



National
Qualifications
2021
RESOURCE

2021 Mathematics Paper 1

Advanced Higher

Finalised Marking Instructions

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General marking principles for Advanced Higher Mathematics

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

The marking instructions for each question are generally in two sections:

generic scheme – this indicates why each mark is awarded

illustrative scheme – this covers methods which are commonly seen throughout the marking

In general, you should use the illustrative scheme. Only use the generic scheme where a candidate has used a method not covered in the illustrative scheme.

- (a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.
- (b) If you are uncertain how to assess a specific candidate response because it is not covered by the general marking principles or the detailed marking instructions, you must seek guidance from your team leader.
- (c) One mark is available for each O. There are no half marks.
- (d) If a candidate's response contains an error, all working subsequent to this error must still be marked. Only award marks if the level of difficulty in their working is similar to the level of difficulty in the illustrative scheme.
- (e) Only award full marks where the solution contains appropriate working. A correct answer with no working receives no mark, unless specifically mentioned in the marking instructions.
- (f) Candidates may use any mathematically correct method to answer questions, except in cases where a particular method is specified or excluded.
- (g) If an error is trivial, casual or insignificant, for example $6 \times 6 = 12$, candidates lose the opportunity to gain a mark, except for instances such as the second example in point (h) below.
- (h) If a candidate makes a transcription error (question paper to script or within script), they lose the opportunity to gain the next process mark, for example

This is a transcription error and so the mark is not awarded.

$$x^2 + 5x + 7 = 9x + 4$$

This is no longer a solution of a quadratic equation, so the mark is not awarded.

$$x - 4x + 3 = 0$$

$$x = 1$$

The following example is an exception to the above

This error is not treated as a transcription error, as the candidate deals with the intended quadratic equation. The candidate has been given the benefit of the doubt and all marks awarded.

$$\begin{aligned}x^2 + 5x + 7 &= 9x + 4 \\x - 4x + 3 &= 0 \\(x-3)(x-1) &= 0 \\x &= 1 \text{ or } 3\end{aligned}$$

(i) **Horizontal/vertical marking**

If a question results in two pairs of solutions, apply the following technique, but only if indicated in the detailed marking instructions for the question.

Example:

$$\begin{array}{cc} \textcircled{5} & \textcircled{6} \\ \textcircled{5} & x = 2 \quad x = -4 \\ \textcircled{6} & y = 5 \quad y = -7 \end{array}$$

Horizontal: $\textcircled{5} x = 2$ and $x = -4$ Vertical: $\textcircled{5} x = 2$ and $y = 5$
 $\textcircled{6} y = 5$ and $y = -7$ $\textcircled{6} x = -4$ and $y = -7$

You must choose whichever method benefits the candidate, **not** a combination of both.

(j) In final answers, candidates should simplify numerical values as far as possible unless specifically mentioned in the detailed marking instruction. For example

$$\begin{array}{ll} \frac{15}{12} \text{ must be simplified to } \frac{5}{4} \text{ or } 1\frac{1}{4} & \frac{43}{1} \text{ must be simplified to } 43 \\ \frac{15}{0.3} \text{ must be simplified to } 50 & \frac{4}{5} \text{ must be simplified to } \frac{4}{15} \\ \sqrt{64} \text{ must be simplified to } 8^* & \end{array}$$

*The square root of perfect squares up to and including 100 must be known.

(k) Commonly Observed Responses (COR) are shown in the marking instructions to help mark common and/or non-routine solutions. CORs may also be used as a guide when marking similar non-routine candidate responses.

(l) Do not penalise candidates for any of the following, unless specifically mentioned in the detailed marking instructions:

- working subsequent to a correct answer
- correct working in the wrong part of a question
- legitimate variations in numerical answers/algebraic expressions, for example angles in degrees rounded to nearest degree
- omission of units
- bad form (bad form only becomes bad form if subsequent working is correct), for example

$$(x^3 + 2x^2 + 3x + 2)(2x + 1) \text{ written as}$$

$$(x^3 + 2x^2 + 3x + 2) \times 2x + 1$$

$$= 2x^4 + 5x^3 + 8x^2 + 7x + 2$$

gains full credit

- repeated error within a question, but not between questions or papers

(m) In any ‘Show that...’ question, where candidates have to arrive at a required result, the last mark is not awarded as a follow-through from a previous error, unless specified in the detailed marking instructions.

- (n) You must check all working carefully, even where a fundamental misunderstanding is apparent early in a candidate's response. You may still be able to award marks later in the question so you must refer continually to the marking instructions. The appearance of the correct answer does not necessarily indicate that you can award all the available marks to a candidate.
- (o) You should mark legible scored-out working that has not been replaced. However, if the scored-out working has been replaced, you must only mark the replacement working.
- (p) If candidates make multiple attempts using the same strategy and do not identify their final answer, mark all attempts and award the lowest mark. If candidates try different valid strategies, apply the above rule to attempts within each strategy and then award the highest mark.

For example:

Strategy 1 attempt 1 is worth 3 marks.	Strategy 2 attempt 1 is worth 1 mark.
Strategy 1 attempt 2 is worth 4 marks.	Strategy 2 attempt 2 is worth 5 marks.
From the attempts using strategy 1, the resultant mark would be 3.	From the attempts using strategy 2, the resultant mark would be 1.

In this case, award 3 marks.

Marking instructions for each question

Question		Generic scheme	Illustrative scheme	Max mark
1.	(a)	<ul style="list-style-type: none"> •¹ evidence use of product rule •² complete differentiation 	<ul style="list-style-type: none"> •¹ $3x^2(\dots) + \dots$ OR $\dots + 5e^{5x}(\dots)$ <ul style="list-style-type: none"> •² $3x^2e^{5x} + 5x^3e^{5x}$ 	2
	(b)	<ul style="list-style-type: none"> •³ evidence use of quotient rule with denominator and one term of the numerator correct •⁴ complete differentiation 	<ul style="list-style-type: none"> •³ $\frac{(x^6 + 1)\sec^2 x - \dots}{(x^6 + 1)^2}$ OR $\frac{\dots - 6x^5 \tan x}{(x^6 + 1)^2}$ •⁴ $\frac{(x^6 + 1)\sec^2 x - 6x^5 \tan x}{(x^6 + 1)^2}$ 	2

Question		Generic Scheme	Illustrative Scheme	Max Mark
2.	(a)	<ul style="list-style-type: none"> •¹ state the transpose of B •² calculate AB' 	<ul style="list-style-type: none"> •¹ $B' = \begin{pmatrix} 4 & 2 & -2 \\ 0 & 3 & 1 \end{pmatrix}$ •² $\begin{pmatrix} -8 & 8 & 8 \\ -12 & 15 & 13 \end{pmatrix}$ 	2
	(b)	<ul style="list-style-type: none"> •³ calculate the determinant of A •⁴ find the inverse of A 	<ul style="list-style-type: none"> •³ $\det A = -2$ •⁴ $\frac{1}{2} \begin{pmatrix} -7 & 4 \\ -3 & 2 \end{pmatrix}$ 	2

Question		Generic scheme	Illustrative scheme	Max mark
3.		<ul style="list-style-type: none"> •¹ rewrite integral •² integrate and rewrite in terms of θ, including constant of integration 	<ul style="list-style-type: none"> •¹ $\int u^3 du$ •² $\frac{1}{4} \sin^4 \theta + c$ 	2

Question		Generic scheme	Illustrative scheme	Max mark
4.		<ul style="list-style-type: none"> •¹ set up augmented matrix •² obtain two zeros ¹ •³ complete row operations ¹ •⁴ write down value of λ 	<ul style="list-style-type: none"> •¹ $\left(\begin{array}{ccc c} 1 & 2 & 1 & 5 \\ 3 & -1 & 2 & 4 \\ -2 & 3 & \lambda & -8 \end{array} \right)$ •² eg $\left(\begin{array}{ccc c} 1 & 2 & 1 & 5 \\ 0 & -7 & -1 & -11 \\ 0 & 7 & 2+\lambda & 2 \end{array} \right)$ •³ $\left(\begin{array}{ccc c} 1 & 2 & 1 & 5 \\ 0 & -7 & -1 & -11 \\ 0 & 0 & 1+\lambda & -9 \end{array} \right)$ •⁴ -1 	4

Question		Generic scheme	Illustrative scheme	Max mark
5.		<ul style="list-style-type: none"> •¹ correct form of integral •² evaluate 	<ul style="list-style-type: none"> •¹ $\pi \int_3^5 y^2 dx$ •² 32π (cubic units) 	2

Question		Generic scheme	Illustrative scheme	Max mark
6.	(a)	<ul style="list-style-type: none"> • ¹ start to integrate • ² find expression 	<ul style="list-style-type: none"> • ¹ $t^3 \dots$ or $\dots -\frac{1}{-2}e^{-2t}$ • ² $t^3 + \frac{1}{2}e^{-2t} - \frac{1}{2}$ 	2
	(b)	<ul style="list-style-type: none"> • ³ differentiate • ⁴ calculate acceleration 	<ul style="list-style-type: none"> • ³ $6t + 2e^{-2t}$ • ⁴ 2ms^{-2} 	2

Question			Generic scheme	Illustrative scheme	Max mark
7.	(a)	(i)	• ¹ state vertical asymptote	• ¹ $x = 2$	1
		(ii)	• ² complete algebraic division and restate function • ³ state non-vertical asymptote with justification	• ² $x + 2 + \frac{4}{x - 2}$ • ³ eg As $x \rightarrow \pm\infty, \frac{4}{x-2} \rightarrow 0$ $\therefore y = x + 2$	2
		(b)	• ⁶ sketch showing shape of curve with approach to asymptotes	• ⁶ 	1

Question			Generic scheme	Illustrative scheme	Max mark
7.	(c)	(i)	• ⁷ sketch showing shape of curve with approach to asymptotes	<p>•⁷</p>	1
		(ii)	• ⁸ state values of k	• ⁸ $0 < k < 8$	1

Question		Generic scheme	Illustrative scheme	Max mark
8.		<ul style="list-style-type: none"> •¹ solve auxiliary equation •² state complementary function •³ state particular integral •⁴ differentiate complementary function •⁵ evaluate C •⁶ general solution stated or implied by •⁹ •⁷ differentiate •⁸ form equations and solve for one constant •⁹ give particular solution 	<ul style="list-style-type: none"> •¹ $m = 2, m = -3$ •² $y = Ae^{2x} + Be^{-3x}$ •³ $y = Cxe^{2x}$ •⁴ $\frac{dy}{dx} = Ce^{2x} + 2Cxe^{2x}$ $\frac{d^2y}{dx^2} = 4Ce^{2x} + 4Cxe^{2x}$ •⁵ $C = 7$ •⁶ $y = Ae^{2x} + Be^{-3x} + 7xe^{2x}$ •⁷ $\frac{dy}{dx} = 2Ae^{2x} - 3Be^{-3x} + 7e^{2x} + 14xe^{2x}$ •⁸ $A = 4 \text{ or } B = 1$ •⁹ $y = 4e^{2x} + e^{-3x} + 7xe^{2x}$ 	9

[END OF MARKING INSTRUCTIONS]