Cambridge Assessment International Education

Cambridge O Level

ADDITIONAL MATHEMATICS **4037/02**

Paper 2 Calculator **For examination from 2025**

MARK SCHEME

Maximum Mark: 80

Specimen

This document has **10** pages.

© Cambridge University Press & Assessment 2022

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 descriptions for the question
- the specific skills defined in the mark scheme or in the generic level descriptions 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 descriptions.

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).

© Cambridge University Press & Assessment 2022

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 descriptions 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.

© Cambridge University Press & Assessment 2022

MARK SCHEME NOTES

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

Anything in the mark scheme which is in square brackets […] is not required for the mark to be earned, but if present it must be correct.

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.

Types of mark

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

A Accuracy mark, given 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.

Abbreviations

awrt	answers which round to
cao	correct answer only
dep	dependent on the previous mark(s)
FT	follow through after error
isw	ignore subsequent working (after correct answer obtained)
nfww	not from wrong working
oe	or equivalent
rot	rounded or truncated
SC	special case
soi	seen or implied

© Cambridge University Press & Assessment 2022

Question	Answer	Marks	Partial Marks
1(a)	$x = 2, x = \frac{4}{5}$ oe	3	**B1** for $x = 2$ **M1** for $5x - 7 =$ *their* (-3) oe, soi or $25x - 35 =$ *their* (-15) oe, soi **A1** for $x = \frac{4}{5}$ oe Alternative method **B1** for $25x^2 - 70x + 40 = 0$ oe **M1** for factorising e.g. $(5x - 4)(x - 2)$ **A1** for $x = 2, \frac{4}{5}$
1(b)	Finds three correct critical values: -1.5 to -1.4 inclusive -0.4 0.8 to 0.9 inclusive	B1	
	A correct pair of inequalities: $x \leqslant -1.45$ and $-0.4 \leqslant x \leqslant 0.85$	B2	**B1** for either inequality correct
2	$m = \frac{9-5}{8-6}$ oe	M1	
	$9 =$ *their* $2(8) + c$ oe or $5 =$ *their* $2(6) + c$ oe or $Y - 9 =$ *their* $2(X - 8)$ oe or $Y - 5 =$ *their* $2(X - 6)$ oe	M1	
	$\ln y = 2\ln x - 7$	A1	
	Correct completion to answer: $y = e^{\ln x^2 - 7} = e^{-7}x^2$ nfww	A1	
	Alternative $\ln y = p + q\ln x$ soi	(B1)	
	$m = \frac{9-5}{8-6}$ oe	(M1)	
	$9 =$ *their* $2(8) + c$ oe or $5 =$ *their* $2(6) + c$	(M1)	
	$y = e^{-7}x^2$	(A1)	

© Cambridge University Press & Assessment 2022

Question	Answer	Marks	Partial Marks
3	Uses $b^2 - 4ac$: $6^2 - 4(2k - 1)(k + 1)$	**M1**	
	$-8k^2 - 4k + 40$[*0 where * is = or any inequality sign] oe	**M1**	**dep** on first **M1** Condone one sign or arithmetic slip in simplification
	Factorises or solves *their* 3-term quadratic expression or equation for critical values	**M1**	e.g. $(5 + 2k)(8 - 4k)$ oe
	Finds correct critical values: –2.5 oe, 2	**A1**	
	$-2.5 \leqslant k \leqslant 2$	**A1**	mark final answer
4(a)(i)	$3 \times 10! \times 4$	**M1**	
	43 545 600 oe	**A1**	
4(a)(ii)	$5! \times 8 \times 7!$ oe	**M1**	
	4 838 400 oe	**A1**	
4(b)(i)	${}^9C_3$	**M1**	
	84	**A1**	
4(b)(ii)	${}^3C_1 \times {}^4C_1 \times {}^5C_1$ oe	**M1**	
	60	**A1**	
5	$\frac{dy}{dx} = \sec^2 x$	**B1**	
	$\frac{\delta y}{h} = \textit{their} \left.\frac{dy}{dx}\right\|_{x=-\frac{\pi}{4}}$	**M1**	
	$2h$	**A1**	

© Cambridge University Press & Assessment 2022

Question	Answer	Marks	Partial Marks
6	$\frac{dy}{dx} = \frac{1}{5-3x} \times -3$	**M2**	**M1** for $\frac{dy}{dx} = \frac{k}{5-3x}$, $k \neq -3$
	$\left.\frac{dy}{dx}\right\|_{x=-5} = -\frac{3}{20}$	**A1**	
	$y = \ln 20$ isw or 2.9957…	**B1**	
	$m_{\perp} = \frac{20}{3}$ oe	**M1**	**FT** $-\frac{1}{their\left(-\frac{3}{20}\right)}$
	$y - \ln 20 = \frac{20}{3}(x+5)$ oe, isw or $y - 2.9957\ldots = 6.67(x+5)$ oe, isw	**A1**	**FT** *their y* and *their* perpendicular gradient
	–5.45 or –5.449[35…] rot to 4 or more significant figures	**A1**	
7(a)(i)	$(x-8)^2 + (y-5)^2 - 64 - 25 + 73 = 0$ oe	**M1**	
	(8, 5)	**A1**	
	$r = 4$	**A1**	
	Alternative Centre (8, 5)	**(B1)**	
	$r = \sqrt{(-8)^2 + (-5)^2 - 73}$ oe	**(M1)**	
	$r = 4$	**(A1)**	
7(a)(ii)	[Distance between (10, 6.5) and centre =] $\sqrt{(10-8)^2 + (6.5-5)^2}$	**M1**	**FT** *their* (8, 5)
	[Distance between (10, 6.5) and centre < radius] 2.5 oe < 4	**A1**	
7(b)	[$r_2 - r_1$ =] 4 – 1.5 = 2.5 [= distance between centres]	**B1**	
8(a)(i)	Uses correct Pythagorean identity in the left-hand side of the given identity e.g. $\frac{1-\sin^2 2x}{1+\sin 2x}$	**M1**	
	$\frac{(1-\sin 2x)(1+\sin 2x)}{1+\sin 2x}$ oe and completion to given answer	**A1**	

© Cambridge University Press & Assessment 2022

Question	Answer	Marks	Partial Marks
8(a)(ii)	$\sin 2x = \frac{2}{3}$	**M1**	
	$x = \frac{1}{2}\sin^{-1}\left(\frac{2}{3}\right)$ soi	**M1**	**dep** on first **M1**
	20.9 or 20.905… rounded or truncated to 4 or more figures and 69.1 or 69.094… rounded or truncated to 4 or more figures	**A2**	with no incorrect values in range **A1** for either angle correct, ignoring extra values
8(b)	$\tan\left(y - \frac{\pi}{2}\right) = \frac{1}{\sqrt{3}}$ soi	**M1**	
	$y = \frac{\pi}{6} + \frac{\pi}{2}$	**M1**	**dep** on first **M1**
	$\frac{2}{3}\pi$ oe or 2.09 or 2.094[39…] rot to 4 or more sig figs	**A1**	with no incorrect values in range
9(a)	[radius =] $\sqrt{8^2 + 15^2}$ or 17	**B1**	
	[angle AOB =] $\pi - 2\tan^{-1}\frac{8}{15}$ oe or $\cos^{-1}\left(\frac{17^2 + 17^2 - 30^2}{2 \times 17 \times 17}\right)$ oe	**M1**	**FT** *their* 17 if necessary
	2.16[167…]	**A1**	
	$8 + 8 + 30 + 17 \times 2.16[167\ldots]$	**M1**	**FT** *their* 17 and *their* 2.16[167…]
	82.7[485…]	**A1**	
9(b)	Complete correct plan including use of $\frac{1}{2}r^2\theta$	**M1**	
	432[.362…]	**A1**	

© Cambridge University Press & Assessment 2022

Question	Answer	Marks	Partial Marks
10(a)	Identifies the correct term: ${}^5C_2 \times (2k)^3 \times \left(-\frac{1}{k}\right)^2$ [$\times x^2$] oe, soi	**B1**	
	$10 \times \frac{8k^3}{k^2} = 160$ soi	**M1**	**FT** only for correct term with bracketing errors; condone one slip.
	$k = 2$ nfww	**A1**	
10(b)(i)	$1 + 18x + 135x^2$	**B2**	**B1** for any 2 terms correct or for all 3 correct terms listed but not summed or **M1** for a correct unsimplified expansion, e.g.: $1 + 6(3x) + 15(3x)^2$
10(b)(ii)	Uses constant/coefficient of x to find $a = -2$ only	**B2**	**B1** for both $a = 2$ and -2 or for both $a = \frac{17}{9}$ and -2
	$b = 469$ only	**B1**	**FT** *their* calculated value of a
11(a)	$y = \frac{30}{x^2}$ oe	**B1**	
	$S = \pi x\sqrt{x^2 + \left(their\ \frac{30}{x^2}\right)^2}$	**M1**	**FT** *their* $\frac{30}{x^2}$ providing $10\pi = \frac{1}{3}\pi x^2 y$ was attempted
	Correct completion to given answer	**A1**	

© Cambridge University Press & Assessment 2022

Question	Answer	Marks	Partial Marks
11(b)	$\frac{\mathrm{d}([\pi]\sqrt{x^6+900})}{\mathrm{d}x} = [\pi \times]\ \frac{1}{2}(x^6+900)^{-\frac{1}{2}} \times 6x^5$	**B2**	**B1** for $[\pi \times]\ (x^6+900)^{-\frac{1}{2}}$, $k \neq 3$ or 0
	Applies correct form of quotient or product rule, e.g.: $\frac{\pi x\left(3x^5(x^6+900)^{-\frac{1}{2}}\right) - \pi(x^6+900)^{\frac{1}{2}}}{x^2}$ or $-\pi x^{-2}(x^6+900)^{\frac{1}{2}} + \frac{\pi}{x}\left(3x^5(x^6+900)^{-\frac{1}{2}}\right)$	**M1**	**FT** *their* $\frac{\mathrm{d}([\pi])\sqrt{x^6+900})}{\mathrm{d}x}$
	their $\frac{\mathrm{d}S}{\mathrm{d}x} = 0$ and attempt to solve	**M1**	**dep** on previous **M1**
	2.77 or 2.768[2…] rot to 4 or more sig figs or $\sqrt[6]{450}$ isw	**A1**	
12	x coordinate of $A = 6$ soi	**B1**	
	x coordinate of $B = 9$ soi	**B1**	
	$k - 3 = (9 - k)(k - 3)$	**M1**	
	$k = 8$ [therefore $C(8, 5)$]	**A1**	
	$(8 - 6) \times 5$ or 10 oe soi	**B1**	
	$\left[\mathrm{F}(x) = \int_{\textit{their } 8}^{\textit{their } 9} (12x - 27 - x^2)\,\mathrm{d}x = \right] \frac{12}{2}x^2 - 27x - \frac{x^3}{3}$	**M2**	**M1** for 2 correct terms
	their 10 + F(*their* 9) – F(*their* 8)	**M1**	**dep** on at least **M1** for integration
	$\frac{38}{3}$ or $12\frac{2}{3}$ or 12.7 or 12.66[66...] rot to 4 or more sig figs nfww	**A1**	

© Cambridge University Press & Assessment 2022