Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Cycle 2023

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	A	B	C	D
No of categories	2	3	4	5
5-mark scale	0, 5	0, 2, 5	0, 2, 4, 5	0, 2, 3, 4, 5
10-mark scale		0, 5, 10	0, 3, 7, 10	0, 3, 5, 8, 10
15-mark scale			0, 5, 10, 15	0, 4, 8, 12, 15

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, where necessary.

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. 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.

Summary of mark allocations and scales to be applied

Question 1 (15)
(a),(b),(c) 15D

Question 2 (35)
(a),(b) 15C
(c), (d) 10D
(e) 10C

Question 3 (25)
(a) 10B
(b),(c) 15D

Question 4 (25)
(a),(b) 10D
(c) 10C
(d) 5C

Question 5 (15)
(a),(b),(c) 15D

Question 6 (10)
(a) 5A
(b) 5C

Question 7 (30)
(a) 10D
(b) 10D
(c) 10C

Question 8 (30)
(a) 5B
(b) 5C
(c) 15D
(d) 5D

Question 9 (10)
(a),(b),(c) 10D

Question 10 (20)
(a),(b) 15D
(c) 5C

Question 11 (15)
(a),(b) 10D
(c) 5D

Question 12 (15)
(a) 5B
(b) 10D

Question 13 (10)
(a),(b) 5D
(c) 5C

Question 14 (15)
(a),(b) 15D

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)	
o	Oversimplify	The candidate has oversimplified the work	
WOM			The candidate has presented work or merit

Note: Where work of substance is presented in the body of the script, the annotations on the right margin should reflect a combination of annotations in the work.

In a **C scale** that is not marked using steps, where * and  and  appear in the body of work, then **L** should appear in the right margin.

In a **D scale** with the same annotations, **M** should appear in the right margin.

A  is in the body of the work may indicate a portion of work that has value and has merited one of the levels of merit in the marking scheme. The level of credit is then indicated in the right margin.

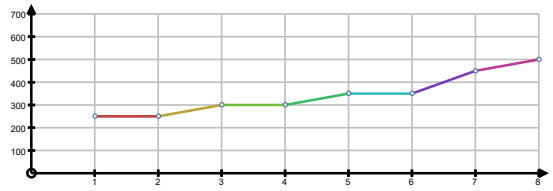
Detailed marking notes

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 – 15 marks	Marking Notes
(a), (b) & (c)	(a) $17{\cdot}5°$ C, $17{\cdot}9°$C, $18{\cdot}49°$C etc. (b) $17{\cdot}5°$ C $\leq t < 18{\cdot}5°$ C (c) $t \in \mathbb{R}$ Values of temperature (t) will take on decimal places over the course of a day (continuous)	**Scale 15D (0, 4, 8, 12, 15)** *Low Partial Credit:* • Some work of merit, for example: one correct value in (a); one correct endpoint of the required interval in (b). • Correct box ticked in (c) and no further work. • Correct reason based on incorrect tick in (c). *Mid Partial Credit:* • Work of merit in (a) **and** (b) **and** (c). *High Partial Credit:* • Two values correct in (a). • (b) **or** (c) fully correct.

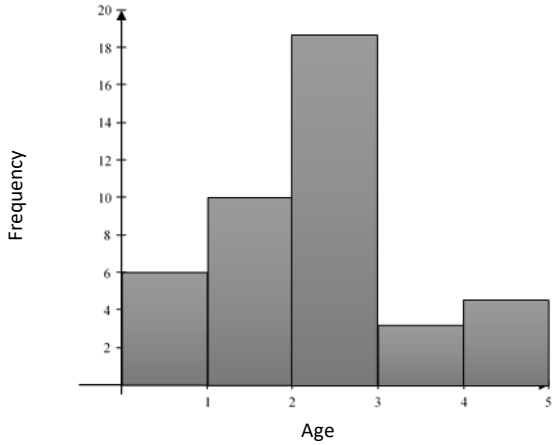
<table>
<tr><th>Q2</th><th>Model Solution – 35 marks</th><th>Marking Notes</th></tr>
<tr><td>(a)
&
(b)</td><td>(a)
(i) 300
(ii) 50

(b)
Month 7</td><td>Scale 15C (0, 5, 10, 15)
Low Partial Credit:
• One correct answer.
High Partial Credit:
• Two correct answers.</td></tr>
<tr><td>(c)
&
(d)</td><td>15 items: 7 table entries and 8 points to graph.
<table><tr><th>1</th><th>2</th><th>3</th><th>4</th></tr><tr><td>250</td><td>250</td><td>300</td><td>300</td></tr></table>
<table><tr><th>5</th><th>6</th><th>7</th><th>8</th></tr><tr><td>350</td><td>350</td><td>450</td><td>500</td></tr></table>
  </td><td>Scale 10D (0, 3, 5, 8, 10)
Low Partial Credit:
• Any 1 item correct.
Mid Partial Credit:
• Any 7 items correct.
High Partial Credit:
• Any 10 items correct.
Full Credit −1:
• All items correct but points not joined or joined inappropriately.
• All items but 1 correct and points appropriately joined.
• Axes not scaled or incorrectly scaled, if graph is drawn in the box below the question.</td></tr>
<tr><td>(e)</td><td>Month 3

Justification:
Month 3: $\frac{50}{300} \times 100 = 16\frac{2}{3}\%$

Month 5: $\frac{50}{400} \times 100 = 12\frac{1}{2}\%$</td><td>Scale 10C (0, 3, 7, 10)
Low Partial Credit:
• Correct answer without justification.
• Some work of merit, for example: shows some knowledge of percentages.
High Partial Credit:
• One correct percentage increase calculated and the month correct.</td></tr>
</table>

Q3	Model Solution – 25 marks	Marking Notes
(a)	$V_{block} = 35 \times 45 \times 16 = 25\,200 \text{ cm}^3$	**Scale 10B (0, 5, 10)** Accept correct answer without work. *Partial Credit:* • Some correct substitution into a relevant formula. *Full Credit −1:* • No units or incorrect units
(b) & (c)	(b) $V_{cylinder} = \pi(r^2)(9) = 9\pi r^2 \text{ cm}^3$ (c) $V_{wax\ used} = 25\,200 \times 90\% = 22\,680 \text{ cm}^3$ $9\pi r^2 = \frac{22\,680}{100}$ $r^2 = \frac{22\,680}{900\pi}$ $r = \sqrt{\frac{22\,680}{900\pi}}$ $r = 2{\cdot}8322$ $r = 2{\cdot}8$ cm [to 1 decimal place]	**Scale 15D (0, 4, 8, 12, 15)** Note: Surface Area formula used in (b) merits MP at most. Accept answer from (a). Consider solution as requiring 5 steps: 1. Finds volume of cylinder in (b) 2. Finds the volume of wax used 3. Sets up equation correctly. 4. Finds r^2 5. Finds r *Low Partial Credit:* • One step correct. *Mid Partial Credit:* • Two steps correct. *High Partial Credit:* • Three steps correct. • One error and finishes correctly. *Full Credit −1:* • No rounding, incorrect rounding or early rounding. • No units or incorrect units. • Answer not in terms of π in (b).

Q4	Model Solution – 25 marks	Marking Notes
(a) & (b)	(a)  (b) $\%\ \text{Aged}\ (1-2) = \frac{10}{43} \times 100 = 23{\cdot}26$ $= 23\%$ [to the nearest percentage]	**Scale 10D (0, 3, 5, 8, 10)** Accept area defined by area key or by scale on frequency axis. Accept correct answer for percentage without work. *Low Partial Credit:* • Work of merit, for example: one axis correctly graduated; one correct bar drawn; number of children identified in (b). *Mid Partial Credit:* • Three correct bars in histogram. • All bars of correct height, but with gaps between them. • Work of merit in both parts. • One part correct and no work of merit in the other part. *High Partial Credit:* • One part correct and work of merit in the other part. *Full Credit −1:* • One or both axes are not labelled or incorrectly labelled. • No rounding or incorrect rounding in (b).
(c)	Estimated Mean: $\frac{(6 \times 0.5) + (10 \times 1.5) + (19 \times 2.5) + (3 \times 3.5) + (5 \times 4.5)}{43}$ $= \frac{3 + 15 + 47 \cdot 5 + 10 \cdot 5 + 22 \cdot 5}{43}$ $= \frac{98 \cdot 5}{43}$ $= 2{\cdot}2\dot{9}$ $= 2{\cdot}3$ years [to 1 decimal place]	**Scale 10C (0, 3, 7, 10)** Accept correct answer without work. Accept correct answer without units. *Low Partial Credit:* • Work of merit, for example: indicates division by 43; one correct mid-interval value; numerator with consistent incorrect mid-interval values. *High Partial Credit:* • Consistent incorrect mid-interval values and finishes correctly. • First line of the solution. • One error and finishes correctly. *Full Credit −1:* • No rounding, incorrect rounding or early rounding.

Q4	Model Solution – 25 Marks	Marking Notes
(d)	$0-1$: 2 staff $1-2$: 2 staff $2-3$: 4 staff $3-6$: 1 staff Total: 9 staff	**Scale 5C (0, 2, 4, 5)** Accept correct answer without work. *Low Partial Credit:* • Some work of merit, for example: the correct number of staff for any one of the age groups. *High Partial Credit:* • Correct number of staff for any three of the age groups. *Full Credit −1:* • Correct number of staff for each of the age groups but the least number of staff for all the groups not given.

Q5	Model Solution – 15 marks	Marking Notes
(a), (b) & (c)	(a) $a \times b = c$ **1** even × even = even **2** odd × odd = odd **3** odd × even = even (b) **E E E** | **E E O** | **E O E** | **O E E** **E O O** | **O E O** | **O O E** | **O O O** (c) $\frac{7}{8}$	**Scale 15D (0, 4, 8, 12, 15)** 9 items required: 8 entries in tables and probability *Low Partial Credit:* • 1 item correct. • Work of merit, for example: correct numerator or denominator in (c). *Mid Partial Credit:* • 5 items correct. • Two parts correct. *High Partial Credit:* • Two parts correct and work of merit in the third part. *Full Credit –1:* • 7 in 8 or 7: 8 in (c).

Q6	Model Solution – 10 marks	Marking Notes
(a)	$x + 3$	**Scale 5A (0, 5)**
(b)	$x = 8$ Maximum occurs when $8 - x \geq 0$ $8 \geq x$ $x = 8$	**Scale 5C (0, 2, 4, 5)** *Low Partial Credit:* • Works with $x - 2$ and finds the least possible value for x. • Effort at substituting values for $x(> 0)$, with no conclusion or incorrect conclusion. *High Partial Credit:* • Correct value for x without justification or incorrect justification. • Incorrect value for x with a valid justification.

Q7	Model Solution – 30 marks	Marking Notes
(a)(i) & (a)(ii)	(i) Plot $C(8,4)$ and $D(3,6)$ (ii) $A(1,1)$ and $B(6,-1)$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • Some work of merit, for example: one point plotted correctly; co-ordinates reversed in (ii). *Mid Partial Credit:* • Work of merit in both parts. *High Partial Credit:* • (i) or (ii) correct. *Full Credit –1:* • Answers in (ii) in incorrect boxes. • Both points not labelled in (i).
(b)(i) & (b)(ii)	**(i)** $\|AB\| = \sqrt{(6-1)^2 + (-1-1)^2}$ $= \sqrt{29}$ $\|BC\| = \sqrt{(8-6)^2 + (4-(-1))^2}$ $= \sqrt{29}$ $[\therefore \|AB\| = \|BC\|]$ **(ii)** $m_{AB} = \frac{-1-1}{6-1} = -\frac{2}{5}$ $m_{BC} = \frac{4+1}{8-6} = \frac{5}{2}$ $m_{AB} \times m_{BC} = -\frac{2}{5} \times \frac{5}{2} = -1$ [$\therefore$ AB is perpendicular to *BC*]	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • Some work of merit, for example: some correct substitution into correct formula in either (i) or (ii). • Indication of the property of slopes of perpendicular lines. • Slope$= \frac{\text{rise}}{\text{run}}$ in (ii). *Mid Partial Credit:* • Correctly substituted formulae in either (i) **or** (ii). • Work of merit in both parts. *High Partial Credit:* • Either (i) **or** (ii) correct. • Correctly substituted formulae in both (i) **and** (ii).

Q7	Model Solution – 30 marks	Marking Notes
(c)(i) & (c)(ii)	(i) False Justification: For example: 'Not all parallelograms contain right angles' 'A rectangle is not a square' (ii) 'Every square is a parallelogram'	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Some work of merit, for example: correct answer with incorrect justification or no justification • Some attempt to explain the meaning of converse *High Partial Credit:* • (i) **or** (ii) correct

Q8	Model Solution – 30 marks	Marking Notes
(a)	$7500\ [\text{m}]$	**Scale 5B (0, 2, 5)** Accept correct answer without work. *Partial Credit:* • Work of merit, for example: indication that $1\ \text{km} = 1000\ \text{m}$.
(b)	$\sin E = \frac{200}{7500}$ $E = \sin^{-1}\frac{200}{7500} = 1{\cdot}528°$ $= 1{\cdot}5°$ [to 1 decimal place]	**Scale 5C (0, 2, 4, 5)** Accept answer from (a). *Low Partial Credit:* • Work of merit, for example: correctly identifies either the opposite side or the hypotenuse; $\sin E = \frac{\text{opposite}}{\text{hypotenuse}}$; uses the theorem of Pythagoras to find the length of the adjacent side. • Incorrect trigonometric ratio and finishes correctly. *High Partial Credit:* • $\sin E = \frac{200}{7500}$. • Correct answer without work. • One error and finishes correctly. *Full Credit −1:* • No rounding or incorrect rounding. • Calculator in incorrect mode.

Q8	Model Solution – 30 marks	Marking Notes
(c)(i) & (c)(ii)	(i) $\frac{1}{3}$ hour (ii) $\frac{598}{2\frac{1}{3}} = 256{\cdot}28571$ $= 256{\cdot}3$ km/hour [to 1 decimal place] **Or** $\frac{598}{140} = 4{\cdot}27 \times 60$ $= 256{\cdot}285$ $= 256{\cdot}3$ km/hour [to 1 decimal place]	**Scale 15D (0, 4, 8, 12, 15)** Accept correct answers without units. In (i) accept correct answer without work. *Low Partial Credit:* • (i) correct. • Some work of merit, for example: indication of 60 minutes in an hour; speed $= \frac{\text{distance}}{\text{time}}$. *Mid Partial Credit:* • Work of merit in both parts. • (ii) correct without work and (i) not answered or incorrect. *High Partial Credit:* • Speed $= \frac{598}{2\frac{1}{3}}$ and stops. • Speed $= \frac{598}{140}$ and stops. • Speed $= \frac{598}{2{\cdot}20} = 271{\cdot}8$. • Speed $= 4{\cdot}27$ and stops. • Speed $= \frac{598000}{140} = 4271$. • (ii) correct and (i) not answered or incorrect. • (i) correct and $256{\cdot}3$ km/hr, without work, in (ii). *Full Credit −1:* • No rounding, incorrect rounding or early rounding. • $\frac{20}{60}$ given as answer in (i).

Q8	Model Solution – 30 marks	Marking Notes
(d)	Label as D the point at the foot of perpendicular from B onto AC. $\|AD\|^2 + 280^2 = 598^2$ $\|AD\|^2 = 598^2 - 280^2$ $\|AD\|^2 = 279\,204$ $\|AD\| = 528{\cdot}39757\ \ldots$ $\tan 35^\circ = \frac{280}{\|DC\|}$ $\|DC\| = \frac{280}{\tan 35^0}$ $= 399{\cdot}88144\ \ldots$ $\|AC\| = \|AD\| + \|DC\|$ $= 528{\cdot}39757\ \ldots + 399{\cdot}88144\ \ldots$ $= 928{\cdot}27901$ $= 928\ \text{km}$ [to the nearest kilometre]	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • Some work of merit, for example: some correct substitution into $a^2 + b^2 = c^2$. • $\tan A = \frac{\text{opposite}}{\text{adjacent}}$. *Mid Partial Credit:* • Either $\|AD\|$ or $\|DC\|$ calculated correctly. • Work of merit in both parts. *High Partial Credit:* • $\|AD\|$ calculated correctly with work of merit in calculating $\|DC\|$. • $\|DC\|$ calculated correctly with work of merit in calculating $\|AD\|$. • $\|AD\|$ and $\|DC\|$ not added. *Full Credit −1:* No rounding, incorrect rounding or early rounding.

Q9	Model Solution – 10 marks	Marking Notes
(a) **(b)** **&** **(c)**	(a) $4x(5x+4)-3(x-2)$ $20x^2+16x-3x+6$ $20x^2+13x+6$ (b) $(3-5y)(3+5y)$ (c) $\frac{5^7\times5^6}{5^{\frac{1}{2}}}=\frac{5^{13}}{5^{\frac{1}{2}}}=5^{\frac{25}{2}}$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • One term correctly multiplied in (a). • Indicates or shows understanding of difference of two squares in (b). • 3 or $5y$ appear in (b). • Some correct work with indices in (c). *Mid Partial Credit:* • One part correct and work of merit in one of the other two parts. • Work of merit in (a) **and** (b) **and** (c). *High Partial Credit:* • Two parts correct.

Q10	Model Solution – 20 marks	Marking Notes
(a) & (b)	(a) USC @ $1{\cdot}5\% = 12\,012 \times 0{\cdot}015$ $= €180{\cdot}18$ USC @ $3{\cdot}5\% = 5\,564 \times 0{\cdot}035$ $= €194{\cdot}74$ (b) $\frac{x}{20}$ or $0{\cdot}05x$ **Or** $0{\cdot}07(x - 17\,576) + 374{\cdot}92$	**Scale 15D (0, 4, 8, 12, 15)** Accept correct answers without work. Accept correct answers without unit. *Low Partial Credit:* • Some work of merit, for example: $12\,012 \times 1{\cdot}5$; $1{\cdot}5\% = \frac{3}{200}$, $x \times 5\%$; $5\% = \frac{1}{20}$. *Mid Partial Credit:* • Work of merit in both parts. *High Partial Credit:* • (a) correct • (b) correct with work of merit in (a)
(c)	$0{\cdot}07(x - 17\,576) + 180{\cdot}18 + 194{\cdot}74$ $= 0{\cdot}05x$ $0{\cdot}07x - 1230{\cdot}32 + 374{\cdot}92 = 0{\cdot}05x$ $0{\cdot}07x - 0{\cdot}05x - 1230{\cdot}32 + 374{\cdot}92 = 0$ $0{\cdot}02x = 855{\cdot}40$ $x = \frac{855{\cdot}40}{0{\cdot}02}$ $x = €42\,770$	**Scale 5C (0, 2, 4, 5)** Accept answers from parts (a) and (b). Accept correct answer without unit. *Low Partial Credit:* • Work of merit, for example: $17\,576 \times 0{\cdot}07$; $374{\cdot}92$; $x - 17\,576$. • Relevant work with trial and improvement. • Correct answer without work. *High Partial Credit:* • First line of the solution.

Q11	Model Solution -15 marks	Marking Notes
(a) **&** **(b)**	(a) $21\,000$ people remain 6 minutes after the end of the match. (b) $W(20,0)$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • Some work of merit, for example: 6 refers to time or 21 000 refers to the number of people. • One correct coordinate, for example $(x, 0)$ or $(20, y)$, where $x \neq 20$ and $y \neq 0$. • (b) correct and no work in (a). *Mid Partial Credit:* • Work of merit in both parts. • (a) correct and no work in (b). *High Partial Credit:* • (a) correct and work of merit in (b). • (b) correct and work of merit in (a).
(c)(i) **&** **(c)(ii)**	$P = 30\,000 - 1500(12)$ $= 30\,000 - 18\,000$ $= 12\,000$ 1500 people leave the stadium each minute after the match ends.	**Scale 5D (0, 2, 3, 4, 5)** Accept correct answer without work in (i). *Low Partial Credit:* • Some work of merit in either (i) or (ii). • 12 substituted correctly in the given equation. • Some reference to rate or slope or speed in (ii). • Recognises that $t = 12$. *Mid Partial Credit:* • Work of merit in both parts. *High Partial Credit:* • (i) **or** (ii) correct.

Q12	Model Solution – 15 marks	Marking Notes
(a)	Perpendicular bisector of any **one** of $[AB], [AC]$ or $[BC]$. Construction arcs shown with bisector continued to the third vertex. **Or** Angle bisector of any **one** of $\angle ABC, \angle ACB$ or $\angle BAC$. Construction arcs shown with angle bisector continued to opposite side.	**Scale 5B (0, 2, 5)** Allow tolerence of ± 2mm for perpendicular bisector and ± 2° for angle bisector. *Partial Credit:* • Work of merit, for example: a relevant construction arc drawn. • No construction lines. *Full Credit −1:* • Axis of symmetry not fully drawn.
(b)(i) & (b)(ii)	$\lvert\angle ACB\rvert = 60^\circ$ Length of Circular Arc $= \frac{\theta}{360}(2\pi r)$ $= \frac{60}{360}(2\pi)(40)$ $= 41{\cdot}8879$ $= 41{\cdot}89$ cm [to 2 decimal places]	**Scale 10D (0, 3, 5, 8, 10)** Allow $\pi = \frac{22}{7}$ or $3{\cdot}14$ for full marks. *Low Partial Credit:* • (i) correct. • 40 or 60 correctly substituted in $\frac{\theta}{360}(2\pi r)$. • 40 substituted for r in $2\pi r$. • 40 substituted for r in $l = r\theta$. • Indication that the sum of the angles in a triangle is 180°. *Mid Partial Credit:* • Work of merit in both parts. • (ii) correct without work and (i) not answered or incorrect. *High Partial Credit:* • (ii) correct and (i) not answered or incorrect. *Full Credit −1:* • No units or incorrect units in (i). • No rounding or incorrect rounding in (ii).

Q13	Model Solution – 10 marks	Marking Notes
(a) & (b)	(a) Total height $= x + 0{\cdot}5$ m (b) $x(x + 0 \cdot 5) = 50$ $x^2 + 0 \cdot 5x - 50 = 0$ $2x^2 + x - 100 = 0$	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • Some work of merit, for example: indicates that the height of the square image is x. • Incorrect operation, for example: $x \times 0{\cdot}5$ in (a). • Some work of merit in (b), for example: an area expression in x set equal to 50; indication that area $=$ length $\times$ width. • (a) correct. *Mid Partial Credit:* • Work of merit in both parts. *High Partial Credit:* • (a) correct and work of merit in (b), for example: $x(x + 0 \cdot 5) = 50$. • (b) correct.
(c)	$x = \frac{-1 \pm \sqrt{1^2 - 4(2)(-100)}}{2(2)}$ $x = \frac{-1 \pm \sqrt{801}}{4}$ $x = 6{\cdot}825 \ldots \quad x = -7{\cdot}325 \ldots$ $x = 6{\cdot}83 \quad x \neq -7{\cdot}33$ [$x = 6$ m 83 cm or $x = 6{\cdot}83$ m] [to the nearest centimetre]	**Scale 5C (0, 2, 4, 5)** *Low Partial Credit:* • Some correct substitution in the quadratic formula. • Identifies a or b or c. *High Partial Credit:* • Quadratic formula fully substituted. • One error in filling in formula but evaluates correctly. • $-1 \pm \frac{\sqrt{801}}{4}$ and finishes correctly. • Correct answer without work. *Full Credit −1:* • No rounding or incorrect rounding. • Answer not correct to the nearest centimetre. • Negative answer not excluded.

Q14	Model Solution – 15 marks	Marking Notes
(a) & (b)	(a) $x^2 + 9^2 = 15^2$ $x^2 + 81 = 225$ $x^2 = 144$ $x = 12$ (b) $\frac{15}{2x} = \frac{9}{y}$ $\frac{15}{24} = \frac{9}{y}$ $15y = 216$ $y = 14{\cdot}4$	**Scale 15D (0, 4, 8, 12, 15)** Accept correct answer in (a) without work. *Low Partial Credit:* • Some reference made to the theorem of Pythagoras. • Some correct substitution in the formula $a^2 + b^2 = c^2$. • Triangles redrawn separately or identified, or understanding of similar triangles in (b). *Mid Partial Credit:* • Work of merit in both parts, for example: some correct substitution in the formula $a^2 + b^2 = c^2$ and triangles redrawn separately in (b) or one relevant ratio in (b), for example, $\frac{9}{y}, \frac{y}{9}, \frac{\lvert EC\rvert}{\lvert AC\rvert}, \frac{9}{15}, \frac{2x}{y}, \frac{9}{x}$, etc. • (a) correct. • (a) correct and relevant work of merit, using trigonometry, in (b) *High Partial Credit:* • (a) correct and work of merit in (b). • Error finding x in part (a) but continues correctly. • (a) correct (b) correct, using trigonometry