# Cambridge International A Level

**MATHEMATICS** **9709/31**

Paper 3 Pure Mathematics 3 **May/June 2026**

MARK SCHEME

Maximum Mark: 75

**Published**

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

This document consists of **23** printed pages.

**General marking principles**

All examiners must apply these marking principles when marking candidate responses.

| | |
|---|---|
| 1 | Examiners must award marks for each response in line with:<br><br>• the specific **content** defined in the mark scheme<br>• the specific **skills** defined in the mark scheme or in the level descriptions<br>• the **standard of response** required as exemplified by the standardisation scripts. |
| 2 | Examiners must award **whole marks** (not half marks, or other fractions). |
| 3 | Examiners must award marks **positively**. This means that:<br><br>• marks are not deducted for errors or omissions<br>• marks are awarded for correct/valid answers as defined in the mark scheme and also for **other valid answers** which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate<br>• the quality of spelling, punctuation and grammar are judged **only** when the mark scheme indicates that these features are **specifically assessed** in the question. However, the meaning of all responses must be unambiguous. |
| 4 | Examiners must **consistently** apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly. |
| 5 | Examiners must use the **full range of marks** defined in the mark scheme, unless limited by the quality of the candidate responses seen. |
| 6 | Examiners must award marks according to the mark scheme and **must not** award marks 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.

**Annotations guidance for centres**

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

**Annotations**

| Annotation | Meaning |
|---|---|
| ^ | More information required |
| A0 | Accuracy mark awarded zero |
| A1 | Accuracy mark awarded one |
| B0 | Independent accuracy mark awarded zero |
| B1 | Independent accuracy mark awarded one |
| B2 | Independent accuracy mark awarded two |
| BOD | Benefit of the doubt |
| BP | Blank Page |
| ✗ | Incorrect |
| Dep | Used to indicate DM0 or DM1 |

| Annotation | Meaning |
|---|---|
| DM1 | Dependent on the previous M1 mark(s) |
| FT | Follow through |
| | Indicate working that is right or wrong |
| Highlighter | Highlight a key point in the working |
| ISW | Ignore subsequent work |
| J | Judgement |
| JU | Judgement |
| M0 | Method mark awarded zero |
| M1 | Method mark awarded one |
| M2 | Method mark awarded two |
| MR | Misread |
| O | Omission or Other solution |
| Off-page comment | Allows comments to be entered at the bottom of the RM marking window and then displayed when the associated question item is navigated to. |
| On-page comment | Allows comments to be entered in speech bubbles on the candidate response. |
| PE | Judgment made by the PE |
| Pre | Premature approximation |
| SC | Special case |
| SEEN | Indicates that work/page has been seen |

| Annotation | Meaning |
|---|---|
| SF | Error in number of significant figures |
| ✓ | Correct |
| TE | Transcription error |
| XP | Correct answer from incorrect working |

## 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. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

**A** Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).

**B** Mark for a correct result or statement independent of method marks.

**DM** or **DB** When a part of a question has two or more 'method' steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly, when there are several B marks allocated. The notation DM or DB is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

**FT** Implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only.

- A or B marks are given for correct work only (not for results obtained from incorrect working) unless follow through is allowed (see abbreviation FT above).
- For a numerical answer, allow the A or B mark if the answer is correct to 3 significant figures or would be correct to 3 significant figures if rounded (1 decimal place for angles in degrees).
- The total number of marks available for each question is shown at the bottom of the Marks column.
- Wrong or missing units in an answer should not result in loss of marks unless the guidance indicates otherwise.
- Square brackets [ ] around text or numbers show extra information not needed for the mark to be awarded.

**Abbreviations**

| | |
|---|---|
| AEF/OE | Any Equivalent Form (of answer is equally acceptable) / Or Equivalent |
| AG | Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid) |
| CAO | Correct Answer Only (emphasising that no 'follow through' from a previous error is allowed) |
| CWO | Correct Working Only |
| ISW | Ignore Subsequent Working |
| SOI | Seen Or Implied |
| SC | Special Case (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance) |
| WWW | Without Wrong Working |
| AWRT | Answer Which Rounds To |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1 | **EITHER:**<br>State or imply non-modular inequality $3^2(x+4)^2 > (2x-1)^2$, or corresponding quadratic equation, or pair of linear equations | **(M1** | $5x^2+76x+143(>0)$ |
| | Make a reasonable attempt at solving a 3-term quadratic, or solve two linear equations for $x$ | **M1** | E.g. $(5x+11)(x+13)$ |
| | Obtain critical values $x=-13$ and $x=-\frac{11}{5}$ | **A1** | OE |
| | State final answer $x<-13$, $x>-\frac{11}{5}$ | **A1)** | OE. No ISW.<br>Do not condone $\leqslant$ for $<$ in the final answer.<br>Do not allow $x<-13$ and $x>-\frac{11}{5}$ or $-\frac{11}{5}<x<-13$.<br>Allow $\cup$ but not $\cap$. |
| | **OR:**<br>**Alternative Method for Question 1**<br><br>Obtain critical value $x=-13$ | **(B1** | May be from a graphical method, or by solving a linear equation or linear inequality. |
| | Obtain critical value $x=-\frac{11}{5}$ | **B1B1** | OE<br>May be from a graphical method, or by solving a linear equation or linear inequality. |
| | State final answer $x<-13$, $x>-\frac{11}{5}$ | **B1)** | OE. No ISW.<br>Do not condone $\leqslant$ for $<$ in the final answer.<br>Do not allow $x<-13$ and $x>-\frac{11}{5}$ or $-\frac{11}{5}<x<-13$.<br>Allow $\cup$ but not $\cap$. |
| | Available marks | **4** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 2 | **EITHER:**<br>State or imply $3\ln y = \ln A + kx$ | **(B1** | Accept with $\ln e$ not simplified. |
| | Substitute values of $\ln y$ and $x$ in equation of correct form and solve for $k$ | **M1** | $3 \times 5.09 = \ln A - 1.32k$ and<br>$3 \times 1.16 = \ln A + 0.25k$, if correct. |
| | Obtain $k = -7.51$ | **A1** | May be more accurate: –7.509… or $\frac{-1179}{157}$. |
| | Solve for $A$ | **M1** | Using $x$ and $\ln y$ values in equation of correct form. |
| | Obtain $A = 212$ | **A1)** | May be more accurate: 212.17… |
| | **OR:**<br>**Alternative Method for Question 2**<br>Obtain two correct equations in $A$ and $k$ by substituting $x$ and $y$ values in the given equation | **(B1** | $(e^{5.09})^3 = Ae^{-1.32k}$ and $(e^{1.16})^3 = Ae^{0.25k}$. |
| | Solve for $k$ after substituting $x$ and $y$ values in equation of correct form | **M1** | |
| | Obtain $k = -7.51$ | **A1** | May be more accurate: –7.509… or $\frac{-1179}{157}$. |
| | Solve for $A$ | **M1** | Using $x$- and $y$-values in equation of correct form. |
| | Obtain $A = 212$ | **A1)** | May be more accurate: 212.17… |
| | Available marks | **5** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 3 | Use the correct product or quotient rule | M1 | I.e. $\dfrac{\left(3x^2-1\right)\dfrac{\mathrm{d}}{\mathrm{d}x}\left(2x^2+7x\right)-\left(2x^2+7x\right)\dfrac{\mathrm{d}}{\mathrm{d}x}\left(3x^2-1\right)}{\left(3x^2-1\right)^2}$ |
| | Obtain the correct derivative in any form, e.g $\dfrac{\left(3x^2-1\right)\left(4x+7\right)-\left(2x^2+7x\right)\left(6x\right)}{\left(3x^2-1\right)^2}$ | A1 | |
| | Substitute $x = 1$ into *their* $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ | M1 | |
| | Find gradient of normal = –1 ÷ *their* $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ | M1 | Expect $\frac{1}{8}$ if correct. |
| | Substitute their gradient of normal, $x = 1$ and *their* $y$ into $y = mx + c$ | M1 | OE<br>$y = \frac{9}{2}$ if correct.<br>E.g. $y-\frac{9}{2}=\frac{1}{8}\left(x-1\right)$. |
| | $x - 8y + 35 = 0$ | A1 | OE<br>May be a scalar multiple but all coefficients must be integers and be of the form $ax + by + c = 0$.<br>Must all be on one side but accept $py + qx + r = 0$. |
| | | **6** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 4 | Square $x + iy$ and equate real and imaginary parts to $-71$ and $-20\sqrt{3}$ respectively | *M1 | Ignore sign errors but must use $i^2 = -1$. |
| | Obtain equations $x^2 - y^2 = -71$ and $2xy = -20\sqrt{3}$ | A1 | |
| | Eliminate one variable and find an equation in the other | DM1 | Attempt to find $x^2 - y^2$ [$= -71$] and $(x^2 + y^2)^2$ [$= 79^2$] instead. |
| | Obtain $x^4 + 71x^2 - 300 = 0$ or $y^4 - 71y^2 - 300 = 0$, or three-term equivalents | A1 | Allow $x^2 - y^2 = -71$ and $x^2 + y^2 = 79$ instead. |
| | Obtain answers $\pm\left(2 - 5\sqrt{3}i\right)$ | A1 | Or exact equivalent, e.g. $\pm\left(2 - \sqrt{75}i\right)$. |
| | | 5 | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 5(a) | **EITHER:**<br>Expand the brackets to obtain cos $x$ cosec $x$ – 1 + 1 – sin $x$ sec $x$ or equivalent | **(M1** | Allow one error.<br>Confusing sec and cosec is M0. |
| | Simplify to $\cot x - \tan x$ or $\dfrac{1}{\tan x} - \tan x$ | **A1** | OE, e.g. $\dfrac{1-\tan^2 x}{\tan x}$ or $\dfrac{\cos x}{\sin x} - \dfrac{\sin x}{\cos x}$. |
| | Use double angle formula | **M1** | E.g. $\dfrac{2}{\tan 2x}$. |
| | Obtain $2\cot 2x$ following full and correct working | **A1)** | **AG** |
| | **OR:**<br>$(\cos x + \sin x)\left(\dfrac{\cos x - \sin x}{\sin x \cos x}\right)$ | **(B1** | Express the second bracket as a single fraction in terms of sin $x$ and cos $x$.<br>E.g. $(\cos x + \sin x)\left(\dfrac{1}{\sin x} - \dfrac{1}{\cos x}\right)$. |
| | Expand the brackets to obtain $\dfrac{\cos^2 x + \cos x \sin x - \sin x \cos x - \sin^2 x}{\sin x \cos x}$ or better | **M1** | E.g. $\dfrac{\cos^2 x - \sin^2 x}{\sin x \cos x}$.<br>Allow one error. |
| | Use double angle formulae for numerator and denominator | **M1** | E.g. $\dfrac{\cos 2x}{\frac{1}{2}\sin 2x}$. |
| | Obtain $2\cot 2x$ following full and correct working | **A1)** | **AG** |
| | Allow working from both ends to show each side is $\cot x - \tan x$ | | |
| | Available marks | **4** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 5(b) | Find a value of $x$ in the given interval | **M1** | From $2\cot 2x = 3$ or $\tan^2 x + 3\tan x - 1 = 0$. |
| | Obtain one answer, e.g. 0.294 | **A1** | |
| | Obtain all answers 0.294, 1.86 and no others in the interval | **A1** | AWRT<br>Accept 1.865 or 1.87 for 1.86.<br>Treat answers in degrees as a misread. Withhold one A1 only for any instances of this throughout.<br>Ignore answers outside the given interval. |
| | | **3** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 6(a) | **EITHER:**<br>Use the correct product rule | (M1 | I.e., $\cos^2 x \dfrac{\mathrm{d}}{\mathrm{d}x}\left(\mathrm{e}^{x^2+4x}\right)+\mathrm{e}^{x^2+4x}\dfrac{\mathrm{d}}{\mathrm{d}x}\left(\cos^2 x\right)$. |
| | Obtain the correct derivative in any form | A1 | E.g., $(2x+4)\mathrm{e}^{x^2+4x}\cos^2 x-2\mathrm{e}^{x^2+4x}\sin x\cos x$. |
| | Equate $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ to 0 and obtain $\tan x = x + 2$ with no omissions and without wrong working | A1) | **AG** |
| | **OR:**<br>**Alternative Method for Question 6(a)**<br>Use logs to eliminate powers to obtain $\ln y = x^2 + 4x + 2\ln(\cos x)$ | (B1 | |
| | Correct method to differentiate | M1 | E.g. $\dfrac{1}{y}\dfrac{\mathrm{d}y}{\mathrm{d}x}=(2x+4)-2\dfrac{\sin x}{\cos x}$. |
| | Equate $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ to 0 and obtain $\tan x = x + 2$ with no omissions and without wrong working | A1) | **AG** |
| | Available marks | **3** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 6(b) | Sketch $y = \tan x$ for $-\pi < x < \pi$ | M1 | Allow $y = \tan x$ for $-\frac{1}{2}\pi < x < \frac{1}{2}\pi$. |
| | Sketch $y = x + 2$ for $-\pi < x < \pi$ and justify the given statement | A1 | Must have both graphs sketched over $-\pi < x < \pi$ |
| | | 2 | |
| 6(c) | Calculate the values of a relevant expression or pair of expressions at $x = 1.2$ and $x = 1.3$ | M1 | $f(x) = \tan x - x - 2$:<br>$f(1.2) = -0.63 < 0$, $f(1.3) = 0.30 > 0$<br><br>Or comparing $\tan x$ and $x + 2$:<br>1.2: $\tan x = 2.6$ $x + 2 = 3.2$ $2.6 < 3.2$<br>1.3: $\tan x = 3.6$ $x + 2 = 3.3$ $3.6 > 3.3$<br><br>Using $x$ and $\tan^{-1}(x+2)$:<br>$1.2 < 1.268$, $1.3 > 1.277$ |
| | Complete the argument correctly with correct calculated values | A1 | M0A0 if working in degrees. |
| | | 2 | |
| 6(d) | Use the iterative process at least once | M1 | M0 if working in degrees |
| | Obtain final answer 1.274 | A1 | |
| | Show sufficient iterations to 5 d.p. to justify 1.274 to 3 d.p. or show there is a sign change in the interval (1.2735, 1.2745) | A1 | 1.2, 1.26791, 1.27384, 1.27435<br>1.25, 1.27230, 1.27421, 1.27438<br>1.3, 1.27656, 1.27458, 1.27441, 1.27439 |
| | | 3 | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(a) | Obtain Re $z \geqslant -2$<br>Or $\lvert z+3\rvert \geqslant \lvert z+1\rvert$ o.e. | **B1** | Condone strict inequalities for throughout. |
| | Obtain answer of the form $\lvert z-a\rvert \le b$ | **M1** | Accept equation or any inequality sign. Needs $a$ with both real and imaginary parts non-zero and $b$ real. |
| | Obtain answer $\lvert z+3+\mathrm{i}\rvert \le 2$ | **A1** | OE, e.g. $\lvert z-(-3-\mathrm{i})\rvert \le 2$. |
| | | **3** | |
| 7(b) | Attempt to solve $(x+3)^2+(y+1)^2=2^2$ with $x=-2$ | ***M1** | For one or both points, e.g. $\left(-2,-1-\sqrt{3}\right)$. |
| | Carry out a correct method for finding the greatest value of $\lvert z\rvert$ | **DM1** | For the correct point. |
| | Obtain answer 3.39 or $\sqrt{8+2\sqrt{3}}$ | **A1** | E.g. 3.3858… |
| | | **3** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 8 | **EITHER:**<br>Commence integration by parts and reach $Ax^2e^{3x} - \int Bxe^{3x}dx$ | (*M1 | OE<br>$B > 0$ |
| | Obtain $x^2e^{3x} - \int 2xe^{3x}dx$ | A1 | OE |
| | Complete integration by parts and reach $Ax^2e^{3x} - Bxe^{3x} + Ce^{3x}$ | *M1 | OE<br>$B > 0$, $C > 0$ |
| | Obtain $x^2e^{3x} - \frac{2}{3}xe^{3x} + \frac{2}{9}e^{3x}$ | A1 | OE |
| | Substitute limits correctly in an expression of the form $Ax^2e^{3x} - Bxe^{3x} + Ce^{3x}$ | DM1 | $e^3 - \frac{2}{3}e^3 + \frac{2}{9}e^3 - \frac{2}{9}$ if correct. |
| | Obtain answer $\frac{5}{9}e^3 - \frac{2}{9}$ | A1) | Or exact two-term equivalent.<br>Working required for mark to be awarded. |
| | **OR:**<br>Assume $\int f(x)dx = e^{3x}(ax^2 + bx + c)$ and use product rule to differentiate | *M1 | |
| | Obtain $e^{3x}(2ax + b + 3ax^2 + 3bx + 3c)$ | A1 | |
| | Compare coefficients: $3a = 3$, $2a + 3b = 0$, $b + 3c = 0$ | *M1 | |
| | Obtain $a = 1$, $b = -\frac{2}{3}$, $c = \frac{2}{9}$ | A1 | |
| | Substitute limits correctly in an expression of the form $Ax^2e^{3x} - Bxe^{3x} + Ce^{3x}$ | DM1 | |
| | Obtain answer $\frac{5}{9}e^3 - \frac{2}{9}$ | A1 | Or exact two-term equivalent.<br>Working required for mark to be awarded. |
| | Available marks | **6** | |

| Question | Answer | Marks | Guidance |
| --- | --- | --- | --- |
| 9(a) | Use a correct method to form an equation for line $t$ | **M1** | Allow without ‘**r** = …’. |
| | Obtain $\mathbf{r} = \begin{pmatrix} 2 \\ -5 \\ 3 \end{pmatrix} + \lambda \begin{pmatrix} -8 \\ 9 \\ -2 \end{pmatrix}$ | **A1** | OE<br>Must have **r** = or $\begin{pmatrix} x \\ y \\ z \end{pmatrix} =$ A0 for $t = \ldots$<br>May use $B$ $\begin{pmatrix} -6 \\ 4 \\ 1 \end{pmatrix}$ in place of $A$. |
| | | **2** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 9(b) | Justify lines are not parallel, e.g. $\begin{pmatrix}-1\\2\\-1\end{pmatrix} \neq d\begin{pmatrix}-8\\9\\-2\end{pmatrix}$ | B1 | E.g. $\begin{pmatrix}-1\\2\\-1\end{pmatrix}.\begin{pmatrix}-8\\9\\-2\end{pmatrix} = 8+18+2=28$ <br> $\neq \sqrt{(-1)^2+2^2+(-1)^2}\sqrt{(-8)^2+9^2+(-2)^2} = \sqrt{6}\sqrt{149}$ <br> $=\sqrt{894}$ <br> Can find angle (20.5°, 159.5°, 0.358$^c$ or 2.78$^c$) instead, but if incorrect B0 and A0 at end. <br> Do not accept: <br> 'direction vectors are not equal', <br> or 'direction vectors are different', <br> or '$\mu \neq \lambda$' <br> or 'scalar product $\neq 0$' <br> or 'the line equations are not multiples of each other'. |
| | Express $s$ or $t$ in component form <br> e.g. $(1-\mu,\ 3+2\mu,\ 4-\mu)$ or $(2-8\lambda_1,\ -5+9\lambda_1,\ 3-2\lambda_1)$ <br> or $(-6-8\lambda_2,\ 4+9\lambda_2,\ 1-2\lambda_2)$ or $(-2-8\lambda_3,\ -\frac{1}{2}+9\lambda_3,\ 2-2\lambda_3)$ | B1 | |
| | Equate two pairs of components of general points on $s$ and *their* $t$ and solve simultaneously for $\lambda$ or for $\mu$ | M1 | |
| | Obtain correct answer for $\lambda$ or $\mu$, e.g. $\mu = -\frac{55}{7}$, $\lambda_1 = -\frac{6}{7}$ | A1 | |

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>9(b)</td><td>Determine that all three equations are not satisfied and the lines fail to intersect, and conclude the lines are skew<br><br>Conclusion needs to follow correct working</td><td>A1</td><td>Alternatives:
<table>
<tr><th>1</th><th>$\mu$</th><th>$\lambda_1$</th><th></th></tr>
<tr><td>ij</td><td>$-\frac{55}{7}$</td><td>$-\frac{6}{7}$</td><td>$\frac{83}{7} \neq \frac{33}{7}$</td></tr>
<tr><td>jk</td><td>5</td><td>2</td><td>$-4 \neq -14$</td></tr>
<tr><td>ik</td><td>$\frac{5}{3}$</td><td>$\frac{1}{3}$</td><td>$\frac{19}{3} \neq -2$</td></tr>
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<tr><th>2</th><th>$\mu$</th><th>$\lambda_2$</th><th></th></tr>
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<br>Dependent on four previous marks gained.</td></tr>
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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 10(a) | Substitute $x = 2$ or $-2$ into $\text{p}(x)$ and equate to 0 | **M1** | |
| | Obtain $8a - 44 + 2b + 4 = 0$ | **A1** | OE, e.g. $8a + 2b = 40$. |
| | Substitute $x = 2$ into $\text{p}'(x)$ and equate to 24 | **M1** | |
| | Obtain $12a - 44 + b = 24$ | **A1** | OE, e.g. $12a + b = 68$ |
| | Obtain $a = 6$ and $b = -4$ | **A1** | |
| | | **5** | |
| 10(b)(i) | Equate $(x - 2)(6x^2 + Ax + B)$ to $6x^3 - 11x^2 - 4x + 4$ and obtain equations to solve for $A$ and $B$<br>or divide $6x^3 - 11x^2 - 4x + 4$ by $x - 2$ and reach $ax^2 \pm kx$ | **M1** | Using their $a$ and their $b$<br>$A = 1$ and $B = -2$ |
| | $(x - 2)(6x^2 + x - 2)$ | **A1** | SOI |
| | Obtain $(x - 2)(3x + 2)(2x - 1)$ | **A1** | Incorrect factors, e.g. $(x-2)\left(x+\frac{2}{3}\right)\left(x-\frac{1}{2}\right)$, and no evidence of division scores M0. |
| | | **3** | |
| 10(b)(ii) | Obtain one correct region $-\frac{2}{3} \le x \le \frac{1}{2}$ or $x \ge 2$ | **B1** | Condone $-\frac{2}{3} < x < \frac{1}{2}$ or $x > 2$. |
| | Obtain both regions $-\frac{2}{3} \le x \le \frac{1}{2},\ x \ge 2$ | **B1** | Not $-\frac{2}{3} < x < \frac{1}{2},\ x > 2$.<br>Condone $-\frac{2}{3} \le x \le \frac{1}{2}$ and $x \ge 2$.<br>Allow B1B1 after M0 for calculator method in **(b)(i)**. |
| | | **2** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 11(a) | Use correct quotient rule to obtain expression of the form $\dfrac{\sin 4x \frac{\mathrm{d}}{\mathrm{d}x}(\cos 4x) - \cos 4x \frac{\mathrm{d}}{\mathrm{d}x}(\sin 4x)}{(\sin 4x)^2}$ | M1 | |
| | Obtain $\dfrac{\sin 4x(-4\sin 4x) - \cos 4x(4\cos 4x)}{\sin^2 4x}$ | A1 | OE |
| | Obtain $\dfrac{\mathrm{d}y}{\mathrm{d}x} = -4\operatorname{cosec}^2 4x$ correctly | A1 | **AG** From $\dfrac{-4}{\sin^2 4x}$ or from $-4\left(1+\cot^2 4x\right)$. |
| | | **3** | |
| 11(b) | Separate variables correctly and reach $a\operatorname{cosec}^2 4y$ or $be^{-3x-2}$ | B1 | Not for $\dfrac{1}{\sin^2 4y}$ and $\dfrac{1}{e^{3x+2}}$. |
| | Obtain term $-\frac{1}{3}e^{-3x-2}$ | B1 | |
| | Obtain term $-\frac{1}{4}\cot 4y$ | B1 | |
| | Use $x = -\frac{2}{3}$, $y = \frac{1}{16}\pi$ to evaluate a constant or as limits in a solution containing terms of the form $a\cot by$ and $ce^{\pm(3x+2)}$ | M1 | E.g. $-\frac{1}{4} = -\frac{1}{3} + C$. |
| | Obtain correct answer in any form | A1 | E.g. $-\frac{1}{4}\cot 4y = -\frac{1}{3}e^{-3x-2} + \frac{1}{12}$. |
| | Obtain $y = -0.314$ | A1 | E.g. $-0.31428\ldots$ |
| | | **6** | |