dependent on correct line • $1.84P = 0.92$ • Check graph if no method shown
	$P = 0.48$ to 0.52	**A1**		• isw attempt to change form • Implies M1 if not from wrong working
	$Q = 0.15$ to 0.25	**B1**		• isw attempt to change form • Using $y = mx + c$ to determine Q is fine if it is in the range on the left • Allow values of P and Q embedded in the equation
4(c)	[$x^4 = 1.05^4$ or $1.215\ldots$ $y =$] 0.76 to 0.86	**1**		• Range to be decided at STM • Using $Px^4 + Q$ and their values from **(b)** is fine as this is still using the graph. However if their value is out because of their P and/or Q, there is no FT

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Question	Answer	Marks	Partial marks	Guidance
5(a)	Correct trapezium shape: • starting at (0, 0) • ending at (k, 0) where k is positive • all sections linear	**M1**		• Condone a good freehand
	T, $3T$ and 60 marked appropriately on t-axis and V marked appropriately on v-axis	**A1**		• Condone e.g. T and $3T$ written appropriately on the graph itself rather than on the axis
5(b)	$\frac{V}{T} = 1.5$ oe, soi	**M1**		• Accept use of lower case letters all through • Must be relating V and T not e.g. Δs and T
	$\frac{1}{2}(2T + 60) \times V = 1104$ oe	**M1**	or $\frac{1}{2}(2T + 60) \times 1.5T = 1104$	• $\frac{1}{2}TV + 2TV + \frac{60 - 3T}{2} \times V = 1104$
	Correct quadratic in T or V e.g. $3T^2 + 90T - 2208 = 0$ oe or $2V^2 + 90V - 3312 = 0$ oe	**A1**		• $T^2 + 30T - 736 = 0$ oe • $V^2 + 45V - 1656 = 0$
	Factorises or solves *their* 3-term quadratic in T or V e.g. $3(T - 16)(T + 46)$ [= 0] or $2(V - 24)(V + 69)$ [= 0]	**M1**	**dep** first **M1**	Attempt to solve *their* quadratic in form $ax^2 + bx + c = 0$ by: • factorising – factorisation must result in correct a and c for FT equation, or scaled form of FT equation. • quadratic formula – discriminant of FT equation must not be negative. Formula must be correct but condone one sign error in substitution. • completing the square – must get as far as $(x + \frac{b}{2})^2 = -\frac{c}{a} + \frac{b^2}{4}$ or equivalent, condone one sign error.
	$T = 16$ nfww	**A1**		• A0 if –46 not rejected; can be rejected by not using to find a value of V

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Question	Answer	Marks	Partial marks	Guidance
	$V = 24$ nfww	**A1**		• A0 if –69 not rejected; can be rejected by not using to find a value of T

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Question	Answer	Marks	Partial marks	Guidance
6(a)	Common denominator and simplifies numerator or denominator e.g. $\frac{\sin\theta\sec\theta+\sin\theta\tan\theta+\sin\theta\sec\theta-\sin\theta\tan\theta}{(\sec\theta-\tan\theta)(\sec\theta+\tan\theta)}$ oe or $\frac{\sin\theta(\sec\theta+\tan\theta)+\sin\theta(\sec\theta-\tan\theta)}{\sec^2\theta-\tan^2\theta}$ or rewrites in terms of $\sin\theta$ and $\cos\theta$ e.g. $\frac{\frac{\sin\theta}{1}}{\frac{\cos\theta}{\cos\theta}-\frac{\sin\theta}{\cos\theta}}+\frac{\frac{\sin\theta}{1}}{\frac{\cos\theta}{\cos\theta}+\frac{\sin\theta}{\cos\theta}}$ oe	**M1**		• Accept e.g. $\frac{2\sin\theta\sec\theta}{\sec^2\theta-\tan^2\theta}$ or $\frac{\sin\theta\cos\theta}{1-\sin\theta}+\frac{\sin\theta\cos\theta}{1+\sin\theta}$ or $\frac{\tan\theta(1+\sin\theta)+\tan\theta(1-\sin\theta)}{\sec^2\theta-\tan^2\theta}$ • Only accept the numerator only for this mark if they have indicated e.g. $\sec^2\theta-\tan^2\theta=1$ somewhere
	An expression that is one step away from justifying the answer e.g. $2\sin\theta\sec\theta$ or $\frac{\tan\theta(1+\sin\theta)+\tan\theta(1-\sin\theta)}{[1]}$ or $\frac{2\sin\theta\cos\theta}{1-\sin^2\theta}$	**A1**		• Accept $\frac{2\sin\theta\sec\theta}{[1]}$ or $\frac{\frac{2\sin\theta}{\cos\theta}}{1}$ • Accept $\frac{\sin\theta\cos\theta+\sin^2\theta\cos\theta+\sin\theta\cos\theta-\sin^2\theta\cos\theta}{1-\sin^2\theta}$ or $\frac{(1+\sin\theta)\sin\theta\cos\theta}{(1-\sin\theta)^2}+\frac{(1-\sin\theta)\sin\theta\cos\theta}{(1-\sin\theta)^2}$ or $\frac{1+\sin\theta}{1+\sin\theta}\times\frac{\sin\theta\cos\theta}{1-\sin\theta}+\frac{\sin\theta\cos\theta}{1+\sin\theta}\times\frac{1-\sin\theta}{1-\sin\theta}$

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Question	Answer	Marks	Partial marks	Guidance
6(a)	Correct, justified completion to given answer e.g. $\frac{2\sin\theta}{\cos\theta} = 2\tan\theta$ or $\tan\theta + \tan\theta\sin\theta + \tan\theta - \tan\theta\sin\theta = 2\tan\theta$ or $\frac{2\sin\theta\cos\theta}{\cos^2\theta} = 2\tan\theta$	**A1**		For the **first 2 marks** condone poorly expressed work e.g. omission of arguments, use of a mix of letters, things like $\sin\theta^2$ and allow recovery of omitted brackets. For the **last mark** condone **only the following errors:** • brackets missing in at most one step • the omission of the argument/use of the wrong letter if the work is **convincing** Do not condone **any** use of $\sin\theta^2$ or $\frac{\sin}{\cos}\theta$ for the final mark

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Question	Answer	Marks	Partial marks	Guidance
6(b)	$2\tan\theta = \cos\theta$ leading to $2\sin\theta = \cos^2\theta$ oe	**M1**		• $2\sin\theta = 1 - \sin^2\theta$ oe • Accept e.g. $\frac{2\sin\theta}{\cos^2\theta} = 1$
	$\sin^2\theta + 2\sin\theta - 1$ [= 0]	**A1**		• Writes in solvable form
	Solve *their* 3-term quadratic in $\sin\theta$ using the formula or completing the square e.g. $\frac{-2 \pm \sqrt{2^2 - 4[1](-1)}}{2}$ or $(\sin\theta + 1)^2 = 1 + 1$	**M1**		Attempt to solve *their* quadratic in form $ax^2 + bx + c = 0$ by: • quadratic formula – discriminant of FT equation must not be negative. Formula must be correct but condone one sign error in substitution. • completing the square – must get as far as $(x + \frac{b}{2})^2 = -\frac{c}{a} + \frac{b^2}{4}$ or equivalent, condone one sign error.
	$\sin\theta =$ $\frac{-2 \pm \sqrt{8}}{2}$ or $-1 + \sqrt{2}$ or 0.414[21…]	**A1**		• Condone 0.41
	$\theta =$ 24.5 or 24.46[98…] 155.5 or 155.53[01…] with no extras in $0° \leqslant \theta \leqslant 360°$ and no values of θ from $\sin\theta = -1 - \sqrt{2}$	**A1**		• Ignore extras outside $0° \leqslant \theta \leqslant 360°$
7	A $p = 2$ $q = 2$	**B1**		
	C $p = -1$ $q = 2$	**B1**		

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Question	Answer	Marks	Partial marks	Guidance
8(a)	36	**2**	**M1** for $2 \times 3 \times 3!$ or $2 \times {}^3P_3 \times 3$ oe	
8(b)(i)	80	**2**	**M1** for ${}^4C_1 \times {}^5C_4 + {}^4C_2 \times {}^5C_3$ or $4 \times 5 + 6 \times 10$	
8(b)(ii)	120	**2**	**M1** for ${}^9C_5 - {}^6C_5$ oe or ${}^3C_1 \times {}^6C_4 + {}^3C_2 \times {}^6C_3 + {}^3C_3 \times {}^6C_2$ oe	• e.g. 126 – 6 • e.g. 45 + 60 + 15

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Question	Answer	Marks	Partial marks	Guidance
9(a)	$y = \frac{250}{x^2}$ or $y = \frac{1000 + 250\sqrt{3}}{x^2(4+\sqrt{3})}$ oe, nfww	**B3**	**B2** for Volume: $\left(1 + \frac{\sqrt{3}}{4}\right)x^2 y$ oe or **B1** for Area triangle: $\frac{1}{2}x^2 \sin 60$ oe	• Do not accept use of decimals • For B3 accept e.g. $y = \frac{250 + 62.5\sqrt{3}}{x^2\left(\frac{4+\sqrt{3}}{4}\right)}$ • For B2 accept e.g. $y\left(x^2 + \frac{\sqrt{3}}{4}x^2\right)$ oe; may be embedded • For B1 accept e.g. $\frac{\sqrt{3}}{4}x^2$ or $\frac{1}{2} \times x \times \frac{\sqrt{3}}{2}x$; may be embedded • Must not be from working back
	$A = 5xy + 2\left(1 + \frac{\sqrt{3}}{4}\right)x^2$ oe	**M1**	must be in exact form with any trigonometric functions evaluated	• Correct expression for total area • Do not accept use of decimals
	$5x \times \frac{250}{x^2} + 2\left(1 + \frac{\sqrt{3}}{4}\right)x^2$ oe and correct completion to given answer $\left(2 + \frac{\sqrt{3}}{2}\right)x^2 + \frac{1250}{x}$	**A1**	or $2\left(x^2 + \frac{\sqrt{3}}{4}x^2\right) + 5x \times \frac{1000 + 250\sqrt{3}}{x^2(4+\sqrt{3})}$ and correct completion to given answer e.g. $\left(2 + \frac{\sqrt{3}}{2}\right)x^2 + 5x \times \frac{250(4+\sqrt{3})}{x^2(4+\sqrt{3})} =$ $\left(2 + \frac{\sqrt{3}}{2}\right)x^2 + \frac{1250}{x}$	• Must be convincing

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Question	Answer	Marks	Partial marks	Guidance
9(b)(i)	Correct first derivative $2\left(2+\frac{\sqrt{3}}{2}\right)x-1250x^{-2}$ oe, isw	**B1**		• Accept e.g. $\left(4+\sqrt{3}\right)x-\frac{1250}{x^2}$ oe
	$2\left(2+\frac{\sqrt{3}}{2}\right)x-1250x^{-2}=0$ and solves for x	**M1**	**FT** *their* first derivative = 0 providing at least one term is correct	• Must get as far as a value for x even if there are errors in the method of solution
	$x = 6.019[1\ldots]$	**A1**		• Accept $\sqrt[3]{\frac{1250}{4+\sqrt{3}}}$ • Condone 6.02 or 6
	$A =$ $\left(2+\frac{\sqrt{3}}{2}\right)6.019[1\ldots]^2+\frac{1250}{6.019[1\ldots]}$ oe	**M1**	**dep** previous **M1** **FT** *their* x providing *their* $x > 0$	• If FT evidence of substitution must be seen
	312 or 311.5[07…]	**A1**		
9(b)(ii)	$\frac{\mathrm{d}^2A}{\mathrm{d}x^2}=2\left(2+\frac{\sqrt{3}}{2}\right)+2500x^{-3}$ oe	**M1**	**FT** *their* first derivative providing of the form $ax+\frac{b}{x^2}$	• Accept e.g. $4+\sqrt{3}+\frac{2500}{x^3}$
	$\left.\frac{\mathrm{d}^2A}{\mathrm{d}x^2}\right\|_{x=6.02} > 0$ [minimum] or $\frac{\mathrm{d}^2A}{\mathrm{d}x^2} = 17.2$ or 17.19[6…] [minimum]	**A1**	**dep** on $x = 6.02$ or 6.019[1…]	• This statement, or equivalent, is all that is required • Condone e.g. $\frac{\mathrm{d}^2y}{\mathrm{d}x^2} > 0$ when $x = 6.02$, [minimum] • Condone use of $x = 6.02$, or $x = 6$ if they go on to use it to find A

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Question	Answer	Marks	Partial marks	Guidance
10(a)	$2x\cos(2x-3)+\sin(2x-3)$ oe, isw	**2**	**M1** for correct structure of the product rule	• Sum with u and v correct, du and dv may be incorrect • Allow $x\sin(2x+3)$ as a misread if not contradicted in **(b)**
10(b)	$\frac{1}{2}\left[x\sin(2x-3)+\frac{1}{2}\cos(2x-3)\right]_0^{\frac{1}{2}}$ oe	**B2**	**B1** for $\frac{1}{2}\left[x\sin(2x-3)\right]_0^{\frac{1}{2}}-\frac{1}{2}\int_0^{\frac{1}{2}}\sin(2x-3)\mathrm{d}x$ oe	• Ignore limits for these 2 marks • May be in steps • dependent on a correct derivative
	$\frac{1}{2}\left[\frac{1}{2}\sin(-2)+\frac{1}{2}\cos(-2)-\frac{1}{2}\cos(-3)\right]$ oe	**M1**	**FT** *their* expression of the form $\left[\frac{1}{2}\right]x\sin(2x-3)+k\cos(2x-3)$ where k is a constant	• May be in steps • $\frac{1}{4}\left(\sin(-2)+\cos(-2)-\cos(-3)\right)$ • –0.2273… + –0.1040… – –0.2474… • If FT evidence of substitution must be seen
	= −0.0839 or –0.08386[29…] nfww	**A1**		

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Question	Answer	Marks	Partial marks	Guidance
11(a)	$ar^n - ar^{n-1} = \frac{1}{6}\left(ar^{n+2} - ar^n\right)$ oe	**M1**		• Accept e.g $r^n - r^{n-1} = \frac{1}{6}\left(r^{n+2} - r^n\right)$ • Note: Beware 'correct answer' from e.g $ar^{n+1} - ar^n = \frac{1}{6}\left(ar^{n+3} - ar^{n+1}\right)$ M0 XP
	$(r-1) = \frac{1}{6}r(r-1)(r+1)$ nfww or $r^3 - 7r + 6 = 0$ nfww	**A2**	**A1** for dividing by or factoring out ar^n oe e.g. $r - 1 = \frac{1}{6}\left(r^3 - r\right)$ oe nfww or $7 - \frac{6}{r} - r^2 = 0$ oe nfww or $ar^{n-1}(7r - 6 - r^3) = 0$ oe, nfww	
	Correct completion to given answer e.g. $6 = r(r+1)$ $r^2 + r - 6 = 0$ nfww or $(r-1)(r^2 + r - 6) = 0$ $[r \neq 1]$ therefore $r^2 + r - 6 = 0$ nfww	**A1**		
11(b)	$(r-2)(r+3) = 0$	**M1**		Attempt to solve *their* quadratic in form $ax^2 + bx + c = 0$ by: • factorising – factorisation must result in correct a and c for FT equation, or scaled form of FT equation. • quadratic formula – discriminant of FT equation must not be negative. Formula must be correct but condone one sign error in substitution. • completing the square – must get as far as $(x + \frac{b}{2})^2 = -\frac{c}{a} + \frac{b^2}{4}$ or equivalent, condone one sign error.

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Question	Answer	Marks	Partial marks	Guidance
	$r = 2$ and no other value, nfww	**A1**		• rejection of $r = –3$ is implied by it not being used unless they restate it as part of *their* final answer
	Correct factorised expression e.g. $2^k\left(2-\frac{1}{2}\right) = 48$ or $2^{k-1}(2^2 - 1) = 48$ or $2^{k+1}(1 - 2^{-2}) = 48$	**M1**		• Free from a • Accept e.g. $2^{k-1} = 16$ or $2^{k+1} = 64$
	$k = 5$	**A1**		
12	$1 + \cot^2 2x + 2\cot 2x = 1$ oe	**B1**		• Accept e.g. $1+\frac{1}{\tan^2 2x}+\frac{2}{\tan 2x}=1$ oe • Accept $1 + 2\cos 2x \sin 2x = 1 – \cos^2 2x$
	$\cot 2x(\cot 2x + 2)$ [= 0] oe	**B1**		• Accept e.g. $\frac{1}{\tan 2x}\left(\frac{1}{\tan 2x}+2\right)[=0]$ • Accept $\cos 2x(2\sin 2x + \cos 2x) = 0$ • Do not accept $\tan 2x(\tan 2x + 2) = 0$ • May state and use a substitution
	$\cot 2x = 0$ oe	**B1**		• Accept e.g. $\cos 2x = 0$ or $\frac{1}{\tan 2x} = 0$ • Accept $\cot 2x = 0$ followed by $\tan 2x = 0$ • Do not accept $\tan 2x = 0$ only • May state and use a substitution
	$\cot 2x = –2$ oe	**B1**		• Accept e.g. $\frac{1}{\tan 2x} = –2$ or $\tan 2x = -\frac{1}{2}$ • May state and use a substitution

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Question	Answer	Marks	Partial marks	Guidance
	Any one correct value of $2x$: $\frac{\pi}{2}$ or $-\frac{\pi}{2}$ or 2.677[9…] or −0.463[6…]	**M1**		• Implied by one correct answer • May be 2sf or more in radians • Candidates **working in degrees** do not earn any method marks until they convert their values to radians.
	[x =] $\frac{\pi}{4}$, $-\frac{\pi}{4}$, 1.34 or 1.338[97…], −0.232 or –0.2318[2…] and no extras in $-\frac{\pi}{2} \leqslant x \leqslant \frac{\pi}{2}$	**A2**	**A1** for any two correct answers, ignoring extras	• Note: e.g. B1 B0 B0 B1 M1 A1 is possible • Ignore extras outside $-\frac{\pi}{2} \leqslant x \leqslant \frac{\pi}{2}$ whether correct or not

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