



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2023

Marking Scheme

Mathematics

Foundation 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.

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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, 3, 5	0, 2, 3, 4, 5
10-mark scale		0, 4, 10	0, 3, 7, 10	0, 3, 5, 8, 10
15-mark scale			0, 5, 10, 15	0, 4, 7, 11, 15
20-mark scale				0, 5, 10, 15, 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, 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, a mark that is one mark below the full-credit mark may 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*.

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

Section A (210) Answer any seven questions		Section B (90) Answer any two questions
Question 1 (30) (a)(i)(ii) 20D (b)(i)(ii) (c) 10D Question 2 (30) (a)(i) 10D (a)(ii) 10D (b)(i)(ii) 10D Question 3 (30) (a)(i)(ii) 10D (a)(iii) 5C (b)(i)(ii) 15D Question 4 (30) (a)(b) 10D (c)(i) 10C (c)(ii)(iii) 10D	Question 5 (30) (a)(i)(ii) 20D (b)(c) 10D Question 6 (30) (a)(i)(ii) 10D (b)(i)(ii) 15D (b)(iii) 5C Question 7 (30) (a)(i)(ii) 15D (b) 5C (c)(i)(ii)(iii) 10D Question 8 (30) (a)(i) 10B (a)(ii) 10C (b)(i)(ii) 10D	Question 9 (45) (a)(i)(ii) 10D (b)(i)(ii) 10D (c)(i)(ii) 10D (d)(i) 10C (d)(ii)(iii) 5D Question 10 (45) (a)(i)(ii) 10D (b) 5C (c)(i)(ii) 15D (d)(i)(ii) 15D Question 11 (45) (a)(b)(c) 20D (d) 5B (e) 10D (f) 10C

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		The work presented in the body of the script merits a partial credit for B scales
	L		The work presented in the body of the script merits low partial credit
	M		The work presented in the body of the script merits mid partial credit
	H		The work presented in the body of the script merits high partial credit
	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)	
	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.

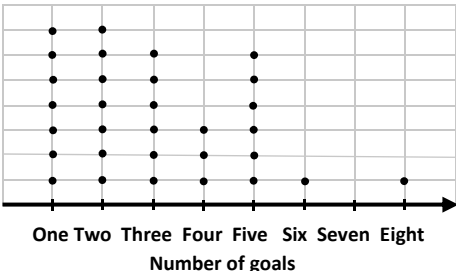
In a **C scale** where * and appear in the body of work, then should appear in the right margin.

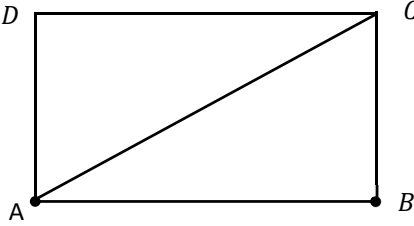
In a **D scale** with the same annotations a should appear in the right margin.

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.

Model Solutions & Marking Notes

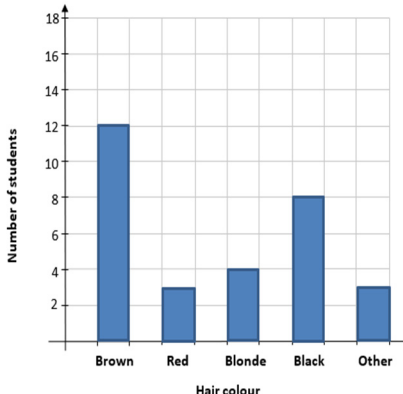
The model solutions for each question are not intended to be exhaustive – there may be other correct solutions. Any Examiner unsure of the validity of the approach adopted by a particular candidate to a particular question should contact his / her Advising Examiner.

Q1	Model Solution – 30 Marks	Marking Notes
(a) (i) (ii)	7, 7, 6, 3, 6, 1, 0, 1  One Two Three Four Five Six Seven Eight Number of goals	Scale 20D (0, 5, 10, 15, 20) <i>Low Partial Credit</i> - Work of merit in one part <i>Mid Partial Credit</i> - One part correct - Work of merit in both parts <i>High Partial Credit</i> - One part correct and work of merit in the other part <i>Full credit – 1</i> <i>Allow one counting error with a Tolerance ± 1.</i>
(b)(i)(ii)&(c) (i) (ii) (c)	7 $3 + 6 + 1 + 1 = 11$ $7 + 7 = 14$ $\frac{14}{31} \times 100$ $= 45.16 \dots$ $= 45\%$ to nearest percent	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> - Work of merit in one part only. - One part correct. <i>Mid Partial Credit</i> - Two parts correct - One part correct and work of merit in the two other parts. - Work of merit in the three parts <i>High Partial Credit</i> - Two parts correct and work of merit in the other part. <i>Full credit – 1</i> <i>Correct percentage but not rounded to nearest percent.</i>

Q2	Model Solution – 30 Marks	Marking Notes
(a)(i)		Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit, for example, 1 new additional line constructed correctly. • 5 cm line drawn but not right angled <i>Mid Partial Credit</i> • Right angled 5 cm line drawn with additional line <i>High Partial Credit</i> • 3 lines constructed correctly. <i>Tolerance: ± 0.25 cm</i>
(a)(ii)	$ AC ^2 = BC ^2 + AB ^2$ $ AC ^2 = 5^2 + 9^2$ $= 25 + 81 = 106$ $ AC = \sqrt{106}$ $= 10.295$ $= 10.30 \text{ cm}$	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit, for example, some correct substitution in formula <i>Mid Partial Credit</i> • Formula fully correctly substituted • 106 <i>High Partial Credit</i> • $\sqrt{106}$ and fails to finish <i>Full credit -1</i> No, or incorrect rounding
(b) (i) (ii)	$\tan X = \frac{5}{9}$ $X = \tan^{-1} \frac{5}{9}$ $= 29.05 = 29^\circ$	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • <i>Work of merit</i> in one part, for example, identifies opposite/adjacent/hypotenuse <i>Mid Partial Credit</i> • <i>One part correct</i> • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part <i>Full credit –1</i> • <i>Radians instead of degrees</i>

Q3	Model Solution – 30 Marks	Marking Notes
(a) (i) (ii)	$5 \times 0.8 = \text{€}4$ $600 \times 1.1 = 660 \text{ g}$	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit in one part <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part
(a) (iii)	A: $400 \div 4 = 100 \text{ g per euro}$ B: $660 \div 6 = 110 \text{ g per euro}$ <i>Or similar</i> Answer: B (more grams per euro)	Scale 5C (0, 2, 3, 5) <i>Low Partial Credit</i> • Work of merit • Correct answer with no calculations/justification <i>High Partial Credit</i> • Correct calculations but no conclusion
(b) (i) (ii)	$\frac{108}{12-3} = \frac{108}{9} = 12$ 11.8	Scale 15D (0, 4, 7, 11, 15) <i>Low Partial Credit</i> • Work of merit in one part, for example, one or both numbers rounded off correctly in (i) • 5.8 as answer in (ii) <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part

Q4	Model Solution – 30 Marks	Marking Notes									
(a) (b)	$\frac{3}{8}$ Likely: 0.79 Unlikely: 0.2 Certain: 1	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit in one part • One correct entry in table • Clearly identifies number of favourable outcomes <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part									
(c)(i)	<table border="1"> <tr> <td></td><td>Study French</td><td>Study German</td></tr> <tr> <td>Number of Boys</td><td>96</td><td>144</td></tr> <tr> <td>Number of Girls</td><td>110</td><td>50</td></tr> </table>		Study French	Study German	Number of Boys	96	144	Number of Girls	110	50	Scale 10C (0, 3, 7, 10) <i>Low Partial Credit</i> • Work of merit, for example, 240 – 96 and fails to finish correctly <i>High Partial Credit</i> • One correct entry
	Study French	Study German									
Number of Boys	96	144									
Number of Girls	110	50									
(c)(ii) & (iii) (ii) (iii)	$\frac{96}{240} \quad \text{or} \quad \frac{2}{5}$ $\frac{160}{400} \quad \text{or} \quad \frac{2}{5}$	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit in one part • Correct numerator or denominator <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part									

Q5	Model Solution – 30 Marks	Marking Notes
(a) (i) (ii)	$12 + 3 + 4 + 8 + 3 = 30$ 	Scale 20D (0, 5, 10, 15, 20) Low Partial Credit • Work of merit in one part • One correct bar drawn Mid Partial Credit • One part correct • Work of merit in both parts High Partial Credit • One part correct and work of merit in the other part
(b) & (c) (b) (c)	$1, 2, 4, 9, 10, 14, 18$ $4, 4, 7$	Scale 10D (0, 3, 5, 8, 10) Low Partial Credit • Work of merit in one part • 9 entered correctly • 1 and 17 identified but not completed • 4 entered in two boxes • 5×3 or 15 identified Mid Partial Credit • One part correct • Work of merit in both parts High Partial Credit • One part correct and work of merit in the other part

Q6	Model Solution – 30 Marks	Marking Notes
(a) (i) (ii)	 $(3, 4)$ Axial symmetry in x-axis: D or (3, -4) Axial symmetry in y-axis: B or (-3, 4) Central symmetry in the point (0, 0): C or (-3, -4)	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit in one part • One or two correct entries in (ii) • $(4, 3)$ <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part
(b)(i) & (ii) (i) (ii)	 10 minutes 16 km	Scale 15D (0, 4, 7, 11, 15) <i>Low Partial Credit</i> • Work of merit in one part • Correct entry on graph for either part but no conclusion <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part
(b) (iii)	 c The slope of the line is less steep than a or b (or similar)	Scale 5C (0, 2, 3, 5) <i>Low Partial Credit</i> • Some attempt at reason, for example, mention of slope • Correct answer but no attempt at reason <i>High Partial Credit</i> • Correct answer and some attempt at reason.

Q7	Model Solutions – 30 Marks	Marking
(a)(i) & (ii) (i) (ii)	$500 \times 0.23 = \text{€}115$ $500 + 115 + 40 = \text{€}655$	Scale 15D (0, 4, 7, 11, 15) <i>Low Partial Credit</i> • Work of merit in one part <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part
(b)	$384\,000 \div 12 = 32\,000 \text{ seconds}$ $= 533\,333 \text{ mins}$ $\approx 533 \text{ mins}$	Scale 5C (0, 2, 3, 5) <i>Low Partial Credit</i> • $384\,000 \div 12\,000$ and fails to finish correctly <i>High Partial Credit</i> • Answer not converted (or incorrectly converted) to minutes
(c) (i) (ii) (iii)	1 2 3 4 or other correct answer $10 \times 10 \times 10 \times 10 = 10\,000$ 2 3 4 6 or other correct answer	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit in one part only. • One part correct. <i>Mid Partial Credit</i> • Two parts correct • One part correct and work of merit in the two other parts. <i>High Partial Credit</i> • Two parts correct and work of merit in the other part.

Q9	Model Solution – 45 Marks	Marking Notes
(a) (i) (ii)	$2 \times 3 = 6 \text{ m}^2$ $R = (1.5 + 0.5) \text{ m} = 2 \text{ m}$ $A = \pi r^2$ $= \pi(2)^2$ $= 12.566 \dots$ $= 12.57 \text{ m}^2$ to 2 decimal places	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit in one part • Correct formula • Radius of pond + path = 2 <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part
(b) (i) (ii)	Total Area = 96 m^2 Area of Shed + Pond and Path $= 6 + 12.57$ $= 18.57 \text{ m}^2$ $96 - 18.57 = 77.43 = 77 \text{ m}^2$ $77 \times 2.4 = 184.8 = 185 \text{ g}$	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit in one part • $6 + 12.57, 96 - 12.57, 2.4 \times 96.$ <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part
(c) (i) (ii)	15 cm Week 1: 17 cm Week 0: 15 cm $17 - 15 = 2 \text{ cm per week}$ Or Similar consecutive point differences	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit in one part • Correct indication on graph in either part but no conclusion <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts • Correct indications on graph but answers not specified <i>High Partial Credit</i> • One part correct and work of merit in the other part

(d)(i)	<table><tr><th>Week</th><th>Maja</th></tr><tr><td>0</td><td>10</td></tr><tr><td>1</td><td>13</td></tr><tr><td>2</td><td>16</td></tr><tr><td>3</td><td>19</td></tr><tr><td>4</td><td>22</td></tr><tr><td>5</td><td>25</td></tr><tr><td>6</td><td>28</td></tr></table>	Week	Maja	0	10	1	13	2	16	3	19	4	22	5	25	6	28	Scale 10C (0, 3, 7, 10) <i>Low Partial Credit</i> - One or two correct entries <i>High Partial Credit</i> 3 or 4 correct entries - Incorrect but consistent entries, for example, 15, 18, 21...
Week	Maja																	
0	10																	
1	13																	
2	16																	
3	19																	
4	22																	
5	25																	
6	28																	
(d)(ii) & (iii) (ii)	Height (cm) Week number Maja's plant Ronan's plant	Scale 5D (0, 2, 3, 4, 5) <i>Low Partial Credit</i> - Work of merit in one part <i>Mid Partial Credit</i> - One part correct - Work of merit in both parts <i>High Partial Credit</i> - One part correct and work of merit in the other part																
(iii)	(5, 25) After 5 weeks both plants are 25 cm tall																	

Q10	Model Solution – 45 Marks	Marking Notes
(a) (i) $4 \times 3 \times 2 = 24$ (ii) $2 \times 3 \times 1 = 6$		Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit in one part <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part
(b) $4 \times 0.2 = \text{€}0.80 \text{ per lunch}$ $500 \div 0.8 = 625$		Scale 5C (0, 2, 3, 5) <i>Low Partial Credit</i> • Work of merit. <i>High Partial Credit</i> • $500 \div 0.8$; fails to finish
(c) (i) $\frac{6}{10}$ (ii) $\frac{5}{9}$		Scale 15D (0, 4, 7, 11, 15) <i>Low Partial Credit</i> • Work of merit in one part <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part • $\frac{4}{10}$ and $\frac{3}{9}$
(d) (i) Two curved ends $\Rightarrow$ half circle $\begin{aligned} \text{Curved perimeter} &= \frac{1}{2}(2\pi r) \\ &= \frac{1}{2}(2\pi(40)) \\ &= 40\pi \end{aligned}$ $\begin{aligned} 140 + 140 + 40\pi &= 405.66 \\ &= 406 \text{ m} \end{aligned}$ (ii) $\begin{aligned} 5000 \div 406 &= 12.315 \\ \therefore 13 \text{ laps} \end{aligned}$		Scale 15D (0, 4, 7, 11, 15) <i>Low Partial Credit</i> • Work of merit in one part • Correct substitution into formula <i>Mid Partial Credit</i> • One part correct • Work of merit in both parts <i>High Partial Credit</i> • One part correct and work of merit in the other part <i>Full credit -1</i> Incorrect or no rounding

Q11	Model Solution – 45 Marks	Marking Notes
(a), (b) & (c) (a) $\frac{200}{2.5} = 80 \text{ km/hour}$ (b) $14:50 - 3:30 - 2:30 = 08:50$ (c) $14:50 - 5:00 = 9:50$ $9:50 + 8:35 = 17:85$ $= 18:25$		Scale 20D (0, 5, 10, 15, 20) <i>Low Partial Credit</i> • Work of merit in one part only. • One part correct. <i>Mid Partial Credit</i> • Two parts correct • One part correct and work of merit in the other two parts. • Work of merit in the three parts <i>High Partial Credit</i> • Two parts correct and work of merit in the other part.
(d)	$500 \div 0.97 = \$515.46$	Scale 5B (0, 2, 5) <i>Partial Credit</i> • $500 \div 0.97$ and fails to finish
(e)	$5000 \times 1.06 = 5300$ $5300 - 2000 = 3300$ $3300 \times 1.06 = \text{€}3498$	Scale 10D (0, 3, 5, 8, 10) <i>Low Partial Credit</i> • Work of merit, for example, finds 6% of 5000 • €5300 <i>Mid Partial Credit</i> • €3300 <i>High Partial Credit</i> • 3300×1.06 and stops • Mishandles or ignores 2000
(f)	$102 \times 450 \times 6535$ $= 299,956,500 \text{ g}$ $= 299,956.5 \text{ kg}$	Scale 10C (0, 3, 7, 10) <i>Low Partial Credit</i> • Multiplies any two correct figures <i>High Partial Credit</i> • Does not convert to kilograms

