National
Qualifications
2024

# 2024 Mathematics

# Higher - Paper 1

# Question Paper Finalised Marking Instructions

**General marking principles for 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.*

*For each question, the marking instructions 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 •. 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 $6\times6=12$, 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. | $x^2+5x+7=9x+4$<br>$x-4x+3=0$ |
| This is no longer a solution of a quadratic equation, so the mark is not awarded. | $x=1$ |

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. | $x^2+5x+7=9x+4$<br>$x-4x+3=0$<br>$(x-3)(x-1)=0$<br>$x=1$ or $3$ |

**(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:

$$\begin{array}{ccc} & \bullet^5 & \bullet^6 \\ \bullet^5 & x=2 & x=-4 \\ \bullet^6 & y=5 & y=-7 \end{array}$$

Horizontal: $\bullet^5$ $x=2$ and $x=-4$    Vertical: $\bullet^5$ $x=2$ and $y=5$
$\bullet^6$ $y=5$ and $y=-7$    $\bullet^6$ $x=-4$ 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

$\frac{15}{12}$ must be simplified to $\frac{5}{4}$ or $1\frac{1}{4}$    $\frac{43}{1}$ must be simplified to 43

$\frac{15}{0.3}$ must be simplified to 50    $\frac{4/5}{3}$ must be simplified to $\frac{4}{15}$

$\sqrt{64}$ must be simplified to 8*

*The square root of perfect squares up to and including 144 must be known.

**(k)** Commonly Observed Responses (CORs) 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
  $(x^3+2x^2+3x+2)(2x+1)$ 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. | | | $\bullet^1$ use $m = \tan\theta$<br>$\bullet^2$ evaluate exact value<br>$\bullet^3$ determine equation | $\bullet^1$ $m = \tan 30°$<br>$\bullet^2$ $\dfrac{1}{\sqrt{3}}$<br>$\bullet^3$ eg $y = \dfrac{1}{\sqrt{3}}x + 4$ or $\sqrt{3}y - 4\sqrt{3} = x$ | 3 |

**Notes:**

1. Do not award $\bullet^1$ for $m = \tan^{-1} 30°$. However $\bullet^2$ and $\bullet^3$ are still available.
2. Do not penalise the omission of a degree symbol at $\bullet^1$.
3. Where candidates make no reference to a trigonometric ratio, or use an incorrect trigonometric ratio, $\bullet^1$ and $\bullet^2$ are unavailable. See Candidate A.
4. $\bullet^3$ is only available as a consequence of attempting to use a tan ratio. See Candidate F.
5. $\bullet^3$ is not available for using a gradient of 30.
6. At $\bullet^3$ accept any rearrangement of a candidate's equation where constant terms have been simplified.
7. Accept $y - 4 = \dfrac{1}{\sqrt{3}}(x)$ but not $y - 4 = \dfrac{1}{\sqrt{3}}(x - 0)$ for $\bullet^3$.

**Commonly Observed Responses:**

| | | |
|---|---|---|
| **Candidate A - no trig ratio**<br>$m = \dfrac{1}{\sqrt{3}}$ $\bullet^1$ ^ $\bullet^2$ ✓[2]<br>$y = \dfrac{1}{\sqrt{3}}x + 4$ $\bullet^3$ ✓[1] | **Candidate B**<br>$m = \tan\theta$ $\bullet^1$ ^<br>$y = \dfrac{1}{\sqrt{3}}x + 4$ $\bullet^2$ ✓ $\bullet^3$ ✓ | **Candidate C**<br>$m = \tan\theta$ $\bullet^1$ ^<br>$y = \sqrt{3}x + 4$ $\bullet^2$ ✗ $\bullet^3$ ✗ |
| **Candidate D**<br>$m = \tan\theta = 30$ $\bullet^1$ ✗<br>$m = \dfrac{1}{\sqrt{3}}$ $\bullet^2$ ✓[1]<br>$y = \dfrac{1}{\sqrt{3}}x + 4$ $\bullet^3$ ✓[1] | **Candidate E - no reference to *m***<br>$\tan 30° = \dfrac{1}{\sqrt{3}}$ $\bullet^2$ ✓<br>$y - 4 = \dfrac{1}{\sqrt{3}}(x - 0)$ $\bullet^1$ ✓<br>$y = \dfrac{1}{\sqrt{3}}x + 4$ $\bullet^3$ ✓ | **Candidate F - not using tan**<br>$m = \sin 30°$ $\bullet^1$ ✗<br>$m = \dfrac{1}{2}$ $\bullet^2$ ✓[2]<br>$y = \dfrac{1}{2}x + 4$ $\bullet^3$ ✓[2] |

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| **2.** | (a) | | •[1] calculate second term | •[1] 16 | **1** |

**Notes:**

1. Candidates who use $u_0 = 20$ and then calculate $u_1 = 16$ gain •[1].

**Commonly Observed Responses:**

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| | (b) | (i) | •[2] communicate condition for limit to exist | •[2] a limit exists as $-1 < \frac{1}{5} < 1$ | **1** |
| | | (ii) | •[3] know how to calculate a limit<br><br>•[4] calculate limit | •[3] $\frac{12}{1-\frac{1}{5}}$ or $L = \frac{1}{5}L + 12$<br><br>•[4] 15 | **2** |

**Notes:**

2. For •[2] accept:

   any of '$-1 < \frac{1}{5} < 1$' or '$\left|\frac{1}{5}\right| < 1$' or '$0 < \frac{1}{5} < 1$' with no further comment;

   or statements such as:

   '$\frac{1}{5}$ lies between $-1$ and 1' or '$\frac{1}{5}$ is a proper fraction'.

3. •[2] is not available for:

   '$-1 \leq \frac{1}{5} \leq 1$' or '$\frac{1}{5} < 1$'

   or statements such as:

   'It is between $-1$ and 1.' or '$\frac{1}{5}$ is a fraction'.

4. Candidates who state $-1 < a < 1$ can only gain •[2] if it is explicitly stated that $a = \frac{1}{5}$.

5. Do not accept $L = \frac{b}{1-a}$ with no further working for •[3].

6. •[3] and •[4] are not available to candidates who conjecture $L = 15$ following the calculation of further terms in the sequence.

7. For $L = 15$ with no working award 0/2.

8. •[4] is only available where •[3] has been awarded.

**Commonly Observed Responses:**

| Candidate A | Candidate B - no explicit reference to $a$ |
|---|---|
| $a = \frac{1}{5}$<br>$-1 < a < 1$ so a limit exists •[2] ✓ | $u_{n+1} = au_n + b$<br>$u_{n+1} = \frac{1}{5}u_n + 12$<br>$-1 < a < 1$ so a limit exists •[2] ^ |

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| 3. | | | •¹ start to differentiate<br><br>•² complete differentiation | •¹ $7\left(5x^2+3\right)^6\ldots$<br><br>•² $\ldots\times 10x$ | 2 |

**Notes:**

1. •¹ is awarded for the appearance of $7\left(5x^2+3\right)^6$.
2. For $70x\left(5x^2+3\right)^6$ with no working, award 2/2.
3. Accept $7u^6$ where $u=5x^2+3$ for •¹.
4. Do not award •² where the answer includes '$+c$'.

**Commonly Observed Responses:**

| Candidate A - differentiating over two lines | Candidate B - poor notation |
|---|---|
| $7\left(5x^2+3\right)^6$ •¹ ✓<br><br>$7\left(5x^2+3\right)^6\times 10x$ •² ^ | $y=\left(5x^2+3\right)^7$ $y=5x^2+3$<br>$\frac{dy}{dx}=10x$<br><br>$\frac{dy}{dx}=7\left(5x^2+3\right)^6\times 10x$ •¹ ✓ •² ✓ |

| Candidate C - poor communication | Candidate D - insufficient evidence for •¹ |
|---|---|
| $y=\left(5x^2+3\right)^7$<br><br>$y=7\left(5x^2+3\right)^6\times 10x$ •¹ ✓ •² ✓ | $70\left(5x^2+3\right)^6$ •¹ ✗ •² ✗<br>or<br>$35\left(5x^2+3\right)^6$ •¹ ✗ •² ✗ |

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| 4. | | | **Method 1** | **Method 1** | 2 |
| | | | •¹ interpret ratio | •¹ $\begin{pmatrix}2\\4\\-4\end{pmatrix}$, $\begin{pmatrix}-2\\-4\\4\end{pmatrix}$, $\begin{pmatrix}3\\6\\-6\end{pmatrix}$ or $\begin{pmatrix}-3\\-6\\6\end{pmatrix}$ | |
| | | | •² find coordinates of R | •² $(-4,5,-2)$ | |
| | | | **Method 2** | **Method 2** | |
| | | | •¹ interpret ratio | •¹ eg $\overrightarrow{PR}=\frac{2}{5}\overrightarrow{PQ}$, $\overrightarrow{QR}=\frac{3}{5}\overrightarrow{QP}$ or $\overrightarrow{PR}=\frac{2}{3}\overrightarrow{RQ}$ | |
| | | | •² find coordinates of R | •² $(-4,5,-2)$ | |
| | | | **Method 3** | **Method 3** | |
| | | | •¹ use section formula | •¹ $\frac{1}{5}(3\mathbf{p}+2\mathbf{q})$ | |
| | | | •² find coordinates of R | •² $(-4,5,-2)$ | |

**Notes:**

1. For $(-4,5,-2)$ without working award 2/2.
2. For $\begin{pmatrix}-4\\5\\-2\end{pmatrix}$ without working award 1/2.
3. For $(-3,7,-4)$ (ratio of 3:2 with working) award 1/2. See Candidate A.
4. For $\begin{pmatrix}-3\\7\\-4\end{pmatrix}$ without working award 0/2.

**Commonly Observed Responses:**

| **Candidate A** | | **Candidate B** | |
|---|---|---|---|
| $\overrightarrow{PR}=\frac{3}{5}\overrightarrow{PQ}$ | •¹ ✗ | $\frac{\overrightarrow{PR}}{\overrightarrow{RQ}}=\frac{2}{3}$ | •¹ ✓ |
| $R=(-3,7,-4)$ | •² ✓₁ | $3\overrightarrow{PR}=2\overrightarrow{RQ}$ | |
| | | $3(\mathbf{r}-\mathbf{p})=2(\mathbf{q}-\mathbf{r})$ | |
| | | $5\mathbf{r}=2\mathbf{q}+3\mathbf{p}$ | |
| | | Leading to correct answer of | |
| | | $R=(-4,5,-2)$ | •² ✓ |

| Question | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|
| 4. (continued) | | | |

**Candidate C**

$$\overrightarrow{PQ} = \begin{pmatrix} 5 \\ 10 \\ -10 \end{pmatrix}$$

$$R = \begin{pmatrix} 2 \\ 4 \\ -4 \end{pmatrix}$$ $\bullet^1$ ✓

$$R = \begin{pmatrix} -6 \\ 1 \\ 2 \end{pmatrix} + \begin{pmatrix} 2 \\ 4 \\ -4 \end{pmatrix}$$

$$R = \begin{pmatrix} -4 \\ 5 \\ -2 \end{pmatrix}$$

$R(-4, 5, -2)$ $\bullet^2$ ✓

**Candidate D**

$$\overrightarrow{PR} = \begin{pmatrix} 2 \\ 4 \\ -4 \end{pmatrix}$$ $\bullet^1$ ✓

$R(-8, -3, 6)$ $\bullet^2$ ✗

**Candidate E - stepping out using absolute values**

2 : 3

5

−6 −1

2 or 3

10

1 11

4 or 6

10

2 −8

4 or 6 $\bullet^1$ ✓

$R(-4, 5, -2)$ $\bullet^2$ ✓

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| 5. | | | **Method 1** | **Method 1** | 3 |
| | | | •¹ equate composite function to $x$ | •¹ $h\left(h^{-1}(x)\right)=x$ | |
| | | | •² write $h\left(h^{-1}(x)\right)$ in terms of $h^{-1}(x)$ | •² $2\left(h^{-1}(x)\right)^3-7=x$ | |
| | | | •³ state inverse function | •³ $h^{-1}(x)=\sqrt[3]{\dfrac{x+7}{2}}$ | |
| | | | **Method 2** | **Method 2** | |
| | | | •¹ write as $y=h(x)$ and start to rearrange | •¹ $y=h(x)\Rightarrow x=h^{-1}(y)$<br>$y+7=2x^3$ | |
| | | | •² express $x$ in terms of $y$ | •² $x=\sqrt[3]{\dfrac{y+7}{2}}$ | |
| | | | •³ state inverse function | •³ $h^{-1}(y)=\sqrt[3]{\dfrac{y+7}{2}}$<br>$\Rightarrow h^{-1}(x)=\sqrt[3]{\dfrac{x+7}{2}}$ | |

**Notes:**

1. In method 1, accept $2\left(h^{-1}(x)\right)^3-7=x$ for •¹ and •².
2. In method 2, accept '$y+7=2x^3$' without reference to $y=h(x)\Rightarrow x=h^{-1}(y)$ at •¹.
3. In method 2, accept $h^{-1}(x)=\sqrt[3]{\dfrac{x+7}{2}}$ without reference to $h^{-1}(y)$ at •³.
4. In method 2, beware of candidates with working where each line is not mathematically equivalent. See candidates A and B for example.
5. At •³ stage, accept $h^{-1}$ written in terms of any dummy variable.

   For example $h^{-1}(y)=\sqrt[3]{\dfrac{y+7}{2}}$.
6. $y=\sqrt[3]{\dfrac{x+7}{2}}$ does not gain •³.
7. $h^{-1}(x)=\sqrt[3]{\dfrac{x+7}{2}}$ with no working gains 3/3.

| Question | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|
| 5. (continued) | | | |

**Commonly Observed Responses:**

**Candidate A**

$h(x)=2x^3-7$

$y=2x^3-7$

$x=\sqrt[3]{\dfrac{y+7}{2}}$ $\quad\bullet^1$ ✓ $\bullet^2$ ✓

$y=\sqrt[3]{\dfrac{x+7}{2}}$ $\quad\bullet^3$ ✗

$h^{-1}(x)=\sqrt[3]{\dfrac{x+7}{2}}$

**Candidate B**

$h(x)=2x^3-7$

$y=2x^3-7$

$x=2y^3-7$ $\quad\bullet^1$ ✗

$y=\sqrt[3]{\dfrac{x+7}{2}}$ $\quad\bullet^2$ ✓$_1$

$h^{-1}(x)=\sqrt[3]{\dfrac{x+7}{2}}$ $\quad\bullet^3$ ✓$_1$

**Candidate C**

$x=2h(x)^3-7$ $\quad\bullet^1$ ✗

$h(x)=\sqrt[3]{\dfrac{x+7}{2}}$ $\quad\bullet^2$ ✓$_1$

$h^{-1}(x)=\sqrt[3]{\dfrac{x+7}{2}}$ $\quad\bullet^3$ ✓$_1$

**Candidate D - Method 1**

$h\left(h^{-1}(x)\right)=2\left(h^{-1}(x)\right)^3-7$ $\quad\bullet^2$ ✓

$x=2\left(h^{-1}(x)\right)^3-7$ $\quad\bullet^1$ ✓

$h^{-1}(x)=\sqrt[3]{\dfrac{x+7}{2}}$ $\quad\bullet^3$ ✓

**Candidate E**

$x\to x^3\to 2x^3\to 2x^3-7=h(x)$

$\times 2\to -7$

$\therefore +7\to \div 2$ $\quad\bullet^1$ ✓

$\sqrt[3]{\dfrac{x+7}{2}}$ $\quad\bullet^2$ ✓

$h^{-1}(x)=\sqrt[3]{\dfrac{x+7}{2}}$ $\quad\bullet^3$ ✓

**Candidate F - BEWARE of incorrect notation**

$h'(x)=$ $\quad\bullet^3$ ✗

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| 6. | (a) | (i) | •1 find value of $\cos p$<br>•2 substitute into the formula for $\sin 2p$<br>•3 simplify answer | •1 $\cos p = \frac{2}{\sqrt{5}}$ stated or implied by •2<br>•2 $2 \times \frac{1}{\sqrt{5}} \times \frac{2}{\sqrt{5}}$<br>•3 $\frac{4}{5}$ | 3 |
| | | (ii) | •4 evaluate $\cos 2p$ | •4 $\frac{3}{5}$ | 1 |

**Notes:**

1. Evidence for •1 may appear in (a)(ii).
2. Where a candidate substitutes an incorrect value for $\cos p$ at •2, •2 may be awarded if the candidate has previously stated this incorrect value or it can be implied by a diagram or Pythagoras calculation. See Candidates A and B.
3. Where a candidate explicitly states a value for $\cos p$, subsequent working must follow from that value for •2 to be awarded.
4. •3 is only available as a consequence of substituting into a valid formula at •2.
5. Do not penalise trigonometric ratios which are less than −1 or greater than 1 throughout this question.

**Commonly Observed Responses:**

**Candidate A – incorrect use of Pythagoras**

$\sqrt{\sqrt{5}^2 + 1^2} = \sqrt{6}$ •1 ✘

$2 \times \frac{1}{\sqrt{5}} \times \frac{\sqrt{6}}{\sqrt{5}}$ •2 ✓1

$\frac{2\sqrt{6}}{5}$ •3 ✓1

**Candidate B – no evidence of Pythagoras**

•1 ^

$2 \times \frac{1}{\sqrt{5}} \times \frac{\sqrt{6}}{\sqrt{5}}$ •2 ✘

$\frac{2\sqrt{6}}{5}$ •3 ✓1

**Candidate C**

$2 \times \sin \frac{1}{\sqrt{5}} \times \cos \frac{2}{\sqrt{5}}$ •1 ✓ •2 ✘

$\frac{4}{5}$ •3 ✘

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| | (b) | | •5 evaluate $\sin 4p$ | •5 $\frac{24}{25}$ | 1 |

**Notes:**

6. •5 is only available for an answer expressed as a single fraction.

**Commonly Observed Responses:**

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| 7. | | | **Method 1** | **Method 1** | 4 |
| | | | •1 substitute for $y$ | •1 $x^2+(2x)^2-14x-8(2x)+45=0$ | |
| | | | •2 write in standard quadratic form | •2 $5x^2-30x+45=0$ | |
| | | | •3 determine $x$-coordinate | •3 3 | |
| | | | •4 determine $y$-coordinate | •4 6 | |
| | | | **Method 2** | **Method 2** | |
| | | | •1 substitute for $x$ | •1 $\left(\frac{y}{2}\right)^2+y^2-14\left(\frac{y}{2}\right)-8y+45=0$ | |
| | | | •2 write in standard quadratic form | •2 $\frac{5}{4}y^2-15y+45=0$ | |
| | | | •3 determine $y$-coordinate | •3 6 | |
| | | | •4 determine $x$-coordinate | •4 3 | |
| | | | **Method 3** | **Method 3** | |
| | | | •1 use centre and perpendicular gradient to determine equation of radius through point of contact | •1 $x+2y=15$ | |
| | | | •2 substitute for $y$ | •2 $x+2(2x)=15$ | |
| | | | •3 determine $x$-coordinate | •3 3 | |
| | | | •4 determine $y$-coordinate | •4 6 | |

**Notes:**

1. In Methods 1 and 2, treat an absence of brackets at the •1 stage as bad form only if corrected on the next line of working.
2. In Methods 1 and 2, •1 is only available if the '=0' appears by the •2 stage.
3. In Methods 1 and 2, if a candidate arrives at an equation which is not a quadratic •3 and •4 are unavailable.
4. Where the quadratic obtained at •2 in Methods 1 and 2, does not have repeated roots •3 and •4 are not available.
5. In Method 3 accept $y-4=-\frac{1}{2}(x-7)$, $-\frac{1}{2}=\frac{4-y}{7-x}$ or equivalent for •1.
6. In Method 3 •2, •3 and •4 are unavailable to candidates who find the equation of any other line.
7. For (3,6) without working, award 0/4.
8. For answer of (3,6) verified in both equations, or (3,6) generated by the linear equation and verified in the equation of the circle, award 4/4.

| Question | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|
| **7. (continued)** | | | |

**Commonly Observed Responses:**

| | |
|---|---|
| **Candidate A - substitution into the equation of the circle**<br>$\vdots$<br>$x = 3$ $\quad\bullet^3$ ✓<br>$(3)^2 + y^2 - 14(3) - 8y + 45 = 0$<br>$y^2 - 8y + 12 = 0$<br>$(y-2)(y-6) = 0$<br>$y = 6$ $\quad\bullet^4$ ✓<br>no need to explicitly consider $y = 2$<br>**However,**<br>(3,6) and (3,2) $\quad\bullet^4$ ✗ | |

| Question | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|
| 8. | •¹ use discriminant<br><br>•² apply condition<br><br>•³ identify roots of quadratic expression<br><br>•⁴ state range with justification | •¹ $(m-4)^2-4(1)(2m-3)$<br><br>•² $(m-4)^2-4(1)(2m-3)<0$<br><br>•³ 2, 14<br><br>•⁴ $2<m<14$ with eg labelled sketch or table of signs | 4 |

**Notes:**

1. At •¹, treat the inconsistent use of brackets: For example $m-4^2-4(1)(2m-3)$ or $(m-4)^2-4\times1\times2m-3$ as bad form only if the candidate deals with the unbracketed terms correctly in the next line of working.
2. Where candidates express $a$, $b$ and $c$ in terms of $m$, and then state $b^2-4ac<0$, award •².
3. If candidates have the condition 'discriminant $>0$', 'discriminant $\leq 0$' or 'discriminant $\geq 0$', then •² is lost but •³ and •⁴ are available.
4. Ignore the appearance of $b^2-4ac=0$ where the correct condition has subsequently been applied.
5. If candidates only work with the condition 'discriminant $=0$', then •² and •⁴ are unavailable.
6. Accept the appearance of 2 and 14 within inequalities for •³.
7. At •⁴ accept "$m>2$ and $m<14$" or "$m>2$, $m<14$" together with the required justification.
8. For the appearance of $x$ in any expression of the discriminant, no further marks are available.

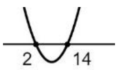
**Commonly Observed Responses:**

**Candidate A - no expressions for *a*, *b* and *c***

No real roots $b^2-4ac<0$

$m^2-16m+28=0$ •¹ ✓

$m=2,\ m=14$ •³ ✓

$2<m<14$  •² ✓ •⁴ ✓



**In this case •² is only available where •⁴ is awarded**

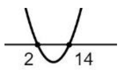
**Candidate B**

$(m-4)^2-4(1)(2m-3)$ •¹ ✓

$m^2-16m+28=0$

$m=2,\ m=14$ •³ ✓

$b^2-4ac<0$

$2<m<14$  •² ✓ •⁴ ✓



**In this case •² is only available where •⁴ is awarded**

| Question | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|
| **8. (continued)** | | | |

**Candidate C**

$(m-4)^2 - 4(1)(2m-3)$ •¹ ✓

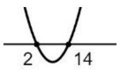
$b^2 - 4ac = 0$

$m^2 - 16m + 28 = 0$

$m = 2,\ m = 14$ •³ ✓

$m^2 - 16m + 28 < 0$ •² ✓

$2 < m < 14$ •⁴ ✓



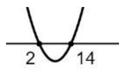

**Candidate D**

$(m-4)^2 - 4(1)(2m-3)$ •¹ ✓

$m^2 - 16m + 28 = 0$ •² ✗

$m = 2,\ m = 14$ •³ ✓

$2 < m < 14$ •⁴ $\checkmark_2$




**Candidate E - not solving a quadratic**

$m - 4^2 - 4(1)(2m-3) < 0$ •¹ ✗ •² ✓ •³ ✗

$-7m - 4 < 0$

$m > -\frac{4}{7}$ •⁴ $\checkmark_2$

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| 9. | | | **Method 1** | **Method 1** | 3 |
| | | | •[1] apply $\log_a x+\log_a y=\log_a xy$ | •[1] $\log_a(5\times 80)$… stated or implied by •[3] | |
| | | | •[2] apply $m\log_a x=\log_a x^m$ | •[2] $\ldots-\log_a 10^2$ stated or implied by •[3] | |
| | | | •[3] apply $\log_a x-\log_a y=\log_a \frac{x}{y}$ and express in required form | •[3] $\log_a 4$ | |
| | | | **Method 2** | **Method 2** | |
| | | | •[1] apply $m\log_a x=\log_a x^m$ | •[1] $\ldots-\log_a 10^2$ stated or implied by •[3] | |
| | | | •[2] apply $\log_a x-\log_a y=\log_a \frac{x}{y}$ | •[2] $\ldots+\log_a\left(\frac{80}{10^2}\right)$ stated or implied by •[3] | |
| | | | •[3] apply $\log_a x+\log_a y=\log_a xy$ and express in required form | •[3] $\log_a 4$ | |

**Notes:**

1. Where an error at the •[1] or •[2] stage leads to a non-integer value for $k$, •[3] is still available.
2. Each line of working must be equivalent to the line above within a valid strategy. See commonly observed responses.
3. Where candidates apply the laws of logarithms in the incorrect order see Candidates A and B.
4. Where candidates do not consider the '2', a maximum of 1/3 is available. See Candidate C.
5. Do not penalise the omission of the base of the logarithm.
6. Correct answer with no working, award 3/3.
7. Where candidates form an invalid equation, •[1] and •[2] may only be awarded for working with $\log_a 5+\log_a 80-2\log_a 10$ on one side of the equation; •[3] is not available.

**Commonly Observed Responses:**

| Candidate A | Candidate B |
|---|---|
| $\log_a 5+2\log_a\left(\frac{80}{10}\right)$<br>$2\log_a\left(\frac{5\times 80}{10}\right)$<br>$\log_a(40)^2$<br>$\log_a 1600$<br>**Award 1/3** | $\log_a 400-2\log_a 10$<br>$2\log_a\left(\frac{400}{10}\right)$<br>$\log_a(40)^2$<br>$\log_a 1600$<br>**Award 2/3** |
| **Candidate C - ignoring the 2**<br>$\log_a 5+\log_a 80-2\log_a 10$<br>$\log_a 5+\log_a \frac{80}{10}$<br>$\log_a 40$<br>**Award 1/3** | |

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| **10.** | (a) | | •[1] use 1 in synthetic division or in evaluation of quartic | •[1] $\begin{array}{c\|ccccc} 1 & 2 & 3 & -4 & -3 & 2 \\ \hline & 2 & & & & \boxed{\phantom{0}} \end{array}$ <br> **or** $2\times(1)^4+3\times(1)^3-4\times(1)^2$ $-3\times(1)+2$ | **2** |
| | | | •[2] complete division/evaluation and interpret result | •[2] $\begin{array}{c\|ccccc} 1 & 2 & 3 & -4 & -3 & 2 \\ & & 2 & 5 & 1 & -2 \\ \hline & 2 & 5 & 1 & -2 & \boxed{0} \end{array}$ <br> $\text{Remainder}=0 \therefore (x-1)$ is a factor <br> **or** <br> $f(1)=0 \therefore (x-1)$ is a factor | |

**Notes:**

1. Communication at •[2] must be consistent with working at that stage i.e. a candidate's working must arrive legitimately at 0 before •[2] can be awarded.
2. Accept any of the following for •[2]:
   - '$f(1)=0$ so $(x-1)$ is a factor'
   - 'since remainder = 0, it is a factor'
   - the '0' from any method linked to the word 'factor' by 'so', 'hence', $\therefore$, $\longrightarrow$, $\Longrightarrow$ etc.
3. Do not accept any of the following for •[2]:
   - double underlining the '0' or boxing the '0' without comment
   - '$x=1$ is a factor', '… is a root'
   - the word 'factor' only, with no link.

**Commonly Observed Responses:**

**Candidate A - grid method**

| | $2x^3$ | | | |
|---|---|---|---|---|
| $x$ | $2x^4$ | $5x^3$ | | |
| $-1$ | $-2x^3$ | | | |

•[1] ✓

| | $2x^3$ | $5x^2$ | $x$ | $-2$ |
|---|---|---|---|---|
| $x$ | $2x^4$ | $5x^3$ | $x^2$ | $-2x$ |
| $-1$ | $-2x^3$ | $-5x^2$ | $-x$ | $2$ |

'with no remainder'

$\therefore (x-1)$ is a factor •[2] ✓

**Candidate B - grid method**

| | $2x^3$ | | | |
|---|---|---|---|---|
| $x$ | $2x^4$ | $5x^3$ | | |
| $-1$ | $-2x^3$ | | | |

•[1] ✓

| | $2x^3$ | $5x^2$ | $x$ | $-2$ |
|---|---|---|---|---|
| $x$ | $2x^4$ | $5x^3$ | $x^2$ | $-2x$ |
| $-1$ | $-2x^3$ | $-5x^2$ | $-x$ | $2$ |

$\therefore (x-1)(2x^3+5x^2+x-2)=2x^4+3x^3-4x^2-3x+2$

$\therefore (x-1)$ is a factor •[2] ✓

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| **10.** | (b) | | •³ identify cubic and attempt to factorise | •³ eg $\begin{array}{r\|rrrr} -1 & 2 & 5 & 1 & -2 \\ & & -2 & -3 & \\ \hline & 2 & 3 & & \boxed{\phantom{0}} \end{array}$ **or** $\begin{array}{r\|rrrr} -2 & 2 & 5 & 1 & -2 \\ & & -4 & -2 & \\ \hline & 2 & 1 & & \boxed{\phantom{0}} \end{array}$ | **4** |
| | | | •⁴ find second factor | •⁴ eg $\begin{array}{r\|rrrr} -1 & 2 & 5 & 1 & -2 \\ & & -2 & -3 & 2 \\ \hline & 2 & 3 & -2 & \boxed{0} \end{array}$ leading to $(x+1)$ **or** $\begin{array}{r\|rrrr} -2 & 2 & 5 & 1 & -2 \\ & & -4 & -2 & 2 \\ \hline & 2 & 1 & -1 & \boxed{0} \end{array}$ leading to $(x+2)$ | |
| | | | •⁵ identify quadratic | •⁵ $2x^2+3x-2$ **or** $2x^2+x-1$ | |
| | | | •⁶ complete factorisation | •⁶ $(x-1)(x+1)(2x-1)(x+2)$ **stated explicitly** | |

**Notes:**

4. Ignore the appearance of '$=0$'.
5. Candidates who arrive at $(x-1)(x+1)(2x^2+3x-2)$ or $(x-1)(x+2)(2x^2+x-1)$ by using algebraic long division or by inspection, gain •³, •⁴ and •⁵.
6. Where a candidate only identifies additional factors from a quartic, only •⁴ is available.
7. •³ and •⁴ may be awarded for applications of synthetic division even when previous trials contain errors. •⁵ and •⁶ are available.

| Question | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|

**10. (b) (continued)**

**Commonly Observed Responses:**

**Candidate C - grid method**

(a)

| | $2x^3$ | $5x^2$ | $x$ | $-2$ |
|---|---|---|---|---|
| $x$ | $2x^4$ | $5x^3$ | $x^2$ | $-2x$ |
| $-1$ | $-2x^3$ | $-5x^2$ | $-x$ | $2$ |

(b)

| | $2x^2$ | $\ldots$ | $\ldots$ |
|---|---|---|---|
| $x$ | $2x^3$ | $\ldots$ | $\ldots$ |
| $\ldots$ | $\ldots$ | $\ldots$ | $\ldots$ |

$\bullet^3$ ✓

$\bullet^3$ is awarded for evidence of the cubic expression (which may be in the grid from part (a) ) **AND** the terms in the diagonal boxes summing to the second and third terms in the cubic respectively.

| | $2x^2$ | $3x$ | $-2$ |
|---|---|---|---|
| $x$ | $2x^3$ | $3x^2$ | $-2x$ |
| $+1$ | $2x^2$ | $3x$ | $-2$ |

$\bullet^4$ ✓

$2x^2+3x-2$ $\bullet^5$ ✓

$(x-1)(x+1)(2x-1)(x+2)$ $\bullet^6$ ✓

**Candidate D - grid method**

(a)

| | $2x^3$ | $5x^2$ | $x$ | $-2$ |
|---|---|---|---|---|
| $x$ | $2x^4$ | $5x^3$ | $x^2$ | $-2x$ |
| $-1$ | $-2x^3$ | $-5x^2$ | $-x$ | $2$ |

(b)

| | $2x^2$ | $\ldots$ | $\ldots$ |
|---|---|---|---|
| $x$ | $2x^3$ | $\ldots$ | $\ldots$ |
| $\ldots$ | $\ldots$ | $\ldots$ | $\ldots$ |

$\bullet^3$ ✓

$\bullet^3$ is awarded for evidence of the cubic expression (which may be in the grid from part (a) ) **AND** the terms in the diagonal boxes summing to the second and third terms in the cubic respectively.

| | $2x^2$ | $x$ | $-1$ |
|---|---|---|---|
| $x$ | $2x^3$ | $x^2$ | $-x$ |
| $+2$ | $4x^2$ | $2x$ | $-2$ |

$\bullet^4$ ✓

$2x^2+x-1$ $\bullet^5$ ✓

$(x-1)(x+2)(x+1)(2x-1)$ $\bullet^6$ ✓

**Candidate E**

$$\begin{array}{c|cccc} \frac{1}{2} & 2 & 5 & 1 & -2 \\ & & 1 & 3 & 2 \\ \hline & 2 & 6 & 4 & \boxed{0} \end{array}$$

$\bullet^3$ ✓ $\bullet^4$ ✓

$\left(x-\frac{1}{2}\right)\left(2x^2+6x+4\right)$ $\bullet^5$ ✓

$(2x-1)\left(x^2+3x+2\right)$

$(x-1)(2x-1)(x+1)(x+2)$ $\bullet^6$ ✓

**Candidate F**

$$\begin{array}{c|cccc} \frac{1}{2} & 2 & 5 & 1 & -2 \\ & & 1 & 3 & 2 \\ \hline & 2 & 6 & 4 & \boxed{0} \end{array}$$

$\bullet^3$ ✓ $\bullet^4$ ✓

$\left(x-\frac{1}{2}\right)\left(2x^2+6x+4\right)$ $\bullet^5$ ✓

$\left(x-\frac{1}{2}\right)(2x+2)(x+2)$

$(x-1)\left(x-\frac{1}{2}\right)(2x+2)(x+2)$ $\bullet^6$ ^

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| **11.** | (a) | | •[1] use compound angle formula | •[1] $k\cos x^\circ \cos a^\circ + k\sin x^\circ \sin a^\circ$ **stated explicitly** | **4** |
| | | | •[2] compare coefficients | •[2] $k\cos a^\circ = 1, k\sin a^\circ = \sqrt{3}$ **stated explicitly** | |
| | | | •[3] process for $k$ | •[3] $k = 2$ | |
| | | | •[4] process for $a$ and express in required form | •[4] $2\cos(x-60)^\circ$ | |

**Notes:**

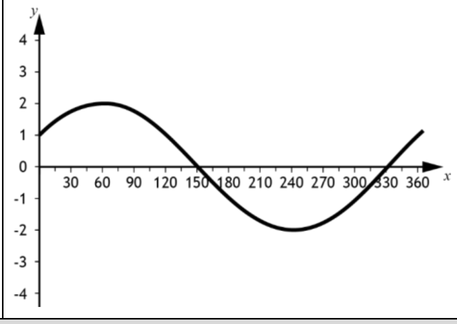
1. Accept $k(\cos x^\circ \cos a^\circ + \sin x^\circ \sin a^\circ)$ for •[1]. Treat $k\cos x^\circ \cos a^\circ + \sin x^\circ \sin a^\circ$ as bad form only if the equations at the •[2] stage both contain $k$ .
2. Do not penalise the omission of degree signs.
3. $2\cos x^\circ \cos a^\circ + 2\sin x^\circ \sin a^\circ$ or $2(\cos x^\circ \cos a^\circ + \sin x^\circ \sin a^\circ)$ is acceptable for •[1] and •[3].
4. •[2] is not available for $k\cos x^\circ = 1, k\sin x^\circ = \sqrt{3}$ , however •[4] may still be gained- see Candidate E
5. •[3] is only available for a single value of $k, k > 0$ .
6. •[3] is not available to candidates who work with $\sqrt{4}$ throughout parts (a) and (b) without explicitly simplifying at any stage. •[4] is still available.
7. •[4] is not available for a value of $a$ given in radians.
8. Candidates may use any form of the wave function for •[1], •[2]and •[3]. However, •[4] is only available if the wave is interpreted in the form $k\cos(x-a)^\circ$.
9. Evidence for •[4] may not appear until part (b).

**Commonly Observed Responses:**

| **Candidate A** | **Candidate B - inconsistency** | **Candidate C** |
|---|---|---|
| •[1] ^ | $k\cos x^\circ \cos a^\circ + k\sin x^\circ \sin a^\circ$ •[1] ✓ | $\cos x^\circ \cos a^\circ + \sin x^\circ \sin a^\circ$ •[1] ✗ |
| $2\cos a^\circ = 1$ | $\cos a^\circ = 1$ | $\cos a^\circ = 1$ |
| $2\sin a^\circ = \sqrt{3}$ •[2] ✓ •[3] ✓ | $\sin a^\circ = \sqrt{3}$ •[2] ✗ | $\sin a^\circ = \sqrt{3}$ •[2] ✓2 |
| | | $k = 2$ •[3] ✓ |
| $\tan a^\circ = \sqrt{3}$ | $\tan a^\circ = \sqrt{3}$ | $\tan a^\circ = \sqrt{3}$ |
| $a = 60$ | $a = 60$ | $a = 60$ |
| $2\cos(x-60)^\circ$ •[4] ✓ | $2\cos(x-60)^\circ$ •[3] ✓ •[4] ✗ | $2\cos(x-60)^\circ$ •[4] ✗ |

| Question | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|
| 11. (a) (continued) | | | |

| | | |
|---|---|---|
| **Candidate D - errors at •2** | **Candidate E - use of $x$ at •2** | **Candidate F** |
| $k\cos x^\circ \cos a^\circ + k\sin x^\circ \sin a^\circ$ •1 ✓ | $k\cos x^\circ \cos a^\circ + k\sin x^\circ \sin a^\circ$ •1 ✓ | $k\sin A\cos B + k\cos A\sin B$ •1 ✗ |
| $k\cos a^\circ = \sqrt{3}$<br>$k\sin a^\circ = 1$ •2 ✗ | $k\cos x^\circ = 1$<br>$k\sin x^\circ = \sqrt{3}$ •2 ✗ | $k\cos A = 1$<br>$k\sin A = \sqrt{3}$ •2 ✗ |
| $\tan a^\circ = \frac{1}{\sqrt{3}}$<br>$a = 30$ | $\tan x^\circ = \sqrt{3}$<br>$x = 60$ | $\tan A = \sqrt{3}$ |
| $2\cos(x-30)^\circ$ •3 ✓ •4 ✓1 | $2\cos(x-60)^\circ$ •3 ✓ •4 ✓1 | $2\cos(x-60)^\circ$ •3 ✓ •4 ✓1 |

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| 11. | (b) | | •5 exactly two roots identifiable from graph<br><br>•6 coordinates of exactly two turning points identifiable from graph<br><br>•7 $y$-intercept and value of $y$ at $x=360$ identifiable from graph | •5 $(150,0)$ and $(330,0)$<br><br>•6 $(60,2)$ and $(240,-2)$<br><br>•7 1<br> | 3 |



**Notes:**

10. •5, •6 and •7 are only available for attempting to draw a "cosine" graph with a period of $360°$.
11. Ignore any part of a graph drawn outwith $0 \le x \le 360$.
12. Vertical marking is not applicable to •5 and •6.
13. Candidate's sketch in (b) must be consistent with the equation obtained in (a), see also Candidates G and H.
14. For any incorrect horizontal translation of the graph of the wave function arrived at in part (a) only •6 is available.

**Commonly Observed Responses:**

**Candidate G - incorrect translation**

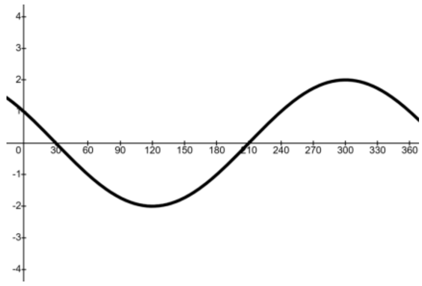
(a) $2\cos(x-60)°$ - correct equation

(b) Incorrect translation:
Sketch of $2\cos(x+60)°$
only •6 is available

**Candidate H - incorrect equation**

(a) $2\cos(x+60)°$ - incorrect equation

(b) Sketch of $2\cos(x+60)°$
all 3 marks available



| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| 12. | | | •[1] write in differentiable form | •[1] $12x^{\frac{1}{3}}$ stated or implied by •[2] | 4 |
| | | | •[2] differentiate | •[2] $12\times\frac{1}{3}\times x^{-\frac{2}{3}}$ | |
| | | | •[3] solve for $a^{-\frac{2}{3}}$ or $a^{\frac{2}{3}}$ | •[3] $a^{-\frac{2}{3}}=\frac{1}{4}$ or $a^{\frac{2}{3}}=4$ | |
| | | | •[4] solve for $a$ | •[4] $a=8$ | |

**Notes:**

1. •[2] is only available for differentiating a term with a fractional index.
2. Where candidates attempt to integrate or make no attempt to differentiate, only •[1] is available.
3. Accept $x^{-\frac{2}{3}}=\frac{1}{4}$ or $x^{\frac{2}{3}}=4$ at •[3]. See Candidates A and B.
4. •[4] is only available where the expression at •[2] is of the form $kx^{-\frac{m}{n}}$ where $m\neq1$.
5. Do not penalise the inclusion of $-8$ at •[4].

**Commonly Observed Responses:**

| Candidate A - working in terms of $x$ throughout | | Candidate B | |
|---|---|---|---|
| … | •[1] ✓ •[2] ✓ | … | •[1] ✓ •[2] ✓ |
| $x^{-\frac{2}{3}}=\frac{1}{4}$ | •[3] ✓ | $x^{-\frac{2}{3}}=\frac{1}{4}$ | •[3] ✓ |
| $x=8$ | •[4] ✗ | $(x=8)$ | |
| | | $a=8$ | •[4] ✓ |

| Candidate C | | Candidate D - partly differentiated | |
|---|---|---|---|
| $f(x)=12x^{\frac{3}{2}}$ | •[1] ✗ | $f(x)=12x^{\frac{1}{3}}$ | •[1] ✓ |
| $f'(x)=18x^{\frac{1}{2}}$ | •[2] $✓_1$ | $f'(x)=12\times\frac{1}{3}x^{\frac{4}{3}}$ | •[2] ✗ |
| $a^{\frac{1}{2}}=\frac{1}{18}$ | •[3] $✓_1$ | $1=4a^{\frac{4}{3}}$ | |
| | | $\frac{1}{4}=a^{\frac{4}{3}}$ | •[3] $✓_1$ |
| $a=\frac{1}{324}$ | •[4] $✓_2$ | $a=\frac{1}{\sqrt{8}}$ | •[4] $✓_2$ |

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| **13.** | (a) | | •1 find midpoint of PQ<br>•2 find gradient of PQ<br>•3 find perpendicular gradient<br>•4 find equation of perpendicular bisector | •1 (5,6)<br>•2 $-4$ or $-\frac{8}{2}$<br>•3 $\frac{1}{4}$<br>•4 $4y = x + 19$ | 4 |

**Notes:**

1. •4 is only available as a consequence of using a perpendicular gradient and a mid-point.
2. The gradient of the perpendicular bisector must appear in fully simplified form at •3 or •4 stage for •3 to be awarded.
3. At •4 accept $4y - x = 19$, $4y - x - 19 = 0$, or any other rearrangement of the equation where the constant terms have been simplified.

**Commonly Observed Responses:**

| Question | | | Generic scheme | Illustrative scheme | Max mark |
|---|---|---|---|---|---|
| | (b) | | •5 identify $x$-coordinate of centre<br>•6 find $y$-coordinate of centre<br>•7 find radius<br>•8 state equation of circle | •5 9<br>•6 7<br>•7 $\sqrt{34}$<br>•8 $(x-9)^2 + (y-7)^2 = 34$ | 4 |

**Notes:**

4. Do not accept "centre = (9,2)" as evidence of •5.
5. Where candidates use PQ, QR or PR as the diameter of the circle no marks are available.
6. •7 and •8 are only available as a consequence of using the point of intersection of two perpendicular bisectors and a point on the circumference of the circle.
7. Accept $r^2 = 34$ for •7.
8. $(x-9)^2 + (y-7)^2 = (\sqrt{34})^2$ does not gain •8.

**Commonly Observed Responses:**

| **Candidate A - horizontal line through midpoint of PQ** | **Candidate B - perpendicular bisector of PR** |
|---|---|
| Centre = (9,6) •5 ✓ •6 ✗<br>Radius = 5 •7 ✗<br>Equation: $(x-9)^2 + (y-6)^2 = 25$ •8 ✗ | Perpendicular bisector of PR: $y = x - 2$<br>Centre = (9,7) •5 ✓ •6 ✓<br>⋮ |

**[END OF MARKING INSTRUCTIONS]**