Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Cycle 2025

Marking Scheme

Mathematics

Higher Level

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

Structure of the marking scheme

Candidate responses are marked according to different scales, depending on the types of response anticipated. Scales labelled A divide candidate responses into two categories (correct and incorrect). Scales labelled B divide responses into three categories (correct, partially correct, and incorrect), and so on. The scales and the marks that they generate are summarised in this table:

Scale label	**B**	**C**	**D**
No of categories	3	4	5
5-mark scale	0, 3, 5	0, 2, 3, 5	0, 2, 3, 4, 5
10-mark scale	0, 5, 10	0, 4, 6, 10	0, 4, 5, 6, 10
15-mark scale		0, 4, 6, 15	
20-mark scale		0, 4, 7, 20	

A general descriptor of each point on each scale is given below. More specific directions in relation to interpreting the scales in the context of each question are given in the scheme.

Marking scales – level descriptors

A-scales (two categories)

- incorrect response (no credit)
- correct response (full credit)

B-scales (three categories)

- response of no substantial merit (no credit)
- partially correct response (partial credit)
- correct response (full credit)

C-scales (four categories)

- response of no substantial merit (no credit)
- response with some merit (low partial credit)
- almost correct response (high partial credit)
- correct response (full credit)

D-scales (five categories)

- response of no substantial merit (no credit)
- response with some merit (low partial credit)
- response about half-right (mid partial credit)
- almost correct response (high partial credit)
- correct response (full credit)

In certain cases, typically involving incorrect rounding, omission of units, a misreading that does not oversimplify the work, or an arithmetical error that does not oversimplify the work, a mark that is one mark below the full-credit mark may also be awarded. This level of credit is referred to as *Full Credit –1*. Thus, for example, in Scale 10C, *Full Credit –1* of 9 marks may be awarded.

The only marks that may be awarded for a question are those on the scale above, or *Full Credit –1*.

A rounding penalty is applied only once in each question item. A penalty for an omitted unit is applied only once in each question. There is no penalty for omitted units if the question specifies the unit to be used in the answer, and there is generally no penalty for an omitted euro symbol in questions involving money.

In general, accept a candidate's work in one part of a question for use in subsequent parts of the question, unless this oversimplifies the work involved.

Unless otherwise specified, an answer without sufficient supporting work is generally awarded the lowest non-zero level of credit (typically *Partial Credit* or *Low Partial Credit*, as appropriate).

Palette of annotations available to examiners

Symbol	Name	Meaning in the body of the work	Meaning when used in the right margin
✓	Tick	Work of relevance	The work presented in the body of the script merits full credit
✗	Cross	Incorrect work (distinct from an error)	The work presented in the body of the script merits 0 credit
*	Star	Rounding / Unit / Arithmetic error Misreading	
~~	Horizontal wavy	Error	
P	P		The work presented in the body of the script merits a partial credit for B scales
L	L		The work presented in the body of the script merits low partial credit
M	M		The work presented in the body of the script merits mid partial credit
H	H		The work presented in the body of the script merits high partial credit
F*	F star		The work presented in the body of the script merits Full Credit (– 1)
[	Left Bracket		Another version of this solution is presented elsewhere and it merits equal or higher credit
≀	Vertical wavy	No work on this page (portion of the page)	
WOM		The candidate has presented work or merit	
o	Oversimplify	The candidate has oversimplified the work	
✓s	SWOM	The candidate has presented significant work or merit	

Model Solutions & Marking Notes

Note: The model solutions for each question are not intended to be exhaustive – there may be other correct solutions. Any Examiner unsure of the validity of the approach adopted by a particular candidate to a particular question should contact his / her Advising Examiner.

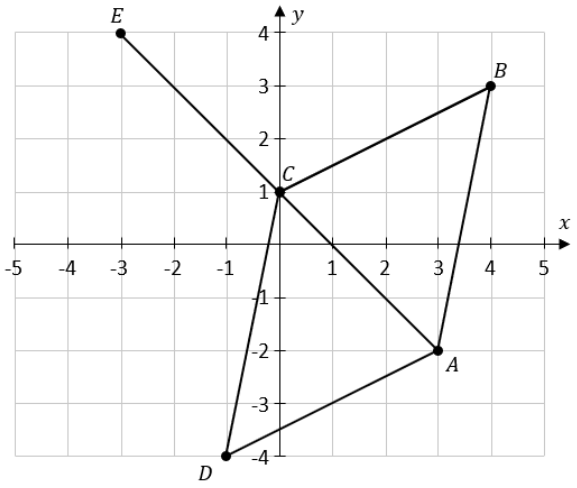
Q1	Model Solution – 10 marks	Marking Notes
(a)	$3 \times 4 \times 4 = 48$ **OR** *Lists all* 48 *choices, or a relevant subset of this, and gives answer as* 48	**Scale 5C (0, 2, 3, 5)** Accept correct answer without work *Low Partial Credit:* • Work of merit, for example, lists one other choice (other than B, yellow, 7); indicates or calculates 3×4 or 4×4 *High Partial Credit:* • Indicates $3 \times 4 \times 4$ • Lists all 48 entries with no duplications, but correct answer not given
(b)	$€140 - €93{\cdot}80 = €46{\cdot}20$ $= \frac{€46{\cdot}20}{€140} \times 100$ $= 33\ [\%]$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Two numbers with a relevant operation (for example, $140 - 93{\cdot}80$ or $93{\cdot}80 \times 100$, or $\frac{140}{100}$) • Shows some knowledge of percentages *High Partial Credit:* • Finds $46{\cdot}20$ and indicates a relevant operation to it (dividing by 140 or multiplying by 100) • Finds 67% (i.e. $93{\cdot}80$ as a percentage of 140)

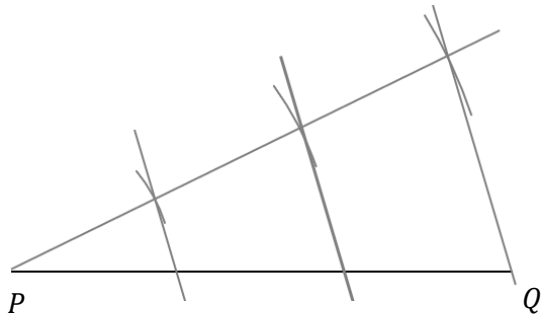
Q2	Model Solution – 15 marks	Marking Notes
(a)	**(i)** $13,\ 17$ **(ii)** $108,\ 324$ **(iii)** $24,\ 22$	**Scale 5D(0, 2, 3, 4, 5)** *Low Partial Credit:* • Work of merit in 1 part, for example, finds one correct term in 1 part; in **(i)**, indicates common difference; in **(ii)**, indicates $\times\ 3$; in **(iii)**, finds first or second difference *Mid Partial Credit:* • 1 part correct *High Partial Credit:* • Part **(iii)** correct and work of merit in other two parts
(b)	**(i)** Red **(ii)** 6 groups of 4, plus 1 red block, so $6 \times 2 + 1 = 13$ red. $P(Red) = \frac{13}{25}$ **or** 52% **OR** *Solution by listing the rest of the first 25 terms*	**Scale 10D (0, 4, 5, 6, 10)** *Low Partial Credit:* • Work of merit, for example, lists the next colour block in **(i)**; lists at least 2 blocks beyond the 10th block in **(ii)**; indicates division by 4 or similar (that is, shows understanding of relevance of groups of 4 blocks); correct numerator or denominator; lists the first 25 terms in **(ii)** *Mid Partial Credit:* • **(i)** correct **and** work of merit in **(ii)** • Significant work of merit in **(ii)**, for example, finds 13 red blocks or finds 12 red blocks and puts it over 25 *High Partial Credit:* • **(ii)** correct • **(i)** correct **and** significant work of merit in **(ii)** *Full Credit −1:* • Answer not given as a fraction, decimal or percentage

Q3	Model Solution – 15 marks	Marking Notes
(a)	**A** $= €42{\cdot}50 \times 3 = [€]\ 127{\cdot}50$ **B** $= \frac{13{\cdot}98}{6{\cdot}99} = 2$ **C** $= 33{\cdot}80 \times 1 = [€]\ 33{\cdot}80$ **D** $= 120 \times 3{\cdot}5 = [€]\ 420$	**Scale 10D (0, 4, 5, 6, 10)** Accept correct answers given in the answer box grid, as long as each value is labelled Accept correct answers without units Accept correct answer without work *Low Partial Credit:* • 1 value correct *Mid Partial Credit:* • 2 values correct *High Partial Credit:* • 3 values correct
(b) **(c)**	**(b)** **E** $= 595{\cdot}28 \times \frac{13{\cdot}5}{100} = 80{\cdot}3628$ $= [€]\ 80{\cdot}36$ [2 D.P.] **(c)** **F** $= 80{\cdot}36 + 595{\cdot}28 = [€]\ 675{\cdot}64$	**Scale 5C (0, 2, 3, 5)** Accept correct answers without units Accept correct answer without work *Low Partial Credit:* • Work of merit in **(b)**, for example, 2 numbers with a relevant operation (for example, $\frac{13{\cdot}5}{100}$, or $13{\cdot}5 \times 595{\cdot}28$, or $0{\cdot}135$) • **(c)** correct, based on incorrect answer to **(b)** *High Partial Credit:* • **(b)** correct • **(c)** correct **and** work of merit in **(b)**

Q4	Model Solution – 30 marks	Marking Notes
(a)	*Accurate stem and leaf diagram given.* Note: Stem and leaf diagram does not need to be ordered Art | | Business 7 4 | 3 9 7 7 6 | 4 4 2 1 0 | 5 | 2 3 4 9 9 2 | 6 | 4 5 6 7 7 8 9 1 | 7	**Scale 10D (0, 4, 5, 6, 10)** *Low Partial Credit:* • 1 correct entry *Mid Partial Credit:* • 7 correct entries *High Partial Credit:* • 15 correct entries *Full Credit −1:* • 23 correct entries
(b)	*Answer has two aspects that are considered independently: (1) how well students did, on average, and (2) how spread out the marks are.* *Answer should be checked against the candidate's stem and leaf plot.* *For example:* Students did better in Business, on average, but the marks were more spread out in Art.	**Scale 10B (0, 5, 10)** *Partial Credit:* • One of the aspects required in the answer correct • Calculates a correct measure of central tendency or a correct spread
(c)	$69 - 52 = 17$ [marks]	**Scale 5B (0, 3, 5)** Accept correct answer without work Accept correct answer without unit *Partial Credit:* • Shows some understanding of range in this context, for example, finds maximum or minimum value *Full Credit –1:* • Answer of "52 to 69", or similar

Q4	Model Solution – 30 marks	Marking Notes
(d) **(e)**	**(d)** *Any valid explanation, for example:* Michael could have got 53 and then he just did a little better, like 54. This won't change the range. **OR** If the old and new marks are between the minimum and the maximum mark, then the range won't change **OR** If Michael went from 52 to 70, the range would stay the same. **(e)** Total before Ajani $= 12 \times 50 = 600$ Total after Ajani $= 13 \times 51 = 663$ Ajani's mark $= 663 - 600 = 63$ [marks]	**Scale 5C(0, 2, 3, 5)** *Low Partial Credit:* • Work of merit in **(d)** • Work of merit in **(e)**, for example, finds total before Ajani or indicates increase of 12 or 12×1 *High Partial Credit:* • **(d)** correct **and** work of merit in **(e)** • **(e)** correct

Q5	Model Solution – 20 marks	Marking Notes
(a) **(b)**	**(a)** $A = (3, -2)$ $C = (0, 1)$ **(b)** $B(4, 3)$ *correctly plotted and labelled*	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit:* • Work of merit in one part, for example, x- or y-co-ordinate correct; x and y swapped but otherwise correct *High Partial Credit:* • Two points correct from A, B, and C *Full Credit −1:* • Three points correct, but B not labelled
(c) **(d)**	 **(c)** $D = (-1, -4)$ *correctly plotted and labelled* **(d)** $E = (-3, 4)$ *by translation on the diagram* **OR** $\left(\frac{3+x}{2}, \frac{-2+y}{2}\right) = (0, 1)$ x co-ordinate: $3 + x = 0$ so $x = -3$ y co-ordinate: $-2 + y = 2$ so $y = 4$ $E = (-3, 4)$ **OR** $A(3, -2) \rightarrow C(0, 1) \rightarrow E = (-3, 4)$ x: -3, y: $+3$	**Scale 10D (0, 4, 5, 6, 10)** *Low Partial Credit:* • Work of merit in 1 part, for example, in **(c)**, finds correct x- or y-co-ordinate, or draws in $[AB]$ and/or $[BC]$; in **(d)**, mid-point formula with some correct substitution, or draws line through A to C and extends beyond C; indication of relevant translation *Mid Partial Credit:* • 1 part correct • Work of merit in both parts *High Partial Credit:* • 1 part correct **and** work of merit in the other part *Full Credit −1:* • *D* not labelled • E plotted but not written out

Q6	Model Solution – 30 marks	Marking Notes
(a)	*Note: arcs are not required to measure* 3 *equal parts on ray constructed from* P *or* Q  	**Scale 15C (0, 4, 6, 15)** Tolerance is 2 mm per segment *Low Partial Credit:* • Line divided into 3 equal lengths, with insufficient construction lines • Ray drawn from P or Q *High Partial Credit:* • Ray drawn from P or Q with 3 equal lengths marked on it (starting at P or Q, respectively)
(b)(i)	$x = 72°$ [corresponding angle to $\angle ABC$] $y = 180 - (28 + 72) = 180 - 100$ $= 80$ [°] $z = 180 - x = 180 - 72$ $= 108$ [°] **OR** $z = 28 + y = 28 + 80$ $= 108$ [°]	**Scale 5D (0, 2, 3, 4, 5)** Accept correct answers without units Accept correct answers without work *Low Partial Credit:* • Work of merit towards x, y, or z, for example, indicates corresponding angles; indicates relevant result (sum of angles in a triangle is $180°$ or exterior angle in a triangle is the sum of the opposite interior angles) *Mid Partial Credit:* • x correct **and** work of merit towards y or z • y **or** z correct *High Partial Credit:* • 2 values correct, from x, y, and z
(b)(ii)	*Any correct explanation, for example:* Similar: the three angles are the same **OR** DF is parallel to BC Not Congruent: they are not the same size **OR** Their sides are different sizes	**Scale 5B (0, 3, 5)** *Partial Credit:* • Work of merit in 1 explanation (similar / not congruent) correct

Q6	Model Solution – 30 marks	Marking Notes
(c)	$\frac{\lvert GE\rvert}{\lvert CB\rvert}=\frac{\lvert AE\rvert}{\lvert AB\rvert}$ $\frac{\lvert GE\rvert}{14\cdot 3}=\frac{20}{30}$ $\lvert GE\rvert=\frac{20\times 14\cdot 3}{30}=\frac{143}{15}$ **or** $9\frac{8}{15}$ **or** $9\cdot 533\ldots$ **OR** $\frac{\lvert GE\rvert}{\lvert AE\rvert}=\frac{\lvert CB\rvert}{\lvert AB\rvert}$ $\frac{\lvert GE\rvert}{20}=\frac{14\cdot 3}{30}$ $\lvert GE\rvert=\frac{20\times 14\cdot 3}{30}=\frac{143}{15}$ **or** $9\frac{8}{15}$ **or** $9\cdot 533\ldots$	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • 1 relevant ratio indicated, for example, $\frac{20}{30}$, $\frac{EG}{14.3}$, $\frac{\lvert EG\rvert}{\lvert AE\rvert}$, $\frac{\lvert BC\rvert}{\lvert AB\rvert}$ etc. • Triangles redrawn separately / identified or shows some understanding of similar triangles *Mid Partial Credit:* • Correct equation in $\lvert GE\rvert$ • Finds scale factor of $1\cdot 5$ *High Partial Credit:* • Isolates $\lvert GE\rvert$ • Uses scale factor of $1\cdot 5$ *Full Credit −1:* • Answer rounded

Q7	Model Solution – 60 marks	Marking Notes
(a)(i)	$x = \frac{50}{2} = 25$ m $y = 300 - x = 300 - 25 = 275$ m	**Scale 5B (0, 3, 5)** Accept correct answers without work *Partial Credit:* • x or y correct *Full Credit −1:* • Apply a * once for incorrect or no units
(a)(ii)	$(50 \times 275) + \frac{1}{2}\pi(25^2)$ $= 13\,750 + \frac{1}{2}(1963.4954\ldots)$ $= 13\,750 + 981{\cdot}7\ldots$ $= 14\,731{\cdot}7\ldots$ $= 14\,732$ [m^2] $[\in \mathbb{N}]$	**Scale 10C (0, 4, 6, 10)** Accept correct answer without unit Consider solution as being composed of 4 steps: **Step 1.** Finds area of rectangle **Step 2.** Finds area of circle **Step 3.** Finds area of semicircle **Step 4.** Finds sum of two areas. Note: Only consider Step 4 completed if a rectilinear and a curvilinear area have been found and are being added. *Low Partial Credit:* • Work of merit in any step, for example, a correct formula with some substitution (area of circle, semicircle, sector) or the formula for area of a rectangle • Indicates or finds 300×50 *High Partial Credit:* • 3 steps correct *Full Credit −1:* • No rounding or incorrect rounding
(b)	$\frac{809\,371 \times 6}{250}$ $= 19424{\cdot}904 = 19\,425$ [litres] $[\in \mathbb{N}]$ **OR** 1 litre covers $\frac{250}{6} = 41{\cdot}66\ldots$ m^2 So needs $809\,371 \div 41{\cdot}66\ldots$ $= 19424{\cdot}904 = 19\,425$ [litres] $[\in \mathbb{N}]$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Work of merit, for example, 2 numbers with a relevant operation (for example, $809\,371 \times 6$ or $\frac{6}{250}$ and stops) *High Partial Credit:* • Indicates $\frac{809\,371 \times 6}{250}$ or equivalent *Full Credit −1:* • No rounding or incorrect rounding

Q7	Model Solution – 60 marks	Marking Notes
(c)	**Method 1:** $1+\frac{3}{2}+\frac{5}{3}=\frac{25}{6}$ Amount of **B** $=1000\times\frac{\left(\frac{3}{2}\right)}{\left(\frac{25}{6}\right)}=360$ [ml] **OR** **Method 2:** $1:\frac{3}{2}:\frac{5}{3}=\ 6:9:10$ $6+9+10=25$ Amount of **B** $=1000\times\frac{9}{25}=360$ [ml]	**Scale 15C (0, 4, 6, 15)** Accept correct answer without unit *Low Partial Credit:* • Work of merit, for example, correct conversion of litres to ml; in **Method 1**, indicates or evaluates $1+\frac{3}{2}+\frac{5}{3}$ or $1000\times\frac{3}{2}$; in **Method 2**, finds 6 (common denominator) *High Partial Credit:* • In **Method 1**, finds $\frac{25}{6}$ **and** does further relevant work, for example, indicates or evaluates $1000\div\left(\frac{25}{6}\right)$ or $1000\times\frac{3}{2}$ • In **Method 2**, finds $6:9:10$ **and** finds 25 • Uses 100 or $10\ 000$ ml in a litre, otherwise fully correct *Full Credit –1:* • Finds answer in litres instead of ml $(0{\cdot}36)$ • Finds ml for **A** (240) or **C** (400)
(d)	$r=0{\cdot}9$ m $V=\pi r^2h\ =\pi(0{\cdot}9^2)(4)=\frac{81}{25}\pi$ $=10{\cdot}178\ldots$ $=10{\cdot}18$ [m^3] [2D.P.] **OR** $h=400$ cm $V=\pi r^2h\ =\pi(90^2)(400)=3\ 240\ 000\pi$ $=10\ 178\ 760{\cdot}2\ldots$ cm^3 $=10{\cdot}18$ [m^3] [2D.P.]	**Scale 5C (0, 2, 3, 5)** Accept correct answer without unit *Low Partial Credit:* • Work of merit, for example, one correct relevant conversion; some correct substitution into the correct formula; $h = 4$ *High Partial Credit:* • Correct formula fully substituted *Full Credit –1:* • Incorrect rounding, otherwise correct

Q7	Model Solution – 60 marks	Marking Notes
(e)	$h = 3r$ $V = \pi r^2 h \quad = \pi r^2(3r)$ $= 3r^3\pi = \frac{81\pi}{125}$ $r^3 = \frac{27}{125}$ $r = \sqrt[3]{\frac{27}{125}} = \frac{3}{5}$ [m] **or** $0{\cdot}6$ [m]	**Scale 20C (0, 4, 7, 20)** Accept correct answer without unit Consider solution as being composed of 4 steps: **Step 1**. $h = 3r$ **Step 2**. Sets up correct equation (may involve h, if Step 1 has not been done already) **Step 3**. Isolates r^3 **Step 4**. Finds r Note: Steps 1 and 2 can be done in either order. Steps 3 and 4 cannot be done unless 1 and 2 have been done. *Low Partial Credit:* • Work of merit in 1 step *High Partial Credit:* • 3 steps correct

Q8	Model Solution – 15 marks	Marking Notes
(a)	$A = \cos^{-1} 0{\cdot}27 = 74{\cdot}3 \ldots = 74[°] \ [\in \mathbb{N}]$	**Scale 5B (0, 3, 5)** Accept correct answer without unit Accept correct answer without work No credit is awarded for finding $cos\ 0{\cdot}27 = 0{\cdot}99998 \ldots$ *Partial Credit:* • Some mention of $\cos^{-1}$ *Full Credit –1:* • Incorrect rounding, otherwise correct • Calculator in incorrect mode, otherwise correct with work ($1{\cdot}2974$ or $82{\cdot}5953$ to 4 D.P.)
(b)	$h = \lvert BD\rvert - \lvert BC\rvert$ $\tan 22° = \frac{\lvert BC\rvert}{23}$ so $\lvert BC\rvert = 23 \tan 22°$ i.e. $\lvert BC\rvert = 9{\cdot}292 \ldots$ $\tan 29° = \frac{\lvert BD\rvert}{23}$ so $\lvert BD\rvert = 23 \tan 29°$ i.e. $\lvert BD\rvert = 12{\cdot}749 \ldots$ Then $h = 12{\cdot}749 \ldots - 9{\cdot}292 \ldots$ $= 3{\cdot}45 \ldots = 3{\cdot}5$ m [1 D.P.]	**Scale 10C(0, 4, 6, 10)** Consider solution as being composed of 4 steps: **Step 1**. Sets up 1 correct ratio that allows $\lvert BC\rvert$ or $\lvert BD\rvert$ to be found **Step 2**. Finds $\lvert BC\rvert$ or $\lvert BD\rvert$ **Step 3**. Finds second one of $\lvert BC\rvert$ or $\lvert BD\rvert$ **Step 4**. Finds h Note: If $\lvert AC\rvert$ or $\lvert AD\rvert$ are found, these constitute work of merit; one step is completed only once a trigonometric ratio has been correctly set up that allows $\lvert BC\rvert$ or $\lvert BD\rvert$ to be found. *Low Partial Credit:* • Work of merit, for example, indicates that $h = \lvert BD\rvert - \lvert BC\rvert$; writes $\tan 22°$ or $\tan 29°$; identifies opposite or adjacent sides *High Partial Credit:* • 3 steps correct *Full Credit –1:* • Apply a * once for incorrect or no units • Apply a * for early rounding • Calculator in incorrect mode, otherwise correct with work ($2{\cdot}98$ or $20{\cdot}20$ to 2 D.P.)

<table>
<tr><th>Q9</th><th>Model Solution – 25 marks</th><th>Marking Notes</th></tr>
<tr><td>(a)
(b)</td><td>(a)
Any value strictly between $2{\cdot}5$ and 3, with relevant work on the graph.

(b)
4 [hours]</td><td>Scale 5C (0, 2, 3, 5)
Accept correct answers without units

Low Partial Credit:
• Work of merit, for example, some relevant work on the graph for either part; states 3 or 7 in (b)

High Partial Credit:
• 1 part correct

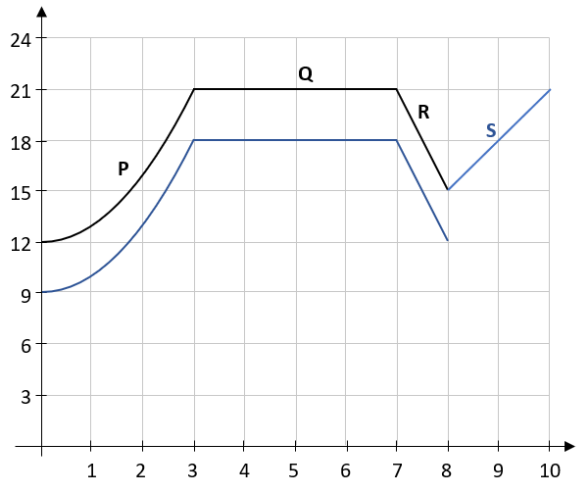
Full Credit −1:
• Correct answers, but no supporting work on the graph for part (a)
• No rounding or incorrect rounding in (a)</td></tr>
<tr><td>(c)
(d)</td><td>(c)
Section S drawn within tolerance.

(d)
<table><tr><th>Section
(P, Q, or R)</th><th>During this section, the function for the temperature is:</th></tr><tr><td>Q</td><td>$T(x) = 21$</td></tr><tr><td>P</td><td>$T(x) = x^2 + 12$</td></tr><tr><td>R</td><td>$T(x) = -6x + 63$</td></tr></table></td><td>Scale 5D (0, 2, 3, 4, 5)
Tolerance of 2 mm in drawing section S
Accept correct answers without work

Low Partial Credit:
• Work of merit, for example, some relevant work towards evaluating or drawing a point on S or one value in (d) correct

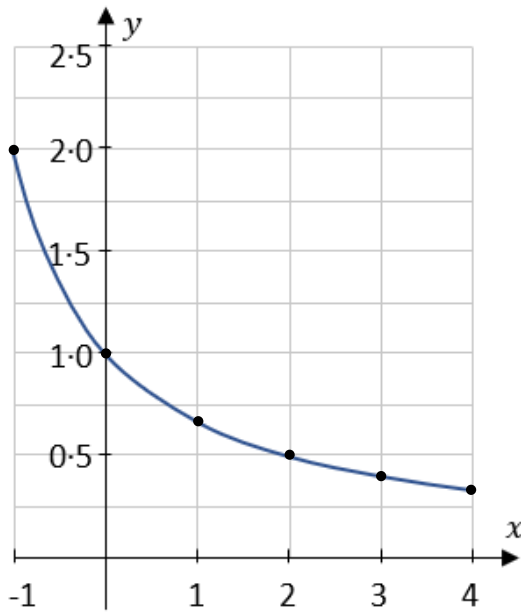
Mid Partial Credit:
• (c) or (d) correct
• Work of merit in both parts

High Partial Credit:
• 1 part correct and work of merit in the other part.</td></tr>
</table>

Q9	Model Solution – 25 marks	Marking Notes
(e)	**Answer**: $T(x) = 3x - 9$ **Justification**: *Any appropriate justification, for example:* States that slope $= 3$ and shows one point on S is on $y = 3x - 9$ **OR** Shows that two points on **S** are on $y = 3x - 9$ **OR** Shows one point on **S** is not on $y = -3x - 12$ and that one point on **S** is not on $y = 3x + 12$ **OR** States that slope $= 3$, so not the middle one; and gives a valid reason for why it must be the first, for example, continues graph to the left of $x = 8$ and says y-intercept is not 12.	**Scale 10B (0, 5, 10)** *Low Partial Credit:* • Answer correct • Work of merit in justification, for example, checks one point on **S** with one expression; states $m = 3$
(f)	*Correct graph drawn, 3 units below the given graph.* *Ignore any drawing outside the domain* $[0, 8]$.  	**Scale 5B (0, 3, 5)** *Partial Credit:* • Some vertical shift of the graph, other than down by 3 units. Note that this applies to a shift upwards of 3 units, as well as a shift downwards of 3 boxes (9 units). No credit is awarded for a horizontal shift of the graph.

Q10	Model Solution – 10 marks	Marking Notes
(a)	**(a)(i)** Missing value $= 40 - x$ (or correct equivalent) **(a)(ii)** $40 + 2x + 1 + 37 = 88$ $2x = 10$ $x = 5$ **OR** $C \setminus D = 88 - 37 - 40$ $2x + 1 = 11$ $2x = 10$ $x = 5$	**Scale 5D (0, 2, 3, 4, 5)** If incorrect answer in **(i)** leads to non-natural number as solution in **(ii)**, no penalty applies in **(ii)** for rounding/not rounding. Consider solution as generally being composed of 3 steps: **Step 1**. Part **(a)(i)** **Step 2**. Writes a correct equation in x **Step 3**. Solves for x with supporting work Note: Candidates may also find x by trial and improvement. In this case, the value of x needs to be verified; i.e. the value in each region needs to be found, and the total shown to be 88. Otherwise, only 1 of the steps of **(ii)** is considered correct. *Low Partial Credit:* • Work of merit, for example, adds values in two or more regions in **(ii)** *Mid Partial Credit:* • 1 step correct *High Partial Credit:* • 2 steps correct
(b)	He is in the debating club but not the chess club.	**Scale 5B (0, 3, 5)** *Partial Credit:* • Work of merit, for example, says that Michael is in the debating club, or is not in the chess club. • Explains $C \setminus D$, that is, that Michael is in the chess club but not the debating club.

Q11	Model Solution – 15 marks	Marking Notes
(a)	$8x^2 - 13x$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Work of merit, for example, indicates a pair of "like" terms (two x^2 terms or two x terms) *High Partial Credit:* • 1 term in answer correct
(b)	$x^2 + 8x - 9$ $x + 3 \overline{)x^3 + 11x^2 + 15x - 27}$ $\underline{x^3 + 3x^2}$ $8x^2 + 15x - 27$ $\underline{8x^2 + 24x}$ $-9x - 27$ $\underline{-9x - 27}$ [0] **OR** x^2 $+8x$ -9 x: x^3 $8x^2$ $-9x$ $+3$: $3x^2$ $24x$ -27	**Scale 10D (0, 4, 5, 6, 10)** *Low Partial Credit:* • Work of merit, for example, any correct division or sets up long division / array method correctly *Mid Partial Credit:* • One correct term in long division or array method *High Partial Credit:* • 2 correct terms in answer in long division method • 2 correct terms in answer **and** correctly splits up the $11x^2$ or the $15x$ in the array method

Q12	Model Solution – 15 marks	Marking Notes
(a)	**(i)** x | -1 | 0 | 1 | 2 | 3 | 4 $f(x)$ | **2** | 1 | **0·67** | 0·5 | 0·4 | **0·33** **(ii)** *6 points plotted from the values in the table, and joined appropriately (by a curve)*  	**Scale 10D (0, 4, 5, 6, 10)** Consider solution as consisting of 10 parts: **3 parts:** the 3 values in the table in **(i)** **6 parts:** 6 pointed plotted from the values in the table **1 part:** points joined appropriately *Low Partial Credit:* • 1 part correct *Mid Partial Credit:* • 4 parts correct *High Partial Credit:* • 7 parts correct *Full Credit –1:* • Apply a * once for incorrect rounding of 0·67 and/or 0·33 • Fully correct apart from 1 part

Q12	Model Solution – 15 marks	Marking Notes
(b)	Eqn 2: $y = 9 - 2x$ Eqn 1: $3x + 4(9 - 2x) = 29$ $3x + 36 - 8x = 29$ $-5x = -7$ $x = \frac{7}{5}$ or $1{\cdot}4$ $y = 9 - 2\left(\frac{7}{5}\right) = \frac{31}{5}$ or $6{\cdot}2$ **OR** Eqn 1: $3x + 4y = 29$ Eqn 2 × (-4): $\underline{-8x - 4y = -36}$ So: $-5x = -7$ $x = \frac{7}{5}$ or $1{\cdot}4$ $3\left(\frac{7}{5}\right) + 4y = 29$ $\frac{21}{5} + 4y = 29$ $4y = 29 - \frac{21}{5}$ $4y = \frac{124}{5}$ $y = \frac{124}{5} \div 4$ $y = \frac{31}{5}$ or $6{\cdot}2$ **OR** Eqn 1: $y = \frac{29-3x}{4}$ Eqn 2: $y = 9 - 2x$ $\frac{29-3x}{4} = 9 - 2x$ $29 - 3x = 36 - 8x$ $5x = 7$ $x = \frac{7}{5}$ or $1{\cdot}4$ $y = 9 - 2\left(\frac{7}{5}\right)$ $y = \frac{31}{5}$ or $6{\cdot}2$	**Scale 5D (0, 2, 3, 4, 5)** Consider solution is consisting of 4 steps: **Step 1.** Multiplies equation(s) so that 1 variable will cancel / express one variable in terms of the other **Step 2.** Produces one equation in one variable **Step 3.** Finds value of one variable **Step 4.** Finds value of second variable *Low Partial Credit:* • Work of merit, for example, relevant work in isolating one variable in one equation or indicates multiplying one equation by a constant *Mid Partial Credit:* • 2 steps correct *High Partial Credit:* • 3 steps correct

Q13	Model Solution – 10 marks	Marking Notes
(a) **(b)**	**(a)** $w = 12 + 2x$ **(b)** $l \times w \;\; = (18 + 2x)(12 + 2x)$ $= 216 + 36x + 24x + 4x^2$ $= 4x^2 + 60x + 216$	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • Work of merit in **(a)**, for example, writes w as $12 - 2x$ or $12 + x$ • Work of merit in **(b)**, for example, fills in correctly for l or w in $l \times w$ *Mid Partial Credit:* • Work of merit in both **(a)** and **(b)** • **(a)** not correct, but significant work of merit in **(b)**, for example, 3 of the 4 terms in $l \times w$ fully multiplied out *High Partial Credit:* • **(a)** correct **and** significant work of merit in **(b)**, for example, 3 of the 4 terms in $216 + 36x + 24x + 4x^2$ correct • **(a)** not correct, but $l \times w$ fully multiplied out and simplified for candidate's own value of w *Full Credit −1:* • $216 + 36x + 24x + 4x^2$ but no conclusion. (In the model solution, "$216 + 60x + 4x^2$" is considered as an appropriate conclusion.)

Q13	Model Solution – 10 marks	Marking Notes
(c)	$216 + 60x + 4x^2 = 648$ $4x^2 + 60x - 432 = 0$ $x = \frac{-b+\sqrt{b^2-4ac}}{2a} = \frac{-60\pm\sqrt{60^2-4(4)(-432)}}{2(4)}$ $= \frac{-60\pm\sqrt{3600+6912}}{8}$ $= \frac{-60\pm\sqrt{10\,512}}{8}$ $= 5{\cdot}31\ldots$ as $x > 0$ from the context $= 5{\cdot}3$ [cm] [1 D.P.] **OR** $x^2 + 15x - 108 = 0$ $x = \frac{-b+\sqrt{b^2-4ac}}{2a} = \frac{-15\pm\sqrt{15^2-4(1)(-108)}}{2(1)}$ $= \frac{-15\pm\sqrt{225+432}}{2}$ $= \frac{-15\pm\sqrt{657}}{2}$ $= 5{\cdot}31\ldots$ as $x > 0$ from the context $= 5{\cdot}3$ [cm] [1 D.P.]	**Scale 5C (0, 2, 3, 5)** Accept correct answer without unit Consider solution as consisting of 3 steps: **Step 1.** Sets up quadratic equation **Step 2.** Fully substitutes quadratic formula **Step 3.** Finds the value of x Note: If a candidate effectively solves $216 + 60x + 4x^2 = 0$, they can be considered to have steps 2 and 3 completed and be awarded HPC, they will also have a $*$ applied as they cannot pick the positive value of x (both values of x will be negative). Note: Step 2 can be assumed correct if step 1 and step 3 correct *Low Partial Credit:* • 1 step correct • Identifies a, b, or c *High Partial Credit:* • 2 steps correct *Full Credit –1:* • No rounding or incorrect rounding, otherwise correct • Two values of x found as per the equation, but negative one not excluded / positive one not selected