MATHEMATICS (US)	**0444/41**
Paper 4 (Extended)	**May/June 2023**
MARK SCHEME	
Maximum Mark: 130	

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 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **9** printed pages.

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 descriptors 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.

	Maths-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, 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 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 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.

Abbreviations

cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
oe	or equivalent
SC	Special Case
nfww	not from wrong working
soi	seen or implied
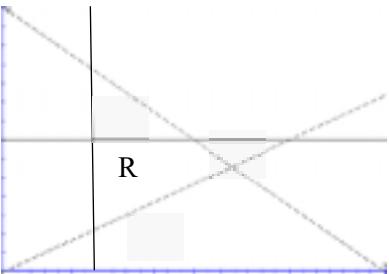
Question	Answer	Marks	Partial Marks
1(a)(i)	9	**1**	
1(a)(ii)	8	**1**	
1(a)(iii)	7.47 or 7.466 to 7.467 or $7\frac{7}{15}$.	**3**	**M2** for $\dfrac{2\times4+4\times5+3\times6+5\times7+5\times8+7\times9+4\times10}{30}$ or **M1** for $2\times4+4\times5+3\times6+5\times7+5\times8+7\times9+4\times10$
1(b)	93.3 or 93.33... or $93\frac{1}{3}$	**1**	
1(c)	7	**2**	**M1** for $\dfrac{30}{100}\times30$
1(d)	$\dfrac{42}{145}$ oe	**3**	**M2** for $[2]\times\dfrac{6}{30}\times\dfrac{21}{29}$ oe or **M1** for $\dfrac{6}{30}$ or $\dfrac{21}{29}$ or $\dfrac{6}{29}$ or $\dfrac{21}{30}$ seen If 0 scored **SC1** for answer $\dfrac{7}{25}$, $\dfrac{63}{145}$ or $\dfrac{48}{145}$
2(a)(i)	600	**2**	**M1** for $\dfrac{1250}{12+9+4}\times k$ where $k=1,4,9,12$ oe
2(a)(ii)	80	**2**	**M1** for 1250×64 [÷ 1000]
2(a)(iii)	60	**2**	**M1** for $x\times\left(1-\dfrac{10}{100}\right)=5$ oe
2(a)(iv)	1000	**2**	**M1** for $1250-(1250\div5)$ oe or **B1** for 250
2(b)(i)	3.52	**2**	**M1** for $[10-]\,12\times0.54$ or **B1** for 6.48
2(b)(ii)	0.08	**3**	**B2** for 0.077[4...] or **M1** for $0.51\div0.826$ If 0 or 1 scored award instead **SC2** for 0.93 final answer OR If 0 scored **SC1** for 0.06 as answer
3(a)	136 or 136.0...	**3**	**M2** for $938\times145\times\dfrac{1000}{1000\,000}$ oe or **M1** for figs 136 or 13601

Question	Answer	Marks	Partial Marks
3(b)	3.02 or 3.020 to 3.021	3	**M2** for $\frac{1}{2} \times 6.4 \times EM \times 15 = 145$ oe or **M1** for $\frac{145}{15}$ or for $\frac{1}{2} \times 6.4 \times EM \times 15$ oe
3(c)	32[.0] or 31.99 to 32.01	2	**M1** for $\sin = \frac{their\ \textbf{(b)}}{5.7}$
3(d)	3.4[0] or 3.401 to 3.403...	3	**M2** for $\sqrt{6.4^2 + 5.7^2 - 2 \times 6.4 \times 5.7 \times \cos(their\ \textbf{(c)})}$ OR **M1** for $6.4^2 + 5.7^2 - 2 \times 6.4 \times 5.7 \times \cos(their\ \textbf{(c)})$ **A1** for 11.56 to 11.58...
3(e)	252 or 251.8 to 251.9	3	**M1** for 6.4×15 or 5.7×15 or *their* (d) $\times 15$ **M1** for $[2 \times] \frac{145}{15}$ or $\left[2 \times\right] \frac{1}{2} \times 6.4 \times their\ \textbf{(b)}$
4(a)	(5, 2) (2, −2)	4	**B3** for 3 correct values or answers for C and D reversed or correct coordinates given on diagram wrongly labelled or **B2** for one correct coordinate pair correctly labelled or **M2** for A, B, C and D correctly plotted or **M1** for A and B correctly plotted If 0 or 1 scored instead award **SC2** for answers (−3, 8) and (−6, 4) or answers (1.5, 1.5) and (−2.5, 4.5)
4(b)(i)	(2.5, 3.5) oe	2	**B1** for each
4(b)(ii)	7.07 or 7.071...	3	**M2** for $(6 - -1)^2 + (4 - 3)^2$ oe or **M1** for $(6 - -1)$ or $(4 - 3)$ oe
4(b)(iii)	$\frac{1}{7}$	2	**M1** for $\frac{4 - 3}{6 - -1}$ oe
4(b)(iv)	$y = \frac{1}{7}x - \frac{2}{7}$ or $7y = x - 2$ oe final answer	3	**M1** for gradient = *their* **(iii)** **M1dep** for substituting (2, 0) in a linear equation with *their m* allow if (2, 0) satisfies $y = (their\ \textbf{(b)(iii)}$ gradient$)\ x + c$
5(a)	204 or 204.2...	3	**M2** for $\pi \times 5 \times \sqrt{5^2 + 12^2}$ **M1** for $5^2 + 12^2$

Question	Answer	Marks	Partial Marks
5(b)	622 or 622.0 to 622.1....	2	**M1** for $[\frac{1}{2}\times]\pi\times 6^2\times 11$ or $\frac{1}{2}\times\pi\times 6^2[\times 11]$
5(c)(i)	246 or 246.2 to 246.3...	5	**M4** for $15\times 20 - 4\times 4 - \frac{270}{360}\times\pi\times 4^2$ oe OR **M2** for $\frac{270}{360}\times\pi\times 4^2$ oe or **M1** for $k\times\pi\times 4^2$, where $k \leqslant 1$ **M1** for 15×20 or 4×4 oe
5(c)(ii)	80.8 or 80.9 or 80.84 to 80.85...	3	**M1** for $15+20+11+16$ oe **M1** for $\frac{3}{4}\times 2\times\pi\times 4$ oe
6(a)(i)	25	1	
6(a)(ii)	17 to 18	1	
6(a)(iii)	12	2	**B1** for 148 seen
6(a)(iv)	30	2	**B1** for 104 seen
6(b)(i)	36.4 or 36.44 to 36.45	4	**M1** for 3 of 10, 25, 40, 65 correct **M1** for Σfx where x is in correct class interval or on boundary **M1 dep** for $\frac{\Sigma fx}{52+37+24+60}$ **dep** on second M1
6(b)(ii)	correct histogram	3	**B1** for each correct block width 10 height 3.7 width 20 height 1.2 width 30 height 2 If 0 scored **SC1** for correct frequency densities 3.7, 1.2, 2 oe
7(a)	−7	1	
7(b)	$\frac{x-5}{2}$ oe final answer	2	**M1** for correct first step e.g. $x=2y+5$ or $2x=y-5$ or $\frac{y}{2}=x+\frac{5}{2}$

Question	Answer	Marks	Partial Marks
7(c)	$\dfrac{1}{27} \leqslant \mathrm{h}(x) \leqslant 243$ oe	2	**B1** for $\dfrac{1}{27}$ or 243 in correct place on answer line or for answers reversed $\dfrac{1}{27} \leqslant \mathrm{h}(x)$ or $\mathrm{h}(x) \leqslant 243$ seen in working or $\dfrac{1}{27}$ **and** 243 seen
7(d)	$2x^2 - 5x - 21$ final answer	4	**M2** for $(x-4)(2x+5) - (2x+5-4)$ oe or **M1** for $(2x+5-4)$ or $-\left(2x+5-4\right)$ or better **B1** for 3 of the 4 terms correct in $2x^2 - 8x + 5x - 20$ oe
7(e)	0	2	**M1** for $\mathrm{g}(-2)$ or $2(x-4)+5$ oe or $3^x = 1$ or $\mathrm{g}(\mathrm{f}(2)) = 1$
7(f)	$\dfrac{1}{9}$ or $0.\dot{1}$ cao	2	**M1** for $x = \mathrm{h}(-2)$ or 3^{-2} or better seen
8(a)(i)	299	1	
8(a)(ii)	119	2	**FT** *their* **(i)** – 180 **M1** for *their* **(i)** – 180 oe or + 180 if *their* **(a)(i)** between 0 and 180
8(b)	109.9 or 109.94 to 109.95	4	**B3** for [angle $C =$] 41.1 or 41.05 to 41.06 OR **M2** for $\dfrac{42\sin 29}{31}$ or **M1** for $\dfrac{31}{\sin 29} = \dfrac{42}{\sin C}$ oe **M1** for $180 - 29 - \textit{their } C$
9(a)(i)	$3(3y-1)(3y+1)$ final answer	3	**B2** for $(9y-3)(3y+1)$ or $(3y-1)(9y+3)$ or or **M1** for $3(9y^2-1)$ or $[...]\,(3y-1)(3y+1)$ if 0 scored **SC1** for an otherwise correctly completely factorised expression but with fractions within the brackets
9(a)(ii)	$(2-p)(m+k)$ final answer	2	**M1** for $2(m+k) - p(m+k)$ or $m(2-p) + k(2-p)$

Question	Answer	Marks	Partial Marks
9(b)	$\dfrac{3x+7}{(x+1)(x-1)}$ oe final answer	4	**B2** for $3x+7$ seen or **M1** for $(x-1)(x-1)+5(x+1)-(x-1)(x+1)$ oe **M1** for common denominator $(x-1)(x+1)$ or x^2-1 If 0 scored **SC1** for $\dfrac{x^2+3x+6}{(x+1)(x-1)}$
9(c)	$\dfrac{-(-3)\pm\sqrt{(-3)^2-4(4)(-2)}}{2\times4}$	M2	**M1** for $\sqrt{(-3)^2-4(4)(-2)}$ or for $\dfrac{-(-3)+\sqrt{q}}{2(4)}$ or $\dfrac{-(-3)-\sqrt{q}}{2(4)}$ or for $[4]\left(x-\dfrac{3}{8}\right)^2$
	−0.43 and 1.18 final ans cao	A2	**B1** for each **SC1** for −0.4, −0.42 or −0.425... and 1.2 or 1.17 or 1.175... or answers 0.43 and −1.18 or −0.43 and 1.18 seen in working
10(a)	$k=\dfrac{4m}{1-pm}$ or $k=\dfrac{-4m}{pm-1}$ final answer	4	**M1** for clearing fractions **M1** for collecting terms in k **M1** for factorising **M1** for dividing by bracket Maximum 3 marks if answer incorrect
10(b)	±6	3	**B2** for $[x=]$ 6 or $[x=]$ −6 or **M1** for $x^2+64=10^2$ or better
10(c)(i)	$(x+5)^2-28$ final answer	2	**M1** for $(x+5)^2$
10(c)(ii)	−28	1	**FT** *their* −28 provided **(c)(i)** in form $(x+a)^2+b$ $a\neq0$, $b\neq0$
11(a)	$y\leqslant7$ oe $xy<14$ oe $y>\dfrac{2}{3}x$ oe	3	**B1** for each
11(b)	$x=4$ solid $y=7$ solid $x+y=14$ dashed $y>\dfrac{2}{3}x$ dashed	M4	**B1** for each

Question	Answer	Marks	Partial Marks
	correct shading everywhere but region R	**A2**	**M1dep** (dependent on M4 or B1B1B1B0 where the only error is wrong use of solid/dashed lines) for shading the correct side of 3 of the 4 lines.