Cambridge Assessment International Education

Cambridge O Level

MATHEMATICS (SYLLABUS D) **4024/22**

Paper 2 **October/November 2023**

MARK SCHEME

Maximum Mark: 100

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 October/November 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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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.

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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.

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

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Question	Answer	Marks	Partial Marks
1(a)(i)	105[.00]	**2**	**M1** for 56 + 4 × 12.25 oe
1(a)(ii)	5.45 [pm] or 17 45	**3**	**B2** for answer 4.45 [pm] or 16 45 or for 3.25 [hours] soi or for 3.30[pm] and 2.25 [hours] oe for 4.30 [pm] and 1.25 [hours] oe or **M1** for $\frac{166.25-56}{12.25}$ [×15] oe or $\frac{166.25-105}{12.25}$ [×15] oe
1(b)	432.47	**3**	**M2** for $6200\times\left(1+\frac{1.7}{100}\right)^4\left[-6200\right]$ oe or **M1** for $6200\times\left(1+\frac{1.7}{100}\right)^k$ oe where $k > 1$
1(c)	927.38 cao	**3**	**M2** for $\frac{760}{0.84}\times\left(1+\frac{2.5}{100}\right)$ oe or **M1** for $A \div 0.84$ or $A \times 1.19[0\ldots]$ or $A\times\left(1+\frac{2.5}{100}\right)$ oe
2(a)(i)	156	**2**	**M1** for $\left[180-\right]\frac{360}{15}$ oe or $180(15-2)$ [/15] oe
2(a)(ii)	144	**2**	**M1** for $\frac{180-their156}{2}$ oe soi where 90 < *their* 156 <180

Question	Answer	Marks	Partial Marks
2(b)	$\angle ADC = 114$ with complete reasons eg $\angle ACB = 90$, angle in semicircle $\angle ABC = 66$, sum of angles in triangle $\angle ADC = 114$, [angles in] opposite segments [are supplementary] OR $\angle ADB = 90$, angle in semicircle $\angle BDC = 24$, [angles in] same segment [are equal] $\angle ADC = 114$	**4**	**B2** for $\angle ADC = 114$ nfww or **B1** for $\angle ACB = 90$ or $\angle ABC = 66$ or $\angle ADB = 90$ or $\angle BDC = 24$ AND **B2** for complete reasons for a correct method to find $\angle ADC$ or **B1** for reason 'angle in semicircle' or '[angles in] opposite segments [are supplementary]' or '[angles in] same segment [are equal]' correctly linked with the appropriate angles Max 3 marks if any incorrect angles or reasons
3(a)(i)	240	**2**	**M1** for $\frac{90}{135}[\times 360]$ oe or $\frac{360}{135}[\times 90]$ oe
3(a)(ii)	$\frac{5}{24}$ cao	**2**	**M1** for $\frac{75}{360}$ oe or $\frac{360-60-135-90}{360}$ oe
3(b)(i)	Correct histogram	**3**	**B2** for 3 correct bars or **B1** for 2 correct bars or 3 or more correct frequency densities soi
3(b)(ii)	46.7 or 46.66 to 46.67 or $46\frac{2}{3}$	**2**	**B1** for 28 seen or **M1** for $\frac{6+15+7}{60}[\times 100]$ oe If 0 scored, **SC1** for 53.3[3…] oe
4(a)	–3	**2**	**M1** for isolating x-terms $5x - 3x = -6$ oe
4(b)	$n + 2n + 2n + 50 = 450$ oe	**B1**	
	80	**B2**	**M1FT** for correct rearrangement to $an = b$

Question	Answer	Marks	Partial Marks
4(c)	$(x+3)(x-7)$ [= 0]	**B2**	**B1** for brackets giving two out of three terms correct or for $x(x+3)-7(x+3)$ or $x(x-7)+3(x-7)$
	–3 7	**B1**	If B1 or 0 scored, **SC1** for $(x + s)(x + t)$ [=0] leading to $x = –s$, $x = –t$ where $s = \pm 3$ and $t = \pm 7$
5(a)(i)	$\frac{12}{40}$ oe	**1**	
5(a)(ii)	60	**1**	**FT** *their* $\frac{12}{40} \times 200$
5(b)(i)	Correct tree diagram $\frac{7}{16}$ on first branch $\frac{7}{15}$, $\frac{9}{15}$ oe , $\frac{6}{15}$ oe on second branches	**2**	**B1** for two or three probabilities correct
5(b)(ii)	$\frac{19}{40}$ oe	**2**	**M1** for one correct product: $\frac{9}{16} \times \frac{8}{15}$ oe or *their* $\frac{7}{16} \times$ *their* $\frac{6}{15}$ oe
6(a)(i)	0.1 oe	**1**	
6(a)(ii)	Correct smooth curve	**3**	**B2FT** for 6 or 7 points correctly plotted or **B1FT** for 4 or 5 points correctly plotted
6(a)(iii)	Reading *their* graph at $y = 5$	**1**	**Strict FT** *their* graph
6(a)(iv)	Tangent drawn at (2, 1.6)	**B1**	Dependent on curve drawn between $x = 1.5$ and $x = 2.5$
	1.7 to 2.5	**B1**	Dependent on close attempt at tangent
6(b)	[a =] –7 [b =] 10	**3**	**B2** for [y =] $x^2 – 7x + 10$ seen OR **M1** for $(x-2)(x-5)$ oe or $2a+b=–4$ oe **and** $5a+b=–25$ oe or $2 \times 5 = \frac{b}{1}$ oe **and** $2+5=\frac{-a}{1}$ oe **B1** for one correct
7(a)(i)	(–2, 4) (–2, –1) ✓ (–1, –2) (6, 1) ✓ (–4, 6)	**2**	**B1** for each

Question	Answer	Marks	Partial Marks
7(a)(ii)	$\begin{pmatrix}5\\3\end{pmatrix}$	**1**	
7(a)(iii)	11.7 or 11.66…	**3**	**M2** for $(2\times their\ 5)^2+(2\times their\ 3)^2$ oe or $2\sqrt{(their\ 5)^2+(their\ 3)^2}$ oe or **M1** for $\left[\overrightarrow{DB}=\right]\begin{pmatrix}2\times their\ 5\\2\times their\ 3\end{pmatrix}$ or for $(their\ 5)^2+(their\ 3)^2$ oe After 0 scored, **SC1** for (–9, –2) seen
7(b)	(22, 0)	**4**	**B1** for gradient = $-\frac{1}{4}$ oe **M1** for substituting (6, 4) in $y=\left(their\left(-\frac{1}{4}\right)\right)x+c$ oe **M1** for substituting $y = 0$ in $y=\left(their\left(-\frac{1}{4}\right)\right)x+k$, where k is numerical If 0 scored, **SC1** for answer (5, 0)
8(a)	$(x-6)(4x-6)=80$ oe	**M2**	**B1** for $x-6$ or $4x-6$ seen
	$4x \times x - 80 = 3x+3x+4x\times3+4x\times3-4\times3\times3$ oe		**B1** for $4x \times x - 80$ oe
	$4x^2-24x-6x+36[=80]$	**M1**	**FT** expansion of $(4x - c)(x - d)$
	$4x^2 - 80 - 3x - 3x - 12x - 12x = -36$ oe		**FT** dep on a maximum of one omission or a numerical error in previous equation
	Correct simplification to $2x^2-15x-22=0$	**A1**	**A0** if any errors or omissions

Question	Answer	Marks	Partial Marks
8(b)	$\frac{-(-15)\pm\sqrt{(-15)^2-4\times2\times-22}}{2\times2}$ oe or $\frac{-(-15)}{2\times2}\pm\sqrt{\left(\frac{-15}{2\times2}\right)^2-\left(\frac{-22}{2}\right)}$	**B2**	**B1** for $\sqrt{(-15)^2-4\times2\times-22}$ oe or for $\frac{-(-15)\pm\sqrt{their\ \text{discriminant}}}{2\times2}$ or for $\left(x+\frac{-15}{2\times2}\right)^2$
	–1.26 and 8.76	**B1**	
8(c)	227 or 226.6 to 226.9…	**2**	**M1** for $(their\ 8.76)\times(4\times their\ 8.76)-80$ oe or $30\times their\ 8.76-36$ oe
9(a)(i)	15 cao	**3**	**M2** for $\frac{2\times450+2\times210}{5.2}\times\frac{60}{1000}$ oe or **M1** for $\frac{2\times450+2\times210}{5.2}$ oe isw or for (450 + 210) ÷ 5.2 × $\frac{60}{1000}$
9(a)(ii)	$180+\tan^{-1}\left(\frac{450}{210}\right)$ oe or $270-\tan^{-1}\left(\frac{210}{450}\right)$ oe	**M2**	**M1** for $\tan[DAC]=\frac{450}{210}$ oe or $\tan[CAB]=\frac{210}{450}$ oe
	244.98…	**A1**	

Question	Answer	Marks	Partial Marks
9(b)	7.58 or 7.575 to 7.577	**5**	**M2** for [PQ =] $\frac{12.6\sin 35}{\sin 42}$ or [PR =] $\frac{12.6\sin 103}{\sin 42}$ or **M1** for $\frac{\sin 35}{PQ}=\frac{\sin 42}{12.6}$ oe or $\frac{\sin 103}{PR}=\frac{\sin 42}{12.6}$ oe **M2** for any correct method using *their PQ* or *their PR* to find *QS* e.g. $\sqrt{PQ^2+10.3^2-2\times PQ\times 10.3\cos 42}$ or **M1** for any correct method for QS^2 e.g. $PQ^2+10.3^2-2\times PQ\times 10.3\cos 42$
10(a)(i)	$\frac{18\times 14}{21}$ or $\frac{18}{21}=\frac{x}{14}$ oe leading to $x = 12$ or $\frac{9\times 14}{21}$ or $\frac{9}{21}=\frac{y}{14}$ oe leading to $y = 6$ or $\left(\frac{14}{21}\right)^3$ oe	**M1**	
	$\frac{1}{3}\pi\times 9^2\times 21-\frac{1}{3}\pi\times 6^2\times 14=399\pi$ or $\left(1-\left(\frac{2}{3}\right)^3\right)\left(\frac{1}{3}\pi\times 9^2\times 21\right)=399\pi$	**A2**	No errors between volume calculations and 399π **M1** for $\frac{1}{3}\pi\times 9^2\times 21$ or $\frac{1}{3}\pi\times(their\ r)^2\times 14$

Question	Answer	Marks	Partial Marks
10(a)(ii)	1070 or 1074 to 1075	**6**	**M2** for $\sqrt{21^2+9^2}$ **and** $\sqrt{14^2+their\ 6^2}$ or $\frac{2}{3}\sqrt{21^2+9^2}$ oe or **M1** for 21^2+9^2 or $14^2+their\ 6^2$ AND **M2** for $\pi\times9\times their\sqrt{522}+\pi\times their\ 6\times their\sqrt{232}$ oe or $\left(1+\left(\frac{14}{21}\right)^2\right)\pi\times9\times their\sqrt{522}$ oe or **M1** for $\pi\times9\times their\sqrt{522}$ oe or $\pi\times their\ 6\times their\sqrt{232}$ oe or $\left(\frac{14}{21}\right)^2\pi\times9\times their\sqrt{522}$ oe AND **M1** for $\pi\left(9^2-\left(their\ 6\right)^2\right)$ oe
10(b)	878 or 878.0 to 878.1… nfww	**3**	**B1** for 13.5 seen or 4.55 seen **M1** for $\pi\times their\ 4.55^2\times their\ 13.5$
11(a)	–11	**1**	
11(b)	$\frac{x+3}{2}$ oe final answer	**2**	**M1** for $x=2y-3$ or $y+3=2x$ or $\frac{y}{2}=x-\frac{3}{2}$ or better
11(c)	$\frac{8x-5}{(4x+1)(2x-3)}$ or $\frac{8x-5}{8x^2-10x-3}$ final answer	**3**	**B1** for $2(2x-3)+4x+1$ oe isw **B1** for denominator $(4x+1)(2x-3)$ oe isw