



Cambridge IGCSE™

ADDITIONAL MATHEMATICS (US)

0459/02

Paper 2

For examination from 2020

MARK SCHEME

Maximum Mark: 80

Specimen

This document has **8** pages. Blank pages are indicated.

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.

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 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.

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

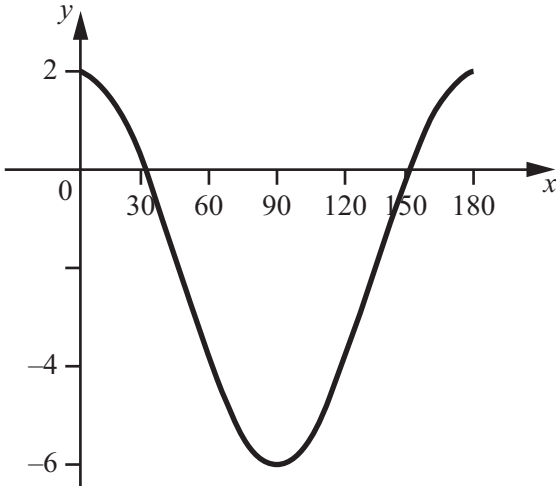
awrt	answer which rounds to
cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
nfwf	not from wrong working
oe	or equivalent
rot	rounded or truncated
SC	special case
soi	seen or implied

Question	Answer	Marks	Partial Marks
1	$\frac{x+1}{x^2-3} \overline{)x^3+x^2+4x+6}$ $\frac{x^3-3x}{x^2+7x+6}$	M1	for getting as far as $x^2 + 7x$ or for a reasonable attempt at a valid method
	$\frac{x^2-3}{7x+9}$ $a = 1, b = 7, c = 9$	A2	A2, 1, 0 -1 each error
2	$\overrightarrow{PQ} = \begin{pmatrix} 9 \\ 20 \end{pmatrix} - \begin{pmatrix} 6 \\ 7 \end{pmatrix}$	M1	
	$\overrightarrow{QR} = \begin{pmatrix} 12 \\ 52 \end{pmatrix}$	A1	
	$\overrightarrow{OR} = \begin{pmatrix} 21 \\ 72 \end{pmatrix}$	B1	FT
	$ \overrightarrow{OR} = \sqrt{21^2 + 72^2} = 75$	M1	
	Unit vector = $\frac{1}{75} \begin{pmatrix} 21 \\ 72 \end{pmatrix}$ oe	A1	$\begin{pmatrix} 21/75 \\ 72/75 \end{pmatrix}$ or $\begin{pmatrix} 7/25 \\ 24/25 \end{pmatrix}$ or $\begin{pmatrix} 0.28 \\ 0.96 \end{pmatrix}$
3	$\frac{(3-x)^{-2} + (3-x)^{\frac{1}{3}}}{(3-x)^{\frac{1}{3}}}$	B1	soi
	$(3-x)^{-1} + 1$	B2	B1 + B1
	<i>their</i> $(3-x)^{-1} = \frac{2}{3} - 1$ or better	M1	
	6	A1	
4	$f(3) = \frac{1}{2}f(2) + f(1)$	B1	soi
	$28.5 = \frac{1}{2} \times 17 + f(1)$	M1	
	$b = 20$	A1	
	$17 = \frac{1}{2} \times \textit{their } 20 + f(0)$	M1	
	$a = 7$	A1	
5(a)	Accuracy of plots	B2	B2, 1, 0 -1 each error, allow tolerance ± 1 mm
5(b)	$\bar{o} = 26 \quad \bar{w} = 55$	B2	B1 + B1
	Reasonable line of best fit through <i>their</i> (26, 55)	B1	FT
	Linear equation with reasonable slope	B1	FT
5(c)	Approximately 27	B1	FT <i>their</i> line provided line reasonable

Question	Answer	Marks	Partial Marks
6(a)	Expresses as powers of 2 or 4 or 8	M1	
	Applies rules of indices	M1	$[2x - (5 - x) = 4x - 3(x - 3)]$
	7	A1	
6(b)	$\lg(2y + 10) + \lg y = \lg \{y(2y + 10)\}$	B1	
	or $2 = \lg 100$ $2y^2 + 10y = 100$ oe	B1	
	5 only	B1	

Question	Answer	Marks	Partial Marks
7	Either $(300 \ 240)$, $\begin{pmatrix} 0.6 & 0.3 & 0.1 \\ 0.5 & 0.4 & 0.1 \end{pmatrix}$, $\begin{pmatrix} 5 \\ 7 \\ 10 \end{pmatrix}$ or $(5 \ 7 \ 10)$, $\begin{pmatrix} 0.6 & 0.5 \\ 0.3 & 0.4 \\ 0.1 & 0.1 \end{pmatrix}$, $\begin{pmatrix} 300 \\ 240 \end{pmatrix}$	B2	B2, 1, 0 The order of writing down is not important for B2, provided the matrices they have written down are conformable if they are written in the correct order –1 each incorrect matrix
	First product, either $(300 \ 240) \begin{pmatrix} 0.6 & 0.3 & 0.1 \\ 0.5 & 0.4 & 0.1 \end{pmatrix}$ or $\begin{pmatrix} 0.6 & 0.3 & 0.1 \\ 0.5 & 0.4 & 0.1 \end{pmatrix} \begin{pmatrix} 5 \\ 7 \\ 10 \end{pmatrix}$ or $(5 \ 7 \ 10) \begin{pmatrix} 0.6 & 0.5 \\ 0.3 & 0.4 \\ 0.1 & 0.1 \end{pmatrix}$ or $\begin{pmatrix} 0.6 & 0.5 \\ 0.3 & 0.4 \\ 0.1 & 0.1 \end{pmatrix} \begin{pmatrix} 300 \\ 240 \end{pmatrix}$	M1	selection of pair of matrices conformable for multiplication and an attempt to multiply
	$(300 \ 186 \ 54)$ or $\begin{pmatrix} 6.1 \\ 6.3 \end{pmatrix}$ or $(6.1 \ 6.3)$ or $\begin{pmatrix} 300 \\ 186 \\ 54 \end{pmatrix}$	A1	
	Second product, either $(300 \ 186 \ 54) \begin{pmatrix} 5 \\ 7 \\ 10 \end{pmatrix}$ or $(300 \ 240) \begin{pmatrix} 6.1 \\ 6.3 \end{pmatrix}$ or $(6.1 \ 6.3) \begin{pmatrix} 300 \\ 240 \end{pmatrix}$ or $(5 \ 7 \ 10) \begin{pmatrix} 300 \\ 186 \\ 54 \end{pmatrix}$	M1	selection of their first product and remaining matrix, conformable for multiplication and an attempt to multiply
	3342	A1	if M0 then SC2 for correct arithmetic method leading to 3342
8(a)	$\frac{3}{8} = \frac{5}{8} - \cos A \sin B$	M1	
	$\frac{1}{4}$ oe	A1	

Question	Answer	Marks	Partial Marks
8(b)	$\frac{5}{8} + \text{their } \frac{1}{4}$	M1	
	$\frac{7}{8}$	A1	
8(c)	$\frac{\tan A}{\tan B} = \frac{\sin A}{\cos A} \bigg/ \frac{\sin B}{\cos B}$	M1	or $\cos A = \text{their } \frac{1}{4 \sin B}$ and $\sin A = \frac{5}{8 \cos B}$ and an attempt at $\frac{\sin A}{\cos A}$ oe
	$= \frac{\sin A \cos B}{\cos A \sin B}$	A1	or $\tan A = \frac{5}{8 \cos B} \times 4 \sin B$ oe
	$= \frac{\frac{5}{8}}{\frac{1}{4}} = 2.5$	A1	or $\tan A = \frac{5}{2} \tan B$ therefore $\frac{\tan A}{\tan B} = \frac{5}{2}$ oe
9(a)	$z = \frac{27 - 24}{4}$	M1	
	0.2266	A1	
9(b)	0.5987	A1	
	0.1587	A1	
	0.5987 – 0.1587 oe	M1	
	0.44	A1	
10(a)	$-3 - 2i$	B1	
10(b)		B2	B2, 1, 0 FT their (i). –1 for each error or omission
10(c)	MN is parallel to the Re axis; LM is parallel to the Im axis, therefore $LM \perp MN$ and LMN is right-angled at M	B2	B2, 1, 0

Question	Answer	Marks	Partial Marks
10(d)	$-15 + 3i + 10i - 2i^2$	M1	for at least 3 out of 4 correct soi
	Correct use of $i^2 = -1$ in <i>their</i> expression	M1	
	$-13 + 13i$	A1	
10(e)	$(13\sqrt{2}, \frac{3}{4}\pi)$ oe	B2	B1dep + B1dep on <i>their</i> (iv)
11(a)	Amplitude 4, Period 180	B2	B1 + B1
11(b)	$x = 90, y = -6$ oe	B2	B1 + B1
11(c)	$2x = \cos^{-1}\left(\frac{2}{4}\right)$ or better	M1	
	$x = 30$	A1	
	$x = 150$	A1	
11(d)		B2	B2, 1, 0 2 and -6 marked on the y -axis 30 and 150 marked on the x -axis correct shape between 0 and 180 ignore any extra sections outside 0 to 180
11(e)	Section between ($x =$) 30 and 150 reflected in x -axis oe	B1	any portion of the graph below the x -axis will be reflected above
12(a)	$x = -1$ or 7 or $-\frac{1}{2}$ seen	M1	for attempt to find a root
	Either $(x + 1)(2x^2 - 13x - 7)$	M1	for attempt to find quadratic factor
	or $(x - 7)(2x^2 + 3x + 1)$	A1	for correct quadratic factor
	or $(2x + 1)(x^2 - 6x - 7)$	M1	for attempt to factorize their quadratic factor
	leading to $(x + 1)(x - 7)(2x + 1)$	A1	for correct factorization Must be 3 term
12(b)	Find $f(2)$ or $f(-3)$	M1	or long division as far as remainder
	$8 + 4a - 30 + b = 0$ or $4a + b = 22$	A1	
	$-27 + 9a + 45 + b = 75$ or $9a + b = 57$	A1	
	Solve simultaneous equations	M1	
	$a = 7, b = -6$	A1	